EdTech Hub

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EdTech Evidence for Covid-19 Response

Rapid Evidence Reviews of EdTech use in low-income and crisis contexts

Edited by **Katy Jordan and Joel Mitchell**

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EDTECH EVIDENCE FOR COVID-19 RESPONSE

Rapid evidence reviews of EdTech use in low-income and crisis contexts

Editors: Katy Jordan and Joel Mitchell

Contributing authors: Amy Ashlee, Katie Barringer, Giulia Clericetti, Kalifa Damani, Gill Francis, Jessica Gladwell, Louis Major, Nora McIntyre, Rebecca Torrance, Joe Watson, and Daniel Webb

EdTech Hub

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ABOUT THIS BOOK

This eBook is a compilation of articles which were commissioned and published by EdTech Hub, as part of its Covid-19 response.

EdTech Hub

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PART I

INTRODUCTION

INTRODUCTION TO THE COLLECTION

Katy Jordan and Joel Mitchell

The Covid-19 pandemic prompted an unprecedented level of shock and disruption in education systems across the globe. On 11 March 2020, the World Health Organisation formally declared the spread of the virus to have reached a pandemic level (WHO, 2020). School closures were the policy measure most swiftly implemented by governments worldwide in response to the unfolding crisis (Hale et al., 2021). By the end of the month, full school closures were in place in more than 180 countries (Jordan et al., 2020; UNESCO, 2020a).

With in-person schooling suspended due to the risk of spreading the disease, attention quickly turned to how technology might be used to help support the continuation of education. While an 'online pivot' was characteristic of responses in many countries, particularly in high-income contexts (Vegas, 2020), discussion emerged around practical constraints of the use of educational technology (EdTech) in low- and middle-income countries (LMICs) (Jordan, 2020).

In this context, EdTech Hub was well-placed to adapt to the challenges faced by education during the pandemic. EdTech Hub is a global non-profit research partnership, with an overall goal "to empower people by giving them the evidence they need to make decisions about technology in education" in LMICs (EdTech Hub,

2021). Helping to ensure that policymakers receive practical guidance on the effective use of EdTech, supported by rigorous research evidence, is a key part of the Hub's remit. The events of March 2020 both shifted the operating context of EdTech Hub and increased the urgency of its cause.

The rapid evidence review approach

EdTech Hub rapidly responded to the unfolding crisis in education by refocusing part of its activities on Covid-19 responses (EdTech Hub, 2020a). Although the scale of the disruption to education was unprecedented, key questions emerged around how existing evidence and experiences from previous crises and periods of school closure could help to inform an effective response to the pandemic. Policymakers and education practitioners urgently required research-informed and practical guidance on topics of relevance to supporting education during school closures.

The rapid evidence review (RER) format was developed as an effective way to help address this need, and provide evidence-based guidance in a timely way. The RER format draws on guidelines published by the Cochrane Rapid Reviews Methods Group in March 2020, setting out their definition of 'Cochrane Rapid Reviews' (Garritty et al., 2020, p.2).

> "A rapid review is a form of knowledge synthesis that accelerates the process of conducting a traditional systematic review through streamlining or omitting

> specific methods to produce evidence for stakeholders in a resource-efficient manner."

This definition and guidance provided the starting point for the reviews undertaken by EdTech Hub; the methodology will be discussed in further detail in the next chapter.

The RERs produced by EdTech Hub were part of this broader trend in Covid-19 responses from the research community. Relevant evidence reviews undertaken by other organisations include reviews on remote learning (EEF, 2020), mass communication (INEE, 2020), distance education during previous emergencies (Morris & Farrell, 2020), strategies used to mitigate disruption to education during previous disease outbreaks (Hallgarten, 2020a), and accelerated education (Shah & Choo, 2020). However, significant gaps remained in relation to topics within the Hub's particular focus on school-level education in LMICs.

To address this, eight RERs were undertaken by EdTech Hub across a period of six months in mid-2020. These focused on a range of topics that were prominent issues in relation to the continuation of education in LMICs as the Covid-19 educational crisis emerged and developed. The topics were identified in response to key issues being discussed in the wider field as the pandemic unfolded and the extent of disruption to education became apparent.

Initial questions focused on what could be learned from the experiences of previous crises, which were the starting point for reviews on education in emergencies and refugee education. Girls' education was also selected as a focal point, as previous crises — such as

Ebola — suggest that girls are more likely to be subject to a range of risks due to being out of school, and less likely to return. As education systems began to tackle the practical questions of how to reach learners at home, questions of how to use more frequently available and low-tech modalities to support learning, including broadcast media and mobile devices became urgent. This was identified as a particular concern for LMICs, where lower levels of internet connectivity precluded a shift to online learning (Dreesen et al., 2020). Relying on EdTech risked exacerbating inequality and widening digital divides. Two of the topics — personalised learning and accelerated learning — came to the fore as focus began to shift towards the uneven gaps in learning that were emerging, and towards looking ahead to returning to school.

The topics selected for reviews broadly fall within one of three categories, reflecting the need for EdTech use to consider not just technology and modalities, but also pedagogical approaches and context. This volume is structured according to the three categories:

- In **Part 1**, the focus is on different contexts that may have transferable insights for the pandemic context. First, education in emergencies; second, refugee education; and third, girls' education.
- In **Part 2**, the two RERs that addressed different applications of EdTech — personalised learning and accelerated learning — which could be useful to help ensure that learners needs are still met from a distance, or to help ameliorate unequal gaps in learning that have developed as a result of the pandemic.

- Multimodal approaches emerged as a strategy to try to reach as many learners at home as possible (Dreesen et al., 2020) and this is reflected in **Part 3**, which focuses on communication media, including radio, television, and mobile-phone-based messaging.

In keeping with EdTech Hub's goal and scope, two criteria defined the bounds for the literature searches for the evidence reviews. First, the literature discussed EdTech (broadly defined) and focused on school-age learners, teachers, or aspects of the educational system relevant to school-age learners. Note that this specifically excluded studies focusing on Higher Education (HE), unless the focus was teacher professional development (TPD). Second, studies were only included if the focus was on a low- or middle-income country (as defined by the World Bank Atlas Calculation; World Bank, 2020a); studies undertaken in high-income countries were excluded.

Emergent themes

Once the literature associated with each of the RER topics had been identified and screened, the articles selected for inclusion were thematically analysed and the discussion within each RER was structured around the emergent themes. Although the RERs span a wide range of topics, some commonalities can be traced across the themes identified in the set of RERs. In the introductory section of each RER, the findings were concisely summarised in up to four bullet points. In order

to map the common emergent themes in the RERs, the bullet point summaries were extracted, compared, and categorised into overarching themes. These relationships are illustrated in Figure 1.

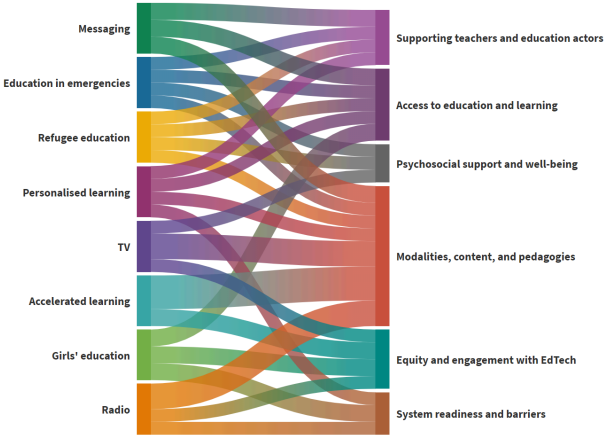

Figure 1: Flow diagram illustrating the links between the RERs (shown to the left) and categories of emergent themes (right).

Four prominent themes were identified through the categorisation shown in Figure 1: Access to education and learning; modalities, content, and pedagogies; supporting teachers and education actors; and equity and engagement with EdTech.

The theme of *access to education and learning* reflects the impetus for undertaking the RERs, and the relevance of the topics concerned, for supporting the continuation of educational provision during the Covid-19 pandemic. Ownership and the cost of hardware — television, radio, mobile devices — is a key consideration, and the reviews highlight that levels vary in different contexts. It is also important to recognise that access to technology is not simply an issue of owning the hardware, but also one of acknowledging local attitudes to technology and its use. The importance of community

participation is particularly highlighted in the RER on education in emergencies.

This theme is also linked to the theme of *equity and engagement with EdTech*, as access to technology — including its mediation by gatekeepers — can risk deepening digital divides. Examples found in the RERs on messaging and girls' education highlight that while technology use can have benefits for girls' education, girls may be less likely to have access to technology. Personalised and accelerated learning approaches can enhance equity, through closing gaps for lower attaining students and for those who have missed out on education to a greater extent through a period of absence.

The most frequently used category in Figure 1 is *modalities, content, and pedagogies*. This reflects the fact that three of the RERs focused explicitly on technology and communication media — radio, television and mobile-phone-based messaging — but in each case, the technology concerned is closely linked to the ways it can be used to support education in practice. For example, the benefits of the practice of co-viewing are highlighted in the RER on television, and the RER on radio discusses how interactive radio instruction (well-established in classroom settings) can be adapted for remote use. In the RER on messaging, examples move beyond using the medium for delivery of content, to more interactive and group-based applications, and formative assessment. In relation to the RERs with a focus on particular emergency educational contexts, the types of pedagogy that can be supported through the use of EdTech — and the importance of considering context — emerged in the RERs on refugee education

and education in emergencies. This theme is also related to the theme of psychosocial support and well-being, which is one of the less prominent themes in Figure 1.

The need for technology to be used to *support teachers and education actors* was clearly conveyed across all the RERs. The RERs on personalised learning and refugee education explicitly flag that the use of EdTech should support or enhance the role of the teacher. In emergencies, informal actors may be well-placed to take on the role of educators, and all are likely to require support in the use of technology in such situations. Technology can also be used to support the needs of teachers during periods of crisis and uncertainty, both in terms of their own professional development needs (which may include the novel use of EdTech), and their psychosocial support and well-being.

Conclusions and future work

While the main purpose of undertaking the RERs was to help inform policymakers and practitioners in relation to immediate Covid-19 responses, the topics addressed by the reviews remain relevant, both for the ongoing pandemic and beyond. Looking ahead, the work of EdTech Hub will address particular evidence gaps and thematic areas (Hennessy et al., 2021).

Building on the RERs, examples of key topics include girls' education, personalised learning, messaging to promote participation, teacher professional development, and the use of data to strengthen education systems. The importance of girls' education as a global challenge and research focus has been

highlighted in the recent Foreign, Commonwealth and Development Office (FCDO) five-year action plan (FCDO, 2021); the RER on girls' education (Chapter 4) provides an invaluable overview of key findings and gaps in the existing research (Webb et al., 2020). The RER on personalised learning (Major & Francis, 2020; Chapter 6) was subsequently developed further with meta-analysis being undertaken (Major et al., 2021). Targeted instruction through low-tech channels continues to be an active area for research, following its application during the pandemic (e.g., Angrist et al., 2020a). Similarly, the pandemic has highlighted the need for messaging to promote participation in education — whether in supporting pupils and caregivers at home or to promote a return to school in due course. On this topic, the RER on messaging apps and SMS (Jordan & Mitchell, 2020; Chapter 10) provides an essential overview of previous work in LMICs on this topic. While the topics of data to strengthen education systems and teacher professional development were not directly addressed through specific RERs, both emerged as cross-cutting themes (Figure 1).

The RERs were published open-access, under Creative Commons 4.0 licenses, to promote accessibility and sharing. Each RER is reproduced as a chapter in this edited volume, which itself will be made available online, in full, through the Pressbooks platform, and simultaneously available for download as a PDF and a range of e-reader formats. In the next chapter, we take a more detailed look at the RER methodology.

THE RAPID EVIDENCE REVIEW METHODOLOGY

Joel Mitchell and Katy Jordan

As mentioned in Chapter 1, EdTech Hub undertook a series of rapid evidence reviews (RERs) in response to the Covid-19 pandemic. The RER format is a pragmatic compromise between the rigour of a systematic review and the speed of response demanded by a crisis situation. The EdTech Hub RER approach drew on the Cochrane Rapid Review guidance (Garritty et al., 2020) — adapting it to be more applicable to education research in the current context of needing to disseminate key lessons from existing evidence to inform policy and practice. In order to do this, the search criteria were focused and queried key databases relevant to education and technology. Strict screening criteria were applied to limit time wasted on marginally relevant literature. In order to equitably represent sources from a broader range of relevant research, the RERs also included intervention-related research and limited emphasis on aggregated findings, meta-analysis, and systematic reviews. This helped to ensure that the reviews included practical findings, with the intended audience being policymakers and individuals involved in educational decision-making across systems.

The research process therefore comprised a systematic sequence of scoping, searching, and screening. In the scoping phase, the research questions and eligibility

criteria were defined and initial searches were conducted to help elicit relevant search terms for the search queries. A focused set of searches was then run within the relevant academic databases. The search results were then screened according to the inclusion criteria and the final set of studies were analysed thematically. While the RERs were completed concurrently by different teams, a consolidated approach to review and quality assurance ensured a consistent approach despite the different themes.

Scoping research

The methodological approach is informed by the Cochrane Collaboration Rapid Reviews Methods Group interim guidance on producing rapid reviews (Garritty et al., 2020). This guidance has subsequently been developed further and published by the group (Garritty et al., 2021). Systematic reviews are often regarded as sitting atop the hierarchy of standards of evidence (Cochrane Collaboration, 2019); Higgins and Green (2011) distinguish a systematic review thus:

> "A systematic review is secondary research that seeks to collate all primary studies that fit prespecified eligibility criteria in order to address a specific research question, aiming to minimise bias by using and documenting explicit, systematic methods."

However, a full systematic review approach is a substantial research undertaking, and RERs are intended to quickly provide an overview of the research landscape around a particular topic of current interest.

The approach is similar to scoping studies, which have characteristics in common with systematic reviews; both involve taking a logical, rigorous approach to searching and synthesis across the research literature (Colquhoun, et al., 2014; Pham, et al., 2014). However, scoping reviews differ from systematic reviews in that the goal is typically to profile the current status of a field and identify gaps rather than evaluate the evidence in relation to a specific, bounded question (Arksey, & O'Malley, 2005). As such, this approach to literature discovery is widely considered as representing a stage prior to a systematic review where the key concepts and ideas that define a field are explored and discovered in an iterative process (Daudt et al., 2013; Levac et al., 2010).

Scoping studies follow a similar protocol and are explicit in documenting the process of literature searching, screening, and the reasons why studies have been selected for inclusion. The scoping process for the RERs began by noting relevant keywords and terms already known to the authors to search for additional literature. The process was iterative, with the terms found in one article leading to searches for other articles that then revealed different or the same terms.

The search terms used for individual RERs are shown in full in the Annex. It is important to draw attention to the point that when a search term identified an article with a relevant title, that article was saved to be screened later alongside others that were found during the main literature search, as explained below.

Literature searches

The literature search began after the search terms had been established at the end of the scoping research. Google Scholar constituted the primary bibliographic database for literature, with additional searches being undertaken using Scopus and EdTech Hub's internal searchable publications database ('SPUD'). Details of the particular databases used can be found in each of the RERs. While Google Scholar proved beneficial in aiding discovery of literature aggregated from many sources, including less established portals and publishers, this also had the side effect of surfacing a number of low-quality papers, despite having relevant titles and abstracts. Therefore, these were only filtered out after the full text had been read.

We would also draw your attention to the other methods that were used to find literature. While the main thrust of the literature review involved a highly systematic approach, we recognised that there might be influential literature that might not be captured through those searches alone. Therefore, for some of the RERs, the authors decided to search the reference lists of the most relevant papers found through the systematic literature review for additional sources (a process known as 'snowball sampling'). Expert recommendations were also used. The database searches were typically supplemented by additional searches of non-academic, informal, and grey literature to identify examples of emerging practice.

It is important to note that the results were not screened and ranked for quality or limited to peer-

reviewed academic publications. Relying solely on peer-reviewed academic articles would have resulted in a narrower review. Crucially, this would also have excluded a larger number of voices from LMICs due to the systemic factors that exclude many academic researchers in LMICs from mainstream peer-reviewed journals (Czerniwicz, 2016).

Screening and eligibility criteria

The title and abstract screening, as well as all other subsequent screenings, were conducted according to predefined eligibility criteria, which are shown in full for each RER in the Annex.

In some cases, where few studies were found, a small, complementary collection of sources that were deemed especially informative but did not meet all criteria, were also included. An exception, for example, might therefore be made if a study explored the use of technology for refugee education but focused on refugee camps in high-income countries.

Following database searches, the literature discovered was then subject to a screening process, similar to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol (Liberati et al., 2009). This comprised the following steps, with the number of records being included and excluded recorded at each step:

- All studies yielded from literature searches are screened according to the inclusion and exclusion criteria at the level of title and abstract.

- Duplicate studies are removed.
- Remaining studies are screened according to the criteria but are now applied at the full document text level.
- Any extra documents that have been uncovered by snowball sampling or through recommendations, which meet the criteria for inclusion, are added.
- The final set of studies then form the sample for thematic analysis.

The inclusion and exclusion criteria applied to each RER, and the number of studies screened, are shown in full in the Annex.

Limitations

While the RER methodology represents a rigorous and transparent approach to reviewing the research literature and is based on elements of systematic reviews, it is also subject to limitations stemming from the rapid timeframe and the nature of available evidence. These include the following.

Limited availability of data

There is an acknowledged and long-standing gap in the evidence base on EdTech and the focal topics. For example, gaps are noted in relation to refugee education and emergency settings, particularly in terms of rigorous evaluations, impact studies, and the perspectives of refugee communities and children (see Chapter 5 for further discussion). There are notable gaps in other

settings, particularly those affected by disasters and epidemics. Furthermore, for several of the topics, it was found that existing evidence tended to focus more frequently on Higher Education (HE) rather than school-age learners and systems, and since HE research was out of scope, there was limited evidence.

The search and inclusion strategy

An inherent limitation of the RER is that the search and inclusion strategy is not, by design, exhaustive, and therefore it is possible that not all relevant literature has been located and included. Further, the searches were conducted in English, meaning that relevant literature in languages other than English that are spoken across many LMICs largely remain unacknowledged.

Quality of the evidence

The evidence identified within the literature across the RERs varies in terms of quality and robustness. While some projects have been well-evaluated and frequently cited across the literature, evidence on others is only briefly referenced or studied as part of a smaller evaluation or research project. Variable quality also prevented rigorous comparative analysis from being drawn and instead reviews tended to be more descriptive in nature. Quality was not assessed as part of the screening criteria, in order to ensure that as wide and inclusive a range of relevant studies were included.

The generalisability of the findings to the context of the Covid-19 pandemic

While the purpose for undertaking the RERs was to be able to inform responses to the Covid-19 pandemic, the existing studies were undertaken in a different context and findings will not necessarily transfer easily to the current crisis.

The positionality of the authors

The scope of EdTech Hub focuses on the use of technology in education in LMICs; however, it must be acknowledged that it is primarily led and funded by organisations based in high-income countries. Although effort is placed into trying to best represent and centre the needs and experiences of children from LMICs, there are limitations in doing so as mainly UK-based researchers.

The evidence landscape

The main purpose of the RERs was to provide evidence-based guidance during the Covid-19 pandemic and the educational disruption this has caused (and continues to cause). Additionally, taken together, the RERs also provide an interesting (albeit incomplete) view across the research literature associated with EdTech in LMICs. Given that 'EdTech' is an umbrella term, and the broad range of countries that are defined as LMICs, it would be extremely difficult to conduct an exhaustive literature

review covering EdTech in LMICs as a whole. In combination, the collection of RERs and the research that they draw upon, provide a partial overview of EdTech in LMICs. Similar search strategies and screening processes were used across the RERs. The number of articles selected for inclusion varied according to topic, from 24 to 95.

In addition to providing an indication of the relative size of literature bases associated with the respective topics and EdTech in LMICs, the collection of articles cited within the RERs can also be explored in terms of how much overlap exists between the topics. Figure 2 shows a citation network, where grey nodes represent articles, and coloured nodes represent RERs. A link between a grey and coloured node represents the articles' citations within an RER. Node size is scaled according to the number of works cited within each RER. A total of 448 unique articles were cited in the RERs (including six frequently-cited methodological articles). The layout of the network in Figure 2 illustrates the extent of overlap between the topics of the eight RERs and highlights how the topics align with each other. The groups that emerged form the basis of the three sections within this volume.

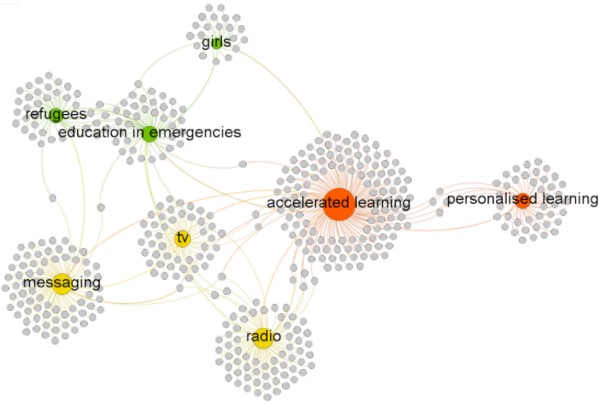

Figure 2: Citation network of literature cited within the RERs.

The articles that form the connections between different RERs would be a valuable starting point for reading lists around EdTech in LMICs. Five of the connected papers relate specifically to EdTech responses to the Covid-19 pandemic (Azevedo et al., 2020; Education Endowment Foundation, 2020; Hallgarten et al., 2020; Vegas, 2020; World Bank, 2020).

The two most closely related RERs are education in emergencies and refugee education, as two closely linked topics, with seven articles in common. The decision was taken early on to separate out these two RERs because initial searches suggested the study would have to cover too much material. A specific concern was that the two studies should distinguish sufficiently between immediate emergency-response interventions, as opposed to protracted disruptions to education. The importance of this distinction has only become clearer as the pandemic has continued to disrupt education. Most of the co-cited articles in the RER on refugees and education in emergencies are reviews themselves, which together would form

essential further reading for the reader interested in these topics (Burde et al., 2015; Carlson, 2013; Gladwell & Tanner, 2014; Lewis & Thacker, 2016; Tauson & Stannard, 2018; Unwin et al., 2017). A further review, by Dahya (2016), spans the topics of education in emergencies, refugee education, and girls' education. A recent study by Almasri et al. (2019) provides a practical example of developing a digital platform to support education for refugees and children affected by the recent crisis in Syria.

As the two reviews concerned primarily with approaches to the use of EdTech, three papers link the RERs on accelerated learning and personalised learning. Examples include the learning gains in mathematics associated with computer-assisted learning interventions in India (Banerjee et al., 2007) and Nigeria (Gambari et al., 2016), while Zaulkerman et al. (2013) draw on the example of using an artificial intelligence tutor in Pakistan, to discuss key considerations for contextualising this type of technology. Menendez et al. (2016) form a connection between accelerated learning and education in emergencies, through their review focusing specifically on accelerated education programmes during crises.

The RER on accelerated learning also shares common ground with one of the technology-focused reviews, specifically radio (Aderinoye et al., 2007; Anzalone & Bosch, 2005; Bosch, 2004; Potter & Naidoo, 2009) and to a lesser extent television (Borzekowski et al., 2019; Moland, 2019). Apart from an older connection related to distance education in low-income contexts more broadly (Perraton, 2005), cited in both the radio and television reviews, there are few citation links between the cluster

of RERs focused on particular technologies. Technologies linked to particular contexts include a link between messaging apps and refugee education, via a study by Dahya et al. (2019) focused on the use of messaging apps to support teachers in refugee camps, and a link between education in emergencies and radio through an example in Sierra Leone (Barnett et al., 2018).

As part of EdTech Hub's commitment to openness and knowledge sharing, the literature cited by each RER has been added to the EdTech Hub Evidence Library, which is an online bibliographic database maintained and curated by EdTech Hub. The Evidence Library can be accessed publicly at: https://docs.edtechhub.org/lib/.

PART II
CONTEXTS

EDUCATION IN EMERGENCIES

Joel Mitchell, Amy Ashlee, Giulia Clericetti, Jessica Gladwell, and Rebecca Torrance

Summary

This rapid evidence review (RER) provides an overview of existing literature on the use of technology for education in emergencies (EiE) in low- and middle-income countries (LMICs). The RER has been produced in response to the novel 2019 coronavirus (Covid-19) and the resulting widespread global shutdown of schools. Established approaches to maintaining continuity of education for the most marginalised have particular salience during this period because of the significant increase in the number of students at risk of disruption. Research consistently shows that while education across

the board is negatively affected by crisis situations, those already facing ongoing crises or disruptions can be disproportionately impacted, or neglected as attention moves on to those affected by new disruptions to their education.

This RER provides a summary of the potential benefits of using technology for EiE as well as its risks, limitations and challenges. The RER aims neither to advocate for nor discourage the use of technology in EiE in response to the present Covid-19 pandemic, but rather to provide an accessible summary of existing evidence on the topic so that educators, policy-makers and donors might make informed decisions about the potential role of technology in delivering education for those facing emergencies. Many of the same constraints and challenges faced in delivering education in emergencies are being faced around the world in response to Covid-19, resulting in greater relevance of learning from EiE to all education systems.

The RER involved a systematic search for academic and grey literature on the use of EdTech in the education of children in emergency contexts in LMICs. After a screening process, 29 papers published since 2009 were analysed. Details on the inclusion criteria, as well as the associated limitations, are explained in the Methodology section. The rapid nature of the review required a focused approach to literature discovery, and a thematically guided process of analysis, so that a timely response to Covid-19 might be provided. The search strategy was, therefore, not designed to be exhaustive.

The thematic analysis of the relevant literature on technology for EiE led to the identification of four core themes:

1. **Facilitating access to education and learning:** This section presents findings on the use of technology to enable access to education and learning during and after an emergency.
2. **Educational content and pedagogy:** This section discusses the importance of quality and contextualised educational content, and examines EdTech-related pedagogical approaches.
3. **Supporting education actors:** This section examines how EdTech is used to support the range of education actors responding in emergency contexts.
4. **Protection and psychosocial well-being:** This section examines the use of EdTech to protect vulnerable children from risks in emergency, and to support children's psychosocial well-being.

The key findings from this review are as follows:

- EdTech has the potential to help children continue to access education during periods of disruption and school closures caused by emergencies. Radio and tablets have demonstrated promise in filling in educational gaps in previous emergencies, including in conflict and post-conflict settings and the Ebola epidemic.
- Leveraging technology to convey key messages to families and communities, as well as to children themselves, can play a critical role supporting children's transitions back to school in post-crisis contexts. Limited evidence from the Ebola epidemic highlights the particular role of radio in this.
- Community participation is important for

contextualised interventions. In times of conflict, conflict-sensitive and culturally appropriate EdTech is particularly critical in ensuring education supports peacebuilding, rather than exacerbating conflict.

- Blended approaches, promoting interactions and connections with teachers and peers, and self-directed approaches, allowing greater autonomy and pacing, each have the potential to promote positive learning outcomes for children in emergencies. To successfully facilitate these approaches, teachers must be willing and able to navigate and use EdTech effectively, and without the adaptation to new technologies leading to additional stress during crisis periods.
- There are positive examples of initiatives supporting teachers and educators with their continuous development and teaching, although these are mostly limited to protracted and post-conflict settings. There is very limited evidence on the transferability of such projects to acute conflict, epidemic or disaster settings.
- Technology has been widely used to support the coordination and effectiveness of EiE responses. The use of technology to support data collection is particularly significant in this context. Digital data collection can be important in informing institutional-level monitoring of students' and schools' performances, as well as shaping wider educational policy planning and identifying critical education needs during emergencies. Data protection and safeguarding must be held at the fore when considering the expansion of EdTech in

emergencies.

- The selected literature demonstrates the ways in which technology can support the protection of children from risks resulting from an emergency. These include: warning teachers and students of risks around schools in conflict; mitigating against negative coping strategies imposed when children are out of school; and supporting children's learning about disaster risks in areas vulnerable to natural disasters and, thus, their disaster preparedness.
- EdTech has the potential to directly support children's psychosocial well-being, and there are notable examples of projects that embed well-being outcomes into project design. EdTech can also indirectly support well-being, with some evidence that engaging with EdTech during emergencies can have positive results, particularly if it allows children to remain connected with their peers and teachers when schools close, and enhances their self-esteem and confidence.

The review also identifies the barriers to implementing EdTech interventions in a context of disrupted education which is partly similar to the current Covid-19 scenario. Where possible, enabling environmental factors are highlighted that may be drivers of positive learning engagement. The review does not specifically encompass refugee education. This is the focus of a separate RER in this series (see Ashlee, et al., 2020), which can be read alongside this review.

1. Introduction

The Covid-19 pandemic has resulted in widespread and unprecedented global disruption to education (see http://en.unesco.org/covid19/educationresponse). Physical distancing policies to suppress the spread of Covid-19, which often advise that students and teachers cannot congregate in schools in the conventional manner, has led to a global expansion of the use of technology within education.

This RER provides a summary of the potential benefits of using technology for EiE as well as its risks, limitations and challenges. Many of the same constraints and challenges faced in delivering EiE are being faced around the world in response to Covid-19, resulting in greater relevance of learning from EiE to all education systems. This RER, therefore, offers insight and evidence that can assist in the development and implementation of effective EdTech interventions across the globe and in emergency contexts within the current global global pandemic.

1.1 Background

1.1.1. The importance of education in emergencies

There is widespread recognition that education is an essential component of effective emergency response. For children in emergency situations, education provides “physical, psychosocial and cognitive protection that can sustain and save lives” (INEE, 2012, p.2). In addition, EiE

can play a critical role in supporting other life-saving sectors during emergencies, including shelter, WASH and health (INEE, 2012), contributing to peacebuilding (Bush & Saltarelli, 2000; Pherali, et al., 2016), nurturing resilience and creating a foundation for employment and economic growth (INEE, 2012). It is important to recognise that education can, conversely, act as a perpetrator or exacerbator of conflict (Pherali, et al., 2016). Crucially, education is also considered a key priority by children living in emergency and conflict contexts (Gladwell & Tanner, 2014).

UNICEF (2018, p.5) estimates that, pre-Covid-19, nearly one in three of all out-of-school children aged between five and 17 years old lived in emergency-affected countries – approximately 104 million children. Educational provision is often significantly disrupted in emergency situations (INEE, 2012) as emergencies can weaken or break down national education systems and state services, damage or destroy schools, lead to school closures, and result in shortfalls in qualified teachers (Nicolai & Hine, 2015). Technology has increasingly been used in educational responses in emergency settings, in part because of the increasing role of the private sector in humanitarian responses (Tauson & Stannard, 2018). Beyond the scope of this RER, there are important issues to consider regarding the potential implications of private sector engagement with EdTech in EiE settings (see, for example, Novelli, 2016).

1.1.2. Categories of emergencies examined

An emergency is defined by the INEE Minimum Standards (INEE, 2012) as "a situation where a

community has been disrupted and has yet to return to stability". A focus on EiE encompasses a cycle of preparedness for, response to and recovery from an emergency (Winthrop, 2020; INEE, 2012). For the purposes of this RER, the term emergency is used to encompass situations of conflict, epidemics and natural disasters. This review examines the use of EdTech across three different categories of emergencies:

- **Conflict settings:** Conflict and violence can disrupt the delivery of education services and cause destruction or damage to education infrastructure in the short- and long-term (Baytiyeh, 2019; Alfarah & Bosco, 2016). Safety risks for students and teachers are a particular concern in armed conflict settings: schools, students, teachers and other education personnel can become the targets of attacks, violence and kidnapping (GCPEA, 2020; Baytiyeh, 2019; Almasri, et al., 2019).
- **Epidemics:** During epidemics, extended school closures are widespread. Whilst this is often a necessary step to mitigate the risk of disease or virus spread, extending school closures can lead to children dropping out of school entirely and poor educational attainment and outcomes (Baytiyeh, 2019; Hallgarten, 2020a).
- **Natural disasters:** Natural disasters can have significant impacts on education systems, causing rapid school closures. School buildings can be particularly vulnerable in the face of earthquakes, hurricanes and floods, and the lack of risk mitigation measures can have severe consequences for schools and the delivery of education (Baytiyeh, 2019).

It is important to note, however, that many emergency contexts have intersecting risks and vulnerabilities, and span more than one category of emergency. For example, Dahya (2016, p.10) highlighted how civil war had already "depleted" the education system in Sierra Leone leading up to the Ebola crisis. Similarly, after the onset of the conflict and civil war in South Sudan in 2013, the country has also experienced a severe cholera outbreak and malaria epidemic (UNICEF, 2019).

Refugee crises are often examined as a category of EiE. Another RER in this series focuses exclusively on the use of technology to support the education of refugees in LMICs (see Ashlee, et al., 2020). There is a degree of overlap between the two RERs because much of the literature on EiE includes refugee contexts. Thus, this RER focuses specifically on challenges facing the education of children who have lived in emergency and crisis contexts in their countries of origin, rather than those who have been forcibly displaced by them.

1.2. Purpose

Lessons learnt from the use of technology for EiE are salient in the current global context. There are, to an extent, similarities that can be observed between the widespread disruption caused to education resulting from the Covid-19 crisis and the disruption resulting from other emergencies – including armed conflict, natural hazards and epidemics. In a wide range of emergency settings, schools and non-formal education programmes may close and there may be gaps in learning that contribute to educational inequities, delay

educational progress, and threaten children's safety (Morris & Farrell, 2020).

This RER, alongside others, contributes to an emerging evidence base on the use of technology for education during the Covid-19 pandemic. It organises the most relevant literature into coherent themes for the consideration of key stakeholders.

1.3. Application

The RER aims neither to advocate for nor discourage the use of technology in EiE in response to the present Covid-19 pandemic. Rather, it aims to provide an accessible summary of existing evidence on the topic so that educators, policy-makers and donors might make informed decisions about the potential role of technology in delivering education for those facing emergencies.

The insights presented in this RER are expected to be viewed as principles for the planning and implementation process of technology for the education of children living in emergency settings. The expectation is that readers will take their own expertise from their local context to apply the findings of the review. Patterns of good practice have emerged from the evidence on how, when and why technology can be used for EiE, and it can be reasonably expected that many of the insights are applicable in the context of widespread educational disruption caused by the Covid-19. The evidence can also inform how EiE interventions in LMICs can be adapted during this time.

1.4. Research questions

Two research questions guide the study:

1. What are the key emergent themes in the available literature on the use of technology for EiE in LMICs?
2. What are the key findings that can be drawn from the available literature to inform effective responses to the Covid-19 pandemic?

1.5. Theme identification

After conducting a scoping review to compile a list of relevant keywords, a systematic search was conducted for evidence on EiE. More detail on that process, including the inclusion and exclusion criteria, can be found in the Methodology section that follows. After screening was completed, 29 papers were selected for analysis. A thematic analysis of these papers led to classification into four themes, all of which have sub-themes, which are discussed in more depth in the Findings section.

- **Facilitating access to education and learning:** This section presents findings on the use of technology to enable access to education and learning during and after an emergency.
- **Educational content and pedagogy:** This section discusses the importance of quality and contextualised educational content, and examines EdTech-related pedagogical approaches.
- **Supporting education actors: T**his section

examines how EdTech is used to support the range of education actors responding in emergency contexts.

- **Protection and psychosocial well-being:** This section examines the use of EdTech to protect vulnerable children from risks in emergency, and to support children's psychosocial well-being.

1.6. Structure of the RER

Following this introduction, the methodological approach is discussed, including details of the scoping review, the literature search, eligibility criteria and possible limitations of the methodology. Detailed findings are then presented under the four themes that emerged from a thematic analysis of identified literature. This report concludes by providing a synthesis of the findings from the literature.

2. Methodology

The methodological approach is informed by the Cochrane Collaboration Rapid Reviews Methods Group interim guidance on producing rapid reviews (Garritty, et al., 2020). This permits a rigorous and systematic approach, while defining the scope narrowly enough that it can be completed within a short span of time.

While the intention was to model this RER on a systematic, thematic review of primary studies, it quickly became apparent that there are significant evidence gaps on the use of technology for EiE, particularly in

terms of rigorous, quality evaluations or impact studies (see, for example, Tauson & Stannard, 2018). Consequently, a decision was made to include reviews of other literature or systematic reviews.

The research process comprised a systematic sequence of scoping, searching and screening. First, in the scoping phase, the research questions and eligibility criteria were defined and a brief scoping review was conducted to help elicit relevant search terms for the search queries. Then a focused set of searches was run, alongside a snowball sampling approach to searching, the results of which were then screened according to the inclusion criteria (see Annex).

2.1. Scoping review

Unlike systematic reviews, the criteria for scoping reviews are not yet well-defined. However, these reviews are widely considered as representing a stage prior to a systematic review where the key concepts and ideas that define a field are explored and discovered in an iterative process (Daudt, et al., 2013; Levac, et al., 2010). Notably, the scoping review of this study did not aim to map out all the concepts, theoretical and otherwise, included in the scope of technology and EiE. Instead, it had a more pointed focus: to identify keywords and terms that had been used in studies that discuss the use of technology in EiE responses.

The scoping review process began by noting relevant keywords and terms that were already known to the authors to search for additional literature. The process was iterative, with the terms found in one article leading

to searches for other articles that then revealed different, or the same, terms. Using this method, a list of over 30 search strings was compiled (for search terms used, see Annex). It is important to note that when a search term brought up an article with a relevant title, those articles were saved to be screened later alongside those that were found during the main literature search that is explained below.

2.2. Literature search

The literature search began after establishing the search terms at the end of the scoping review. Google Scholar constituted the primary source of literature, with a small number of unique search results returned from the EdTech Hub SPUD database and Scopus, confirming that search results had not been missed through this approach. The process used to arrive at the articles that were ultimately thematically analysed in this review is shown in the Annex.

Differing from other RERs in this series, this RER adopted a targeted approach after initial searches returned very few relevant results. Searches by countries impacted by conflict, epidemics and natural disasters or names of specific emergencies were also conducted. Additionally, a snowball sampling approach was also used to identify relevant literature. While the main thrust of the literature review involved a systematic approach, it was recognised that there might be influential literature that might not be captured through those searches alone. The decision was therefore made to search the reference lists of the most relevant papers found

through the systematic literature review, for additional literature, and to explore programmes and literature recommended by expert reviewers.

It is important to highlight that unlike a conventional systematic review process, which may screen all search results, the rapid review methodology used herein relied on a system of quotas. As such, only the top most relevant results (up to a maximum of the top 500 results), as ranked by Google Scholar, were selected for the first round of screening. In addition, the results were not screened and ranked for quality or limited to peer-reviewed/academic publications. Relying solely on peer-reviewed academic articles would have resulted in a narrower, less generalisable review. This would also have excluded a larger number of voices from LMICs due to systemic factors excluding many academic researchers in LMICs from mainstream peer-reviewed journals.

2.3. Screening and eligibility criteria

The title and abstract screening, as well as all other subsequent screenings, were conducted according to the eligibility criteria laid out in the Annex. A total of 73 articles were initially captured for further screening which resulted in 29 papers being selected for analysis. It should be emphasised though that the screening criteria was not absolute. For example, when search terms returned a large number of studies, the date parameters were re-adjusted to return only literature from 2009 onwards.

Moreover, while the majority of selected literature met the eligibility criteria, a small, complementary collection

of literature that was deemed especially informative, but did not meet all criteria, was referenced. However, these exceptions were only made when an article met all except one of the eligibility criteria. For example, a study that focused on LMICs in general, rather than solely on emergency settings, may have been included if one of the countries studied or referenced could be categorised as an 'emergency context' (see, for example, Moon, et al., 2016 and Unwin, et al., 2017).

One limitation of relying on Google Scholar as the primary source of literature was the number of low quality papers collected, and the level of duplication in search results returned. Many of these were eliminated in the initial stages based on duplicate content, and lack of relevance. As a result the search and screening process reflects an unusually high number of irrelevant and duplicate results at the initial stages.

2.4. Limitations

There are several limitations to this review, stemming from the rapid timeframe and the nature of available evidence. These are:

- **Limited availability of evidence:** There is an acknowledged gap in the evidence base on EdTech in emergency settings, particularly in terms of rigorous evaluations, impact studies and the perspectives of children and their communities (Tauson & Stannard, 2018; Lewis & Thacker, 2016; Dahya, 2016). While the literature reviewed for this report references a range of projects and

programmes, there is limited evidence on their effectiveness, impact or other learnings from their implementation.

- **Quality of the evidence:** The evidence identified within the literature varies in terms of quality and robustness. While some projects have been well-evaluated and frequently cited across the literature, evidence on others is only briefly referenced or studied as part of a smaller evaluation or research project.

- **Weighting of evidence to conflict settings:** The majority of evidence on the use of technology in education is centred around conflict and post-conflict settings (Dahya, 2016; Hallgarten, et al., 2020). There are notable gaps in other settings, particularly those affected by disasters and epidemics.

3. Systematic review and thematic analysis

This section presents findings from thematic analysis of available evidence in the literature selected. Four key themes emerged:

- *facilitating access to education and learning*
- *educational content and pedagogy*
- *supporting educators*
- *protection and well-being.*

3.1. Facilitating access to education and learning

A significant theme that emerged from the literature is the use of technology to facilitate access to education and learning during and after emergencies. The ability of technology to help overcome safety and security risks and reach marginalised children is highlighted (Barry & Newby, 2012), as is its potential for providing access to education when institutional capacity is weakened by, or recovering from, an emergency (War Child Holland, et al., 2016; Alfarah and Bosco, 2016).

3.1.1. Continuing education during periods of disruption

Analysis of the literature supports the finding of a landscape review of EdTech in crisis and conflict settings (Dahya, 2016), that the majority of EdTech initiatives focus on longer-term educational goals and are implemented in post-crisis settings. Some literature, however, highlights the way in which technology can help children to continue their learning in the midst of an emergency, helping to "fill-in the gaps during disruption" (Tauson & Stannard, 2018, p.37). The literature focuses on children's learning when they are out of the classroom, unable to attend because of the risks resulting from the emergency. Note that there is more literature on the use of technology to support learning within educational environments (schools or education centres) in refugee and displacement contexts; see Ashlee et al. (2020), pp. 12-13.

3.1.2. Leveraging radio

The use of radio to provide educational access at a distance, particularly during conflict, is particularly prominent in the literature. But while many examples of programmes are referenced, there is limited evidence on their effectiveness or impact. One noteworthy exception is the Somali Interactive Radio Instruction Programme (SIRIP). SIRIP was implemented between 2005 and 2011 in Somalia, during a protracted, complex crisis marked by civil war and drought which, as described by Carlson (2013, p.23), created a "perfect storm" for education. SIRIP leveraged radio technology to provide children with access to education otherwise not available through traditional education methods (Burde, et al., 2015; Dahya, 2016; Carlson, 2013). This educational access was provided in formal and non-formal education spaces and home environments.

Several studies assessed SIRIP as effective. Carlson (2013, p.23) highlighted the successful choice of radio technology given the "security situation, available internet connectivity, unreliable electricity supply, limited local expertise to develop contextually relevant videos, weak institutional capacity and other factors". A quasi-experimental study of SIRIP found that children in the project achieved higher scores in literacy and maths tests than non-SIRIP students (cited by Burde, et al., 2015), and enrolment in schools also increased (cited by Dahya, 2016).

In addition to the use of radio in conflict settings, there is evidence on its use during the Ebola outbreak of 2014-2015 – the only epidemic context identified by this review with evidence on EdTech initiatives. According

to UNICEF (cited in Hallgarten, 2020a, p.7), one million children were reached through radio education during the Ebola outbreak across all West African countries responding to the epidemic. There is some evidence on the effectiveness of such radio programmes in Sierra Leone. The Emergency Radio Education Programme, commissioned by the Ministry of Education, Science and Technology, provided education on core academic subjects for children across a range of age groups. A qualitative evaluation report cited by Hallgarten (2020a) found that the programme helped to sustain a connection to education during a time of severe disruption. However, the evaluation report also found that the programme did not adequately compensate for the loss of access to schools and teachers (cited by Hallgarten, 2020a).

It is worth noting that while radio was used to broadcast education programmes in two other countries during the Ebola outbreak, Guinea and Liberia (Hallgarten, 2020a), this review did not identify any evidence on their impact (Damani & Mitchell, 2020).

3.1.3. Leveraging other forms of technology

Other forms of technology, including mobiles, TVs, tablets, laptops and computers, are not as common as radio during emergencies. When reviewing the strengths and weaknesses of different forms of technology in conflict and crisis in 2013, Carlson (2013, p.17) concluded that there was no large-scale implementation of mobile-based EdTech, leaving the concept largely "unproven". While Carlson (2013)

continued to discuss the use of computers in crisis settings, the examples provided were limited to refugee camps. A paper by Rush et al. (2014) supported this, finding no available evidence to suggest progress is being made towards implementing an 'emergency online school' system in marginalised and extremely poor communities prone to natural disasters.

More recent literature has referenced a range of EdTech initiatives leveraging technology other than radio during emergencies (see, for example, Dahya, 2016 and Morris & Farrell, 2020). However, the evidence on these initiatives is largely limited to how they are implemented, with little insight into their success, impact or effectiveness. For example, while Carlson (2013) identified Ustad Mobile as leveraging mobile technology to enable students to engage with learning in a fragile context, the author noted that there was no available evidence on student learning.

Some exceptions emerged, and there is evidence available from evaluations of two tablet-based EdTech initiatives: the Rumie Tablet and eLearning Sudan (ELS). The Rumie Tablet – a low-cost tablet with preloaded digital educational content for students in severely under-resourced areas – was used during the Ebola outbreak to encourage children's engagement in education when confined to their homes (Hallgarten, 2020a; Moon, et al., 2016). First trialled with refugee children from Syria, the Rumie Tablet was adapted for use in other contexts, including in Liberia to provide educational access during the Ebola outbreak. A small, mixed-methods evaluation of the Rumie Tablet showed positive results in terms of increased participation of children and their parents in education, with no

significant differences in results between Liberia and other participating countries (Moon, et al., 2016).

ELS used tablets to provide basic education in Sudan during a protracted crisis where "formally trained teachers or schools [were] not present" (War Child Holland, et al., 2016, p.15). ELS comprised a serious educational game version of the out-of-school maths curriculum. Note that War Child Holland et al. (2016, p.17) define a serious game as "the result of collaborative efforts by experts in game design, pedagogy, and learning design to develop a game to achieve explicit learning outcomes that are measurable". An evaluation of the programme, which collected data from over 600 children, found that ELS was an effective learning approach for disadvantaged children in Sudan (War Child Holland, et al., 2016). The evaluation concluded that "compared to traditional education approaches in Sudan and selected countries, ELS is more effective for learning outcomes than traditional education, when measured using EGMA as the standardised assessment" (War Child Holland, et al., 2016, p.57).

3.1.4. Encouraging children's return to school

In their literature review on EdTech in crisis and displacement contexts, Tauson and Stannard (2018, p.37) identified a role for technology in "increasing the speed with which learners can return to full time education". However, this RER has not identified any evidence on the use of technology in alternative learning programmes in emergency contexts. A forthcoming, separate RER focuses on alternative learning programmes (Damani,

2020b). More broadly, there is limited evidence on the use of technology to encourage children's return to school.

However, evidence emerged from a well-evaluated project which used radio to support children's learning in the aftermath of the Ebola outbreak once schools had reopened in Sierra Leone: Pikin to Pikin Tok (Barnett, et al., 2018; Dyson & Amara, 2017; Walker, et al., 2015). Pikin to Pikin was a local NGO that, in partnership with the UK-based NGO Child to Child, was already running the project "Increasing Access, Retention, and Performance in Primary Education" in the Kailahun District. This programme launched in 2011 and was operational across twenty-one schools. When the Ebola outbreak occurred and schools closed between July 2014 and April 2015, the programme could no longer continue in its current form. In response the NGOs reconfigured their programme (Dyson & Amara, 2017, p.v). Alongside educational content for children delivered through radio, parents were targeted with "messages about… the importance of ECE [Early Childhood Education] for young children and continuing education for older children" (Dyson & Amara, 2017, p.4). The programme had three main content strands, each with different target audiences: numeracy and literacy skills; health and hygiene measures; and the social problems that were arising because of Ebola (Barnett, et al., 2018). In short, Pikin to Pikin Tok sought to supplement and highlight the importance of children re-accessing the existing school system, rather than seeking to provide a full curriculum.

An endline evaluation of the project written by the Institute for Development (IfD) (Dyson & Amara, 2017) found that the project was largely successful in

encouraging re-enrolment in education. The evaluation argued that among the most significant achievements of the project was its increased enrolment in and preparedness for school within the project's Young Learner's category, as well as a greater self-confidence among 'Young Facilitators', which was measured in terms of active participation in both their school and community (Dyson & Amara, 2017). Increased parental support for and involvement in children's education was also reported (Dyson & Amara, 2017). Overall, the IfD report argued that, in some situations, the use of radio increased participation of children in education after the epidemic more than before: there were found "examples of children who had never been enrolled in school, became enrolled in the listening groups, and... going to school post-EVD" (Dyson & Amara, 2017, p.27).

3.2. Addressing educational inequalities

3.2.1. The importance of equitable access to EdTech

Educational inequalities and divides can be exacerbated by emergencies (Dahya, 2016). They can also be exacerbated by the use of technology, which is often out of reach for marginalised children (Morris & Farrell, 2020). Combined, the use of technology to facilitate education in emergency settings risks further marginalising or entrenching pre-existing educational inequalities, rendering a critical need to specifically plan for equitable

access to education at each stage of an EdTech tool's development (Morris & Farrell, 2020).

Ensuring that EdTech programmes do not exacerbate educational inequalities is particularly critical in times of conflict. Evidence from UNICEF's Peacebuilding, Education and Advocacy in Conflict-Affected Contexts (PBEA) programme revealed how educational inequalities can be a root cause of conflict: in nine out of 14 PBEA programme, the root cause of conflict was noted as "unequal access to and/or quality of social services, including education, between regions and/or urban-rural communities as well as along ethnic/religious lines" (Shah, et al., 2016, p.46). However, Dahya (2016) argued that there is more work needed to understand how technology can be used with specific aim of promoting access to education for marginalised groups in emergencies. Note that the 4R framework may be a useful way to address this, by thinking through: redistribution, recognition, representation and reconciliation; for more information, see http://sro.sussex.ac.uk/id/eprint/69179/1/__smbhome.uscs.susx.ac.uk_dm50_Desktop_JEiE_V3_N1__4Rs_Framework-4.pdf .

3.2.2. Gender inequality

While this RER did not identify any literature that examined the use of EdTech initiatives to support access to education for children with disabilities within EiE, there is some evidence on girls' access to EdTech programmes within EiE. More detailed information on gender and EdTech can be found in the RER on girls' education and EdTech (Webb, et al., 2020). A UN Girls'

Education Initiative case study on the Pikin to Pikin Tok radio programme in Sierra Leone (Walker, et al., 2015) reported that radio contributed to balancing out gender inequalities in educational access, stating that "girls of all ages were able to participate and communicate on an equal footing with boys and they sometimes outperformed boys in their levels of confidence and in providing examples of applying knowledge", which was in "contrast to the general positioning of girls in the community" (Walker, et al., 2015, p.7). Similarly, an evaluation of ELS found that the serious mathematical game was "gender neutral"; that is, it "promotes a more gender balanced learning experience, which stimulates and retains boys and girls equally" War Child Holland, et al., 2016, p.57).

However, there is contrasting evidence from the Pikin to Pikin Tok programme. Walker et al. (2015) found that, as a result of increased demands within the household economy, some children were unable to access formal and informal listening groups for radio education programmes – and that this predominantly affected girls. This reinforces the view of Tauson and Stannard (2018) that girls in emergencies are often unable to access technology on an equal footing to boys; the authors further stated that gender barriers should be considered before implementing EdTech initiatives that "may exacerbate inequality in society" (Tauson & Stannard, 2018, p.98).

3.3. Cost and sustainability considerations

3.3.1. Cost and cost-effectiveness

In order for EdTech interventions to enable continued access in a crisis context it is necessary that they are sustainable in the long-term. The literature reviewed suggests that, in some crisis contexts, EdTech can be cost-effective, particularly when leveraging technology already in place (Tauson & Stannard, 2018; Carlson, 2013). However, the prohibitive costs of EdTech interventions are emphasised, including the cost to provide hard-ware, particularly computers (Carlson, 2013), and the cost of replacing or repairing lost or broken equipment (Tauson & Stannard, 2018).

Dahya (2016) highlighted how the immediacy and unexpected onset of some emergencies can result in short-term and unpredictable forms of funding which are inadequate for implementing long-term EdTech initiatives. She further argued that there is an "expansive gap" between available and needed funding (Dahya, 2016, p.29).

3.3.2 Responding to available infrastructure

Responding to the infrastructure already in place during emergencies is key to the sustainability of an intervention. Access to education through EdTech can be undermined by disrupted or destroyed infrastructure required to support the use of technology, sometimes

rendering its use for reaching marginalised children particularly challenging (Tauson & Stannard, 2018; Barry & Newby, 2012; Dahya, 2016). Some literature reported successful attempts to navigate this challenge, such as through the use of solar power and offline access to educational content (Barry & Newby, 2012). Barry and Newby (2012) highlighted the importance of the choice of EdTech tool being informed by the infrastructure in place in order to deliver education to hard-to-reach children (Barry & Newby, 2012).

A key consideration emphasised by Hallgarten et al. (2020) is that the available infrastructure documented in an emergency is likely to differ from the reality. It is, therefore, important that EdTech initiatives are based on actual existing conditions, rather than simply on the formal documentation of those conditions.

3.3.3 The importance adequately resourcing education

It is important that the education provided or encouraged by EdTech is adequately resourced. One learning from the implementation of the Pikin to Pikin Tok programme was that any "project that increases 'demand' for education services should simultaneously work with the education system to proportionally increase 'supply'" (Dyson & Amara, 2017, p.viii). Although the radio programme led to an increase in children seeking to enrol in school, the project had not sought to "train more teachers, build classrooms, provide teaching materials, ensure school feeding programmes quantify sufficient food supplies, etc." which meant that the

demand for more school places could not be met (Dyson & Amara, 2017, p.viii).

3.4. Educational content and pedagogy

Another prominent theme that emerged from this review centres on EdTech-related educational content and pedagogical considerations.

3.4.1. Continuity and contextualisation of education facilitated by EdTech

The importance of educational continuity during periods of disruption caused by emergencies is highlighted by the literature. The emphasis was not just in keeping children in education, but also in maintaining the learner identity through other disruptions to identity (Tauson & Stannard, 2018). In stating that "no distance learning modality is ideal for teaching all skills to all learners in all contexts" (Morris & Farrell, 2020, p.vii), Morris and Farrell reinforced the importance of tailoring and adapting EdTech initiatives to the context and culture in which they are being implemented, as emphasised by Tauson and Stannard (2018) and Dahya (2016).

3.4.2. Curricula

Curricula emerged as a key consideration throughout the review. Tauson and Stannard (2018) and Dahya (2016) both emphasised the importance of the curriculum being aligned and relevant to local context if children are

to fully engage and progress in their education during periods of disruption caused by emergencies. A successful example of this is ELS, which was aligned to the official curriculum for 'out-of-school' children in Sudan for Grades 1, 2 and 3 and led to official certification (War Child Holland, et al., 2016).

However, despite the emergence of a number of nascent partnerships between national ministries of education and television and radio stations (Trucano, 2020), evidence on how EdTech can support learning outcomes linked to formal curricula in crisis contexts remains limited (Tauson & Stannard, 2018). Additionally, Dahya (2016) found that some initiatives implemented as part of a rapid response to an emergency fail to integrate into certified and accredited school programmes and education trajectories, negatively impacting on continuity.

3.4.3. Language

Another aspect critical to enabling continuity and meaningful participation is the language of instruction. Carlson (2013) suggested that one of the reasons that a radio programme implemented in South Sudan between 2004 and 2012, which focused on teaching English to children, did not meet its objectives was that the content was only available in English; the author noted that teachers' low level of English made it difficult for many to translate the radio content.

Language issues also emerged as a challenge with the Pikin to Pikin Tok radio initiative. The broadcasts were multilingual which proved to be a significant initial barrier for the listening groups where these were not

implemented properly – particularly the informal groups which were not facilitated and, therefore, had no one to help the children "understand and internalize the messages from the broadcasts" (Walker, et al., 2015, p.7).

3.5. Community participation in the design of EdTech initiatives

3.5.1. The importance of involving local actors

The literature emphasises the importance of involving the community and education stakeholders in the development of EdTech initiatives in emergencies (Tauson & Stannard, 2018; Dahya, 2016; Burde, et al., 2015; Barry & Newby, 2012; War Child Holland, et al., 2016). Barry and Newby (2012) argued that while it may be time-consuming in the short-term, meaningful community participation yields more sustainable and cost-effective results in the longer-term (Barry & Newby, 2012).

The involvement of and partnership with local actors was referenced as key to the success of the Pikin to Pikin Tok radio initiative in Sierra Leone (Hallgarten, 2020a; Barnett, et al., 2018). The investment in local organisations who had already collaborated with relevant governmental bodies and community representatives, including women's leaders, religious leaders and community leaders, meant that there was pre-existing community buy-in which was transferred to the Pikin to Pikin Tok (Barnett, et al., 2018).

Another success factor of the Pikin to Pikin Tok initiative was the recruitment and mobilisation of more

than 250 facilitators, many of whom were local, to coordinate listening groups for the children. These facilitators, who were often respected members of the community, were "vital in developing and maintaining both the attendance and learning of child participants" (Walker, et al., 2015, p.9). Pikin to Pikin Tok also maintained a commitment to high levels of child and youth participation, and recruited thirty-six voluntary "young journalists" who they trained to capture audio content on subjects that were affecting them because of the Ebola crisis to include in the programming. As Barnett et al. (2018) reflected, "these children, undoubtedly among the most vulnerable in the world, were not simply beneficiaries of the project but actively participated in creating the programmes." Discussion of this project in the context of other radio programmes can be found in the EdTech Hub rapid evidence review on radio (Damani and Mitchell, 2020).

3.5.2. Conflict-sensitive EdTech content

That community participation in education is key for sustainable peace in conflict settings has long been recognised (Lederach, 1997). However, given the recognition that education can also exacerbate conflict (Bird, 2009), the importance of culturally- and conflict-sensitive EdTech content is of central importance (Dahya, 2016). According to Dahya (2016, p.27), the risk in using standardised content within digital tools is that this content, often created in high-income contexts, "may be laden with particular values, beliefs, or incomplete historical representations of both local and global issues". Moreover, the author stressed that the

distribution of the content must be carefully managed: "pre-recorded content [that is] available to and shared across personal devices, like mobile phones, can have a reach beyond the individuals enrolled in the program for which it was intended" (Dahya, 2016, p.27). While this is not necessarily harmful, sensitive content – ranging from portrayals of historical or political events, to information about gender-based violence – "should be assessed for potential to be misunderstood if digital content is distributed outside its intended form" (Dahya, 2016, p.27).

Potential unintended impacts of community participation should also be considered, as part of a wider recognition that education has the potential to exacerbate conflict. Only one paper (Burde, et al., 2015) engaged with this issue. The author underlined the positive impact of community involvement, yet warned community participation can sometimes have "unintended effects on resolving or exacerbating social and political tensions" (Burde, et al., 2015, p.32).

3.6. Pedagogical considerations

3.6.1. Blended learning

Mirroring evidence on EdTech more broadly, the literature on EdTech in EiE points toward the importance of a focus on pedagogy and modalities over the type of tool used (Kumar, et al., 2017; Moon, et al., 2016). Maintaining connections between students and educators, even in virtual environments, is also key (Dahya, 2016; Tauson & Stannard, 2018). A core finding from the evaluation of the Rumie tablet was that:

> "It is not simply enough to provide hardware (tablets) and software (educational materials and games) to ensure the success of projects. Provision of such tablets needs to be integrated with existing educational provision so that effective 'blended' learning is supported" (Moon, et al., 2016, p.495).

Effective blended learning approaches are reliant on teachers' and educators' ability to navigate and use technology in order to deliver educational content or support children's learning. However, the literature suggests that they may not always have the requisite skills to access and meaningfully use EdTech (Dahya, 2016; Carlson, 2013). In more structured settings where EdTech is used to complement teaching, teachers that are already dealing with stressful or traumatic events may not be willing or feel able to also adopt new technologies and different ways of teaching (Tauson & Stannard, 2018).

3.6.2. Self-directed learning

Almasari et al. (2019) argued that a form of self-directed learning, albeit with supervision, should be a key characteristic of a digital learning platform for children affected by the Syrian crisis, in order to overcome the negative impacts of conflict on education. Self-directed learning was a key feature of ELS in Sudan, and the evaluation of the programme suggested that it allowed for greater autonomy and pacing for learners, particularly benefiting those who were struggling (War Child Holland, et al., 2016). However, the evaluation also noted that, despite the self-directed nature of the mathematical game which allowed for children to take

the tablet with them on the move, there were high levels of drop-outs and children leaving tablets behind. Assumptions should, therefore, not be made that autonomy and self-direction supports all marginalised children in emergency contexts.

3.7. Supporting education actors

Another prominent theme that emerged from the literature reviewed is the use of EdTech to support education systems during an emergency response.

3.7.1. Supporting educators: teacher training and development

Emergencies are known to cause shortfalls in quality teachers (Burde, et al., 2015). While evidence on the use of EdTech for teacher training and professional development is mostly centred on refugee contexts or LMICs, several emergency context-specific examples emerged from the literature. Note that there are additional, more substantive examples of remote teacher training and professional development in the RER on refugee education (see Ashlee, et al., 2020).

Available evidence mostly focuses on conflict, specifically protracted crisis contexts. IRC's Connect to Learn project, for example, was cited as a programme successfully using technology to support teacher development in Iraq (Dahya, 2016). Specifically, the Connect to Learn project drew on "ICT hardware and connectivity via a cloud-based server and the Internet. [...] giving teachers access to resources to support

teaching and learning with children affected by conflict" (Dahya, 2016, p.15). While evidence on this project is limited, Dahya (2016) suggested that Connect to Learn was viable in a context of a protracted crisis with existing institutional structures available to support education – raising a question about the possibility of similar programmes in more acute crisis settings.

Additionally, the Gender Socialization in Schools programme pilot (part of UNICEF's PBEA programme), implemented in Uganda, demonstrated how technology can support teachers upon completion of a training course in a post-conflict setting. Following a training of teachers on gender, conflict and peacebuilding, SMS was used to remind teachers on a bi-weekly basis about content covered during their training and to provide examples of good practice (Chinen & Elmeski, 2016). However, an evaluation of this pilot programme found that there was little evidence to confirm the positive complementary effects of the SMS text messaging component on teachers' attitudes or teaching practices (Chinen & Elmeski, 2016).

There is little evidence on the use of technology to support teacher training and development in other emergency contexts. A recent review of efforts to mitigate the negative impacts of past disease outbreaks (Hallgarten, 2020a) found that there was no evidence on supporting teacher training and development during school closures and periods of disruption caused by epidemics. Furthermore, referencing Dahya (2016), Hallgarten (2020a, p.10) stated that the transferability of technology-enabled teacher training programmes in conflict, such as IRC's Connect to Learn project, to

contexts affected by epidemics is, at present, "speculative and untested".

In terms of disaster contexts, Carlson (2013) briefly discussed the example of continued professional development (CPD) course that was trialled in Haiti, a country frequently affected by disasters including earthquakes and hurricanes. The CPD course targeted school teachers in rural areas and each of the 32 participating schools received a Nokia phone provided with the open-source software, 'Nokia Education Delivery' (Carlson, 2013). A key point highlighted by Carlson (2013) was that prior knowledge or experience of technology can be a significant advantage for learners if EdTech is being used, and should be taken into account when developing CPD courses.

3.7.2. Practical support for teachers

The literature reviewed also provides examples of technology for practical support for educators. Morpeth et al. (2009, p.28), in their report on distance learning in settings affected by crisis and disasters, suggested that EdTech can support teaching in such contexts by providing "ready made educational resources [that] can be deployed in emergency areas or to untrained or under-trained teachers/mentors/carers working in severely under-resourced circumstances". A small mixed methods evaluation of the Rumie Tablet which showed how the use of the tablet with pre-loaded digital educational content led to positive outcomes for teachers in terms of their planning, range of teaching activities, and an improvement in their ability to "teach effectively" (Moon, et al., 2016, p.493).

Additionally, there are examples of mobiles being used to ensure teachers are paid during a time where they may be deterred from visiting banks or school offices as a result of hazards or safety and security risks (Dahya, 2016). Mobile technology – particularly SMS and Whatsapp – is also reportedly used by teachers to communicate with students and parents about homework, the content of lessons and other school matters (Alfarah & Bosco, 2016; Morris & Farrell, 2020).

3.8. Supporting education actors and EiE responses

3.8.1. Coordination and support of EiE responses

The coordination of an EiE response is complex (Sommers & IIEP, 2004). The proliferation of different actors and the challenging and often volatile environments within which they must respond, are key challenges to the EiE sector. In conflict, there are often particular challenges and tensions between different education actors, with Novelli et al. (2014, p.5) drawing attention to a "disconnect between actors in the humanitarian, development and security sectors, all of which have different approaches to the role of education".

While the literature does not specifically address the latter consideration in relation to technology, a prominent theme in the literature is the way in which technology can be used to support the coordination of education actors – including UN bodies, INGOs and state

actors – in their education responses (Barry & Newby, 2012; Dahya, 2016; Alfarah & Bosco, 2016). Barry and Newby (2012) outlined various ways in which technology can help facilitate coordination of humanitarian actors, including: creating and updating stakeholders contact lists; developing capacity-building training; creating communities of practices that are held online; and improving the effectiveness of meetings and training of actors.

3.8.2. Data collection and planning

The way that technology can be used to support data collection and information management is particularly highlighted by the literature reviewed. This can happen at the individual institutional level, with schools using technology to collect data on and monitor students' performance (War Child Holland, et al., 2016; Carlson, 2013; Bird, 2009). Menendez et al. (2016) also emphasised the role of technology to support the monitoring of students participating in alternative education programmes in conflict-affected settings.

Technology supported data collection can also be used to inform wider policy-level educational planning (Bird, 2009; Dahya, 2016; Barry & Newby, 2012). For example, Barry and Newby (2012) highlighted how education actors can use SMS to collect data remotely to ascertain education needs in an emergency, or use mobiles to support in-person data collection. Technology can also be used to map education capacity and resources in specific emergency situations (Barry & Newby, 2012) and support the integration of national, regional and local information and data (Bird, 2009).

Importantly, Dahya (2016) cautioned that, as with any data stored online, there should be careful consideration as to how it is secured and protected. Safeguarding should be of paramount importance when designing data collection tools that store individual or institutional data given that, for example, there could be harmful unintended consequences of geo-mapping schools in situations where schools are a target of conflict (Dahya, 2016). Data on children could be misused "in politics, for capitalist economic gain, or outright exploited to pernicious ends" (Dahya, 2016, p.27). Data protection and safeguarding must be held at the fore when considering the expansion of EdTech in emergencies.

3.8.3. Monitoring children's rights violations

A further use of monitoring specific to conflict settings is demonstrated by the Souktel programme in Palestine and Syria (Al Hamaydah, et al., 2015). This initiative involved an SMS alert system and trained teachers to recognise and report violations of children's rights, including the right to education, through a Monitoring and Reporting Mechanism. The system kept a record of violations that were then reported to the UN Security Council and can work as an advocacy and legal tool (Al Hamaydah, et al., 2015).

3.9. Child protection and psychosocial well-being

The final theme that emerged from this review is the use

of EdTech to protect children from harm and support their psychosocial well-being.

3.9.1. Supporting the protection of children

One of the documented uses of EdTech in emergencies is mitigating the child protection risks associated with emergencies.

3.9.2. Mitigating risks during conflict

During the acute phase of a conflict, safety is the predominant concern and timely, accurate information can be lifesaving. In conflict settings more broadly, authorities use messaging systems to warn the population when an attack is taking place (Alfarah & Bosco, 2016). A similar SMS alert system at the school-level has been developed by Souktel and UNESCO. The project, first piloted in Gaza and then implemented in Syria, enabled predetermined school personnel to warn parents and students via SMS about dangers occurring in the vicinity of the school, as well as alerting the authorities and emergency services (Al Hamaydah, et al., 2015; Burde, et al., 2015). In a review of the programme in Gaza, Al Hamaydah et al. (2015, p.30) noted that the SMS alert system had led to three successful school evacuations in situations of armed conflict.

There are, however, several documented challenges related to this SMS alert system. Firstly, the use of encryption, while necessary in order to protect the system from being hijacked (Dahya, 2016), meant schools needed trained personnel who could use the system. High staff turnover was, therefore, found to be a

challenge to the effective functioning of the project (Al Hamaydah, et al., 2015). Another underlying challenge reported was unreliable electricity and fuel shortages which resulted in difficulties using the internet and computers necessary to access parents' telephone numbers (Al Hamaydah, et al., 2015).

Barry and Newby (2012) referenced Frontline SMS – an open source system – as an alternative to UNESCO and Souktel's SMS alert system which can be accessed offline. Other benefits of Frontline SMS tentatively highlighted by Barry and Newby (2012) included the ease of setting up the initiative, as well as its cost-effectiveness (Barry & Newby, 2012). However, the authors noted that without robust data, the benefits of this system to communities remain unclear.

3.9.3. Disaster preparedness

Literature on the use of EdTech in disaster-prone areas identified by this RER centres on supporting children's understanding of risks in their community or country, with several studies in Indonesia (Sejati, et al., 2019; Winarni, et al., 2018; Robiansyah, et al., 2019; Winarni & Purwandari, 2018). The literature suggests that schools provide a critical opportunity to encourage children's participation and learning about disaster risks, and that technology-enhanced education about disaster risk is an effective participatory and student-centred learning method (Sejati, et al., 2019; Winarni, et al., 2018; Robiansyah, et al., 2019). The projects reviewed in this literature used games, mobile applications, animations and videos to educate children about risks of disasters.

A particular benefit of using EdTech for disaster

preparedness noted in the literature is its ability to clearly and visually illustrate to children, through the use of multimedia and animations, what they should do if a disaster hits. This was found to be beneficial for students' understanding of disaster risks (Sejati, et al., 2019). The use of digital games was discussed as particularly promising by Winarni et al. (2018), although detail behind why this modality is promising was limited.

One paper also suggested that using EdTech can have particular learning benefits for children with disabilities who may need adapted educational content. Robiansyah et al. (2019) presented findings of research on the use of a video game on flood risks with children with hearing impairments in Indonesia. The authors concluded that children responded well to this form of learning and were able to grasp core concepts on flood risks perhaps not available through some other teaching methods. However, Winarni and Purwandari (2018) identified key challenges with using EdTech for disaster preparedness. These included the costly and time-consuming nature of developing mobile applications and visuals that are realistic enough to enable meaningful learning about disaster risks and response.

3.9.4. Protecting from negative coping strategies

Technology, through keeping children engaged in education and learning, can also play a role in mitigating against negative coping strategies that children or their families employ in times of emergency and crisis when out of school – including early marriage, child labour, illegal activities or being recruited by armed actors and

militias (Tauson & Stannard, 2018; Kumar, et al., 2017; Gladwell & Tanner, 2014). However, according to Tauson and Stannard (2018), in order for this to be effective and for children to fully engage with education, emergency-affected communities must feel EdTech is a viable modality for delivering education.

3.10. Psychosocial well-being

3.10.1. EdTech with psychosocial well-being goals

Supporting the long term psychosocial well-being of children and young people affected by emergencies is important, and is often a key priority of EiE interventions (Burde, et al., 2015). Tauson and Stannard (2018) argued that it should also be a core focus of EdTech. Unwin et al. (2017) found that digital trauma counselling for children living in war zones or disaster-affected areas is becoming increasingly prevalent. However, this RER did not identify any additional evidence of this, and the wider evidence base on EdTech use supporting children's psychosocial well-being is scarce.

However, an Arabic-language version of the Sesame Street television show, 'Ahlan Simsin', has been especially adapted for children affected by the Syrian conflict and crisis and intentionally seeks to support children's socio-emotional learning and psychosocial well-being. Kohn, et al.,(2020) presented findings of research on the socio-emotional needs of Syrian children in their article, which were noted to have directly informed the design of Sesame Workshop and International Rescue

Committee's 'Ahlan Simsim' television show. However, lessons learnt from the implementation of this television show are not yet available as it only started to air in February 2020. A separate RER on TV, however, shows that television does have potential for positive impact, although the focus of this RER is broader than emergency contexts (Watson & McIntyre, 2020).

3.10.2. Indirect support to psychosocial well-being

There is also limited evidence that EdTech can indirectly support psychosocial well-being. Carlson (2013) argued that engaging with EdTech in and of itself can be a "positive and worthy experience, particularly if it promotes human connections and community-building" (Carlson, 2013, p.i). Supporting this, Morris and Farrell (2020) found that SMS and WhatsApp are often used as a way for students to remain connected with their peers when schools close.

Evidence on ELS illustrates how EdTech can lead to positive psychosocial well-being outcomes. The evaluation of ELS found that children who engaged with the mathematical game experienced a significant positive effect on their self-esteem (War Child Holland, et al., 2016). The authors of the evaluation noted that the causes of this improved self-esteem were unclear; while linked to improved learning outcomes in mathematics, they were unable to denote causality.

3.11. Synthesis

3.11.1. Facilitating access to education and learning

Available evidence examined by this RER suggests that EdTech may have the potential to enhance access education for students unable to attend school during emergencies, including as a result of school closures and safety and security risks. Radio has been particularly leveraged during emergencies and is often regarded as a suitable modality to respond to the severe disruption caused by the onset of a conflict, disease outbreak or disaster. Other forms of technology, including mobiles, computers, TVs and laptops, are reportedly used in emergencies but there is less evidence on their impact. Tablets, however, with preloaded educational content and materials, have been used in a protracted crisis setting (Sudan) and in an epidemic setting (Liberia), with evidence suggesting they did enable access to education otherwise not available to children at the time.

Evidence from the use of EdTech in Sierra Leone after the Ebola outbreak demonstrates how EdTech can support children's return to school once schools reopen in the aftermath of an emergency. Providing communication with families, parents and students about the importance of returning to school when it is safe to do so is recognised as a key benefit of technology in this regard.

In some cases, EdTech facilitates greater gender equity in access to education, counteracting embedded

inequalities in society. However, it should not be assumed that this occurs in all cases: evidence from an educational radio programme in Sierra Leone found that, when faced with increased household responsibilities in the aftermath of the Ebola epidemic, girls particularly experienced inequitable access to technology and education in times of crisis, widening existing educational divides.

In order for EdTech to allow sustained access to education in times of emergency, it is critical that interventions consider longer-term cost implications and are based on the reality of existing infrastructure. It is also important that adequate resources are provided to support educators to meet a potentially increased demand in enrolment in education enabled by technology.

3.11.2. Educational content and pedagogy

In order to facilitate positive learning outcomes and education experiences for children affected by emergencies, the content and pedagogical approaches of technology-enabled education is critical. Several reports emphasised the importance of ensuring that content is aligned to local curricula and delivered in local languages for educational continuity. However, this RER identified limited evidence on EdTech initiatives successfully achieving this.

Community participation, namely from community leaders, local organisations and children, in the design and delivery of EdTech initiatives is recognised as a critical factor for ensuring positive learning outcomes for children. This becomes particularly important in times

of conflict: contextualised and sensitive education is key in ensuring that education acts as a peacebuilder rather than an exacerbator of conflict. However, one study also warns that community participation has, in the past, had the unintended effect of exacerbating political and social tensions.

Blended learning approaches that promote connections and interactions between students, their peers and teachers are widely argued to promote positive learning outcomes for children. The self-directed nature of many EdTech initiatives can also benefit learners in emergencies, allowing for greater autonomy in how they explore subjects and at what pace. To facilitate successful blended and self-directed learning, however, teachers must be willing and able to navigate and use EdTech. But this is not always possible, and the literature emphasises that EdTech should not cause additional stress for teachers already negatively impacted by an ongoing emergency.

3.11.3. Supporting education actors

EdTech can play a role in supporting education actors during emergencies. Firstly, technology can support teacher development during emergencies, helping them with the continual improvement of their teaching practices through providing access to digital training materials and good practice examples. Technology can also be used to provide practical support for teachers, from supporting payments to providing ready-made and adaptable educational materials that can be delivered during their lessons. However, the available evidence on supporting teachers and educators is

limited to conflict contexts, particularly protracted and post-conflict settings with available infrastructure, with limited evidence on the transferability of such programmes to acute conflict, epidemic or disaster settings.

Technology can also support a broader range of education actors during emergencies and be used to help improve overall coordination. Technology-enabled data collection can also inform institutional-level monitoring of students' performance and progress, as well as shape wider educational policy planning and identification of key education needs during crises. However, it is critical to pay attention to safeguarding risks when storing data on children online, particularly in conflict settings.

3.11.4. Protection and well-being

Technology has the potential to play an important role in supporting the protection of children from the threats resulting from an emergency. The use of SMS to rapidly warn teachers, parents, students and authorities of conflict risks in the vicinity of a school is reported to play an important role in keeping children safe. There is also evidence to suggest that, in making education more accessible to children, technology can mitigate against negative coping strategies that families may impose when children are out of school, including early marriage and engagement in armed conflict. EdTech can also support children's preparedness for emergencies in areas prone to natural disasters, through supporting children's learning about natural hazards and their risks through online and interactive methods.

Supporting the psychosocial well-being of children affected by emergencies is also a critical function of EiE responses. EdTech can directly support well-being, with some projects embedding well-being outcomes into the project design and activities. EdTech can also indirectly support well-being, particularly if it allows children to connect with their peers and teachers when schools are shut and enhances confidence and self-esteem.

GIRLS EDUCATION

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Summary

This rapid evidence review (RER) provides an overview of the existing literature on the use of technology in supporting girls' education in low and middle-income countries (LMICs). The RER has been produced in response to the novel 2019 coronavirus (Covid-19), and the resulting widespread global shutdown of schools. It therefore has an emphasis on transferable insights that may be applicable to educational responses resulting from the limitations to the continuation of schooling caused by Covid-19. Established approaches to maintaining continuity of education for the most marginalised have particular salience during this period

because of the significant increase in the number of students at risk of disruption. Research consistently shows that while education across the board is negatively affected by crisis situations, the schooling of girls is disproportionately impacted. The RER aims neither to advocate nor discourage the use of technology in girls' education in response to the present Covid-19 pandemic, but rather to provide an accessible summary of existing evidence on the topic so that educators, policy makers and donors might make informed decisions about the potential role of technology in delivering education for girls.

The RER involved a systematic search for literature about the use of technology in girls' education from academic journals within education, social science and humanities disciplines. As further detailed in the methodology section, the papers referenced within this RER are primarily written in the last 20 years and focus on the technology-enabled education of girls in LMICs. Details on the inclusion criteria, as well as the associated limitations, are explained in the methodology section. The rapid nature of the review required a focused approach to literature discovery and a thematically guided process of analysis so that a timely response to Covid-19 might be provided. The search strategy was not therefore designed to be exhaustive.

The findings of the thematic analysis of the relevant literature on technology in girls' education are structured according to three themes:

1. **Girls' engagement with technology in education.** This theme explores the potential for technology to promote educational equality with a focus on girls

in LMICs.

2. **Equity of access to technology.** This theme discusses the barriers that girls face in achieving equitable access to educational technologies.
3. **System readiness.** This theme focuses on the broader preparedness of systems and infrastructure in LMICs to use technology to facilitate girls' education.

There are four key findings based on the analysis of the literature.

- Access to technology has been shown to be often disproportionately more empowering for girls relative to boys, with wider benefits which expand beyond formal education.
- Most studies suggest there is a significant existing gender digital divide: cultural bias and gendered assumptions about girls' competence and enjoyment of technology, and the benefits and risks they accrue from using it, mean that girls are afforded less access to technology, both inside and outside the classroom.
- Parents and teachers are key gatekeepers to girls' access to technology. Unless parents and teachers are involved in programme development and receive adequate and ongoing training in technology usage and gender-responsive teaching, there is concern that increased use of technology may only increase the gender digital divide.
- Exploring a broader range of technology options — particularly mobile phones — may provide opportunities to overcome persistent gender

barriers and infrastructural challenges and facilitate more inclusive and empowering learning opportunities for girls.

Within the context of Covid-19 forcing global educational changes, these findings suggest ways in which technology can facilitate increasingly equitable access to education for girls in LMICs.

1. Introduction

The Covid-19 pandemic has led to greater reliance on distance learning methods for students and teachers. Physical distancing policies to suppress the spread of the novel coronavirus often advise that students and teachers cannot congregate in schools in the conventional manner. Digital technology (information and communications technology) has the potential to play an important role in tackling the educational challenges raised by Covid-19 by delivering education over distance and at scale.

1.1. Purpose

This RER provides an overview of how technology has been used in LMICs within girls' education at primary and secondary levels prior to the current pandemic. It does this to offer evidence into how technology can be of potential benefit to girls' education and explores the current barriers preventing equal access to technology. It contributes to the emerging knowledge base and organises the most relevant literature into coherent

themes for the consideration of key stakeholders in how to employ technology to benefit girls' education.

The current health crisis has led to increased global attention on the use of technology within education. This presents an opportunity to explore alternative means of girls accessing education, which is particularly important in LMIC contexts where girls have typically been less likely to access conventional education, particularly those disadvantaged due to poverty, location and disability, for example. This RER presents the potential benefits of technology for girls in education in LMICs but also highlights the risks of implementing technology within education without fully considering the gender digital divide.

1.2. Application

The insights presented in this RER are expected to be viewed as principles for the planning and implementation process for technology within girls' education. The implications for designing and implementing specific strategies are likely to vary according to the local context, and so the principles should be adopted and adapted accordingly. Patterns of good practice have emerged from the evidence on how, when and why technology can and should be used in educating girls, and it can be reasonably expected that many of the insights are applicable in the Covid-19 context.

1.3. Research questions

Two research questions guide the study:

1. What are themes in the use of technology in girls' education in LMICs that relate to the specific challenges of the Covid-19 education crisis?
2. How do major disruptions to education such as Covid-19 affect girls' use of EdTech?

1.4. Structure of the RER

The next section explains the methodology of the RER. This is followed by the presentation of the findings of the systematic literature review and thematic analysis. The final sections provide a synthesis of both the literature review and thematic analysis findings, as well as a series of recommendations on how technology in girls' education might best be employed.

2. Methodology

The methodological approach is informed by the Cochrane Collaboration Rapid Reviews Methods Group interim guidance on producing rapid reviews (Garritty et al., 2020). This permits a rigorous and systematic approach, while defining the scope narrowly enough that it can be completed within a short span of time. Unlike other rapid evidence assessments, such as Education Endowment Foundation's meta-analysis of other systematic reviews on distance learning, this RER

is modelled on a systematic thematic review of primary studies. Higgins and Green (2011) distinguish a systematic review thus:

> "A systematic review is secondary research that seeks to collate all primary studies that fit prespecified eligibility criteria in order to address a specific research question, aiming to minimise bias by using and documenting explicit, systematic methods."

After defining the research question and eligibility criteria, a brief scoping review was conducted to help elicit relevant search terms for the search queries. Details of both the search-term scoping review, as well as the eligibility criteria for the discovered literature, are detailed in the following sections.

2.1. Scoping review

Unlike systematic reviews, the criteria for scoping reviews are not yet well-defined. However, these reviews are widely considered as representing a stage prior to a systematic review where the key concepts and ideas that define a field are explored and discovered in an iterative process (Daudt et al., 2013; Levac et al., 2010). Notably, the scoping review of this study did not aim to map out all the concepts, theoretical and otherwise, included in the scope of technology and girls' education. Instead, it had a more pointed focus: to identify keywords and terms that had been used in studies that discuss the use of technology for girls' education. The scoping review process began by noting relevant keywords and terms that were already known to the authors to search for additional literature. The process was iterative, with

the terms found in one article leading to searches for other articles that then revealed different, or the same, terms. Using this method, a list of 20 search terms was compiled (shown in the Annex). It is important here to draw attention to the point that when a search term brought up an article with a relevant title, those articles were saved to be screened later alongside those that were found during the main literature search explained below.

2.2. Literature search and eligibility criteria

The literature search began after establishing the search terms at the end of the scoping review. Google Scholar constituted our primary source of literature. The process used to arrive at the articles that were ultimately thematically analysed in this review is shown in the Annex. It is important to highlight that unlike a more traditional systematic review process, which may screen all search results, the rapid review methodology used herein relied on a system of quotas. As such, only the most relevant results (up to a maximum of 700 results), as ranked by Google Scholar, were selected for the first round of screening. Twenty different search strings were run, returning over 50,000 results. Of these, 90 articles were initially captured for further screening.

The title and abstract screening, as well as all other subsequent screenings, were conducted according to the eligibility criteria laid out in the Annex. It should be emphasised though that the screening criteria were not absolute. For example, when search terms returned a

large number of studies, the date parameters were re-adjusted to return only literature from 2008 onwards. Moreover, while the majority of selected literature met the eligibility criteria, a small, complementary collection of literature that was deemed especially informative, but did not meet all criteria, was retained. However, these exceptions were only made when an article met all except one of the eligibility criteria. An exception, for example, might be made if a study explored the gendered aspects or use of EdTech, but focused on tertiary or higher education contexts in LMICs.

One limitation of relying on Google Scholar as the primary source of literature was the number of low-quality — and often non-peer-reviewed — papers in the initial screening. While the title and abstract may have demonstrated the necessary relevance for inclusion, the substantive content often turned out to be of low quality. These were only filtered out only after a full reading of the text.

A decision also had to be made about whether to include literature on girls' participation in IT classes in LMICs. There was, for example, a distinct literature exploring girls' lack of participation in IT or STEM subjects in these countries. However, it was decided that this literature, while providing some useful contextual background, addressed issues that were substantively different from those exploring the use of technology in facilitating girls' education. Following the search and screening process outlined in the Annex, 39 papers were selected for inclusion in the review.

2.3. Theme identification

The search and screening process identified 39 papers for analysis. The thematic analysis of these papers led to them being classified into three themes. Those themes and their sub-themes, which are discussed in depth in the findings section, are as follows:

Girls' engagement with EdTech

- Girls' use of technology
- Gendered benefits
- Range of benefits
- Risk of widening the gender divide

Equity of access

- Attitudinal bias
- Unequal access to technology within schools
- Unequal access to technology outside of school
- Self-regulation

System readiness

- Teacher training
- Educational systems
- Policy and government buy-in

3. Findings

Upon completion of the literature search and subsequent screening processes, 39 papers were found and thematically analysed. The groupings that emerged

from that analysis were: girls' engagement with technology; equity of access; and system readiness. These are discussed in the following sections.

3.1. Girls' engagement with EdTech

Inequality in access to EdTech for girls is well documented. Where girls do get access, many studies offer an optimistic view that this access to technology can improve girls' education by expanding and enhancing learning opportunities. This section explores the potential for technology to promote educational equality for girls in LMICs. The following themes emerged from the literature and are discussed in turn.

- **Girls' use of technology:** When barriers are removed and female students are given access to technology and technology-enabled education, studies have shown that girls are likely to respond with a high level of engagement.
- **Gendered benefits:** Furthermore, a number of studies agree that access to technology has been shown to be disproportionately more empowering for girls and women than for boys and men.
- **Range of benefits:** The advantages for girls expand beyond the realm of formal education and empower them in other areas of life.
- **Risk of widening the gender divide:** If the gender dynamics are not considered, the use of EdTech carries the risk of heightening gender disparity within education in LMICs.

3.1.1. Girls' use of technology

Several studies indicate that female students are likely to have a higher level of engagement than male students when provided with equivalent access to technology. As noted in a study with particular relevance to Covid-19 due to the flexible modes of learning it discusses, Zelezny-Green (2018) engaged school girls in Kenya with two educational apps on their mobile phones for after-school learning. The majority of participants within the study were found to use their mobile phone in ways that "enhanced their life choices" and promoted both formal and informal learning. This was the case despite obstacles discouraging phone use such as phone bans within school grounds and limited financial resources for charging and topping up their phones.

Among women and girls who have access to the Worldreader app, significantly greater use of the resource has been recorded among female readers compared to male readers (West & Chew, as cited in Dahya, 2016). The WorldReader platform is aimed at young people, and according to the study cited: "the average survey respondent was 24 years old. Over 90 per cent of the survey respondents were aged 35 and below, and two-thirds of respondents were under 24 years old."

3.1.2. Gendered benefits for girls in accessing technology

Several studies have found that women and girls who are given access to technology benefit from their use to a greater extent than their male counterparts. For example, Khan and Ghadially (2010: p. 670) conclude that

"technology holds empowerment potential for disempowered groups generally, and an equalisation potential for women particularly". This finding was based on a gender analysis of Muslim youth in India, where Khan and Ghadially (2010: p. 665) found that "there was a consistent gender difference — in all cases women experienced more empowerment than men". Furthermore, their study found that women continued to benefit disproportionately from access to technology even in situations where both genders had equal access.

Access to education through technology has also been found to enable women to independently educate themselves further. In an early literature review of mobile-learning and gender across Africa, Zelezny-Green (2011) noted a substantial bonus to mobile-assisted literacy learning for women and girls, giving them access and understanding of online content in languages that they may not have previously been literate in.

3.1.3 Wide range of benefits for women

The benefits of technology to girls and women stretch beyond the realm of formal education. Empowerment as understood holistically by Khan and Ghadially (2010), includes psychological, social, educational and economic advantages for women.

Ferreira (2017: p. 41) identifies through the GIRLS Inspire project in India, Pakistan and Bangladesh, a number of fields where women have benefited from the use of Online and Distance Learning (ODL) in secondary and skill-based education. A large majority of women who participated stated that the training had a positive

impact on their "access to economic opportunities" and also reported an increase in their "ability to make their own health decisions" and access resources as well as in their understanding of their social rights.

3.1.4. Risk of widening the gender divide

While technology-assisted education can be hugely beneficial to girls and women, the use of technology will only create increased segregation if gender is not considered at every stage. Any educational projects that look to leverage technology must always attend to the "gendered nature of human interactions with technology in the design and implementation of the program [or risk] exacerbating existing gender and related divides" (Steeves & Kwami, 2017: p.184).

An awareness of this should be in place before a teacher steps into the classroom, and unless teacher professional development includes instruction in inclusive and gender- responsive teaching and learning, teachers may be liable to reinforce gender stereotypes and divisions. The challenges of this are likely to be particularly felt where there is a lack of female teachers as role models, such as in Uganda where (as of 2016) less than 25% of secondary school teachers were female (Okudi, 2016).

3.2. Equity of access to technology

This section explores the literature on the equity of access to technology in girls' education. Most sources acknowledge that women and girls are rarely afforded

equal access to technology when compared with their male counterparts. The result of this gendered disparity appears to be an inequitable distribution of educational benefits that come with the use of technology. Four sub-themes emerged in the literature discussing this topic and these are discussed in turn.

- **Attitudinal bias:** Girls' access to and usage of technology are governed by socio-culturally constructed gender norms, values, and practices, which in turn reinforce inequities in the following points.
- **Unequal access to technology within schools:** It is generally noted throughout the literature that girls tend to have unequal access to technology facilities inside the classroom setting.
- **Unequal access to technology outside of school:** It is noted throughout the literature that girls have unequal access to technology outside of the institutional spaces of the school due to gendered household attitudes and roles, cost, and fears for security. This limits their access to formal and informal educational content and further impacts upon their technology experience and literacy.
- **Self-regulation:** Through socialisation and the performative practice of certain gender roles, girls can come to self-regulate their own access to technology.

3.2.1. Attitudinal bias and access disparity

Most of the 39 studies reviewed acknowledged that there is a significant gender digital divide in low-income

countries resulting in girls having significantly less access to technology. Studies suggested that this disparity was rooted in broader attitudinal gender biases prevalent in attitudes about girls and technology. Several studies noted that girls were discouraged or limited from using technology because of restrictive socio-cultural values and beliefs vis-à-vis gender roles and interests. For example, drawing on her work in Kenya, Zelezny-Green (2011) suggests that ownership and usage of technology are commonly framed as 'masculine'. Based on their work from Cameroon, Central African Republic, Congo and Swaziland, Meno (2012) and Vilakati (2014), find that these pervasive gender biases are reflected and reinforced by the girls' parents, their school teachers, and the students themselves and this results in girls showing less interest in science and technology subjects at the school level and beyond.

3.2.2. Unequal access to technology within schools

The literature reviewed generally suggested that female students have less equitable access to technology resources at school, but this was rarely evidenced in any substantive way. Were and colleagues (2011) make the point that girls in low-income countries are more likely to be deprived of opportunities to access technology within schools because they are less likely to consistently attend school in the first place.

Both Were and colleagues (2011) and Meno (2012) suggest that girls have less access to technology within the classroom when compared to boys. That said, Meno (2012) also asserts that unequal access within schools

was rarely the result of the unavailability of necessary hardware or infrastructure; rather, it was due to pervading existing gendered assumptions about the use of technology.

Were and colleagues (2011) suggest that teachers can exhibit biases against girls by having lower expectations about their technology competence than their male counterparts. Teachers may also believe stereotypes about which children will enjoy or benefit from using technology, and allocate technology accordingly (Pitchford et al., 2019). Because of their different educational expectations, teachers are more likely to encourage male students to take computer or technology-based courses. Girls, on the other hand, are deterred from enrolling in these classes (Meno, 2012).

3.2.3. Unequal access to technology outside of school

It is outside of the institutional spaces of school that unequal access to technology — and any concomitant educational benefits — is most evident. A number of the studies, which primarily covered countries in sub-Saharan Africa, suggested that girls have unequal access to technology outside of the classroom due to gendered household attitudes and roles, cost, fears for security, and control over their mobility. This also impacts upon their technology experience and literacy and their informal out-of-school learning. The evidence suggests that girls who were previously enrolled in school before closures due to the pandemic may experience greater learning loss than boys while schools are closed.

Were and colleagues (2011), Meno (2012), Basavaraja &

Sampath Kumar (2017) and Steeves & Kwami (2017) all reported that male students had more freedom to use computers for both study and leisure outside of the classroom. Males were more likely to have the time, financial ability and freedom of mobility to be able to access technology in the spaces of their homes or at shared community spaces such as cyber cafés. As Steeves & Kwami (2017: p. 185) state, "The fact that boys had more free time after school, had the freedom to be more mobile and less housebound, and could visit Internet cafés... allowed more boys than girls to acquire experience and fluency in using a computer and the Internet." The use of technology in these settings gave male students access to informal technology training and skills.

By contrast, many of the studies reported that girls were not encouraged to access or use computers outside of school. For example, Meno (2012) found that parents who had access to a computer at home often did not demonstrate to girls how to use it because they thought it was unnecessary or morally dangerous. Similarly, Were and colleagues (2011: p. 41) stated that "among families who own computers boys will have more access to using the computer than girls".

Some of the studies also intimated that girls are also less likely to have the temporal or financial resources needed to access technology outside of school. Were and colleagues (2011), Zelezny-Green (2018) and Steeves & Kwami (2017) all noted that girls are often expected to undertake household chores and contribute to the family income to a much greater extent than boys. As a result, they had limited time or disposable income to access technology or engage with educational material

that might be subsequently provided through such technology.

Moreover, Were and colleagues (2011), Meno (2012), Basavaraja and Sampath Kumar (2017), and Steeves and Kwami (2017) note that girls are less likely to be able to access technology in shared community facilities such as Internet cafes or computer centres because of gendered socio-cultural assumptions. Steeves & Kwami (2017: p. 185) suggested that in Ghana girls were discouraged from visiting cyber cafés as they are considered an "unsavory environment and girls face stigma in these spaces due to the access to pornography and fraudulent activities". Some cafes, they noted, do not even permit entry to girls. Meno (2012, p.18) also observed negative public opinion about girls who go to the cyber café. As a result, she found that some girls were afraid to work in cyber cafés.

More recently, however, Zelezny-Green (2018) sounded a more hopeful note in her exploration of the role of mobile telephony in enabling more equitable access to technology for girls outside of school. She states that there is an increasing indication from the literature that, "girls in the global South access mobile phones after school in ways they choose themselves – sometimes involving formal learning and other times not" (Zelezny-Green, 2018: p. 302). She also found in an earlier study that educational content access through mobile phones could ameliorate the interrupted school attendance of girls (Zelezny-Green, 2014). Potential inequities of access to different types of devices should also be taken into account in designing such programming and content.

3.2.4. Self-regulation

While socially-constructed gender biases were primarily reinforced by parents and teachers, a number of studies intimated that girls came to inhabit these beliefs and values and self-regulate their use of technology. Illustrating this, Meno (2012) and Vilakati (2014) acknowledge that even when girls were afforded the same functional access to technology as their male counterparts (whether in school or otherwise), their usage was further restricted by a lack of confidence, fear, mistrust and disinterest. For example, Meno (2012) notes that some female participants suffered from "technophobia" and were afraid of breaking the computer hardware.

Others felt uncomfortable using the internet and were wary of visiting certain websites without prior knowledge of what would be on them. Zelezny-Green (2014) observed similar reticence in her study on the educational potential of mobile phones in Kenya. Here, some girls had reservations about using mobile phones as they had observed them being, "used inappropriately for social purposes" (Zelezny-Green, 2014: p. 71). Males, on the other hand, are socialised to have a more positive and confident attitudes towards computers.

3.3. System readiness

This final section briefly considers the literature on the readiness of systems and infrastructure in LMICs to use technology to facilitate an improvement in girls' education. It is worth noting that most of the sources

focus on Africa. There are three sub-themes emerge which are discussed in turn:

- **Teacher training and professional development:** The most consistently mentioned challenge is a general lack of both qualified teachers and ongoing professional development training, in parallel with a specific lack of training in technology use and gender-responsive teaching.
- **Educational systems:** Alongside inadequate teacher training, many studies found that the existing curricula and pedagogy in many LMICs discriminate against female students.
- **Policy and government buy-in:** Another key impediment mentioned in most studies is the lack of political will and/or clear mechanisms to implement existing policies which advance the use of EdTech and promote girls' education.

3.3.1. Teacher training and professional development

The literature consistently emphasises the crucial role of teachers in raising standards of teaching and learning, irrespective of technological advances: "educational tools and technologies will continue to improve; nevertheless, teachers, not technology, will determine the quality of education in the foreseeable future" (Saxenian, 2012).

Most studies highlight a lack of well-trained teachers as a key obstacle to improving the quality of educational provision (Ezzeh & Okoh, 2019; Giles, 2004; Kinyanjui, 2016; Okudi, 2016; Zelezny-Green, 2011). The studies refer to a

lack of qualified teachers, to the poor quality of teacher training and ongoing professional development, and to the limited use of technology within much current teacher training.

As Okudi (2016) states: "the majority of African education institutions do not have enough instructors equipped with computer and internet skill", arguing that significant additional investment in this area is needed. Within this, it is noted that gender-responsive pedagogies, and the integration of approaches that are empowering to girl learners, can be particularly difficult for teachers in LMICs because of pre-existing constraints.

3.3.2. Educational systems

Inadequate teacher training and a lack of continuous professional development for teachers is just one factor identified in the education systems of the countries studied as contributing to poor learning outcomes and specific challenges for girls. In addition to unqualified teachers, Kinyanjui (2016) emphasises the significance in Kenya of an "overloaded and irrelevant curriculum, lack of instructional materials, inadequate teacher contact hours and overcrowded classrooms" in contributing to low learning outcomes.

Similarly, Okudi states that Uganda has a "highly academic but irrelevant curriculum" which disadvantages girls as it depends on memorising large sections of content, which girls have less time to do as they have many time-consuming domestic chores. Okudi suggests that rather than mitigating the challenges posed by unequal access to education for girls, certain aspects of the current Ugandan education

system have resulted in the perpetuation of a culture and traditional values that disadvantage girls in school. She states that "gender discrimination, stereotypes, and inequalities are transferred from the community to the school and manifest in textbooks, subject choices, subject content, teachers' delivery and school management".

In Nigeria where technology-facilitated education is already somewhat established at both higher education and teacher training levels, a number of studies explored the possibility of expanding ODL to lower levels of education in Nigeria in order to promote more opportunities for girls remaining in education. Similarly, ODL is being implemented at both college and university levels in Kenya and Righa (2013) and Sarumi and Omazu (2013) urge secondary institutions to learn from the success and experience of these programmes. Gender disparity in accessing education exists from the first years of school, so Sanangurai (2016) stresses that unless gender dynamics are considered when implementing ODL at a primary and secondary level, girls will continue to be disadvantaged and access to education will be further segregated.

3.3.3. Policy and government buy-in

A supportive policy environment and framework at the national level was also identified by many of the studies as a crucial factor in the successful integration of technology into education systems and in particular in enhancing female access to education (Ezzeh & Okoh, 2019; Kinyanjui, 2016; Okudi, 2016; Steeves & Kwami, 2017).

While most countries do have laws, institutions and

policies to promote technology usage and to eradicate the gender bias in education, implementation is often weak due to a lack of political will or clear mechanisms to implement the constitutional gender provisions (Kinyanjui, 2016). Okudi (2016) suggests that some of these policies were developed more to fulfil international obligations than because they were a key government priority. She points out that Uganda has numerous policies and initiatives to support girls' education but they have made little impact on gender divides and questions the country's capacity to tackle the issues affecting girls' education in terms of "implementation of policies and programmes through commitments, planning, budgeting, resourcing, training, supervision, monitoring, coordination, evaluation and reporting".

Evaluating the One Laptop Per Child project in Ghana, Steeves and Kwami (2017) suggest that integrating gender into technology policies had been hampered by a lack of political will and that these policies had "either been sidelined, forgotten over time, or not been seriously pursued". In addition to a lack of political will, some studies (Ezzeh & Okoh, 2019; Okudi, 2016) cite a lack of coordination and integration between different government departments and multiple stakeholders as a limiting factor in the usage of technology to improve girls' education.

4. Synthesis

This RER demonstrates that when barriers are removed and female students are given full and undiscriminated access to technology and technology-enabled

education, girls repeatedly respond with a high level of engagement. Furthermore, some studies indicate that access to technology in education has shown to be disproportionately more empowering for girls and women than for boys and men. Finally, the range of benefits that female students derive from technology expand beyond the realm of formal education and empower them in other areas of life, with reported benefits such as an increase in access to economic opportunities or a greater ability to make informed decisions about their own health.

However, in the majority of cases girls are not currently enjoying full and undiscriminated access to technology and there are a number of external and internal barriers to engagement identified in the literature. Most studies acknowledge that there is a significant gender digital divide in low-income countries resulting in girls having significantly less access to technology compared to boys. The evidence suggests that this disparity is rooted in the broader gender biases prevalent in attitudes to girls and technology. It is also suggested that these gendered assumptions about the use of technology do not stop at the school gates but are implicit within the classroom setting, where girls are afforded less access to technology than their male counterparts. This is primarily due to widespread teacher bias that girls are less competent in technology usage and/or will not enjoy or benefit from technology usage. This in turn means that teachers are less likely to encourage female students to take computer or technology-based courses.

Studies consistently mention endemic problems with teacher training and professional development in LMICs, particularly in Africa. These concerns encompass, among

other areas, the standard of teacher training and instruction both in the usage and application of technology and in inclusive and gender responsive teaching.

A key concern that runs through all three sections of this rapid evidence review is that while technology-assisted education can be hugely beneficial to girls and women, the use of technology will only create increased segregation unless gender is considered at every stage and, crucially, that teachers are trained to resist rather than reinforce gender stereotypes and divisions. Alongside concerns about teacher training, many studies also note systemic problems with curricula and pedagogy which disadvantage female students. Currently, neither educational reform nor teacher training seem to be government priorities in many countries, with most studies identifying a lack of political will or mechanisms to implement policies to advance the use of EdTech and girls' education.

It is noted throughout the literature that girls also have unequal access to technology outside of school due to gendered household attitudes and roles as well as cost and security fears. These factors limit girls' access to formal and informal educational content and impact upon their technology experience and literacy. Some studies also suggest that girls have come to self-regulate their own access to technology as they have internalised these gendered beliefs and attitudes.

A limitation of the literature is the lack of exploration of any differences in girls' access to various forms of technology, and also the differentiation in access between different groups of girls. Most of the studies reviewed understood technology to mean a computer

or tablet, rather than more widely accessible and low-cost devices such as radios or mobile phones. Actively using more diverse forms of technology might go some way to addressing the significant problems with access to power and connectivity in many low-income countries that must be considered in any discussion about girls benefiting from technology-enabled education.

Surprisingly, none of the studies reviewed explore the potential of technology to overcome or alleviate the challenges of gender bias present within existing education systems. For example, further investigation is needed regarding the potential for technology to improve education for girls through the joint provision of teacher training on effective use of technology and on effective gender-responsive pedagogies.

Finally, a crucial issue that warrants more attention than it has received in the literature is the importance of understanding safeguarding issues particular to female students, including the necessity of safeguarding girls from the risks associated with the use of technologies.

REFUGEE EDUCATION

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Summary

This rapid evidence review (RER) provides an overview of existing literature on the use of educational technology (EdTech) for education of refugees in low- and middle-income countries (LMICs). The RER has been produced in response to the widespread global shutdown of schools resulting from the outbreak of Covid-19. It therefore has an emphasis on transferable insights that may be applicable to educational responses resulting from the limitations caused by Covid-19. In the current global context, lessons learnt from the use of EdTech in refugee contexts — in which education is often significantly disrupted and education systems and responses are required to rapidly adapt — are salient.

This RER provides a summary of the potential benefits of using technology for education of refugees as well as its risks, limitations and challenges. Notably, the RER aims neither to advocate nor discourage the use of technology in refugee education in response to the Covid-19 pandemic, but rather to provide an accessible summary of existing evidence on the topic so that educators, policy makers and donors might make informed decisions about the potential role of technology for the education of refugees and more broadly.

The RER involved a systematic search for academic and grey literature about the use of EdTech in the education of refugee children in LMICs. However, in some cases, literature that included refugee education in high-income country contexts were also considered. After a screening process, 33 studies published in the last 15 years were analysed. Details on the inclusion criteria, as well as the associated limitations, are explained in the methodology section. The rapid nature of the review required a focused approach to literature discovery, and a thematically guided process of analysis, so that a timely response to Covid-19 might be provided. As such, the search strategy was not designed to be exhaustive.

The findings of the thematic analysis of the relevant literature on technology for refugee education are structured according to four themes:

1. **Continued access to education:** This theme discusses how technology can facilitate continued access to education amid significant disruption caused by displacement.
2. **Modalities and pedagogies:** This theme examines

the ways in which technology delivers or supports education and learning, with a particular focus on pedagogies.

3. **Supporting educators of refugee children:** This theme explores how technology can support educators of refugees, both inside and outside the classroom.
4. **Psychosocial support:** This theme examines the ways in which EdTech and related pedagogies may support the psychosocial wellbeing of disrupted learners.

The key findings from this review are:

- EdTech can facilitate access to education and learning during periods of disruption caused by forced displacement. However, EdTech must be adapted and contextualised to each refugee setting: this has to account for local attitudes towards technology and promote refugees' feelings of ownership, particularly among education stakeholders on the front lines of implementation.
- EdTech should support, not replace, teachers and others supporting learning, even when they are not fully qualified (as is often the case in refugee settings). Integrating pedagogical capacity-building is key. This will normally necessitate a learner-centred approach, which may differ from the way most teachers and students understand learning. Adapting to the new pedagogical method, together with the use of EdTech tools, is likely to require ongoing training and support for teachers and educators.

- Technology enables continued support for teachers beyond basic training and can facilitate local to global connections, widening the support network and learning community for teachers of refugees.
- Psychosocial wellbeing of children affected by forced displacement can, at times, be supported through EdTech modalities and pedagogies; digital games and EdTech that encourages creativity and imagination and facilitates social connections and support networks demonstrate potential.
- The implementation of EdTech presents some challenges. Cost and logistical feasibility are primary issues, but the design and maintenance of tools and their content should also be considered carefully, as these have further implications on full-cost appraisals over the life of interventions. The sustainability of interventions must be considered from the outset in order to avoid further disruption to refugee children's education progression.

1. Introduction

The Covid-19 pandemic has resulted in widespread and unprecedented global disruption to education. Information Communications Technology (ICT) can play an important role in tackling the educational challenges raised by Covid-19, resulting from physical distancing policies which often advise that students and teachers cannot congregate in schools in the conventional manner, by delivering education over distance and at scale.

This RER provides a summary of the potential benefits

of using technology for education of refugees as well as its risks, limitations and challenges. It does this in order to offer insight and evidence that can assist in the development and implementation of effective EdTech interventions across the globe and in situations of forced migration within the current context.

1.1. Background

Despite being consistently prioritised by refugee children (Gladwell and Tanner, 2014) and a right enshrined by the United Nations Convention on the Rights of the Child, education is often disrupted by forced displacement. Recent UNHCR statistics uncover the extent of this disruption: an estimated 63% of refugees are enrolled in primary school compared to 91% of children globally, and approximately 24% of refugees are enrolled in secondary school compared to 84% of children globally (UNHCR, 2019: pp. 5–6). There are a number of well-documented challenges related to refugee education, including lack of educational resources, limited availability of schools, overcrowded classrooms and untrained teachers (UNESCO, 2018).

Technology has increasingly been leveraged by humanitarian actors to respond to the significant disruption to the education of refugee children. It is believed to hold "great promise" (Lewis and Thacker, 2016: p.5) in supporting refugee education because of its ability to move with refugee populations, deliver educational content to remote locations at a potentially low cost, and reach those unable to be in school (Joynes and James, 2018).

1.2. Purpose

Lessons learnt from the use of technology for the education of refugees are salient in the current global context. There are several similarities that can be observed between the widespread disruption caused to education by the Covid-19 crisis and that resulting from forced displacement. Namely, educational responses in refugee contexts have had to:

- Respond to significant disruption and adapt education systems with limited time and resources;
- Address the disparities between students in terms of educational levels and the resources and support accessed outside of school;
- Support teachers who may be unprepared or under-trained to respond and adapt to a new situation;
- Support the socio-emotional wellbeing of disrupted learners (UNESCO, 2018).

This evidence review, alongside others, contributes to an emerging evidence base on the use of technology for education during the Covid-19 pandemic, and organises the most relevant literature into coherent themes for the consideration of key stakeholders.

1.3. Application

The insights presented in this RER are expected to be viewed as principles for the planning and implementation process of technology for the education of refugees. The expectation is that readers will use their

own expertise from their local context to apply the appropriate recommendations. This means the recommendations are not specific guidelines that can be applied universally. Patterns of good practice have emerged from the evidence on how, when and why technology can be used for refugee education, and it can be reasonably expected that many of the insights are applicable in the context of widespread educational disruption caused by the Covid-19. The evidence can also inform how education for refugees in LMICs can be adapted during this time.

1.4. Research questions

Two research questions guide the study:

1. What are the key emergent themes in the available literature on the use of technology for education of refugees in LMICs?
2. What are the key learnings and recommendations that can be drawn from the available literature to inform a response to the Covid-19 pandemic?

1.5. Definition and scope of the study

For the purposes of this review, the term refugee is used to describe those who have been forced to flee their homes, in particular as a result of or in order to avoid the effects of armed conflict, generalised violence, violations of human rights or natural or human-made disasters (adapted from IOM's key migration terms, available at www.iom.int/key-migration-terms). The term is used in

this RER to cover both internal displacement (internally displaced persons) and cross-border displacement (refugees).

Another RER focuses on the use of technology to support education in emergencies. While there is some overlap with emergency contexts (see Limitations section) this RER focuses specifically on challenges facing the education of those who have been forcibly displaced as opposed to those living in emergency contexts..

1.6. Theme identification

After conducting a scoping review to compile a list of relevant keywords, a systematic search was conducted for evidence on refugee education. More detail on that process, including the inclusion and exclusion criteria, is provided in the Methodology section. After all screening was completed, 33 papers were selected for analysis. A thematic analysis of these papers led to them being classified into four themes, all of which have sub-themes. Those themes and sub-themes, which are discussed in depth in the Findings section of this review, are:

Continued access to education

- Access to education in displacement contexts
- Forms of education and learning made accessible
- Quality and continuity of education content
- Equitable access to education
- Cost and sustainability considerations

Modalities and pedagogies

- Modalities of delivering education and learning
- Integrating pedagogy into EdTech interventions
- Learner-centred approaches
- Community participation for contextualisation

Supporting educators of refugee children

- Educators of refugee children targeted by EdTech initiatives
- Supporting continuous teacher development
- Enhancing access to teacher training courses
- Practical support to educators and education systems
- Supporting teachers to engage with EdTech resources

Psychosocial support

- Psychosocial wellbeing and EdTech-related pedagogies and modalities
- Game-based EdTech tools
- Nurturing resilience and identity development.

1.7. Structure of the RER

Following this introduction, the methodological approach is discussed, including details of the scoping review, the literature search, eligibility criteria and possible limitations of the methodology. Detailed findings are then presented under the four themes that emerged from a thematic analysis of identified

literature. The report concludes by providing a synthesis of the findings from the literature.

1.8. Methodology

The methodological approach is informed by the Cochrane Collaboration Rapid Reviews Methods Group interim guidance on producing rapid reviews (Garritty et al., 2020). This permits a rigorous and systematic approach while defining the scope narrowly enough that it can be completed within a short span of time.

While the intention was to model this rapid evidence review on a systematic, thematic review of primary studies, it quickly became apparent that there are significant evidence gaps on this topic, particularly in terms of rigorous, quality evaluations or impact studies (Tauson & Stannard, 2018). Consequently, a decision was made to include reviews of other literature or systematic reviews. Higgins and Green (2011) distinguish a systematic review thus:

> "A systematic review is secondary research that seeks to collate all primary studies that fit prespecified eligibility criteria in order to address a specific research question, aiming to minimise bias by using and documenting explicit, systematic methods."

The research process therefore comprised a systematic sequence of scoping, searching and screening. In the scoping phase, the research questions and eligibility criteria were defined and a brief scoping review was conducted to help elicit relevant search terms for the search queries. A focused set of searches was then run within the relevant academic databases. The search

results were then screened according to the inclusion criteria.

1.9. Scoping review

Unlike systematic reviews, the criteria for scoping reviews are not yet well-defined. However, these reviews are widely considered as representing a stage prior to a systematic review where the key concepts and ideas that define a field are explored and discovered in an iterative process (Daudt et al., 2013; Levac et al., 2010). Notably, the scoping review of this study did not aim to map out all the concepts, theoretical or otherwise, included in the scope of technology and refugee education. Instead, it had a more specific focus: to identify keywords and terms that had been used in studies that discuss the use of technology for and in the education of refugees.

The scoping review process began by noting relevant keywords and terms already known to the authors to search for additional literature. The process was iterative, with the terms found in one article leading to searches for other articles that then revealed different, or the same, terms. Using this method, a list of 26 search terms was compiled (see Annex). It is important to draw attention to the point that when a search term brought up an article with a relevant title, those articles were saved to be screened later alongside those that were found during the main literature search explained below.

1.10. Literature search

The literature search began after establishing the search

terms at the end of the scoping review. Google Scholar constituted the primary source of literature. The process used to arrive at the articles that were ultimately thematically analysed in this review is shown in the Annex. It is important to highlight that unlike a more traditional systematic review process, which may screen all search results, the rapid review methodology used herein relied on a system of quotas. As such, only the most relevant results (up to a maximum of 500), as ranked by Google Scholar, were selected for the first round of screening. Seventy-five articles were initially captured for further screening.

It is important to highlight as well that the results were not screened and ranked for quality or limited to peer-reviewed/academic publications. Relying solely on peer-reviewed academic articles would have resulted in a narrower, less generalisable review. Crucially, this would also have excluded a larger number of voices from LMICs due to the systemic factors that exclude many academic researchers in LMICs from mainstream peer-reviewed journals.

1.11. Screening and eligibility criteria

The title and abstract screening, as well as all other subsequent screenings, were conducted according to the eligibility criteria laid out in the Annex. It should be emphasised, though, that the screening criteria were not absolute. For example, when search terms returned a large number of studies, quotation marks were added to core concepts (for example, “education technology”

or “refugee education”) to focus the search on the most relevant literature.

Moreover, while the majority of selected sources met the eligibility criteria, a small, complementary collection of sources that were deemed especially informative, but did not meet all criteria, was referenced. However, these exceptions were only made when an article met all except one of the eligibility criteria. An exception, for example, might therefore be made if a study explored the use of technology for refugee education, but focused on refugee camps in high-income countries.

One limitation of relying on Google Scholar as the primary source of literature was the number of low-quality papers collected. While the title and abstract may have demonstrated the necessary relevance to be captured initially, the substantive content often proved to be of low quality. These, therefore, were only filtered out only after the full text had been read.

Finally, attention is drawn to the other methods that were used to find literature. These involve snowball sampling searches. While the main thrust of the literature review involved a highly systematic approach, we recognised that there might be influential literature that might not be captured through those searches alone. The decision was therefore made to search the reference lists of the most relevant papers found through the systematic literature review for additional sources. Following the search and screening process outlined in the Annex, a total of 33 papers were selected for inclusion in the review.

1.12. Limitations

There are some limitations to this review stemming from the rapid timeframe and the nature of available evidence. These include:

- Limited availability of data: There is an acknowledged and long-standing gap in the evidence base on EdTech and refugee education (Joynes & James, 2018), particularly in terms of rigorous evaluations, impact studies and the perspectives of refugee communities and children (Tauson & Stannard, 2018). Much of the literature examined either draws on narrative summaries of 'good practice' from existing projects in refugee settings (for example, Wagner, 2017) or evidence from EdTech interventions in other low-resource contexts (Joynes & James, 2018).
- Overlaps in the literature: Because of this limited availability of data, it was not always possible to draw from studies that solely focused on the use of technology in pre-tertiary education in refugee settings in LMICs. On some occasions, the literature also incorporated conflict and emergency settings more broadly (notably Tauson & Stannard, 2018; Burde et al., 2015; Carlson, 2013), access to all levels of education, including tertiary education (notably UNESCO, 2018), and refugee education across the globe including in high-income countries (notably UNESCO, 2018).
- The search and inclusion strategy: An inherent limitation of the RER is that the search and inclusion strategy is not, by design, exhaustive and therefore

it is possible that not all relevant literature has been located and included.

2. Systematic review and thematic analysis

2.1. Continued access to education

A prominent theme across the literature examined is the potential of education technology to enable continued access to learning for refugee children which is disrupted in forced displacement.

2.1.1. Access to education in displacement contexts

Type of refugee setting

The literature suggests that technology has the potential to provide access to education in different displacement settings. Camp-based settings are most often discussed across the literature examined (see, for example, UNESCO, 2018). While there is some emerging evidence on EdTech initiatives in urban settings (see, for example, Wagner, 2017, and Baeyer, 2017), UNESCO (2018) notes that relatively few projects have been implemented and evaluated in urban refugee settings. Similarly, while some literature presents examples of technology moving with refugee children on their displacement journeys (see, for example, Wagner, 2017) there is limited evidence on such interventions; instead, it is

technology's potential that is emphasised, such as by Wahyuni and Fatdha (2019).

Type of EdTech used

The type of technology leveraged to provide access to education detailed in the literature includes mobile phones, tablets, computers and, less frequently, radio. Joynes and James (2018) identify two dominant types of media used for refugee education: first, personal smartphones, tablets and other handheld devices promoting mobile learning; and second, 'connected classroom' packages combining computers and digital learning content. Taftaf and Williams (2020), in their literature review on refugee distance education, suggest that the type of technology able to be leveraged for educational purposes varies across urban and camp settings, concluding that refugees residing in urban areas are exposed to a greater variety of technological tools.

Constraining factors

While much of the literature draws on the fact that refugee children and young people are digitally connected (Maitland & Xu, 2016, as cited in Joynes & James, 2018), there are significant challenges that constrain access to technology in refugee contexts. Poor infrastructure across refugee settings — including internet connectivity and electricity — is repeatedly emphasised as undermining the viability of education enhanced or provided by technology (Anderson, 2013; Burde et al., 2015; Kimwise et al., 2019; Lewis & Thacker,

2016; Taftaf & Williams, 2020). Tauson & Stannard (2018) and Unwin et al. (2017) state that the use of technology must respond to the infrastructure in place in refugee settings and assess actually existing conditions.

2.1.2. Forms of education and learning made accessible

The literature outlines emerging evidence on the ability of technology to enhance refugee children's access to formal and informal education and learning.

Access to formal learning

There is evidence that technology can provide increased access to formal learning in schools in refugee contexts (UNESCO, 2018). Technology is often used in this way to overcome the barrier of limited educational resources in classrooms. For example, the Instant Network School programme, implemented by UNHCR and Vodafone, provides schools in refugee camps in Kenya, Tanzania, South Sudan and the Democratic Republic of Congo with equipment, tools and digital educational materials. UNESCO (2018) cites preliminary data from the programme suggesting increased enrolment and retention rates.

Additionally, the literature underscores the potential of open educational resources (OERs) in terms of providing refugee children with rapid access to textbooks and other educational resources at a low cost (UNESCO, 2018; Lewis & Thacker, 2016). However, there are limitations to their use in refugee settings, discussed further in the section on quality and continuity.

Access to non-formal learning in education centres

The literature highlights the use of technology in providing access to non-formal learning in education centres or other settings outside of school (UNESCO, 2018). In particular, a number of articles and papers discuss how EdTech can act as a bridge to formal schooling in displacement by helping children catch up on their study skills, literacy skills and, on some occasions, language learning (Lewis & Thacker, 2016; UNESCO, 2018; Taftaf & Williams, 2020). Tauson and Stannard (2018: p. 37), in their narrative literature review, conclude that technology can "help to fill-in the gaps during disruption and increase the speed with which learners can return to full time education".

Reaching children unable to physically attend school or education centres

Technology is often discussed as being able to reach refugee children unable to physically attend school or education centres, including as a result of insecurity, serious disruption to education systems, or because they are on the move (UNESCO, 2018). The Eneza SMS study tool — providing access to refugee children in Dadaab refugee camps with study materials for primary subjects through SMS content — is referenced as an example of such an initiative (UNESCO, 2018; Wagner, 2017). However, an examination of the literature suggests that these types of initiatives are scarce, adding weight to an argument put forward by Baeyer (2017: p. 453) that education programmes for Syrian refugees in Jordan

rarely design interventions outside of camp settings or community centres or "aim to reach refugees where, for the most part, they really are".

Motivation to learn

The literature tentatively suggests that EdTech can indirectly increase access to learning by enhancing refugee children's motivation to attend school and learn (Tauson & Stannard, 2018; Baeyer, 2017; Wagner, 2017; Tawileh, 2018). For example, Wagner (2017: p. 6) says that, from preliminary observations, "simply introducing Eneza into schools has a direct impact on enrolment and retention as children are excited to be using an innovative learning tool". However, Tauson and Stannard (2018) argue that this should be treated with caution as there is currently not enough robust evidence in the literature to substantiate this claim.

2.1.3. Quality and continuity of education content

The literature confirms that it is not enough to simply increase refugee children's and young people's access to education: the education enhanced or provided by technology must be relevant and high quality (UNESCO, 2018).

Particularly frequently referenced across the literature in this regard is the importance of curricula. While the literature examined does not engage with debates around whether the curricula for refugees should be aligned to home or host countries, the importance of a continuity lens is emphasised. In particular, it is

repeatedly stated that that curriculum must be relevant to local context if children are to fully engage and progress (Tauson & Stannard, 2018; Wagner 2017; Dahya, 2016).

However, the literature suggests that EdTech content is often not contextually or culturally relevant — and this prevents continuity. Lewis and Thacker (2016), UNESCO (2018) and Joynes and James (2018) draw attention to the "scattered" (UNESCO, 2018: p. 6) nature of OERs, which frequently lack quality control, are often unaligned to local curricula, and are rarely provided in languages other than English. Relatedly, Menashy and Zakharia (2019: p. 14) strongly caution against the potential unintended impact of private sector partnerships in leading to the creation of "Northern-driven and decontextualised interventions".

Taftaf and Williams (2020: p. 16) suggest this challenge could be addressed through a 'bottom up' approach to creating EdTech content. Including refugees in the creation of digital content can help them meet the needs of refugee populations. This is elaborated further in the section on pedagogies and modalities.

2.1.4. Equitable access to education

Access for girls and young women

While limited, there is some evidence on the equitable nature of access to education through technology. On the one hand, education technology is discussed as having potential to increase girls' access to education. The programme These Inspiring Girls Enjoy Reading (TIGER Girls) — a programme which provides Syrian

refugee adolescent girls in secondary school in Za'atari refugee camp with access to digital resources and open learning — is an example (UNESCO, 2018; Wagner, 2017). Wagner (2017) cites key findings from a report conducted by Harvard Graduate School of Education that suggests the TIGER Girls programme helped adolescent girls stay in school and increased their desire to learn and improved their academic performance.

However, the literature also stresses the persistent gendered barriers to accessing both education and technology. Tauson and Stannard (2018) conclude that refugee girls are prevented from accessing education technology on an equal footing to their male counterparts. They emphasise that gendered barriers must be considered before engaging in EdTech initiatives that "may exacerbate inequality in society" (Tauson & Stannard, 2018: p. 9). Separate evaluations of UNHCR's Community Technology Access programme and International Education Associations' Digital Learning Innovations in Lebanon reveal higher enrolment rates for boys and young men than for girls and young women (Anderson, 2013; Tawileh, 2018). For Community Technology Access, this was attributed to competing household priorities and a focus on marriage over education (Anderson, 2013). For Digital Learning Innovations, this was initially attributed to cultural perceptions of girls' and boys' interests and a lack of girl-specific programmes (Tawileh, 2018).

Access for children and young people with disabilities

There is limited evidence in the literature on whether

EdTech allows for inclusive education of refugee children with disabilities. Wagner (2017), through her analysis of existing practice on ICTs and education for refugee children, concludes that technology does not always reach the most marginalised refugee children, including those with disabilities. Additionally, the evaluation of the Community Technology Access programme found that those with disabilities were often unable to access computer centres (Anderson, 2013).

Community perceptions

Community perceptions of technology are important in understanding inequitable access to technology. Some children may be prevented from accessing technology because of community and parent perceptions. For example, a study in the Rohingya refugee camps in Bangladesh by Karim and Hussain (2019) found that many research participants viewed technology as unsuitable for providing education.

2.1.5. Cost and sustainability considerations

Issues around the cost-effectiveness of EdTech interventions are frequently raised in the literature and are acknowledged as requiring further evidence (Joynes & James, 2018; UNESCO, 2018).

Cost considerations

Tauson and Stannard (2018) suggest that EdTech interventions can, in some circumstances, represent

value for money. The cost-effectiveness of EdTech interventions depends on the type of technology used, with mobile technology particularly highlighted as being cost-effective when leveraging existing mobile phone infrastructure and usage in refugee settings (Carlson, 2013; UNESCO, 2018).

However, the prohibitive costs of EdTech interventions are often referenced. A number of important considerations make EdTech interventions expensive, including: the provision of hardware, particularly for computer-based interventions (Carlson, 2013); replacing or repairing lost or broken equipment (Tauson & Stannard, 2018); refugees' access to the internet (Lewis & Thacker, 2016; Burde et al., 2015); refugees' access to mobile phone subscriptions (Lewis & Thacker, 2016); and secure storage of equipment (UNESCO, 2018).

Sustainability of interventions

The cost-effectiveness of EdTech interventions is relevant to continued access to education in displacement as it can, alongside infrastructure challenges, undermine the sustainability of projects in the long term (Tauson & Stannard, 2018). Initiatives which are unsustainable may further disrupt educational continuity for refugee children.

This relates to a "do no harm" argument put forward by Dahya (2016: p. 27) in her landscape review of technology in conflict and crisis settings: if a project is unsustainable, leading to "unfulfilled hopes and promises", refugee communities and children may become demoralised and lose faith in education programmes in the long term. Unwin et al. (2017) stress that the sustainability of

an intervention must be considered from the outset and that initiatives should not be "abandoned" (Unwin et al., 2017: p.14) once initial funding has ceased.

2.2. Modalities and pedagogies

The modalities and pedagogies of EdTech and refugees are relevant not only due to the access they provide to continued learning, the emphasis of the previous section, but also due to the nature of that learning. Continuity of access is not a binary issue, and this section addresses the types of learning that exist, and their effects on learners, in more detail.

2.2.1. Modalities of delivering education and learning

The type of technology used can influence the way refugee children learn. The choice of modality should depend on the specific context and take into account what is already available and familiar to the target population (Carlson, 2013; Dahya, 2016), what is economically and logistically feasible, and what the specific needs of the target population are (Baeyer, 2017).

M-learning and e-learning approaches

One notable distinction to be made is between e-learning and m-learning tools. The former require computers and an internet connection, while the latter are based on devices with a wireless connection, such as mobile phones or tablets (Taftaf & Williams, 2020).

Carlson (2013) sees mobile learning as more easily integrated in classroom teaching while other studies (cited in Taftaf & Williams, 2020) consider it useful in isolated areas because of its offline capabilities.

Online and offline capabilities

The literature also states that EdTech tools used in refugee contexts should have both an online and offline component (Dahya, 2016; Lewis & Thacker, 2016). The online side provides the opportunity to gather materials globally, but this should be made available offline to tackle the likely difficulties in internet access (Lewis & Thacker, 2016). Several OER platforms provide offline materials, such as the eGranary Digital Library and KA Lite (Dahya, 2016). Similarly, there are apps and programs that can be used completely or partially offline such as Kolibri and Learn Syria (Dahya, 2016; Lewis & Thacker, 2016).

Blended approaches and the importance of teachers

The literature strongly points to blended approaches that combine technological and human support to complement the strengths and weaknesses of each (UNESCO, 2018; Carlson, 2013; Dahya, 2016; Almasri et al., 2019). Blended learning should incorporate face-to-face, in-person teaching and digital materials (Dahya, 2016), as is the case for the Raspberry Pi for Learning Initiative used by UNESCO in Lebanon (Lewis & Thacker, 2016).

Most of the literature, in fact, agrees on the continued importance of teachers in the learning process:

technology alone is not enough to ensure learning outcomes (Tauson & Stannard, 2018; Dahya, 2016). EdTech, therefore, could be seen as supporting teachers (as will be examined in the next section), and as a tool at their disposal.

2.2.2. Integrating pedagogy into EdTech interventions

The importance of focusing on how EdTech is used over the type of EdTech tool used is repeatedly emphasised in the literature (Tauson & Stannard, 2018: p. 8). While the literature underscores the importance of incorporating a pedagogical approach into the design of EdTech initiatives (UNESCO, 2018; Kamal & Diksha, 2019; Tawileh, 2018), this aspect can often be overlooked (Almasri et al., 2019; Dahya, 2016). However, in an evaluation of the Digital Learning Innovations programme in Lebanon, Tawileh (2018: p. 25) stated that "the [technological] tools and resources alone would have had a very limited effect without the innovations in the process of teaching and learning".

Adapting to the learner's level

EdTech allows teachers to adapt to the learner's level, giving students a greater level of autonomy in their learning pace and ensuring a balance between challenge and progress (Tauson & Stannard, 2018; Almasri at al., 2019). An example is the TIGER girls programme in the Za'atari refugee camp in Jordan, where students can access open and personalised learning material on low-cost digital tablets and can

track their progress on a dashboard. Coaches act as facilitators and can also follow students' progress through the tool, providing support and encouraging peer learning by matching stronger and weaker students to work in the same groups (UNESCO, 2018: p. 55).

Such elements of self-directed learning are seen as particularly useful in large, multi-level classrooms, frequent in refugee contexts: instead of running a standardised lesson, teachers can engage in more meaningful and targeted interaction with the students (Tauson & Stannard, 2018; UNESCO, 2018).

Pedagogy for out-of-school children

While EdTech initiatives seem to be mostly used in a school or community centre environment, with the mediation of a teacher, coach or educator, there are some programmes that target out-of-school children. In such cases, both design and content need to be particularly engaging, relevant for children, and intuitive to use. While evidence is limited, play- and game-based activities to support basic literacy and numeracy skills are often used and appear to demonstrate promise. The "pedagogy" translates into different levels that children go through while playing, gaining rewards when they perform well. Comings (2018) reports on the evaluation of two smartphone-based apps used to increase the literacy of Syrian refugee children in Jordan: Antura and the Letter and Feed the Monster. Although data for the evaluation was limited, the results were promising, with the target group generally performing better than the control one.

2.2.3. Learner-centred approaches

A learner-centred approach is recommended by most of the literature and is adopted by many of the projects that incorporate pedagogy (see, for example, Burde et al., 2015; Carlson, 2013; Dahya, 2016). 'Learner-centred' entails a design that centres around the students' perspectives and allows them a certain level of independence in managing their studies (Almasri et al., 2019). However, traditional, teacher-centred approaches may be prevalent in refugee settings, rather than the active learning solicited by many EdTech applications (Bock et al., 2020; UNESCO, 2018; Kamal & Diksha, 2019). For example, "overcoming traditional models of teaching" (Bock et al., 2020: p. 9) was a major challenge of the Instant School Network project run by the UNHCR in Dadaab camp in Tanzania.

Kamal and Diksha (2019) suggest that there may be challenges related to teachers', students' and communities' beliefs regarding what teaching and learning should look like, compared to what is needed to tackle the challenges of education in displacement. However, even when teachers seem to appreciate the learner-centred approach, the literature suggests that they may not be able or willing to adopt it in their everyday practice, especially if they do not have enough support. Tawileh's (2018) evaluation of two EdTech projects in Lebanon and Jordan supports this: in Jordan, while teachers claimed to appreciate the learner-centred approach involved, surveys with young people revealed that there was very little actual change in teachers' everyday practices.

2.2.4. Community participation for contextualisation

A common problem for EdTech solutions is the converse of one of their biggest advantages: while they can be created by anyone and be easily deployed almost anywhere, this often means a standardised format that does not suit the specific situation, as previously mentioned in relation to OERs (Dahya, 2016; UNESCO, 2018).

The importance of involving the community

It is widely acknowledged that involving the community is key to creating relevant and contextualised EdTech material (Carlson, 2013; Tauson & Stannard, 2018; Lewis and Thacker, 2016; Taftaf & Williams, 2020; Kamal & Diksha, 2019; UNESCO, 2018). Community participation is essential from the early stages of developing an EdTech intervention: an initial assessment can identify technologies that are already available and familiar to the target group, involving lower costs for deployment and a higher likeliness of being used. The community can also be involved through a process of co-creation or co-design of the whole solution, so that final users inform both the type of tool and its content (Alain et al., 2018; Stubbé, 2018; Almasri et al., 2019). The biggest role of community participation, however, is seen in the creation of relevant and contextualised educational content (Lewis and Thacker, 2016; UNESCO, 2018).

Involving the wider community

'Community' can refer to a variety of people that have some connection — direct or indirect — to the educational project, such as parents and carers, community leaders, non-governmental organisations or social workers, teachers, educators and students (Taftaf & Williams, 2020; Alain et al., 2018; Stubbé, 2018; Almasri et al., 2019). Tauson and Stannard (2018) note that contextually appropriate content can make it easier for the families to engage, an aspect crucial in refugee settings (as previously discussed by Karim & Hussain 2019). Moreover, building trust and ownership of the project are essential steps to ensure the buy-in of the community, which will in the end influence the views and the use of the tool (Alain et al., 2018).

Involving students

Students also have a significant role: the TIGER girls programme, for example, has an open learning exchange system called Planet Learning where the girls, supported by facilitators, can add local content that tackles camp problems (UNESCO, 2018: p. 55). In this way the students become educators, which engages them and adds a stronger element of empowerment (Bonasio et al., 2017 cited in Kamal & Diksha, 2019: p. 3).

Involving teachers

Finally, teachers and educators are recognised as being able to significantly contribute to the creation of EdTech interventions (Lewis and Thacker, 2016; UNESCO, 2018). Not only are they best placed to identify relevant

content, they will also be a main user of an EdTech tool and so it is essential for them to feel ownership of it (Lewis and Thacker, 2016). The roles of teachers in relation to EdTech are therefore multiple: as content creators; as content mediators or conveyors; and finally, as receivers, as will be examined in more depth in the next section.

2.3. Supporting educators of refugee children

A common theme across the literature on EdTech in refugee contexts is the use of technology to provide support to teachers and educators, who are key to the quality of education that children access in displacement (Richardson et al., 2018).

2.3.1. Educators of refugee children targeted by EdTech interventions

The skills, background and experiences of teachers significantly vary across and within refugee contexts (UNESCO, 2018). Richardson et al. (2018: p. 32), in their literature review on the teachers of refugees, group teachers into two categories: teachers — both refugees and host country nationals — who are teaching refugee populations; and "refugees who became teachers". The second category, described by Kirk and Winthrop (2007: pp. 718–719) as "spontaneous teachers", often comprises teachers with limited formal training and professional development.

A number of articles in the broader literature emphasise the significant number of under-trained

teachers in refugee settings (see, for example, UNESCO, 2018; Carlson, 2013). While distinctions are not always clear in the literature examined, the target group of technology interventions that support teachers in refugee contexts tends to be untrained teachers. There are exceptions, however, and some initiatives target trained teachers to enhance professional development and to provide specialist information on responding to the distinct circumstances of refugee education (such as the IRC project Connect to Learn (Dayha, 2016) and a planned massive open online course (MOOC) in Lebanon, discussed below).

2.3.2. Supporting continuous teacher development

Technology has been leveraged as a channel through which to connect teachers in refugee contexts with other teachers, both inside and outside of refugee contexts, in order to share learning, experiences and educational practices. A teacher professional development project implemented in Kakuma refugee camp in Kenya — Teachers for Teachers — has often been referenced as an example of how mobile technology has been used in this way (see, for example, UNESCO, 2018; Tauson & Stannard, 2018). Alongside in-person training and peer coaching, the project had a mobile mentoring component. Following training, teachers in Kakuma refugee camp were connected through WhatsApp with other teachers in the project's cohort and with global mentors with which they could share, test and improve teaching strategies (Mendenhall et al., 2018). In an analysis of data collected between 2016 and 2018,

Mendenhall et al. (2018) highlighted the ways in which mobile technology positively affected teacher's professional development, including through building confidence and motivation.

Another study on the use of technology across two teacher training programmes in Dadaab and Kakuma refugee camps in Kenya (Borderless Higher Education for Refugees and the Kenya Equity in Education Program) also examined the potential of mobile technology in supporting teacher learning and development (Dahya et al., 2019). The study found that instant messaging groups were able to facilitate individualised connections between refugee teachers and international instructors. They also discussed "unexpected ways" (Dahya et al., 2019: p. 784) in which refugee teachers in Kakuma refugee camp used instant messaging to establish peer-to-peer networks, using technology to overcome challenges with mobility across Kakuma to actively collaborate with teachers from other schools within Kakuma.

Both studies caution that mobile technology "does not function in isolation" (Mendenhall, 2018: p. 20) and that it cannot replace "face-to-face engagements" (Dahya et al., 2019: p. 786). Across the literature examined, there is a general consensus that technology is most effective in supporting educators when adopted as part of a blended and continuous learning approach, ideally with an in-person component. UNESCO (2018: p. 40) suggests that "technology enables conversational learning [for teachers of refugees], which is otherwise difficult to achieve once in-person training has ended". Additionally, both studies referenced the challenge of sustaining individualised virtual support networks. In particular,

Mendenhall (2018) referenced refugee teachers' and global mentors' demotivation caused by delays in responses (including as a result of time differences), and Dahya (2016) noted global mentors finding engaging in ongoing remote support particularly time-consuming.

2.3.3. Enhancing access to training courses

The literature highlights a small number of examples of technology-enhanced teacher training courses with avenues to certification. Borderless Higher Education for Refugees, previously mentioned in relation to instant messaging groups (Dahya et al., 2019), is a programme that aims to enable training courses for teachers, many of whom are untrained, in Dadaab refugee camp in Kenya (Boškić et al., 2018). This project is often referenced in the literature in relation to providing access to higher education opportunities for refugees, which fell outside of the scope of this report; however, articles which reflect on the programme's value of providing formal teacher training opportunities through technology have been included as relevant (Kirui & Ndalo, 2018 and Boškić et al., 2018). Borderless Higher Education for Refugees — a partnership between universities in Canada and Kenya — used technology to enhance on-site training with access to digital content, including textbooks, videos and articles (UNESCO, 2018), as well as to provide some distance learning components (Boškić et al., 2018). Academics at partner universities — Moi University in Kenya (Kirui & Ndalo, 2016) and the University of British Columbia in Canada (Boškić et al. 2018) suggest that, from their experiences and observations, technology has

the potential to provide access to quality teacher training opportunities otherwise not available in Dadaab. However, Boškić et al. (2018) noted challenges, namely gender-inequitable access to technology and education and technological issues.

Training courses for teachers in refugee settings are also starting to be provided through MOOCS, according to UNESCO (2018). However, evidence on the effectiveness of such initiatives is still emerging. Recognising this, Kennedy and Laurillard (2019) recently conducted mixed methods research to assess the feasibility of using MOOCs to provide specialist teacher training at scale in Lebanon for qualified teachers who may lack the skills and knowledge to respond to the learning and psychosocial needs of Syrian refugee students. MOOCs are found to demonstrate potential; in particular, MOOC platforms can be used to "engage teachers [of refugees] as researchers" through "designing, adapting, and testing learning designs and techniques in the classroom, collecting data, and sharing what they learn with each other" (Kennedy et al., 2019: p. 2). However, in order to fulfil their potential, MOOCs should be co-designed with teachers and local populations.

The importance of adapting teacher training courses to be locally relevant and adaptable to teachers' learning needs is also underscored in the literature (Kennedy et al., 2019; Boškić et al., 2018).

2.3.4. Practical support to educators and education systems

In addition to supporting teachers' pedagogical

approaches and professional development, the literature also sheds light on how EdTech can provide more practical forms of support to teachers, schools and, sometimes, education systems in refugee contexts.

There is some emerging evidence that educators proactively use mobile devices for practical tasks, such as communicating with parents of refugee children or undertaking independent research on teaching practices or content for lessons (Mendenhall, 2018). Joynes and James (2018: p. 15) also draw attention to how technology can help educators use limited school facilities efficiently; by allowing refugee children to study at home or off-site, technology can "relieve pressure on school facilities" which are often stretched in refugee contexts in LMICs.

Joynes and James (2018) also highlight how technology can provide systemic support to education in refugee contexts, particularly through the capture of educational data. They particularly emphasise the ability of mobile devices to rapidly map an educational situation, including the available infrastructure and numbers of teachers and students in a certain location; this can "play an essential role in improving basic operational, planning and controlling functions in education systems" in refugee settings (Joynes & James, 2018: p. 15). Such support can occur at local levels, such as in certain refugee camps, through to national level (UNESCO, 2018). UNESCO (2018: pp. 46–48) provides examples of the use of mobile technology in this way, with OpenEMIS being highlighted as an initiative providing support to education systems in refugee contexts in Malaysia and Jordan.

2.3.5 Supporting teachers to engage with EdTech resources and related pedagogies

Supporting the use of EdTech

Tauson and Stannard (2018) emphasise that the effectiveness of EdTech interventions is dependent on teachers. The literature highlights the importance of ensuring that teachers are appropriately trained to use different technologies and devices used in EdTech initiatives (Tauson & Stannard, 2018; UNESCO, 2018; Lewis & Thacker, 2016; Unwin et al., 2017). Tauson and Stannard (2018) state that EdTech is likely to be unfamiliar to teachers of refugees, as is true in many settings across the globe, and that they must be comfortable using it before adopting it in their teaching. UNESCO (2018) concludes that one-off training on EdTech infrastructure is not sufficient; support must be continuous, and EdTech tools could embed 'real-time' support for teachers into their functionality. Tauson and Stannard (2018) also underscore that EdTech training and support should be adapted to challenges specific to teachers in refugee contexts, including poor infrastructure and teachers' lack of time.

Supporting the adoption of EdTech-related pedagogies

As previously discussed, learner-centred pedagogies may be unfamiliar to teachers of refugees and require "a change in teachers' working habits" (Tauson & Stannard, 2018: p. 49). Tauson and Stannard (2018) state that changing teaching practices can cause additional stress

for refugee teachers already responding to demanding pressures of working in displacement contexts and can have a negative impact on refugee children's learning outcomes. Teachers need time to adjust (Tauson & Stannard, 2018) and should be provided with high quality training and guidance on the level and pace of learning involved when using EdTech (Kamal & Diksha, 2019; Tawileh, 2018).

2.4. Psychosocial support

Although it might not be the primary aim of EdTech initiatives, psychosocial support (PSS) is often associated or evaluated in connection with EdTech tools. While there is limited evidence on the connection between EdTech and refugees' mental health and well-being, there are several points of intersection between the two (UNESCO, 2018).

2.4.1. Psychosocial wellbeing and EdTech-related pedagogies and modalities

Education is widely recognised to provide meaning, normality and stability for refugee children and young people and to support psychosocial wellbeing (UNHCR, 2019; UNESCO, 2018). However, the technology component of EdTech may also support psychosocial wellbeing. For example, Carlson (2013: p. 8) states that:

> "simple, easy-to-use technology builds self-esteem; contextualized educational software reinforces student's identity. Technology which includes two-way

> connectivity enables personal communication which may be highly beneficial for students."

The literature particularly underscores the potential of EdTech to enable communication from local to global level for refugees who may feel trapped in refugee camps (Dryden-Peterson et al., 2017), and to facilitate human support and feelings of connection (UNESCO, 2018). Additionally, through its ability to enable refugee students to connect with and receive support from local and global networks, EdTech may help refugee students feel part of a learning community (Dryden-Peterson et al., 2017).

Additionally, the pedagogical approaches related to EdTech examined earlier carry elements of PSS: they often incorporate play and recreation, encourage the active involvement of students and incorporate life skills such as initiative, teamwork and planning (Tawileh, 2018; UNESCO, 2018).

2.4.2. Game-based EdTech tools

Some game-based EdTech interventions explicitly incorporate PSS elements. For example, the two mobile games developed for the project EduApp4Syria aim to improve refugee children's wellbeing (UNESCO, 2018). An evaluation conducted by Comings (2018) suggests that they successfully supported psychosocial wellbeing. Although this type of app cannot replace face-to-face support, it has the advantage of easily reaching large numbers of children.

Similarly, the mathematical game described in Stubbé (2018) has an added value in engaging out-of-school

children beyond the strictly educational outcomes. This game was found to increase children's self-esteem and image of themselves, which was tentatively attributed to educational gains, the social aspects of learning together (also emphasised by Comings 2018), and the use of ICTs (UNESCO, 2018). However, a report by UNESCO (2018) cautions that while refugee children should be challenged through such games, they should not be overburdened or experience feelings of failure which could undermine psychosocial wellbeing.

2.4.3. Nurturing resilience and identity development

EdTech may also help refugees to come to terms with their experiences. An example of this is the Ideas Box, a portable and customisable multimedia centre providing refugee children in Burundian refugee camps with access to educational and information resources, strongly featuring technology such as computers, mobiles and tablets (UNESCO, 2018). A report using qualitative methods on the project concluded that, among other benefits, Ideas Box provided refugees with a safe and secure space to escape from their daily realities or traumatic thoughts, engage in creativity to stimulate their imagination and rebuild a positive self-image, and access information to help them come to terms with their "painful history" and look towards the future (Lachal, 2015). Overall, it concludes that Ideas Box helps refugees "start a process of resilience that allows them to recover from their traumatic state and overcome their stress and their apprehensions to plan for the future" (Lachal, 2015: p. 28).

Limited evidence suggests that digital storytelling can support identity development processes and expression (UNESCO, 2018). An example provided by UNESCO is the Voices Beyond Walls programme in camps hosting Palestinian refugees in the West Bank and East Jerusalem. This programme engaged marginalised youth in workshops using drama, music, digital video and other modalities to express their perspectives on Palestinian history, culture and life in the camp, as well as their aspirations. An evaluation found that this programme supported "shared satisfaction and identity" (UNESCO, 2018: p. 26). However, the evaluation emphasised the importance of dealing carefully with hidden trauma. Fahed (2020) also identifies the value of digital story-telling modalities in refugee contexts. She discusses Tabshoura Tiny Thinkers, an offline server enabling early childhood education for marginalised children, including refugee children, in Lebanon, which draws on digital story-telling modalities to encourage "autonomy, creativity and analysis" (Fahed, 2020: p.74).

3. Synthesis

The following section offers a synthesis of the findings from the four thematic areas representing the literature. The opportunities and challenges presented by EdTech in refugee contexts likewise reflect potential similarities to those faced in the current crisis in education disruption brought about by Covid-19.

3.1. Continued access to education

The literature identifies a promising role for technology in addressing challenges with access to both formal and informal education in refugee contexts. The literature suggests that technology is being used in refugee contexts to complement formal education in classrooms, to enhance or provide non-formal learning in education or community centres, and to provide location-independent learning when refugee children are unable to be physically present at schools or education centres. The advantage of EdTech appears to be its flexibility and ability to provide education at a distance, move with refugees on their displacement journeys, and reach remote locations.

However, there is no 'one-size-fits-all' EdTech solution. In order to ensure access to quality education for refugee children, the literature repeatedly states that EdTech content must be contextualised, adapted to learners' needs and language, and provide continuity. The literature also cautions that EdTech may not reach marginalised groups, including girls and children with disabilities. Additionally, the sustainability of EdTech interventions are often undermined by cost and the infrastructure in place in refugee contexts. It is important that the sustainability of EdTech interventions is considered from the outset to avoid further disrupting refugee children's education.

3.1.1. Modalities and pedagogies

The literature suggests that the most important part of

an EdTech project is how the content is delivered rather than the specific ICT tool used. There is a broad agreement that technology should support rather than replace teachers, and that blended learning approaches which integrate learner centred pedagogies are important. However, the literature suggests that this can be challenging in refugee contexts where teachers and students are often more familiar with traditional, teacher-centred pedagogies. Involving refugee communities — students, families and teachers — in the design and creation of EdTech interventions is therefore key to the development of contextualised content. In particular, involving teachers can help to ensure that EdTech tools and related pedagogies are adopted in everyday practices.

There is some evidence that EdTech may, through its ability to track students' progress and achievement, offer teachers the opportunity to engage in more personalised and meaningful interactions with students and target support at those who need it. This can be particularly valuable in multi-level classrooms common to refugee contexts.

3.1.2. Supporting educators of refugee children

Teachers are fundamental to the success of EdTech interventions and crucial to the learning process. Some studies point towards the value of technology in providing continuous support to teachers who are often under-trained or unqualified in refugee contexts, with a particular emphasis on technology's potential to facilitate local and global connections and mentoring.

Technology can also provide teachers of refugees with access to more formal teacher training courses at a distance.

Technology, particularly mobile technology, demonstrates potential in providing practical support to teachers teaching in refugee contexts. Mobile technology can also support education systems in refugee contexts more broadly through its potential to capture and analyse key education data.

Teachers should be provided with ongoing support in order to use EdTech tools successfully, particularly if they are unfamiliar with using technology in their teaching practices or learner-centred pedagogies. Steps should be taken to ensure that EdTech does not become a burden in refugee contexts already marked by higher levels of stress for teachers.

3.1.3. Psychosocial support

Finally, EdTech may support refugee children's ability to engage with education and learning by supporting their psychosocial wellbeing. Technology can facilitate social connections at the local and global level, helping refugees feel part of a wider learning community which may be valued by those who feel trapped in camps or other contexts. Moreover, learner-centred pedagogies, when they are included, can support students dealing with stressful or traumatic experiences. They encourage students' active participation and aim to build life-skills that are particularly important in refugee settings.

There is some limited emerging evidence on how game-based EdTech and engaging in creative and imaginative activities in technology-supported

educational spaces can support children's psychosocial wellbeing. Digital story-telling techniques are also beginning to emerge as a way to help refugee students process their displacement experiences and support identity development. However, there remains an evidence gap on this topic.

3.1.4. Relevance to the Covid-19 pandemic

There is an urgent need for robust monitoring and evaluation of EdTech initiatives that move beyond short-term observations to assess the longer-term impact of EdTech on refugee education. Despite persistent evidence gaps, an examination of the literature suggests that technology can support refugee education, and education more broadly, during the Covid-19 pandemic. Promising uses of EdTech in this regard include reaching remote locations, connecting people and resources, adopting learner-centred pedagogies, adapting to student's needs in multi-level classrooms (both in-person and virtual), assisting teachers in and outside the classroom, and supporting children's psychosocial wellbeing.

However, careful planning is needed. Interventions must be contextualised and respond to learners' needs, and communities and teachers should be involved in the planning and development processes. There should be a focus on pedagogies — the 'how' over the 'what' — to ensure quality teaching and learning during this unprecedented time.

PART III
APPROACHES

PERSONALISED LEARNING

Louis Major and Gill Francis

Note that this chapter was first published as the following document, and is reproduced here under the terms of a Creative Commons Attribution 4.0 International licence: Major, L. & Francis, G.A. (2020) *Technology-supported personalised learning: A rapid evidence review*. EdTech Hub. https://docs.edtechhub.org/lib/A2II5ZV7

Summary

This rapid evidence review (RER) provides an overview of existing research on the use of technology to support personalised learning in low- and middle-income countries (LMICs). The RER has been produced in response to the widespread global shutdown of schools resulting from the outbreak of Covid-19. It therefore emphasises transferable insights that may be applicable to educational responses resulting from the limitations caused by Covid-19. In the current context, lessons learnt from the use of technology-supported personalised learning — in which technology enables or supports learning based upon particular characteristics of relevance or importance to learners — are particularly

salient given this has the potential to adapt to learners' needs by 'teaching at the right level'.

This RER provides a summary of the potential benefits of technology-supported personalised learning as well as identifying possible limitations and challenges. It intends to inform educational decision makers, including donors and those in government and NGOs, about the potential to use technology-supported personalised learning as a response to the current pandemic. The findings and recommendations are also anticipated to be of interest to other education stakeholders (e.g. researchers and school leaders).

The RER involved a systematic search for academic and grey literature to address the overarching question: What is known about personalised learning through using technology that can be of value in responding effectively to mass school shutdowns in LMICs? After a rigorous screening process, 24 studies (in 12 countries) published since 2006 were analysed. Details on the inclusion criteria, as well as the associated limitations, are explained in the methodology section. Two specific research questions (RQs) guided the enquiry:

1. How has technology-supported personalised learning been implemented in LMICs?
2. What key themes are reported in the literature that may inform a response to the Covid-19 pandemic?

While a number of potential research limitations must be taken into account, on the whole, an encouraging and positive impact on learning outcomes is reported. Indeed, the RER demonstrates that there is a growing base of strong evidence on the impact of technology-

supported personalised learning to support school-age learners in LMIC contexts.

Research involving a range of digital technologies and learners of various ages is reported. Studies mainly target instruction in mathematics and science although there are examples of research involving the development of non-cognitive skills. Importantly, the RER corroborates previous research which suggests there is no agreed definition of technology-supported personalised learning. It notes that 'personalised learning' does not necessarily mean 'individualised learning'; it can include group-level adaptation and collaborative learning. Levels of personalisation also appear to fall on a continuum of being highly responsive to the user to less responsive. A further interesting finding is that studies report using technology as either a supplementary (providing additional opportunities for students to practice instructional content outside of regular classroom instruction), integrative (using technology during instruction to facilitate teaching and learning), or substitute (investigating the possibility of using personalised technology in lieu of teaching) approach.

Structured according to four themes, the findings of the thematic analysis reveal further insights:

1. **Improving access to education and adapting to the diverse needs of learners:** This theme examines how technology-supported personalised learning enables access to quality educational materials, adapts to learners' needs by 'teaching at the right level', extends learning, and potentially closes educational gaps for the most marginalised.
2. **The role of teachers and appropriate professional**

development: This theme examines the central role of teachers and teacher professional development in enabling technology-supported personalised learning in addition to addressing potential constraints on teaching and learning.

3. **Pedagogical and motivational affordances:** This theme examines the pedagogical affordances of technology-supported personalised learning and the impact this can have on learner motivation.
4. **Potential challenges and barriers in implementation:** This theme examines implications with regard to cost and infrastructure, in addition to potential issues for scalability and sustainability.

The key findings and recommendations from this review are:

- Technology-supported personalised learning appears to offer significant promise to improve learning outcomes, including potentially 'out-of-class' and 'out-of-school' learning.
- The adaptive nature of technology-supported personalised learning to 'teach at the right level' is key as it enables students to learn at their own pace and according to their current proficiency.
- Technology-supported personalised learning may be most beneficial in closing educational gaps for lower attaining students, potentially including those returning to school after an absence.
- Any introduction of personalised learning technology should not be interpreted as decreasing the importance of the teacher, but rather enhancing it.

- Implications for cost and infrastructure are unclear, but using existing hardware solutions is likely to help to reduce costs and increase access.

1. Introduction

The Covid-19 pandemic has resulted in widespread and unprecedented global disruption to education (See: http://en.unesco.org/covid19/educationresponse). Physical distancing policies to suppress the spread of Covid-19, which often advise that students and teachers cannot congregate in schools in the conventional manner, have led to a global expansion of the use of technology within education.

This RER provides a summary of existing research evidence on the use of technology to support personalised learning in LMICs. It offers insights and evidence that can assist in the development and implementation of effective EdTech interventions across the globe and in situations of disruption to education and distance learning within the current context.

1.2. Background

Personalising education by adapting learning opportunities and instruction to individual capabilities and dispositions has been a long-standing objective among educators (Natriello, 2017). Indeed, everyday practice in schools globally almost always involves a degree of personalisation as teachers and students respond to each other's constantly shifting needs, aims

and desires (Beetham, 2005; Holmes et al., 2018). The idea of personalised learning is therefore not new. There are, however, variations in how personalisation is realised in practice.

Research on technology's role in enabling learning that is better suited to the characteristics and needs of learners can be traced back several decades (and even beyond, to groundbreaking work on 'teaching machines' by Pressey and Skinner in the 1920s and 1950s respectively: Holmes et al., 2018). In more recent years, stimulated by the increasing availability and sophistication of digital technology, it has been argued that the adaptive and personalisable affordances of EdTech offer a way of addressing challenges facing education systems around the world. Potentially these affordances can open up new, scalable opportunities for greater personalisation that adjust the learning experience (e.g. based on age, ability, prior knowledge and/or personal relevance; FitzGerald et al., 2018). They may also enable diverse representations of content that reflect learners' own preferences and cultural reference points, in addition to the ability to automatically capture and respond to students' learning patterns with data.

1.3. Purpose

In the context of LMICs in particular, personalised learning carries significant promise in improving the state of education (Zualkernan, 2016): for instance, with regard to identifying and teaching at the 'right' (i.e. the learner's current) level; reducing the negative effects of high pupil–teacher ratios; increasing access to

education; and improving learning outcomes (Kishore & Shah, 2019). The Covid-19 global health emergency has accelerated interest in how EdTech can support personalised learning given the nature of schooling is likely to be seriously affected in the medium to long term due to the introduction of physical distancing, school closures and other policies intended to alleviate the impact of the virus. As a result, there is an urgent need to identify existing research on technology-supported personalised learning in order to inform an effective response to the crisis. This is particularly the case for LMICs where marginalised learners risk falling even further behind. Estimates suggest the pandemic could lead to approximately US$10 trillion of lost earnings over the lifetime of every primary and secondary student globally while substantial reductions in education budgets are also a possibility (Azevedo et al., 2020). This RER, alongside others, contributes to an emerging evidence base on the use of technology for education during the Covid-19 pandemic, and organises the most relevant literature into coherent themes for the consideration of key stakeholders.

1.4. Application

This RER is intended to inform educational decision-makers, including donors and those in government and NGOs, about the potential to use technology-supported personalised learning as a response to the current pandemic. The findings and recommendations are also anticipated to be of interest to other education stakeholders (e.g. researchers and school leaders). Given

that the circumstances surrounding EdTech interventions differ greatly across LMIC and other education systems, as with other related reviews (e.g. Escueta et al., 2017), focusing on research undertaken in LMIC contexts allows for the integration of findings in a way that can yield meaningful policy implications.

1.5. Research questions

This study asks the overarching question: What is known about personalised learning through using technology that can be of value in responding effectively to mass school shutdowns in LMICs?

Two specific research questions (RQs) guide this enquiry:

RQ1. How has technology-supported personalised learning been implemented in LMICs?

- Where has research been undertaken?
- Which learners have been involved in the researched interventions?
- What approaches to technology-supported personalised learning are reported?
- How does technology-supported personalisation relate to learning outcomes?

RQ2. What key themes are reported in the literature that may inform a response to the Covid-19 pandemic?

1.5.1. Definition and scope of the study

Like many concepts in education, there is no universal

definition of personalised learning (Holmes et al., 2018). Indeed, Cuban (2018) describes personalised learning as "like a chameleon; it appears in different forms". According to Cuban, these forms can be conceptualised as a 'continuum' of approaches: from teacher-led classrooms to student-centred classrooms, with 'hybrid' approaches in between. Such ambiguity has led to the idea of personalised learning being conflated with individualised learning and differentiated learning, and sometimes also confused with problem- or inquiry- or project-based learning (Holmes et al., 2018).

Although definitions of personalised learning vary, broadly stated there is agreement that it is learner-centred and flexible, and responsive to individual learners' needs (Groff, 2017). While beyond the scope of the RER, note that the contentious and widely disputed idea of 'learning styles' does not feature in mainstream definitions or approaches to personalised learning (see www.theguardian.com/education/2017/mar/12/no-evidence-to-back-idea-of-learning-styles). As reflected by the keywords used to search the literature (encompassing areas such as computer-aided instruction and intelligent tutoring systems among others; see methodology), an intentionally broad view of technology-supported personalised learning as an 'umbrella' term was adopted from the outset. Influenced by FitzGerald and colleagues (2018), in this RER we conceptualise technology-supported personalised learning as: the ways in which technology enables or supports learning based upon particular characteristics of relevance or importance to learners. This may refer to technology-supported instruction in which: the pace of learning is adjusted; the instructional approach is

optimised for the needs of each learner (e.g. through learning objectives, content or tools); learning is driven by learner interests; learners are empowered to choose what, how and when they learn (Office of Educational Technology, 2017).

1.5.2. Structure of the RER

Following this introduction, the methodological approach is discussed, including details of the scoping review, the literature search, eligibility criteria and possible limitations of the methodology. Then, detailed findings are presented in response to the research questions (including four themes that emerged from a thematic analysis of identified literature). The report concludes by providing a summary of key findings and recommendations.

2. Methodology

The methodological approach for this RER was informed by the Cochrane Collaboration Rapid Reviews Methods Group interim guidance on producing rapid reviews (Garritty et al., 2020) in addition to the framework for undertaking a scoping review (Arksey & O'Malley, 2005; Levac et al., 2010).

2.1. Scoping review

A rigorous and systematic form of secondary research, scoping reviews involve collecting, evaluating and

presenting available evidence at a 'high level'. Differing from 'conventional' systematic reviews in that they are better able to account for studies with varying intentions and designs, scoping reviews provide an accessible and summarised overview of existing research to inform policymakers and other stakeholders (Levac et al., 2010).

Preliminary search terms were developed based on the research questions and after considering the titles, abstracts and keywords of research which was known beforehand to be important and relevant (even if not focusing exclusively on LMICs e.g. the review by FitzGerald et al., 2018). Search terms were iteratively refined during pilot searches that revealed potentially useful studies and terms (identified following further analysis of titles, abstracts and keywords). Using this approach, a final set of 35 search terms was compiled (see Annex).

2.2. Literature search and eligibility criteria

Automated searches were undertaken during May 2020 using Google Scholar and the Searchable PUblication Database (SPUD), an extensive searchable publication database (3+ million records to date) developed by the EdTech Hub team. Unlike a 'traditional' systematic review, which may screen all search results, the rapid review methodology employed relied on a system of quotas. As such, only the most relevant results (up to a maximum of the first 20 pages of results as ranked by Google Scholar) were selected for the first round of screening. In total, the search strings returned 38,335

results across Google Scholar and SPUD, with 198 potential candidate studies being identified through the automated searches.

An overview of the search process is shown in the Annex. The title and abstract screening, as well as all other subsequent screenings, were conducted according to the eligibility criteria, also shown in the Annex. Where research was identified to be potentially important despite not strictly meeting the eligibility criteria this was retained in a complementary collection in case it was useful later. 'Grey literature' (e.g. non-peer reviewed reports) was accepted if relevant to the scope of the RER. All data were shared by the research team through online documents and folders (e.g. Google Docs, Zotero).

After full-text screening according to the eligibility criteria, 41 relevant studies were identified. Nonetheless, the reference lists of studies identified during the automated searches were also examined as a further check to ensure that relevant research was not missed. This 'backward snowballing' strategy resulted in 11 additional studies being identified. Further studies (n=10) were also identified via expert referral. In total, 62 studies were identified. Hassler and colleagues' (2016) adaptation of Gough's (2007) 'weight of evidence' framework was applied to determine those studies of most value. This involved one member of the research team independently scanning identified studies before making an evaluation of 'low', 'medium' or 'high' for each of the following criteria:

- Methodological trustworthiness: the trustworthiness of a study's results based on an

evaluation of the research approach used.

- Relevance to the RER: relevance of a study for the specific purposes of this review, namely how technology-supported personalised learning can be of value in responding effectively to mass school shutdowns during Covid-19.

Any study categorised as 'low' for trustworthiness (n=19), relevance (n=12), or both (n=7) was omitted from further analysis (n=38). Thus these studies were excluded primarily because they reported only minimal empirical findings or considered technology-supported personalisation in a limited way. This process resulted in the inclusion of 24 studies that met a minimum threshold of 'medium trustworthiness' and 'medium relevance'.

To address RQ1, a process of data extraction involving the 24 included studies was undertaken. Initially, this involved extracting data to determine the key characteristics of studies (i.e. where has research been undertaken? Which learners have been involved in the researched interventions? What approaches to technology-supported personalised learning are reported? How does technology-supported personalisation relate to learning outcomes?). Having established this overview of the research landscape, thematic analysis was applied to address RQ2. Whereas data extraction (e.g., numbers of participants) is objective and not interpretive, thematic analysis (or 'thematic synthesis'; Thomas & Harden, 2008) involves telling the story that emerges across the findings reported by the included studies. Informed by established guidelines for narrative syntheses (Ryan,

2013), the research team: read studies to become familiar with their similarities and differences; discussed emerging relationships within and between studies; iteratively revised and refined themes to agree on a final set of themes.

2.3. Limitations

The search only considered English-language research published from 2007 onwards. The choice of keywords used or omitted, publication bias, or the selection and/or nature of digital libraries searched may have had an impact on the eventual findings. Due to the constraints of the RER timeframe, activities such as data extraction and quality assessment were necessarily undertaken primarily by one researcher in a short period of time, and thus some subjectivity or error may have been introduced. Time constraints also likely limited how comprehensively the research questions were addressed. It is also important to note that findings may not be generalisable to the current Covid-19 context, given the majority of reported research was undertaken in a school or 'school-like' context prior to the pandemic. Concerns have also been raised about whether learning gains from using personalised technology are actually attributable to the use of the software (e.g. as opposed to additional lessons conducted by a teacher; Buchel et al., 2020). A further limitation of research in this area is that the software is not always fully described; often the name of the software is omitted, and the full capacity of the software is not outlined. These factors may limit accurate inferences about the degree to which the

reported software was personalised and how. Finally, the broad conceptualisation of technology-supported personalised learning employed resulted in the identification and analysis of a diverse range of heterogeneous studies of varying rigour which may have implications for the interpretation of findings.

Actions to mitigate the potential impact of these issues included undertaking pilot searches, examining the reference lists of included studies for other relevant work ('snowballing' — a process that revealed several commonly cited studies had already been identified thus demonstrating a degree of saturation) and maintaining frequent contact between researchers involved. While the findings of the RER are inherently limited by the quality of evidence available, the application of the quality/relevance assessment helped to mitigate the risk of low-quality or irrelevant research significantly impacting conclusions.

2.4. Theme identification

In the next section we present the findings of the RER. RQ1 contextualises evidence available by outlining the characteristics of research on technology-supported personalised learning in LMICs, including how (and with what impact) this has been implemented. This contextual question provides the basis for informing the thematic outcomes in RQ2, which established four themes (and sub-themes):

Improving access to education and adapting to the diverse needs of learners

- Enabling access to quality educational materials
- Adapting to learners' needs by 'teaching at the right level'
- Extending learning in new ways
- Closing educational gaps for the most marginalised

The role of teachers and appropriate professional development

- The central role of teachers and teacher professional development
- Addressing constraints on teaching and learning

Pedagogical and motivational affordances

- Peer interaction, scaffolding & productivity
- Learner motivation

Potential challenges and barriers in implementation

- Cost
- Infrastructure, scalability and sustainability

3. Findings

RQ1. How has technology-supported personalised learning been implemented in low and middle-income countries?

See a summary of information extracted from included

studies can be found in the following spreadsheet: https://docs.google.com/document/d/1Hkjr70XmDwMVYggzXf0IzAsFO2Tv9q6dA2hjzfjuygM/edit .

Where has research been undertaken?

Evidence on technology-supported personalised learning is continually developing across LMICs. Identified research has assessed the implementation of technology-supported personalised learning in Asia (n=12), Africa (n=6) and Latin America (n=6).

This RER synthesises a total of 24 studies from 12 countries during the period 2007 to 2020: India (n=5), Pakistan (n=1), Nigeria (n= 4), Kenya (n=2), Chile (n=1), Ecuador (n=1), El Savador (n=1), Cambodia (n=1), and rural China (n=6). Note that two interesting studies did not meet the formal inclusion criteria for RQ1 given their focus on the teacher and not students (Stott & Case, 2014; Zualkernan et al., 2013) (their reported findings are, however, considered in response to RQ2). Three additional countries are also reported in two comparative studies: Chile, Mexico and Ecuador were compared in the same experimental study by Casas and colleagues (2014); Brazil, Mexico, and Costa Rica were also compared in the same case study by Ogan and colleagues (2012).

Research addressing technology-supported personalised learning is current and shows that work is ongoing in the field judging by the publication dates of retrieved studies: 2007 (n =1), 2008 (n=1), 2010 (n=1), 2011 (n=1), 2012 (n=2), 2013 (n=3), 2014 (n=2), 2015 (n=3), 2016 (n=2), 2017 (n=1), 2018 (n=2), 2019 (n=3), 2020 (n=2).

In addition, a range of research methods have been employed across different countries. Randomised Controlled Trials (RCTs) were the most common (n=12) and were conducted in rural China (n=6), India (n=4), Cambodia (n=1), and El Salvador (n=1). Quasi-experiments (n=8) were carried out in Nigeria (n=4), India (n=1), and the Latin American countries of Chile, Mexico, and Ecuador. There were 4 case studies; 2 from Kenya, 1 from Venezuela, and one study which compared Brazil, Mexico, and Costa Rica. Note, this classification of 'case study' was applied to studies designed to evaluate the development and implementation of specific personalised learning technologies in LMIC contexts. The four case studies collected both quantitative data (student learning outcomes) and qualitative data (teacher interviews) to assess the efficacy of personalised software (Andallaza et al., 2012; Mutahi, 2015, 2017; Ogan, 2012).

Which learners have been involved in the researched interventions?

Studies involved learners attending primary (n=15) and secondary schools (n= 9). The sample size of the studies overall are considered to be fairly large (minimum sample = 18, maximum sample = 21,936). For instance, an RCT in India by Muralidharan and colleagues (2019) sampled 619 participants, a quasi-experimental study sampled 734 learners across three Latin American countries (Chile, Ecuador and Mexico; Casas et al., 2014), and a case study by Andallaza and colleagues (2012) involved 143 learners from Venezuela.

What approaches to technology-supported personalised learning are reported?

A range of digital technologies are reported to deliver educational content to students in order to maximise opportunities for learning cognitive (test scores or learning outcomes) or non-cognitive skills (social skills, computer proficiency). Note that the Data Description Spreadsheet (https://docs.google.com/document/d/1Hkjr70XmDwMVYggzXf0IzAsFO2Tv9q6dA2hjzfjuygM/edit) includes a list of the personalised technology used in each study; In this context, 'cognitive skills' generally refer to assessment of learning outcomes using tests, and non-cognitive skills include social skills (e.g. Ige, 2019), computer proficiency skills (e.g. Mo et al., 2013), and affective skills (e.g. Andallaza et al., 2012). An interesting observation is the emphasis on assessing cognitive outcomes although learning is of course inextricably linked to non-cognitive skills like students' needs, preferences, socio-emotional development, etc. These have mostly targeted instruction in single subjects: mathematics (n=15), science (n=3), English (n=1), multiple subjects (n=4), and one study addressing social skills.

The introduction to this RER pointed out how there is no agreed definition of technology-supported personalised learning. This is reflected in the varied terminology used by included studies. Common terminologies used to describe research related to 'technology-supported personalised learning' include:

- Computer-assisted learning e.g. Bai et al. (2018), Banerjee et al. (2007)

- Computer-aided Learning e.g. Muralidharan et al. (2019)
- Computer-aided Instruction (CAI) e.g. Carrillo et al. (2011); Ito et al. (2019)
- Intelligent Tutoring Systems (ITS) e.g. Andallaza et al. (2012)
- Cognitive Tutoring Systems (CTS) e.g. Ogan et al. (2012)

The studies which reported using either computer-assisted learning (n=9), computer-aided learning (n=3), or CAI (n=5) appear to use slightly different terms to describe a similar goal. While not all studies provide operational definitions for these terms, two common definitions were observed. Computer-assisted learning is characterised as a type of computer-aided learning which uses computerised instruction, drills and exercises, simulations, and instructional games (Gambari et al., 2016; Lai et al., 2013, 2015), or involves the use of a computer program that offers remedial learning materials in the form of interesting interfaces and games with the aim of improving educational outcomes and interest in learning (Bai et al., 2018; Mo et al., 2013).

In contrast, the studies which reported using ITS (n=3) and CTS (n=4) placed greater emphasis on the affordances the technology provided to the learner. These described how: responses to learner inputs (monitoring and feedback) were provided, content was adjusted to match the level of the learner, and a high volume of user data can be captured as feedback to the learner and teacher. Specifically, ITS are defined as "computer applications that are capable of providing individualised instruction to learners through the use of

artificial intelligence, thereby supporting the learner and facilitating the learning process" (Andallaza et al., 2012, p.1). CTS are defined as a type of ITS that is capable of assessing skill mastery as a student solves problems, and provides context-sensitive hints, error feedback, and adaptive problem selection (Ogan et al., 2012). These adaptive softwares are specifically designed to facilitate self-paced learning through tailoring content to levels of learning (which can free teachers to act as classroom facilitators rather than teaching directly; Ogan et al., 2012).

There appears to be a link between the level of personalisation afforded by the technology and the reported approach to personalised learning. Three levels of personalisation afforded by educational technology were distinguished. Those with 'fewer personalisation affordances' (n=8 studies), 'medium personalisation affordances' (n=6 studies), and 'greater personalisation affordances' (n=10 studies). The classifications 'fewer personalisation affordances' and 'medium personalisation affordances' can broadly be applied to studies reporting personalised learning using approaches like computer-assisted learning, computer-aided learning and CAI. By contrast, studies investigating technology-supported personalised learning using ITS, CTS, or other highly personalised technological software can be described as featuring 'greater personalisation affordances'.

Software featuring fewer personalisation affordances may not use highly sophisticated intelligent software. Generally embedded in their design, however, is the explicit alignment of the software content to the local country's national curriculum, in addition to some level

of personalisation that provides feedback to the learner to support monitoring of learning and progress. Technologies with medium personalisation affordances go beyond aligning the content of the personalised software to the curriculum but also try to coincide use of the software to ongoing class instruction. They also target the level of learner by presenting concepts according to task difficulty and facilitating interactive user feedback. Technologies involving greater personalisation affordances were: highly data driven (examples include data drawn from interfaces and sensors that capture fine-grained user interactions – Mutahi et al., 2015 – or that provide visual feedback on student progress using logs generated during a session, such as the Aplusix ITS in Andallaza et al., 2012); had the potential for interaction (or responsive engagement) between the technology and the learner; involved educational content that was contextualised to meet the local context of the research.

In the present RER, the classifications of 'fewer-', 'medium-' and 'greater-' personalisation affordances are intended to indicate the differences in the extent to which personalisation is affected. Hence, levels of personalisation may fall on a continuum of being highly responsive to the user (e.g., scaffolding learning and providing hints to difficult questions), to less responsive (e.g., by providing activities like exercises for drill and practice, viewing videos linked to questions, and limited feedback such as indicating that user responses are correct or incorrect).

A further interesting finding is that studies implementing technology-supported approaches to personalised learning used the technology as either a

supplementary (n=14), integrative (n=3) or substitute approach (n=2). Further, studies have compared these approaches: supplementary/integrative (n=1), supplementary/substitution (n=1) in addition to attending to software evaluation (albeit involving an analysis of learning outcome data, n=3).

Supplementary approaches provide additional opportunities for students to practice instructional content outside of regular classroom instruction. Such studies typically use additional learning opportunities to provide remedial support through independent practice using a learning software (e.g. Banerjee et al., 2007; Buchel et al., 2020). These have been trialled with software featuring fewer-, medium- and greater-personalisation affordances with content designed to target the different levels of the learner. Variations exist, however, in the extent and quality of engagement and feedback between the learner and the software. Supplementary approaches to personalisation thus complement the quality of instruction available to students. Students can therefore use such technology independently or with teacher guidance (Buchel et al., 2020).

Integrative approaches use the technology during instruction to facilitate teaching and learning. In this approach, the teacher and technology co-exist, where it is the teacher's role to facilitate and reinforce the learning process. They are designed not as supplementary, standalone systems but take into account the teacher, student and classroom interactions (Mutahi, 2015). For instance, the teacher uses technology to complement their lesson instructions by including time for students to use technology (Gambari, 2016b).

During this time the teacher may use the feedback data generated to adjust teaching and re-teach concepts.

Substitute approaches investigate the possibility of using personalised technology in lieu of teaching i.e. where instruction is delivered solely through technology. There is little evidence of technology-supported personalised learning successfully replacing certified teachers or regular teaching. Gambari and colleagues (2015) compared an individualised computer-assisted instructional program to two other non-computer assisted instructional programs. The researchers found no significant differences in learning outcomes among the three groups, implying that neither approach had an advantage.

Two studies designed interventions that compared these approaches with each other (Linden, 2008; Gambari et al., 2016a). Linden (2008) evaluated a computer-assisted learning programme designed to reinforce Indian students' understanding of material presented in class and found this was a poor substitute for the teacher-delivered curriculum and was no better than a complement (supplement) programme delivered using an out of school model. Gambari and colleagues (2016a) study in Nigeria found that an integrative approach – integrating an interactive computer program into chemistry instruction – was no more effective than using conventional teaching methods or a substitute approach (using a computer tutorial instructional package).

In Table 1, an overview of the link between fewer-, medium- and greater-personalisation affordances and the ways in which technology-supported personalised learning has been implemented is outlined. It is worth

recalling that the studies using software with greater personalisation affordances (ITS and CTS) have been the least researched. Further work is required to make affirmative conclusions about the use of any of these approaches.

Table 1. Summarising reported technology-supported personalised learning approaches by the nature of their implementation.

	Fewer personalisation affordances	Medium personalisation affordances	Greater personalisation affordances
	(n=8)	(n=6)	(n=10)
Supplementary (n=14)	3	6	5
Substitute (n=2)	2	0	0
Integrative (n=3)	1	0	2
Supplementary/ integrative (n=1)	1	0	0
Supplementary/ substitution (n=1)	1	0	0
Software evaluation* (n=3)	0	0	3

These studies also attended to an analysis of learning outcomes (n=2).

How does technology-supported personalisation relate to learning

outcomes?

Studies report diverse but broadly positive relationships between technology-supported personalised technology and learning outcomes (Table 2; note that the learning outcomes are summarised to provide a broad overview. Ideally, a meta-analysis that compares effect sizes is a more appropriate way of determining the common effect across different studies and will be the next step towards extending this RER.). It is striking how a relatively limited amount of qualitative or mixed methods research has been undertaken (although as discussed in the Limitations section, this lack of representation may be due to studies being inadvertently filtered out or missed).

Table 2. Summarising reported impact on students' learning (by research method)

	Studies	Positive outcomes	Mixed outcomes	Negative outcomes
RCTs	12	10	2	0
Quasi-experiments	8	4	0	4
Case study	4	3	0	1
Total	24	17	2	5

Note that the studies categorised as mixed outcomes generally found a positive effect on student learning from using the software. However, the effects were small over and above traditional pencil and paper learning (Ma et al., 2020) and the personalised approach was a poor substitute for the teacher-delivered curriculum in comparison to a complementary program which

showed statistically significant gains for the weakest and oldest students in the class (Linden, 2008). The studies within the category 'case studies' were software evaluation studies which trialled newly developed personalised learning software with teachers and/or students to garner feedback on the useability of the tool and users' perceptions. Andallaza and colleagues (2012) collected quantitative data by observing students' affective states while using the software to determine if the software facilitated the development of affective skills. Mutahi and colleagues (2015, 2017) analysed qualitative data via teacher interviews to get feedback on the usability of the software and quantitative software usage data. Ogan and colleagues (2012) presents a qualitative case study featuring teacher interviews.

Of the studies featuring fewer personalisation affordances (Table 1, n=8), five report that the intervention had a negative impact on learning and three report a positive impact. These three studies (all 'supplementary' approaches) were designed to provide remedial instruction that was tightly aligned to the curriculum, teacher instruction and learner feedback.

Similarly, the studies classified as featuring medium personalisation affordances (n=6) all used a supplementary approach that had a positive impact on learning. Moreover, it appears that the effort to contextualise the contents of the software so that it aligns with the national curriculum, classroom lessons or the level of the learner can have profound impact regardless of technology sophistication.

In terms of the impact on learning for studies classified as featuring greater personalisation affordances (n=10): five used a supplementary approach, all of which had

positive impacts on students' learning; two used an integrative approach that also had positive impacts on students learning; and three were software evaluations that reported varying results in terms of impact on learning outcomes.

RQ2. What key themes are reported in the literature that may inform a response to the Covid-19 pandemic?

Building on RQ1, four interconnected themes identified in the literature are now considered. As outlined in RQ1, technology-supported personalised learning has been implemented in three main ways (as a supplementary, integrative or substitute approach). The reported synthesis is intentionally — and necessarily (given the constraints of the RER timeframe and the broad definition of technology-supported personalised learning) — 'high level' as it does not differentiate between the distinct ways in which technology has been used to support personalised learning. Further, the impact of cultural and social differences between different contexts, and the fact that the majority of research relates to mathematics and science education, must be considered when interpreting results from the reviewed studies. Despite these challenges, themes identified are intended to provide an accessible summary of existing evidence so that educators, policymakers and donors might make informed decisions about the potential role of technology-supported personalised learning as a response to the Covid-19 pandemic. Note, findings from two additional

studies, that focus primarily on the role of the teacher, have also been incorporated into the thematic analysis given they provide insights complementing reported themes (Stott & Case, 2014; Zualkernan et al., 2013). Also included are findings reported in two other highly relevant studies undertaken in Latin America, originally published in Spanish, which were identified following the automated search (Perara & Aboal, 2017a, 2017b).

Theme 1: Improving access and adapting to the diverse needs of learners

Enabling access to quality educational materials

Technology-supported personalised learning appears to offer an accessible means by which students can access instructional materials capable of enhancing learning. Thus, such technology can address severe teacher shortages (Ito et al., 2019) and the need for out-of-school learning (e.g. to support homework; Kumar & Mehra, 2018). Established technology-supported personalised learning programs such as Mindspark offer a means to deliver educational content in a variety of settings (in schools, in after-school centres, or through self-guided study). Such solutions are being deployed across increasingly diverse platforms (including computers, tablets and smartphones; Muralidharan et al., 2019), and can be used offline as well as online (Bai et al., 2018; Ma et al., 2020).

In this context, 'quality educational materials' may be evaluated on two levels: (1) technological content carefully developed to be aligned with the curriculum

and instruction at a level of instructional units (e.g. Carillo, 2011; Ito et al., 2019), and (2) lessons being delivered to students (e.g. Mo et al., 2014). As discussed in RQ1, so far much of the evidence points to positive gains when technology-supported personalised learning supplements classroom instruction (Lai et al., 2013; Mo et al., 2014). See Theme 4 for further discussion on potential barriers to equitable EdTech access that may be particularly relevant given the Covid-19 context.

Adapting to learners' needs by 'teaching at the right level'

Somewhat unsurprisingly, the adaptive nature of technology-supported personalised learning is a key emergent theme. For instance, the way this can enable students to learn at their own pace and according to their current proficiency (Ito et al., 2019), including collaboratively (Ogan et al., 2012). Allowing students to work at their own speed using personalised software pitched at their level can avoid potential negative status effects of them being labelled as being in a 'weaker' track, while the dynamic updating of content mitigates the risk of premature permanent tracking of 'late bloomers' (Muralidharan et al., 2019). Even more important is ensuring that the educational content is pitched at the learner's level of proficiency. Here, the technology is used to differentiate instruction in a way that meets the goal of remediation (Banerjee et al., 2007).

While there are several mechanisms by which computer-aided learning can improve teaching and learning, a particularly attractive feature is its ability to

deliver individually customised content for Teaching at the Right Level (TaRL) for all students, regardless of the extent of heterogeneity in learning levels within a classroom (Muralidharan et al., 2019). This can help to directly address one of the main reasons for the general inability to meet desired learning outcomes in LMICs: the inability to meet the heterogeneous learning needs of a large student population with constrained educational resources (Kumar & Mehra, 2018).

Consider the following example reporting the use of a mathematics intervention in urban India. Addressed to all children but adapted to each child's current level of achievement, a technology-supported personalised learning initiative allowed each learner to be individually and appropriately stimulated (Banerjee et al., 2007). Specifically designed to address constraints on effective pedagogy in LMICs, such software may feature the use of an extensive item-level database of test questions and student responses to benchmark the initial learning level of every student; the material being delivered can then be dynamically personalised to match the level and rate of progress made by each individual student (Muralidharan et al., 2019). In addition to allowing for variation in academic content presented, other potential benefits include allowing different entry points and differentiated instruction without the need to reorganise peers in the classroom (including preserving the age-cohort-based social grouping of students; Muralidharan et al., 2019).

Extending learning in new ways

In addition to this capacity to support TaRL, technology-

supported personalised learning appears to offer the potential to promote learning in other ways beyond those previously possible. A randomised controlled trial in Salvadoran primary schools, for instance, reveals not only how computer-assisted personalised learning produces substantial learning gains, but may actually outperform traditional modes of instruction (Buchel et al., 2020). Such a relative advantage seems to be driven by a mismatch between teacher preparation and the complexity of the concepts they have to teach: under traditional teaching models, it seems questionable that children are able to master what their teachers fail to understand. However, technology-supported personalised learning may allow learners to make progress beyond their teachers' content knowledge. Such approaches may thus help to teach or remediate critical deficiencies in both students' and teachers' understandings (Ogan et al., 2012). Researchers including Gambari and colleagues (2016a) have explored using personalised technology as an integrative or blended model where it is used as part of instruction in mathematics and science to address challenges such as a lack of instructional materials and to facilitate the teaching of constructs that are abstract and difficult to understand. While the researchers did not find using computer-simulated instruction during instruction to be more effective than traditional instruction, the study points to a need for research to detangle the contribution of delivering pedagogical content through the teacher versus through the technology.

Closing educational gaps for the most marginalised

Consistent with the promise of technology-supported personalised learning to customise instruction for each student, integrating a novel approach to implementing grade level appropriate material into existing teaching practice can substantially increase learning for students of all baseline learning levels (Muralidharan et al., 2019). Of particular significance during the current context of mass school shutdowns, given many learners will likely require additional support to get to the 'right level' upon returning to school, is a growing collection of evidence that indicates how technology-supported personalised learning may help most in closing educational gaps for marginalised learners. This is evident in examples of studies done in India, rural China and Latin American countries that deliberately target disadvantaged students from low-income backgrounds or aim to address issues relating to quality education (e.g. Carillo et al., 2011; Mo et al., 2013).

Many parents of the most marginalised learners have neither the skills nor the money to provide remedial tutoring, while many teachers often do not have time to give students the individual attention they need. The ability of personalised technology to teach all students equally effectively, for instance as a complementary input to using existing computer resources, has been reported as offering the potential to narrow the urban-rural achievement gap and help disadvantaged populations (Bai et al., 2018). Indeed, students from disadvantaged family backgrounds (Lai et al., 2013), or who have less educated parents (Lai et al., 2015), may

benefit more from such programmes. In settings where students are more likely to be substantially behind grade level, or where there is substantial heterogeneity, the effects of adaptive technology might be larger because technology can personalise education (Ma et al., 2020). As a result, the relative impact of learning gains may be much greater for lower-attaining students (Muralidharan et al., 2019), although arguably such learners may be the most likely to have limited access to required technology.

Positive effects have also been observed with regard to gender, which is indicative of the promising use of computer simulation and tutorial instructional strategies to bridge the academic gaps that might exist between male and female secondary science students (Gambari et al., 2015). Note, however, that other research has reported no similar positive effect for girls, nor indeed for high-performing students irrespective of their gender (Ma et al., 2020). This is something also reported by Kumar and Mehra (2018), who, while finding students with low and medium mathematics attainment benefited significantly from the personalised homework, higher-attaining students did not to the same degree. This might have been because the algorithm offered too many easy questions that could be suboptimal for the learning needs of some high ability students. Other potential explanations include high-attaining students already knowing how to learn effectively (and hence are always more likely to do well), as well as the 'gap' being much smaller in terms of how much they can improve.

Theme 2: The role of teachers and

appropriate teacher professional development

The central role of teachers and teacher professional development

While the exact ways in which technology-supported personalised learning is implemented vary, evidence on the role of the teachers in such implementation is overwhelmingly consistent: any introduction of personalised learning technology should not be interpreted as a loss of the importance of the teacher in teaching. For instance, Buchel and colleagues (2020) found that while students benefited from additional mathematics instruction, the learning gains were greater when this instruction was delivered using personalised learning technology with an experienced teacher over a supervisor who does not offer pedagogical support. It is possible that the availability of the teacher to provide immediate feedback is complemented by the potential of the technology to deliver individualised materials (at the pace and level of the learner) which has benefits for the progress of the whole class.

Overall, the majority of the research on technology-supported personalised learning in LMICs trials supplementary approaches where students used the personalised technology outside of class instruction and without input from the teacher (see RQ1). Importantly, it appears studies that report success typically rely on the teacher or a knowledgeable expert to ensure the quality of the software's instructional content and the alignment between class teaching and further practice

for students. The few studies that have compared substitute and complementary approaches to using personalised technology have consistently reported no advantages when the technology replaces the teacher (Gambari et al., 2016a, 2016b; Linden, 2008).

Thus, reported research should not be interpreted as supporting a reduced emphasis of the role of teachers in education. Rather, since the delivery of education involves tasks that vary for individual students and situations, and requires complex contextually aware communication, technology should be viewed as a complement (rather than substitute) to teachers (Muralidharan et al., 2019). This is, of course, a common message emerging from EdTech research across recent decades and it is no less applicable here. Where a technology-supported personalised learning system is reported to have been used, learners have themselves recognised the role of the teacher as a helpful guide in the learning process (87% of 388 students; Casas et al., 2014).

Using technology in this way can include deploying it to perform routine tasks to free up teachers to spend more time on aspects of education where they have comparative advantages over technology (e.g. such as supporting group learning strategies that can help develop social and other non-cognitive skills; Perara & Aboal, 2017a). Personalised approaches using cognitive tutoring systems that provide self-contained lessons, can help to mitigate common barriers to using educational software (such as the preparation time teachers require; Ogan et al., 2012). In cases where teachers cannot be in class, such technology could potentially assist substitute teachers or aides and supplement existing lessons,

thereby facilitating a dynamic interaction between the teacher, system and learner by tracking student engagement and learning (Mutahi et al., 2015). How personalised technology can provide analytics or support data-analysis-intensive tasks (Muralidharan et al., 2019) is also likely to be an important focus of future research, particularly in those contexts where it is not possible for teachers to be physically present with students. As also highlighted in Theme 1, student progress may be hampered by limited teacher knowledge; hence, investing in the skills of teachers through offering professional development programmes is important (Buchel et al., 2020; Mo et al., 2014). When integrating technology-supported personalised learning approaches, teachers should be trained on the effective pedagogical use of the technology (through seminars, workshops and conferences; Gambari et al., 2016a).

Additionally, there appears to be some limited evidence indicating the effectiveness of electronic tutoring as a tool for promoting conceptual change among in-service teachers themselves. Quantitative data collected from 1,049 South African science teachers who attended 54 in-service teacher workshops suggest that individual use of the software can be effective in developing new knowledge, especially for those who already have relatively high levels of prior knowledge (Stott & Case, 2014).

Addressing constraints on teaching and learning

Providing they are operational and available, reported

personalised technological interventions appear to be well received by teachers (who broadly agree that they offer efficient and effective learning accompaniments; e.g. Mutahi et al., 2017). Teachers' intention to use such systems, however, is strongly dependent on how well the system is aligned with their teaching practices, students' learning habits, and whether the content on the platform is made available in a language that can be understood by students (Zualkerman et al., 2013). Teachers must also reconcile their usual one-size-fits-all delivery model, in line with the order in which their curriculum expects them to teach concepts, with the notion of different pathways for different students.

In addition to enabling 'teaching at the right level' (see Theme 1), personalised learning software may help in addressing other constraints on teaching and learning. For instance, in the case of the Mindspark software, the high quality of content, combined with effective delivery and interface, can help circumvent constraints of teacher human capital and motivation. Algorithms for analysing patterns of student errors and providing differentiated feedback, and follow-up content that is administered in real time, also enable more relevant and more frequent feedback (Muralidharan et al., 2019). As a result, promoting the targeted use of personalised learning technology may be an attractive option for governments and NGOs operating in settings with low teacher quality. This is because learning software can empower teachers to improve the quality of their teaching, particularly when they themselves struggle with particular concepts they have to teach (Buchel et al., 2020). Other ways in which technology-supported personalised learning may support teaching include outside of school uses (e.g.

through easy-to-implement personalised homework; Kumar & Mehra, 2018), and by providing extensive information on student performance to better guide teacher effort in the classroom while not contributing to increasing teacher workload (Muralidharan et al., 2019).

Theme 3: Pedagogical and motivational affordances

There is a close link between the affordances provided by technology and the manner in which it is implemented. Complementing the previous discussion in Themes 1 and 2, in this subsection other potential affordances of technology-supported personalised learning are considered.

Peer interaction, feedback and scaffolding

While the idea of personalised learning may on the surface appear to relate to a more 'solitary' understanding of education, some evidence points to the potential benefits of personalised learning for collaborative working. Peer interaction can be promoted directly through personalised technologies or enabled offline as students use the technology to acquire core knowledge and skills that allows them to contribute to group-based work taking place outside of the technology itself.

For instance, in Ogan and colleagues' (2012) study on the use of mathematics tutoring software in middle schools in Latin America, students collaborated extensively while using a technology primarily designed for individual use; the pace of work was often

interdependent, and work often occurred at classmates' computers in addition to their own. Further, the authors observed that the greater the (group) use in the class, the greater the advantage that the students obtained. Such findings have led to calls for research to explore how personalised technology may be used within classrooms to promote conceptual change through scaffolding and peer tutoring (Araya & Van der Molen, 2013), and active learner participation and classroom dialogue (Stott & Case, 2014). The way that technology-supported personalised learning can enable comparison and competition between peers has also been suggested as a contributing factor to positive learning gains (Brunskill et al., 2010; Bai et al., 2018). Consideration has also been given to how students' social skills might be fostered (Ige, 2019).

While the features of technology-supported learning initiatives differ according to many factors, including the intended audience and deployment location, a case study on how interactive adaptive tutor software (Wayang Outpost) has been used to support mathematics learners (Grades 5-12) in Pakistan is useful in demonstrating how such technology can be designed to support pedagogy by:

- Modelling (introduces the topic via worked examples, making steps explicit, and working through a problem aloud);
- Providing practice with coaching (offering multimedia feedback and hints to sculpt performance to match/resemble that of an expert's);
- Scaffolding (putting into place strategies and methods to support student learning);

- Providing affective support (via characters that reflect about emotions, encourage students to persevere and demystify misconceptions about mathematics problem solving);
- Encouraging reflection (self-referenced progress charts allow students to look back and analyse their performance) at key moments of loss or boredom (Zualkerman et al., 2013).

Such technology features have been reported to improve students' learning efficiency and productivity (Ito et al., 2019) and enable teachers to spend more time on supporting group-based learning strategies that may help build social and other non-cognitive skills (Muralidharan et al., 2019).

Impact on learner motivation

Technology-supported personalised learning appears to be well received by most learners and has a broadly motivational impact as well as improving subject learning. For example, after the implementation of a cognitive tutoring strategy for mathematics learners in Latin America, a high percentage (67%) of students in the intervention group (n=388) increased their motivation toward learning maths, felt more certain about their abilities to solve maths problems (68%), and viewed the technology as a useful tool that substantially helped their learning process (81%; Casas et al., 2014). Other evidence corroborates this conclusion. This includes a study showing that secondary school students in Nigeria performed better on chemistry achievement and motivation tests when compared to

those taught without computer simulations (Gambari et al., 2016a). Positive effects on student interest in mathematics have also been found (whereas there was no effect on maths interest from extra time learning maths; Ma et al., 2020). Indeed, this 'interest-oriented stimulation' is regarded by some researchers as one of the main sources of improvement among students (Bai et al., 2018), although this may in part be due to a novelty effect.

A more general positive impact on student motivation as a result of technology-supported personalised learning is also reported. This includes the adaptive and/or gamified capabilities of technology increasing the probability that students will remain engaged and challenged (Brunskill et al., 2010; Ma et al., 2020), in a way that can significantly increase their interest in learning (Lai et al., 2015) and aspirations for their future education level (Bai et al., 2018; Ito et al., 2019). Trials of emotionally intelligent personalised mathematics software that provides encouragement and support while students learn algebra indicate the creative potential of technology-supported personalised learning to simulate interactions similar to that provided by the teacher (Andallaza et al., 2012). Other research also reveals a strong positive correlation between performance and engagement (Mutahi et al., 2017). Questions remain, however, about whether such motivational benefits manifest across different age and subject groups. For instance, Ito and colleagues (2019) reported only a very slight change in motivation and self-esteem in younger learners following the introduction of a computer-aided instruction programme. Other issues must also be considered, including the problem of questions that do

not challenge those at higher attainment levels (Kumar & Mehra, 2018) or how to prevent learners from 'gaming' a system to get better results (Mutahi et al., 2017).

Theme 4: Potential challenges and barriers in implementation

Cost

As outlined above, due to the constraints of the RER process and scope, we do not differentiate between the distinct ways in which technology has been used to support personalised learning (i.e. whether this is implemented as a supplementary, integrative or substitute approach; see RQ1). Such heterogeneity presents a challenge to drawing firm conclusions about the costs associated with technology-supported personalised learning initiatives. Our findings in this regard are, therefore, tentative and further research is recommended to unpack such factors. Nonetheless, this initial exploration indicates that implementing technology-supported personalised learning need not be prohibitively expensive, even if it may be somewhat more expensive than non-technology based solutions.

Banerjee and colleagues (2007) reported the cost of a non-technology based tutor-led programme for developing primary school literacy and numeracy skills at US$2.25 per student per year, with technology-supported programmes costing $15.18 per student per year (including the cost of computers and assuming a five-year depreciation cycle). In terms of cost for a given improvement in test scores, therefore, scaling up the non-technology based programme would thus be much

more cost effective (if it brings about a similar increase in test scores at a much lower cost). Other research has concluded that the implementation of one personalised-learning technology can be calculated as broadly on par with other interventions to improve student performance in LMICs (e.g. a girls scholarship program, cash incentives for teachers and new textbooks), though less cost-effective than remedial education and teacher training programmes (Linden, 2008). In an experiment by Ma and colleagues (2020), however, the researchers found that the marginal costs of paper workbooks are unsurprisingly lower than those associated with technology and lead to roughly similar effects on academic performance. Importantly they also do not require the high fixed costs and maintenance costs of computers, internet connections, and extra space to securely house such equipment.

Such findings have prompted interest in how lower cost (and less resource-intensive) technology-supported personalised learning initiatives may be implemented in LMIC contexts — for instance, an adaptive multi-user software that splits screen resources and pushes different questions to individual input devices (Brunskill et al., 2010). Beyond an upfront investment, such software can be provided at low cost or even open access, which improves its scalability potential. Another approach includes computer-generated personalised homework, which is reported to be both somewhat effective (showing a 4.16% improvement in exam scores in a study involving 240 students) and inexpensive as associated costs can be spread over a large number of students when applied on a large scale (e.g. less than $1.00 per student; Kumar & Mehra, 2018).

In summary, additional work is needed to explore the cost implications associated with technology-supported personalised learning initiatives. This is a complex matter that boils down to more than the cost of software development or purchasing of a device. Models of technology-supported personalised learning that charge fees may limit the ability of low-income students to access them (Muralidharan et al., 2019). Donated (up-to-date) hardware (Banerjee et al., 2007), 'online' programmes (e.g. Open Educational Resources or Massive Open Online Course) and government-led initiatives may all play a role in enabling greater access to personalised and adaptive learning technology (Muralidharan et al., 2019).

Infrastructure, scalability and sustainability

In a similar manner, further research is needed to determine other factors involved in the broader EdTech ecosystem (including in relation to the potential to scale and sustain technology-supported personalised learning initiatives).

Significant resource constraints and challenges (e.g. intermittent network connectivity, lack of battery power, etc) have been reported in the deployment of technology-supported personalised learning programmes, and this should be a consideration when developing systems for resource-constrained regions or countries (Mutahi et al., 2017). Weak technology infrastructure, poor equipment maintenance, poorly prepared technical support personnel, high frequency of electric supply problems, and unstable connections to the internet have all been reported to present problems;

in addition, such technical difficulties may be more pronounced in students' homes (Araya & Van der Molen, 2013). 'Start-up' costs associated with the development and maintenance of adaptive software have also been flagged as a potential concern, indicating how more research is needed on the trade-offs between adaptive versus non-adaptive software (Ma et al., 2020). In addition to technological deployment (technical issues such as lack of local servers and networks because of poor internet bandwidth and lack of technical assistance for the setup of computer labs), the potential impact of changing political priorities and teachers' attitudes (owing to lack of confidence and engrained practices, particularly for more established teachers) for scalability and sustainability must also be considered (Casas et al., 2014).

While 'traditional' software-based technology-supported personalised learning programmes may sometimes be particularly difficult and costly to implement (compared to other EdTech uses that potentially do not require as high a learner-to-device ratio), solutions that bypass some of these problems have been proposed (e.g. 'online' computer-assisted learning; Bai et al., 2018). Such an approach is reported to eliminate the need to manually install and maintain software in addition to enabling the ability to log in 'anywhere and anytime'. Additional features, such as the integration of social functions (Bai et al., 2018), may open up new avenues for learning. Other personalised approaches, such as computer-generated personalised homework (Kumar & Mehra 2018), have also been reported as relatively easy to implement with minimal need for external monitoring. Moreover, one thing is

clear from the literature: access to technology alone is insufficient (Ito et al., 2019).

4. Recommendations

Personalised learning in LMICs, as both a concept and a practice, remains in its infancy. In general, there is still much to learn about the potential benefits of personalised learning, including how learning environments that can adapt to the unique needs and strengths of students and allow them to have greater ownership of their learning may enable more meaningful and effective education (Groff, 2017). Nonetheless, this RER demonstrates that there is a growing base of evidence on the impact of technology-supported personalised learning to support school-age learners in LMIC contexts.

Following a systematic search of the literature since 2006, 24 studies in 12 countries were identified. On the whole, an encouraging and positive impact on learning outcomes is reported. As previously discussed, the limitations of the RER, heterogeneity of included studies, and fact that the majority of included research reports on the use of technology-supported personalised learning approaches in a school (or school-like) context must be considered when drawing conclusions. Despite these challenges, recommendations can be made to inform educational decision makers, including donors and those in government and NGOs, about the potential to use technology-supported personalised learning as a response to the current pandemic in LMICs:

- Technology-supported personalised learning appears to offer significant promise to improve learning outcomes, including potentially 'out-of-class' and 'out-of-school' learning. This has been successful in providing remedial instruction in mathematics and science. Further research is needed, however, to support these claims and it is important to note that most existing research conducted 'out-of-school' has been in classroom-type settings with support from facilitators. It is also unclear how long any learning gains persist over time.
- The adaptive nature of technology-supported personalised learning to 'teach at the right level' is key as it enables students to learn at their own pace and according to their current proficiency. It can deliver individually customised resources and activities for all students regardless of the extent of heterogeneity in learning levels in the class. Importantly, these adaptive features appear to make a difference to learning, while technology with fewer personalised affordances does not seem to positively impact learning in the same way. Of particular significance in the context of mass school shutdowns, given that many learners are likely to require additional support upon returning to school, is that technology-supported personalised learning may help most in closing educational gaps for marginalised learners.
- Technology-supported personalised learning may be most beneficial in closing educational gaps for lower-attaining students, potentially including those returning to school after an absence. Much of the

evidence points to it being an effective avenue for delivering remedial instruction. Questions remain, however, about whether the approach is as effective for higher-attaining learners. Moreover, 'personalised learning' does not necessarily mean 'individualised learning'; it can include group-level adaptation and some research points to the beneficial nature of student collaboration in this context (as in many others). Indeed, technology-supported personalised learning can also open up a range of other important pedagogical and motivational affordances (e.g. relating to feedback and the scaffolding of learning).

- Any introduction of personalised learning technology should not be interpreted as decreasing the importance of the teacher, but rather enhancing it. Technology-supported personalised learning approaches appear to have promise in helping to teach or remediate deficiencies in student understanding as well as in potentially helping teachers improve their subject and conceptual knowledge. This is particularly important to note when considering low-resource contexts where teaching quality may be low. Such approaches have potential to function as a medium for continuous learning beyond classroom instruction.
- Implications for cost and infrastructure are unclear, but using existing hardware solutions is likely to help to reduce costs and increase access. While significantly more research is needed into the costs associated with technology-supported personalised learning, a number of studies report that such an

approach need not necessarily be prohibitively expensive. Whether the 'added value' of technology-supported approaches is sufficient to merit the additional expenditure remains to be determined. Using existing hardware solutions (e.g. mobile devices or desktop computers in those areas where these are readily available) can clearly help to reduce associated costs and enable greater numbers of students to access personalised learning through technology. In settings without sufficient infrastructure, it is likely that implementation costs will be high.

Further robust quantitative, qualitative and/or secondary research is needed to investigate the various complex and nuanced factors associated with technology-supported personalised learning presented in the RER. In addition to addressing questions relating to cost effectiveness, a particularly important consideration for future research is to understand which approach to the use of technology in personalising student learning will have the greatest impact on learning outcomes (including how this varies according to countries, culture and context). Integrated approaches to design, research and development (e.g. design-based research), that feature close collaboration with practitioners and learners as an integral part of the research process in order to solve 'real-world' educational problems, may be particularly fruitful. Such approaches can help to engender 'buy in' and avoid situations where personalisation technologies developed in higher-income countries are 'parachuted' into LMICs (Zualkernan, 2016). Other avenues of research could

include: rigorous comparison of EdTech personalised adaptive learning and non-EdTech personalised learning approaches; greater consideration of differences in the use of personalised technologies in urban and rural settings; nuanced investigations into learning outcomes (e.g. broken down by gender and level of achievement over time); how the role of teacher may change in the presence of personalised technology; and consideration of the motivational affordances of technology-supported personalised learning from both teacher and learner perspectives (particularly in contexts where a teacher may not be physically present with students).

One important area noticeably absent from the analysis relates to the ethics of technology-supported personalised learning. There are, of course, many assumptions that underpin personalised technologies that warrant scrutiny. This includes whether there is a risk of perpetuating a narrow idea of what it means to 'succeed' academically (e.g. due to an overt focus on 'traditional' learning outcomes such as test scores); whether personalised learning risks promoting individualistic learning aspirations; whether valuing more 'closed' tasks over 'open' ones may be to the detriment of deeper learning experiences; and in what ways personalised data collection impinges upon students' privacy.

It is also worth noting how the majority of research to date has been undertaken in a school context. Many of the most disadvantaged learners will not have regular access to schooling in the traditional sense (much like in the present situation given the Covid-19 pandemic). Future technology-supported personalised learning initiatives should potentially look, therefore, to

specifically target such learners, in particular lower-attaining students who are left behind in 'business-as-usual' instruction (Muralidharan et al., 2019).

ACCELERATED LEARNING

Kalifa Damani

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Summary

This rapid evidence review (RER) provides an overview of the existing literature on the use of accelerated learning in low- and middle-income countries (LMICs), with a focus on how EdTech might best be utilised for accelerated learning. It begins with a broad discussion of the components of accelerated learning, followed by a more focused discussion on how accelerated learning has been used to enhance learning outcomes for marginalised groups in LMICs. An exploration of how EdTech can be utilised for accelerated learning is then presented.

This RER has been produced in response to the novel 2019 coronavirus (Covid-19), and the resulting

widespread shutdown of schools. It, therefore, highlights transferable insights that may be applicable to educational responses resulting from the challenges caused by Covid-19. Amongst those challenges are missed opportunities for education, with many children who were in school prior to the pandemic, falling behind their otherwise expected education level. Those who were previously out of school are falling behind even further. In light of this, measures that help improve the speed and effectiveness of learning are worth considering so that children might better catch-up on lost education. Previous research on accelerated learning can offer insight into the best methods for speeding-up, and potentially making more effective, the learning process. Notably, the RER aims neither to advocate nor discourage the use of accelerated learning in education in response to the Covid-19 pandemic. Instead, it provides an accessible summary of existing evidence on the topic so that educators, policy makers and donors might make informed decisions about the delivery of accelerated learning programmes, and especially through using EdTech.

The RER involved a systematic search for literature about accelerated learning across journals in education, social science and the humanities. Grey literature was also explored. The main studies referenced within this RER are written in the last 20 years and focus on accelerated learning programmes for children in LMICs. Also referenced is literature on how technology has been used to facilitate key pedagogical characteristics associated with accelerated learning, such as learner-centred pedagogy and students' social and emotional learning. There is, however, limited available literature

that specifically explores technology-use and accelerated learning. Therefore the RER discusses EdTech in relation to individual accelerated learning principles instead. Details on the inclusion criteria for the RER, as well as the associated limitations, are explained in the methodology section. As will also be explained, the rapid nature of the review required a focused approach to literature discovery and a thematically guided process of analysis so that a timely response to Covid-19 might be provided. The search strategy was not designed to be exhaustive.

The findings of the thematic analysis of included literature on accelerated learning are structured according to three themes:

1. **Conceptualisations of accelerated Learning.** This theme discusses the history of accelerated learning, as well as what accelerated learning involves in terms of pedagogy and other approaches.
2. **Raising learning outcomes for marginalised groups through accelerated learning.** This theme explores why and how accelerated learning programmes have been used to improve learning outcomes for children who have been marginalised in various ways.
3. **Accelerated learning and EdTech.** This theme discusses how accelerated learning might be facilitated through the use of educational technology in LMICs.

The key findings from this review are:

- Accelerated learning programmes place great

emphasis not only on speeding up learning, but on students' social and emotional learning, safety, interactive learning and flexible education. Across the literature, conceptualisations of accelerated learning differ. However, among the concepts that are commonly involved in such programmes is a focus on students being well supported by teachers, family and community. Also important are students having a psychologically and physically safe learning environment, there being flexibility to adapt to the needs of the learner, and having social interaction and student agency as part of the learning process.

- Accelerated learning programmes can be an effective way to help children who have missed, or fallen behind on, education to catch up. When designing an accelerated learning programme, how much education children have missed, the children's age, the safety of the environment, the level of teacher professional development in accelerated learning, available EdTech, among other factors need to be considered. Different types of accelerated learning programmes are recommended based on those and other factors.

EdTech shows promise as an aid in the delivery of accelerated learning programmes for children, however, the area is under-researched in LMICs. Whilst there has been a great deal of research on accelerated learning and children broadly, and a lesser but still considerable amount on accelerated learning for children in LMICs specifically, there is quite limited evidence on how EdTech can support learning in LMICs. Studies discussing how EdTech can support remedial learning

suggest that it might play a positive role in accelerating learning through facilitating interactivity, learner-centred pedagogy, social and emotional development, giving access to education when children otherwise would not have and as a tool to enhance learners' support systems and assessment. However, due to technology not always being sustainable, feasible, and lacking support through teacher professional development and digital literacy, it is important to also consider non-technology-related education options. More research is needed.

1. Introduction

The Covid-19 pandemic has led to many students missing out on education. Physical distancing policies, to suppress the spread of the novel coronavirus, often advise that students and teachers cannot congregate in schools in the conventional manner. Uncertainty about how and when students might return to school, and how they might catch-up on missed learning when they do, is a challenge faced by many educational stakeholders. Accelerated learning programmes can, however, play an important role in tackling the educational challenges of Covid-19. In this RER, accelerated learning programmes refer to those programmes that aim to speed-up education, or otherwise help students who have 'fallen behind', whether by months or years, to reach the grade level that would be typical of their age. This RER provides a summary of how accelerated learning programmes have been used before the current pandemic, with a special focus on how technology might be used to

facilitate learning as a response to Covid-19. It does this in order to offer insight and evidence that can assist in the development and implementation of effective programmes to help students catch up on learning both during the pandemic, and as the world exits it.

1.1. Purpose

Education has been globally disrupted as a result of the Covid-19 pandemic. Programmes designed to accelerate learning, or to help students to make up for time missed learning at school, are therefore of particular importance. Understanding the evidence on how accelerated learning programmes are applied in different contexts is crucial to informed decision-making in the Covid-19 response. This evidence review, alongside others, contributes to that emerging knowledge base and organises the most relevant literature into coherent themes for the consideration of key stakeholders in their own localised analysis of how to respond to the unique challenges of Covid-19.

1.2. Application

The insights presented in this RER are expected to be viewed as principles for the planning and implementation process of accelerated learning programmes. Many accelerated learning programmes work because the characteristics of, and approaches to, accelerated learning (that will be discussed in Section 3.1) are in place and help to reinforce each other. However, there may be more or less, some or no, need for the

implementation of specific principles based on the unique context that an accelerated learning programme may be applied in. The expectation is that readers will draw on their own expertise from their local context to apply the appropriate recommendations. The recommendations are not specific guidelines that can be applied universally.

1.3. Research questions

Three research questions guide the study:

1. What are the key characteristics of accelerated learning in LMICs?
2. To what extent have educational technologies been used to facilitate accelerated learning? How might these technologies be used?
3. What are the key lessons that can be drawn from the available literature to inform a response to the Covid-19 pandemic?

1.4. Structure of the RER

Following this introduction, the methodological approach is discussed, including details of the scoping review, the literature search, eligibility criteria and possible limitations of the methodology. Detailed findings are then presented under the three themes that emerged from a thematic analysis of identified literature. A brief section on emerging evidence of accelerated learning being used as a response to Covid-19-related learning losses follows. The report

concludes by providing a synthesis of the findings from the literature.

2. Methodology

The methodological approach for this review is informed by the Cochrane Collaboration Rapid Reviews Methods Group interim guidance on producing rapid reviews (Garritty, et al., 2020). This permits a rigorous and systematic approach, while defining the scope narrowly enough that it can be completed within a short span of time. This RER is modelled on a systematic, thematic review of primary studies, reviews, grey and other literature. According to Higgins, et al. (2019):

> "A systematic review attempts to collate all the empirical evidence that fits pre-specified eligibility criteria in order to answer a specific research question. It uses explicit, systematic methods that are selected with a view to minimizing bias, thus providing more reliable findings from which conclusions can be drawn and decisions made (Antman et al 1992, Oxman and Guyatt 1993)."

The research process therefore comprised a systematic sequence of scoping, searching and screening. In the scoping phase, the research questions and eligibility criteria were defined and a brief scoping review conducted to help elicit relevant search terms for the search queries. Then a focused set of searches was run within the relevant academic databases. The search results were then screened according to the inclusion criteria.

2.1. Scoping Review

Scoping reviews involve a rigorous and systematic collection of evidence to inform a summarised and accessible overview; the key concepts and ideas that define a field are explored and discovered in an iterative process (Daudt, et al., 2013; Levac, et al., 2010). Scoping reviews differ from a 'conventional' systematic review in that a greater variety of literature can be incorporated under its framework. Notably, the scoping review of this study did not aim to map out all the concepts, theoretical and otherwise, included in the scope of 'accelerated learning'. Instead, it had a more specific focus: to identify keywords and terms that had been used in studies that discuss accelerated learning, accelerated education, catch-up programmes or other formats of remedial and intensified education programmes. A special emphasis was also placed on the role technology played, or might play, in such programmes.

The scoping review process began by noting relevant keywords and terms that were already known to the author to search for additional literature. The process was iterative, with the terms found in one article leading to searches for other articles that then revealed different, or the same, terms. Using this method, a list of 21 search terms were compiled (see Annex). It is important here to draw attention to the point that when a search term brought up an article with a relevant title, those articles were saved to be screened later alongside those that were found during the main literature search that is explained below.

2.2. Literature Search

Databases, namely Google Scholar and Scopus, were searched for relevant articles. The process used to arrive at the articles that were ultimately thematically analysed is shown in the Annex. It is important to highlight that unlike a more traditional systematic review process, which may screen all search results, the rapid review methodology used relied on a system of quotas. As such, only the top most relevant results (up to a maximum of the top 500 results), as ranked by each database used, were selected for the first round of title and abstract screening.

It is important to highlight as well that the results were not screened and ranked for 'quality' or limited to peer-reviewed/academic publications. Relying solely on peer-reviewed academic articles would have resulted in a narrower, less generalisable review. Crucially, this would also have excluded a larger number of voices from LMICs due to systemic factors excluding many academic researchers in LMICs from mainstream peer-reviewed journals.

2.3. Screening and eligibility criteria

The title and abstract screening, as well as all subsequent screening, were conducted according to the eligibility criteria laid out in the Annex. It should be emphasised that the screening criteria were not absolute. While the majority of sources included for thematic analysis met the eligibility criteria, a number of sources that were deemed especially informative but

did not meet all the inclusion criteria were also included. These exceptions were made when an article met all except one of the eligibility criteria or represented key, theoretical pieces on accelerated learning.

Finally, snowball sampling searches and expert referrals were used to discover relevant research for the thematic analysis. While the main thrust of the literature review involved a systematic approach, it is recognised that some influential sources might not be captured through those searches alone. It was therefore decided to search the reference lists of the most relevant papers found through the rapid evidence review for additional sources. Further, members of the EdTech Hub research team were asked whether they knew of any accelerated learning literature that might be included in the RER. These methods served to expand the literature (31 additional studies were considered) and also acted as an important quality control step, validating the rapid searching strategy.

Upon completion of the literature search and screening process, 95 papers were selected and thematically analysed. The groupings that emerged from that analysis were: Conceptualisations of accelerated learning, Raising learning outcomes for marginalised groups through accelerated learning and Accelerated Learning and Edtech. These three themes provide the structure and coherent organising principle for the discussion of the literature in the section titled 'Findings'.

2.4. Theme identification

The search and screening process identified 95 papers for analysis. A thematic analysis of these papers led to them being classified into three themes:

Conceptualisations of accelerated learning

- The origins of accelerated learning
- Accelerated Learning in the context of LMICs
- Pedagogical characteristics of, and approaches to, Accelerated Learning

Raising learning outcomes for marginalised groups through accelerated learning

- Over-aged and out-of-school children
- Girls

Accelerated learning and EdTech

- What is known and not known: Gaps in the research literature
- EdTech for remedial education

2.5. Limitations

There are some limitations to this review stemming from the rapid timeframe and the nature of available evidence. These include:

- The search and inclusion strategy. An inherent limitation of the RER is that the search and inclusion

strategy is not, by design, exhaustive and therefore it is possible that not all relevant literature has been located and included. Further, the searches were conducted in English, meaning that relevant literature on accelerated learning, in languages other than English – as are often spoken across many LMICs – largely remain unacknowledged.

- Limited empirical evidence. There is limited evidence on accelerated learning using technology in LMICs, and especially as it relates to children. Much of the research on accelerated learning and technology globally is based on higher education. Further, the research on accelerated learning in LMICs largely focuses on delivering primary education, rather than on secondary education, to children who have missed years of foundational schooling; these children are typically over-age, more cognitively advanced, and thus potentially able to learn more in less time. Therefore, the application of lessons learnt from accelerated learning programmes in LMICs, to the context of children at secondary level in LMICs, who have only missed out on a short amount of learning due to Covid-19, should be done cautiously. It might be reasonable to assume that since accelerated learning is quite commonly used in HICs for children's advanced secondary and pre-tertiary education, even when they are not over-age, that it might be possible to use accelerated learning in LMICs for the average secondary-aged child as well. This considered assumption underlies some suggestions made in this RER that accelerated learning might be a potential response to learning

loss – in both primary and secondary education – brought on by the Covd-19 pandemic. However, notably for some children in HICs who partake in accelerated learning on advanced topics, they are believed to also have advanced cognitive abilities. More research is needed before there can be any definitive suggestion that accelerated learning can be effective for children's secondary and advanced education in LMICs, and especially as facilitated by EdTech.

- Limited comparative analysis. Another limitation is that the RER does not rely on comparative analysis to draw insights, but largely on narrative summaries. While an in-depth comparative analysis involving statistical and more comprehensive thematic analysis would certainly be helpful in the future, this was not possible given the diversity of the literature encountered and the time constraints of this review.
- The generalisability of the findings to the pandemic context. Another limitation of this RER is that most of the evidence found does not directly relate to the current Covid-19 crisis. Nevertheless, many of the contextual factors remain consistent, and so valuable lessons might still be learnt.
- Our Positionality. While the EdTech Hub aims to facilitate and encourage global partnerships as they relate to the use of technology in education in LMICs, it is primarily led, funded and based, in HICs. Effort is placed into trying to best represent, and centre, the needs and experiences of children from LMICs, and to critically and empathetically consider their diverse contexts. However, it is recognised that there are limitations in doing so as a 'foreign'

organisation that has shortcomings in the linguistic, and other expertise, relevant for conducting research in various LMICs.

3. Findings

This section provides an analysis of the literature, grouped into the three main themes. The first section will explore the conceptualisation of accelerated learning, including common components of accelerated learning programmes. This will lead into a section that focuses on using accelerated learning for marginalised groups, including discussion of what should be considered when designing accelerated learning programmes. Out-of-school children and girls will be discussed. The final section builds on these discussions to suggest ways in which EdTech might facilitate accelerated learning for children in LMICs. Across all sections, the Covid-19 pandemic context will be considered, and critical considerations will be presented.

3.1. Conceptualisations of accelerated Learning

3.1.1. The origins of accelerated learning

There is no consistent conceptualisation of 'accelerated learning' (Fitzpatrick, 2020). However, broadly speaking, it refers to techniques that speed up the learning process, typically as the consequence of pedagogy and approaches that chiefly aim to encourage deeper and

more intensive learning experiences. Notably, speeding up the learning process is not always the main aim of accelerated learning programmes, but sometimes instead the result of the implementation of more effective learning and teaching practices. These practices commonly, though not always, involve an emphasis on interactivity throughout the learning and teaching process, as well as personalised learning experiences, and less reliance on didactic methods that have been more traditionally used.

When one considers that most learning interventions aim to improve, or speed-up, the learning process, the question justifiably arises: What is the difference between an accelerated learning intervention, and any other intervention aimed at improving or speeding up learning? With the exception of accelerated learning interventions that are designed around condensing the curriculum, or increasing learning hours, differences are difficult to spot. Indeed, there is such a wide variety of programmes self-described as 'accelerated learning' that it can be argued that no real difference exists (Menendez, et al., 2016). However, one might make a distinction between programmes that use more accelerated learning pedagogical principles and approaches, and ones that use less. Accelerated learning programmes, that embrace all aspects of accelerated learning, aim for holistic child development and learning. They may not target one aspect of learning, such as in-classroom teaching, academic learning, or teacher professional development, but instead target multiple levels of education and child development to effect change, with the expectation that learning can take place at a faster pace than typically occurs.

To understand the holistic focus of accelerated learning programmes, it helps to have an appreciation of how the model came into being. The concept of accelerated learning originated from neuroscience and psychological research, and has been developed through the work of many thinkers, including Levin (1988), Lozanov (1979), Smith (2004), Given (2002) and Meier (2000). Through their studies, those, and other, researchers gained greater insights into how the brain processes and recalls information, the environment (and resources within) that encourage learning, and relatedly, pedagogy that stimulate deeper and more effective learning. Insights found on how learning can be sped-up range from focusing on learner-centred approaches (Menendez, et al., 2016), multiple intelligences (Gardner, 2011; Menendez, et al., 2016), learning styles (Silver, et al., 2000; Charlick & Prather, 2004) and learning in a safe, joyous environment that helps promote social and emotional learning (Charlick & Prather, 2004). It is these ideas that form the foundation of how accelerated learning is understood today: as a holistic pedagogical framework. Some of these ideas will be discussed later on in this section.

Notably, some of these traditional principles are contested, namely the ideas of learning styles and multiple intelligences– both of which are routinely conflated (Gardner, 2008; Gardner, 2008). Learning styles have been critiqued on the basis of there not being enough rigorous evidence to support claims of the approach having a significant positive impact on learning outcomes, even when students have learning style preferences, as well as a lack of evidence backing learning styles theories themselves (Pashler, et al., 2008;

Nancekivell, et al., 2020; Newton & Miah, 2017; Gurung & Prieto, 2009). Though there have been critiques of 'general intelligence' being too narrow a concept, the theory of multiple intelligences has been critiqued on the basis of a lack of robust evidence to support the theory. It is also seen as conflating 'intelligence' and aptitude or talent. There are also high correlations between different types of the multiple intelligences and general intelligence, thus suggesting that multiple intelligences are not substantially different from the preceding theory of general intelligence (Visser, et al., 2006). Despite these ideas being contested, they still routinely feature in the accelerated learning literature. However, this review will not explore them further due to the already mentioned critiques.

3.1.2. Accelerated Learning in the context of LMICs

Accelerated learning, as a concept, initially focused on children and adults in HICs where it was, and is still being, used in the education of: children who are academically 'gifted' or believed to be cognitively advanced in certain areas (Steenbergen-Hu & Moon, 2011; Kronborg & Plunkett, 2015; Hemelt & Lenard, 2020; Dare, et al., 2019; Smedsrud, 2018), children who are behind where they would typically be expected to be (Mollette, et al., 2020) and adults in accelerated degree and career-related learning programmes (Cabral & Lambirth, 2018). However, the concept and associated pedagogy have since been widely adopted in LMICs and largely implemented through programmes developed and sustained by non-state education providers (Rose, 2009).

The primary focus in LMICs is commonly on delivering primary and foundational education in literacy and numeracy, alongside life-skills, to children who are behind where they might be expected to be in their education (Menendez, et al., 2016; Power, 2014). These children are typically over-age and/or have been out of school. Accelerated learning programmes in LMICs typically target children who are, and live among, the most disadvantaged communities within those countries, including those affected by conflict and poverty; and the programmes have had considerable success in improving access to education and raising learning outcomes (Power, 2014; Deane, 2016; Bilagher & Kaushik, 2020).

Since accelerated learning programmes in LMICs are often situated among those who are most disadvantaged, they commonly lack the resources (financial, time, etc) necessary to implement a 'full' or holistic accelerated learning programme, such as was originally conceptualised in resource-rich HICs (Boisvert, et al., 2017). Relatedly, they commonly focus on speeding-up learning by condensing the curriculum or removing non-core subject areas, while placing less emphasis on some of the psychological and pedagogical principles that birthed the idea of accelerated learning (Boisvert, et al., 2017). In recent years, this particular 'condensed' conceptualisation of accelerated learning has, instead, been referred to as 'accelerated education' by the Inter-Agency Accelerated Education Working Group (AEWG) (Boisvert, et al., 2017; Shah, et al., 2017). The AEWG further considers accelerated education programmes as being for students who have missed years, as opposed to months of education; they note that

a 'catch-up' programme may be appropriate if only a short period of education has been missed.

Unlike the AEWG's stricter differentiation between 'accelerated learning', 'accelerated education' and 'catch-up programmes', 'accelerated learning' will be used broadly in this review. Herein, accelerated learning therefore includes programmes that aim to speed-up education, or otherwise help students who have 'fallen behind', to reach the grade level that would be typical of their age–regardless of whether they are 'full' or 'condensed' accelerated programmes, for students who are behind on education by months or years, or considered 'remediation programmes'. Further, 'accelerated learning' in the context of this review will refer to accelerated learning with the purpose of having students rejoin or continue on the traditional or established educational trajectories within a country, once they complete an accelerated learning programme or course, so that they might ultimately achieve national primary and secondary qualifications. Unless specifically stated, the literature being referenced therefore does not focus on accelerated learning programmes for 'gifted' students who are already at, or have surpassed, the typical education level achieved for their age and neither does it focus on accelerated learning as a route to alternative certification.

3.1.3. Pedagogical characteristics of, and approaches to, Accelerated Learning

The section details some of the pedagogical characteristics and approaches for accelerated learning that have been found across the literature, alongside

considerations of those characteristics and approaches in light of the Covid-19 pandemic. 'Pedagogical characteristics' refer to teaching practices associated with accelerated learning, while 'Approaches' refer to actions taken to accelerate learning that are less strictly tied to any particular teaching methodology or framework. Notably, these characteristics and approaches are not those listed in any specific theory, but instead have been arrived at through thematically analysing the literature to discover what is common among accelerated learning programmes.

Pedagogical characteristics: cognitive development

The cognitive development of learners is a common focus of accelerated learning programmes (Jaimini, 2014; Charlick & Prather, 2004), as well as of most other educational programmes. Cognitive skills are brain-based functions used to think, reason, learn and remember, make decisions and pay attention – all key to the learning process. However, beyond being a focus of accelerated learning programmes, cognitive development is also a foundational assumption of many accelerated learning programmes in LMICs. Older learners – those who typically tend to participate in accelerated learning programmes – are often more cognitively developed than younger learners, and therefore are better equipped to learn information and concepts that are below their expected grade level, at an accelerated or intensive pace when compared with students who are at the age that is expected of their grade level (Bilagher & Kaushik, 2020; Boisvert, et al.,

2017; Wali & Mustapha, 2019). The fact that older students are more cognitively developed, and at a different developmental stage, also influences how they should best be grouped for accelerated learning, as it may be psychologically detrimental for older learners to group them with younger ones (Boisvert, et al., 2017). The safeguarding of younger learners is also a concern when grouping them with older learners in an accelerated learning programme. This is especially pertinent when grouping younger girls with older boys (Boisvert, et al., 2017).

However, the assumption of being at a further developmental stage, than might be typical of the grade level one is studying, may not as strongly underlie the delivery of accelerated learning programmes as a response to Covid-19 school closures. Unless pandemic-related disruptions continue well into the future, children returning to schooling after Covid-19-related disruptions will likely be at the age and developmental stage that are typical for their grade level – this is apart from those children who were already over-age prior to the pandemic. Therefore, depending on the length of the Covid-19-related disruption, students may not, or may, be a great deal more cognitively developed than they were prior to schooling disruption. Depending on the age and cognitive developmental stage of the students being targeted, the intensity typically associated with accelerated learning programmes may need to be reduced, or adjusted accordingly.

Social and emotional learning and safety

Another characteristic that is commonly present in

Accelerated Learning programmes is that of the promotion of social and emotional learning and wellbeing, and a safe (in terms of health and the broader environment), low-stress learning environment (Acevedo & Hernandez-Wolfe, 2014; Charlick & Prather, 2004; Randall, et al., 2020; Nicholson, 2018). Social and Emotional Learning refers to "the processes through which children and adults acquire and effectively apply the knowledge, attitudes, and skills necessary to understand and manage emotions, set and achieve positive goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions" (Collaborative for Academic, Social, and Emotional Learning, 2012, p.4). However, there is less monitoring and evaluation of social and emotional outcomes, than of cognitive and academic outcomes, in accelerated learning programmes in LMICs (Shah & Choo, 2020).

Both social and emotional learning and safety are important for children in and of themselves. However they also relate to enhanced academic outcomes and the development of cognitive skills (Zins, et al., 2007; Berkowitz, et al., 2017). Whilst social and emotional learning and safety are important in educational programmes generally (Gray, et al., 2011), those characteristics may be especially important in accelerated learning programmes where they can help students cope with the added course intensity (Ramachandran, 2007).

There is further need to consider social and emotional learning and safety when working with vulnerable or marginalised students. Children who have been deprived of opportunities for education sometimes

develop increased motivation, enthusiasm and other social and emotional competencies required for pursuing academic learning. Not having had educational opportunities sometimes fosters great appreciation and motivation to take advantage of the opportunities when they arise (Ramachandran, 2007). However, out-of-school and over-age children, those with disabilities and girls, for example, often also have additional challenges and traumas, placed on them by their environments, that sometimes result in reduced physical safety, poorer health, confidence, motivation and other key social and emotional competencies (Ramachandran, 2007; Acevedo & Hernandez-Wolfe, 2014; Nicholson, 2018).

Discussing accelerating the education of Syrian refugees in Jordan, for example, Shah (2017, p. 6) notes that:

> A strong component of NRC's [Norwegian Refugee Council] programming has been to support children not just academically, but socially and emotionally as well through the inclusion of a strong life skills and PSS [psychological support] component to its programme, as well as by mainstreaming a strong protection component across all its activities. The evaluation found that this focus had demonstrable impacts on the ability of its beneficiaries to regulate their emotions, and improve connections to peers and other adults, as well as their behaviour. More broadly it was also found to have important impacts on their overall state of well-being and sense of safety and security within the camp setting.

An enthusiastic attitude does not offset marginalised children's need for social and emotional learning, appropriate health facilities, safety and other support.

The Covid-19 pandemic has increased the numbers of students dealing with trauma and in a state of educational and socioemotional vulnerability, and has increased the stresses on students who were already marginalised (Clarke, et al., 2020; Cambridge University Press, et al., 2020). The pandemic may not only lead to children's learning loss (Azevedo, et al., 2020), but has already involved a loss of opportunities for children to develop social and emotional relationships with friends (Clarke, et al., 2020). There is consequently even greater need for social and emotional learning, and associated support, as well as its monitoring and evaluation, if students are to catch-up on missed learning, through an accelerated learning programme or otherwise.

Learner-centred and activity-based pedagogy

Accelerated learning programmes are also commonly grounded in the use of learner-centred pedagogy and practice, and interactivity (Akyeampong, et al., 2016; Randall, et al., 2020; Menendez, et al., 2016), which is itself grounded in social constructivist theory (Vygotsky, 1980; Dewey, 1986). Conceptualisations of learner-centred pedagogy vary across the literature, with some conceptualisations of it being narrower than others, or even somewhat contradictory (Bremner, 2020). The conceptualisation of learner-centred pedagogy is not fixed. It exists on a continuum: it can involve some learner-centred practices, and some direct-instructional/teacher-centred practices, and still be considered as 'learner-centred'. Relatedly, the practices incorporated within learner-centred pedagogical frameworks also vary. However, a learner-centred approach can roughly

be thought of as referring to a "pedagogical approach which gives learners, and demands from them, a relatively high level of active control over the content and process of learning. What is learnt, and how, are therefore shaped by learners' needs, capacities and interests" (Schweisfurth, 2013, p. 20). Practices associated with learner-centred approaches therefore tend to facilitate the child's agency and motivation to learn. This sometimes involves a degree of learning personalisation, as might be afforded by smaller class sizes, as well as interactivity – both in terms of student to student interaction and teacher to student interaction, through methods such as dialogic instruction, group-work and play (Schweisfurth, 2015; Lisanza, 2014; Wang, 2018). There is wide-ranging evidence supporting the view that learner-centred approaches, and related practices, can result in greater learning outcomes broadly (Kaput, 2018) and in accelerated learning programmes specifically (Banerji & Chavan, 2016; Rauchwerk, 2017). Learner-centred approaches have also been widely championed by leading international educational donors and non-governmental organisations, such as UNICEF and the UNHCR (Schweisfurth, 2019; UNHCR, 2011).

This championing of learner-centred approaches by donors has been influential in the adoption of the associated approaches for education in LMICs (Chisholm & Leyendecker, 2008; Tabulawa, 2003). However, despite concerted support for such approaches in LMICs, they have achieved fewer success than initially predicted (Schweisfurth, 2015). Limited resources for learner-centred teacher professional development and to support the added time and effort that such approaches often require, alongside frequently large class sizes, often

make learner-centred approaches difficult, or even inappropriate to enact (Schweisfurth, 2015). Further critique has been levied at the approach for insufficiently considering its cultural and ideological applicability to LMICs across the Global South, especially given that much of the research in support of the pedagogy is based on HICs (Tabulawa, 2003). Even in those HICs, learner-centred approaches, while popular, do not have universal support (Clifford, 2015).

Across the literature, there is both support for learner-centred approaches and an appreciation of their shortcomings. There is also an understanding that advocating learner-centred pedagogy need not mean rejecting all direct-instructional pedagogy. Consequently, the overarching message that might be taken from the literature is that learner-centred approaches and practices should be considered when designing an accelerated learning programme, but only insofar as it takes local contexts into account and serves the specific educational needs of a community. Given the specific challenges of Covid-19 – such as remote learning using EdTech, and physical distancing preventing certain levels of interactivity within classrooms – there may be added need for using flexible pedagogical approaches to accelerate learning. Indeed, McAleavy and Gorgen (2020, p. 3) explain that,

> "It is a false dichotomy to propose that undesirable 'teacher-centred' rote learning or desirable 'student-directed [...] the effective remote teacher is a subject matter expert skilled in different aspects of 'direct instruction', including exposition and explanation. At the same time, students are highly engaged in their own learning."

There should be consultation with educators and students in a context, noting where learner-centred inquiry versus, or alongside, direct instruction might be best used for any accelerated learning programme that is developed. Further, it should be kept in mind that a number of LMIC accelerated learning programmes have small class sizes, and are implemented on a small scale by non-state education providers. There is therefore some uncertainty surrounding how the learner-centred approaches, and interactivity of accelerated learning programmes, might be best translated to larger class sizes and scaled up provision by government – as might be the case if accelerated learning is used as a response to Covid-19-related learning losses.

Community-Integrated support

The final pedagogical characteristic of accelerated learning programmes is that of the need for learners to have well-developed support systems (Abreh & Wilmot, 2018). Specifically here, these are support systems in the school (teachers and administration), home (parents and caregivers) and community (Longden, 2013; Hartwell, 2016; Rauchwerk, 2017; Fitzpatrick, 2020; Carter, et al., 2020). The intensive nature of accelerated learning, alongside the common need for flexibility if such programmes are to be successful, often necessitates appropriate teacher professional development as well as holistic social support in the community and otherwise (Hartwell, 2016; Menendez, et al., 2016). Indeed, in some cases, it is the local community that facilitates the establishment and provision of accelerated learning programmes (e.g. Complementary Basic Education:

Akyeampong, et al., 2018 and School for Life: Akyeampong, et al., 2018 – both in Ghana). Parents, caregivers, teachers and community facilitators should ideally be empowered to assist learners in their accelerated learning, and should build relationships with each other, for the benefit of the student. In the absence of such support, children may be unable to engage fully with an accelerated learning programme because of disruptions caused by having too many chores, insufficient time to complete homework, and a general lack of encouragement from, and formal education background among, the adults in their lives (Ramachandran, 2007).

The need for well-developed support systems is especially important during the Covid-19 pandemic, as well as will be in its aftermath. Beyond the already discussed need for children to have socioemotional support to deal with the traumas of Covid-19 – support which parents, caregivers and teachers themselves also need (World Health Organisation, 2020) – are children's need for support in learning at home. The pandemic has resulted in greater instances of education being delivered remotely as well as increased use of blended learning (World Bank, 2020b; McAleavy & Gorgen, 2020). Both remote, and blended learning, though more successful if student's have some degree of autonomy over their learning process, may be even more successful if parents, caregivers, teachers and community facilitators are able to be more supportive in the learning process. This might necessitate investment in parents and caregivers gaining/ developing the knowledge and skills for homeschooling to a greater degree than in recent history. It may also rely on governments and non-

state education stakeholders facilitating the agency of communities to further develop and support accelerated learning programmes.

3.1.4. Approaches to accelerated Learning

As mentioned above, there are also approaches used in accelerated learning programmes that are relatively independent of pedagogy. These are presented below.

Assessment, flexibility and condensed curriculum

Prior to admittance to an accelerated learning programme, as well as during it, establishing a child's educational level and needs, through some form of diagnostic assessment, is important (Baxter & Bethke, 2009; Banerji & Chavan, 2016; Boisvert, et al., 2017; Schwartz, 2012). Needs assessments are essential in ensuring that children who are known to have missed out on schooling, or who have fallen behind on learning, are not placed on courses without the foundational knowledge and skills required, or alternatively, are not placed on courses that repeat what they have already sufficiently learnt.

Whilst diagnostic assessment is a crucial component of many existing accelerated learning programmes in LMICs, insofar as placing children in appropriate learning groupings, its purpose may be different for accelerated learning programmes developed in response to disruptions caused by the Covid-19 pandemic. Students who have missed out on months of schooling, solely due to Covid-19, will have missed out on roughly the same

period of learning, and so may all be able to re-enter schooling in the same grouping they were previously in (Kaffenberger, 2020). However, there will most certainly be some individual and group differences in learning needs. These may be related to the amount of learning that children were able to undertake while away from regular school (a factor heavily influenced by the socioeconomic status of their family and parents/ caregivers ability to support learning) (Vignoles, et al., 2020), individual differences in self-directed learning and the amount of learning they might have forgotten due to a lack of formal practice in school (Kaffenberger, 2020). Consequently, diagnostic learning needs assessment is still important in directing teachers, parents, caregivers and policy makers concerning what level of additional support and remediation a child might need.

Beyond conducting needs assessments of learners if a successful accelerated learning programme is to be run, is the need for flexibility, across multiple domains of a programme. This topic is commonly discussed in the accelerated learning literature (Akyeampong, et al., 2016; Shah, et al., 2017; Menendez, et al., 2016; Börkan, et al., 2015) and relates to flexibility in, for example:

1. adherence to curriculum objectives and policy guidelines – such as a willingness to alter when a stated objective should be achieved, or what is included within it (Baxter & Bethke, 2009);
2. the language of instruction – in many countries that were previously colonised, the official language is not the commonly spoken local language or dialect. However, there is evidence, from Complementary Education programmes (e.g. School for Life ;

Arkorful, 2010), to suggest that many children do not fully grasp concepts taught because it is in a language they are not familiar with. Teaching using a familiar language, or teaching more with a familiar language, can help accelerate learning (Carter, et al., 2020; Abreh & Wilmot, 2018; Akyeampong, et al., 2018; Casely-Hayford & Hartwell, 2010; Zsiga, et al., 2014);

3. the age of children admitted to any specific level of the programme and expectations of children's prior attainment (Boisvert, et al., 2017);
4. schooling hours and schedules – including increasing schooling hours, using shift systems, or otherwise adjusting temporal teaching patterns as necessary to reach all students (Shah, et al., 2017; Banerjee, et al., 2016).

As with the accelerated learning programmes discussed in the pre-Covid-19 literature, accelerated learning programmes that respond to learning disruptions caused by Covid-19 may also need to be flexible in:

1. schooling hours – physical distancing requirements may necessitate temporal distancing, such as through shift systems or part-time learning, so that all students can be safely accommodated in schools (Panovska-Griffiths, et al., 2020). Increased schooling hours may also be necessary to accommodate more intense learning, especially where there are limited provisions for the teacher professional development that might be necessary for improving the effectiveness of teaching;
2. blending learning – varying mixtures of in-person

> and distance (through EdTech and print media) learning may be required to ensure that students can learn, whether they can be in school or not (McAleavy & Gorgen, 2020).

Finally, apart from the need for flexibility, or perhaps included within the framework of 'flexibility', is the consideration of a condensed curriculum as might be necessary when other options for speeding up learning are not feasible (Longden, 2013; Menendez, et al., 2016; Nicholson, 2018). Some accelerated learning programmes omit subjects deemed as unessential so that time and resources might be freed up to spend on subjects considered as core (typically literacy, numeracy and on occasion, science) (Longden, 2013). Curricula can also be less drastically condensed by removing repetitive aspects within subject lessons and ensuring that there is overlap in what is learnt across different subject areas, such that lessons in one subject class can inform learning in another (Boisvert, et al., 2017). These considerations are especially relevant when students or teachers cannot devote more time to catch-up on learning, or there are insufficient human and other resources to support the improvement of pedagogy to facilitate more effective and efficient learning (Boisvert, et al., 2017). Though omitting subject areas might be applied to Covid-19 related learning loss, especially for students who had already lost significant amounts of learning, and have been further disadvantaged due to Covid-19, it may be less necessary for those who have only missed out on a few months of learning. Instead, for students with limited learning loss, reducing repetition, ensuring lesson overlap, or targeting accelerated

learning techniques to the subject areas they find most problematic, might be sufficient.

Formats of accelerated learning classes

This final section on approaches to accelerated learning considers the format of learning delivery. The format can involve:

1. a complementary education programme – this format is commonly used for addressing the needs of students who are outside the formal education system (Baxter & Bethke, 2009; Wang, 2018; Schwartz, 2012; Casely-Hayford & Hartwell, 2010). Examples of programmes using this format are Second Chance (also referred to as 'Speed Schools') by the Luminos Fund (Akyeampong, et al., 2018) and Complementary Basic Education in Ghana (Akyeampong, et al., 2018). Programmes following this format provide education outside of the typical primary and secondary school systems. They are more likely to be successful if they have links to the typical primary and secondary school systems and aim to have students rejoin the conventional education system or achieve nationally accredited qualifications (Fitzpatrick, 2020). This format may be among the least applicable to students who have only missed out on education as a result of Covid-19 disruptions, as those students may be able to reintegrate into the conventional education system with relative ease;
2. more intense lessons – as the name suggests, this format helps accelerate learning by making lessons

more intense, teaching students more and more complex concepts, or giving students special extra attention within the same time frame (Banerjee, et al., 2016; Menendez, et al., 2016). This format is among those that are most reliant on the pedagogical characteristics described previously, as it may require additional pedagogical support and effective teaching;

3. extended learning hours within the normal school day – this format focuses on helping students to catch up on missed learning opportunities by extending teaching and learning time;
4. remedial lessons after-school, on weekends or during school holiday periods – this format offers additional lessons, targeted at addressing the specific needs of learners in all, or specific, subject areas (Banerjee, et al., 2016). An example of a programme using this format is Pratham's Teaching at the Right Level. Notably, Teaching at the Right Level does not aim to accelerate learning, and so technically might not be considered an accelerated learning programme by some definitions. It instead aims to teach students from their point of need. Nevertheless, their approaches might be a useful starting point in the development of accelerated learning programmes as a response to Covid-19 related learning loss;
5. dedicated hours within a regular school day where students are regrouped by education needs – this format relies on setting aside specific time during the school day, where students are regrouped according to their learning needs, as opposed to their grade level. Working with their teachers, focus

is given to building students' competencies in their areas of greatest need. An example of a programme using this format is Pratham's Teaching at the Right Level (Teaching at the right Level, 2020).

3.2. Raising learning outcomes for marginalised groups through accelerated learning

The previous section explored approaches to and the pedagogical characteristics of accelerated learning programmes, with added attention given to their applicability to Covid-19 related learning disruption. This section, however, presents deep dives into two common recipients of accelerated learning programmes: over-aged and out-of-school children, and girls. These 'dives' will be instructive in better appreciating the challenges associated with trying to implement an accelerated learning programme. It will also highlight questions that should be considered when attempting to do so. It showcases what the literature has to say about each group specifically and presents brief illustrative examples of accelerated learning programmes, namely of Speed Schools in Ethiopia and Liberia (Centre for International Education, 2020) and Valorisation de la Scholarisation de la Fille (VAS-Y FIlle!) in the Democratic Republic of the Congo (Development Tracker, 2019). Notably, each group discussed here is not distinct, but intersectional. Therefore, for example, the literature referring to 'girls' cannot be abstracted from 'out-of-school' children', but instead, lessons on 'girls' should be read cognisant that some of them may be out-of-school.

3.2.1. Over-aged and out-of-school children

Accelerated learning for out-of-school and over-aged children is a key focus of the literature from LMICs (Rauchwerk, 2017; Hartwell, 2016; Bilagher & Kaushik, 2020; DeStefano, et al., 2007). Globally, it is estimated that 258 million children and youth are out-of-school (UNESCO Institute for Statistics, 2019). Children who are deemed as over-aged have fallen behind in school by two or more years, while out-of-school children are those who are not currently enrolled in formal education. There are many reasons why children may be out of school, or might be above that age that is typical, or expected, for their grade level. Amongst these reasons are war and conflict in their region/country (Menendez, et al., 2016; Nicolai, 2003), working to help support their family (Rauchwerk, 2017; Ramachandran, 2007), the cost of schooling (Ramachandran, 2007; Randall, et al., 2020; Asante, 2011), as refugees, the absence or inefficiency of policy allowing them to take full advantage of a host country's school systems (Deane, 2016), being too old to re-enter traditional education systems, but too young to enter adult education and natural and other disasters and emergencies (Boisvert, et al., 2017; Babadogan, et al., 2006). Helping out-of-school children to enter or return to education involves targeting programmes to different solutions depending on the reasons for them being out of school, be that financial assistance, improving safety and access to health services or other reasons.

However, even if concerns are addressed allowing out-of-school children to enter the education system (formal or otherwise), there remain challenges to be addressed

within schools. Many children entering, and within, schooling are at different educational levels (Banerjee, et al., 2016), at different ages and there are protection and safeguarding concerns that may arise if older and younger students are put into the same classroom (Boisvert, et al., 2017). Further, enrolment does not necessarily lead to learning; many children who have consistently been enrolled in schools in many LICs have not acquired basic math and language skills (Abreh & Wilmot, 2018; Banerjee, et al., 2016), much less students who have been out-of-school. All of these concerns have been further compounded by the Covid-19 pandemic. Children who were already out-of-school and over-age may be further marginalised in the current climate, with the global financial challenges brought on by the pandemic expected to result in an approximate increase of the global out-of-school population by 2% (Azevedo, et al., 2020). Further, an estimation of learning loss over the 3-months between students transitioning from a Complementary Basic Education programme in Ghana to government schools, estimates losses as between "just over half to more than 100% of the gains attained during the prior year" (Sabates, et al., 2020, p. 26) – this illustrates the urgency of resuming learning in and beyond the Covid-19 context.

Accelerated learning programmes offer a route to helping students quickly catch up on missed learning. Participation in accelerated learning programmes has been shown to result in raised learning outcomes, on average, and relatively higher continuous school enrollment, than participation in conventional education (e.g. Speed Schools: (Akyeampong, et al., 2018; Zerihun, et al., 2019 and Complementary Basic Education:

Akyeampong, et al., 2018). Children in accelerated learning programmes even at times surpass their peers once rejoining conventional schooling (ibid). However, the variety of reasons why children are out of school, alongside their age and prior educational level, may make it difficult to have a one-size-fits-all approach to an accelerated learning programme. In deciding the best route to take in developing a programme for a specific type of out-of-school or over-age child, the literature suggests that a few questions be asked, some of which build on what has already been discussed in Section 3.1. Summarised, these questions, and related considerations are:

1. How much education has a child missed?

    - Limited learning loss: If upon evaluation, students are deemed to not be significantly behind on their schooling, any of the formats discussed in Section 3.1 may be appropriate.
    - Significant learning loss: If students are evaluated as being significantly behind on their learning, and have missed a great amount of time in school, such as over one year, they are likely to have more significant learning loss. A different approach may therefore be needed. Whilst consideration 'a' above still holds if the lost schooling is limited, if students have been out of school for years, then having them immediately return to regular schooling may not be appropriate. Instead, children might benefit most from a complementary accelerated learning programme with a

reduced or condensed curriculum. The aim should be to help them to either return to the formal education system once they've progressed to the expected grade level, or to take the examinations that children in formal school might be working toward.

2. What is the child's educational level and their educational needs?

    - Appropriate diagnostic assessments should be considered.

3. What is the child's age?

    - As discussed in Section 3.1, safeguarding concerns should be considered for younger children and the more advanced cognitive development of older students should be factored in when grouping them. Further, the potentially damaging psychological impact of being grouped with other children of different ages should be considered for students in all age groups.

4. What are the resources available for education?

    - Resources for Teacher Professional Development and Time: If minimal resources are available to support teacher professional development in accelerated learning principles then the accelerated learning programme may have to rely on speeding up learning through

the approaches discussed in Section 3.1. Choosing an appropriate format will, to some extent, depend on the time teachers are able to commit to a programme, as well as the number of teachers that are available to teach.

- Sustainability, Monitoring and Evaluation: Many accelerated learning programmes fail because of a lack of sustainable funding, monitoring and evaluation of the programme. It is crucial that realistic plans are made concerning the scale of a programme; how long an accelerated learning programme needs to be run and how it will be funded. Monitoring and evaluation of the programme and of students' transition out of the programme, need to be considered as well to ensure that all children receive quality education (Fitzpatrick, 2020).

5. Is there a national policy for the integration of complementary accelerated learning programmes and conventional schooling?

    - Complementary accelerated learning programmes are more likely to be successful if they lead to reintegration into national primary and secondary schools, or otherwise lead to nationally recognised qualifications (Fitzpatrick, 2020; Boisvert, et al., 2017).

Box 1. Example of an accelerated learning programme targeting out-of-school children.

Second Chance (Speed Schools)

Organisation: Luminos Fund

Countries it operates in: Ethiopia and Liberia

Target Audience: Over-age and out-of-School children

Learning Focus: Basic skills (literacy & numeracy)

Pedagogical characteristics used: Learner-centred & activity-based, Play, System-wide support, Social and emotional wellbeing

Format: Complementary education programme using individual attention to rejoin mainstream education

Other Approaches: Continuous needs assessment and Condensed curriculum

Status: Ongoing

Additional Reading: (Akyeampong, et al., 2018)

3.2.2. Girls

Although the challenges and solutions discussed above apply to girls, as well as to boys, there are unique considerations that the literature suggests should be taken into account when implementing accelerated

learning for girls who have missed out on education. This section focuses on those considerations.

Girls are a routinely marginalised subsection of the student population in many LMICs, such that their academic outcomes and learning progression are routinely lower than boys' (Indabawa, 2006; Randall, et al., 2020; Ramachandran, 2007; Carter, et al., 2020). Pressure into early marriages, the additional burdens of household chores and childcare responsibilities, a lack of female teachers as role-models, insufficient facilities for female sanitation at schools, pervasive gender stereotypes held by parents, teachers and girls themselves, as well as succeeding in certain subject areas commonly considered as 'masculine' are all gendered concerns (Nicholson, 2018; Evans, et al., 2020; Ramachandran, 2007; Carter, et al., 2020). The picture across LMICs, is not, however, one that can be wholly generalised (Evans, et al., 2020). Whilst in recent years, girls tend to slightly outperform and have greater access to education in a number of Caribbean and Latin American countries, girls in South Asia, the Middle East and sub-Saharan Africa are still well behind boys in educational access and outcomes (Evans, et al., 2020). Across all regions though, and in HICs as well, pervasive gender stereotypes and social norms of girls being caretakers, homemakers, passive, diffident and less analytical than boys means that girls are less encouraged toward success in subject areas such as math and sciences (Miller, et al., 2018). Further, and especially in contexts of war, conflict and with high incidence of crime and sexual violence, girls are less likely than boys to be allowed to travel to school because of increased fears for their safety (Randall, et al., 2020).

Given these broad realities, that centre largely around gendered social attitudes to girls, their additional responsibilities and concerns for their safety, accelerated learning programmes that are designed for girls have had special foci on developing girls' socioemotional well-being, flexible schooling arrangements, life- and vocational- skills development, hiring more female teachers, changing the social attitudes of the support systems around them and developing learning environments and commutes within which they can feel secure (Randall, et al., 2020; Fitzpatrick, 2020; Shah & Choo, 2020; Idara-E-Taleem-O-Aagahi, 2018; Marcus, 2019). These measures are in addition to what has been discussed in the previous subsection. Notably, while accelerated learning programmes can be a route forward for girls who have missed out on education, there should be thorough consideration of the social context within which such a programme is implemented. There is the risk that some parents might choose to keep girls out of school for longer periods because of the knowledge that accelerated learning programmes exist that might help them to catch up later (Ramachandran, 2007). Accelerated learning programmes, of the form that typically exists for children in LMICs, should not be seen as a substitute for quality traditional education routes, but instead as a last resort (ibid.).

Box 2. Example of an accelerated learning programme targeting girls.

Valorisation de la Scolarisation de la Fille (VAS-Y FIlle!)

Organisation: Girls' Education Challenge, Trust Merchant Bank, International Rescue Committee, Save the Children, Catholic Relief Services

Countries it operates in: Democratic Republic of the Congo (primarily in rural areas)

Target Audience: Over-age and out-of-School girls

Learning Focus: Basic skills (literacy & numeracy)

Pedagogical characteristics used: Support-systems, Safety

Format: After-school tutoring, More intense lessons

Other Approaches: Mentoring by past pupils

Status: Completed

Additional Reading: (Randall, et al., 2020)

3.3. Accelerated Learning and EdTech

3.3.1. What is known and not known: gaps in the research literature

Whilst a fair amount of literature explores accelerated learning initiatives in a general sense, there is much less

literature focusing on the role of technology in accelerated learning in LMICs. This is especially true when 'remedial education' more broadly is removed from the expected definitional remit of 'accelerated learning'. Further, while there is wide-ranging literature on EdTech and accelerated learning for higher education, and adult learning (Lowenthal, 2016), the field is much sparser when children are the subject, and especially children from LMICs.

This is not surprising given that EdTech can be expensive to procure, maintain, many students do not have the technological literacy to best capitalise on technology as a learning tool, and EdTech often needs additional teacher professional development and support to be effectively used (Hennessy & London, 2013). Further, many accelerated learning programmes in LMICs operate in communities that are socioeconomically disadvantaged and the projects have limited available funds, and there are often more sustainable learning interventions that a programme's limited funds can be spent on instead of EdTech. Indeed, Sabates,and colleagues (2020, p. 19), in a recent evaluation that explored data on the transition period from complementary basic education, to formal schooling to help estimate learning loss due to Covid-19 school closures, found that "... with respect to having access to a television, radio or mobile phone at home, we did not find statistical differences in relative learning loss for children who had access to at least one of these assets at home and those who did not." Instead, "not being motivated to put forth effort to study lessons learned while in school, being unable to ask for help from primary caregivers or adults in the household, as

well as a lack of books and opportunities to engage in learning activity at home led to the largest relative losses for students" (ibid., p. 26) Sometimes, EdTech is not the best answer (Sancho-Gil, et al., 2019; Selwyn, et al., 2015; Piper, et al., 2016). Only two studies were found that explored relationships between EdTech usage and 'accelerated learning' among children in LMICs (Indonesia and Turkey). Both studies had mixed results and are discussed below.

The Indonesian study used mixed methods and centred around an EdTech (Edmodo) intervention for mathematics learning in secondary education (Yaniawati, et al., 2017). They found that students who learnt using accelerated learning principles, alongside the use of EdTech, were able to better connect mathematical concepts than students who learnt using conventional methods and without EdTech. However, they found no difference in self-regulated learning between students in the accelerated learning and conventional learning groups. Importantly, the accelerated learning principles used in the intervention did not all involve EdTech. EdTech was seen as able to facilitate accelerated learning because of its capability for interactivity and engagement. It was used to help students acquire information according to their own needs, therefore enabling personalised learning, as well as to give them agency in the learning process through searching for the meaning and implications of the problems they encountered. Accelerated learning principles related to student motivation, developing their self-confidence, and sharing and reflecting on what they learnt, were activities engaged in, in the classroom, that did not directly involve EdTech.

The study also did not present a disaggregation of the effects of the EdTech components of the accelerated learning intervention specifically. Instead, it presented effects of the accelerated learning intervention as a whole. It is therefore difficult to confidently say that EdTech for accelerated learning was a significant factor in students' increased mathematical connection capabilities, as opposed to accelerated learning principles more broadly. Further, with little description of what 'conventional learning' involves in the study, it is difficult to know how the accelerated learning intervention substantially differed from conventional learning. Still though, the study presents some initial insight into the potential of EdTech for facilitating accelerated learning, though not roundly confirming its effectiveness.

The second study, based in Turkey (Akbıyık & Şimsek, 2009), compared whether accelerated learning in a computer environment had a different impact on student achievement than accelerated learning in a classroom environment. The study was experimental and focused on teaching science to primary school children. The aspects of accelerated learning explored in the study revolved around ensuring that students felt calm and secure in their learning environment, that they believed the authority of the teacher, as well as were able to engage in interactive, positive and fun activities. There was extensive use of classical and baroque music, and teaching using rhythm and intonation, to help students to relax, as well as to help them consciously and unconsciously process information. Results showed that there was no difference in students' achievement, whether they were taught using accelerated learning in

a computer environment, or in a classroom environment. However, students' achievement was higher in accelerated learning environments than in expository learning environments. Expository learning environments involve direct instruction and the use of examples to help illustrate concepts. In the cited study, it also involved gaining students' attention, motivation, revision, learning activities and summarising work. The study therefore showed that while EdTech might be helpful for accelerated learning, it was not additionally helpful. However, there should be some caution in generalising the results to many other LMICs in the Global South as the theoretical model of accelerated learning used was notably Eurocentric in nature, particularly with the types of music that are central to the version of accelerated learning explored in the study. Further, it is based on a version of accelerated learning (Suggestopedia), some of whose tenets have been critiqued as pseudoscience (Richards & Rodgers, 2012).

With only two studies substantially exploring EdTech and accelerated learning among children, this remains an area of research within which there are many gaps. Consequently, much of the insights in the remainder of this section will be based on literature that does not discuss accelerated learning narrowly, but instead technology for effective education delivery more broadly, with special focus on remedial education and EdTech for facilitating learner-centred pedagogy (a key component of accelerated learning programmes). Alongside the discussion of such literature, will be critical inference of how accelerated learning principles might be aided by EdTech. This inference will be built on insights from the discussion of accelerated learning in the previous

sections and an exploration of EdTech for education more broadly, and especially in the context of the Covid-19 pandemic.

3.3.2. EdTech for remedial education

As suggested in the previous sub-section, there are promising signs that technology can support accelerated learning. With reference to the groups of learners discussed in Section 3.2, evidence also points to EdTech being a useful tool for the empowerment of even the most marginalised students; such as girls, and perhaps even more so than for boys, if girls are given equal, and equitable, access to it (Webb, et al., 2020). More, though less direct, evidence of EdTech being a potential tool to promote accelerated learning for all learners can be seen when research is explored on how technology can be used for facilitating the pedagogical characteristics of, and approaches to, accelerated learning as outlined in Section 3.1. Firstly, this section discusses the personalisation of education delivery, followed by how technology enables access to education when otherwise there would not be and how EdTech might facilitate adults' further support for children's education. Within those discussions the characteristics of, and approaches to, accelerated learning are explored so that a sense of how different technologies might facilitate accelerated learning can be considered.

Personalised delivery of education through EdTech

Whilst there is no consensus on what 'personalised

learning' specifically is, it generally refers to learning that is adjustable to individual learners' needs and is learner-centred and flexible – both also accelerated learning pedagogical characteristics and approaches (Groff, 2017; Major & Francis, 2020). Note that a more detailed exploration of technology-enhanced personalised learning is the focus of another EdTech Hub rapid evidence review (Major & Francis, 2020) and so the discussion herein is brief. Technologies that afford the highest levels of personalised learning and adaptability to the needs of learners are usually more complex technologies (such as computers, tablets and other smart devices) that can allow access to a wide range of digital content both online and off, in more languages than might be available for content created for low-tech options, while also providing (e.g.) real-time feedback. There is evidence to suggest that technology-supported personalised learning has the potential to help improve learning outcomes for students through a combination of interactive and learner-centred approaches and by developing students' socioemotional skills (Ignacio Casas, et al., 2014; Gambari, et al., 2016; Zaulkerman, et al., 2013). Notably, 'personalised learning' does not necessarily mean 'individualised learning', and so there is scope within a framework of personalised adaptive learning to incorporate adaptive group-level interactive activity. Students can also learn from their level, onwards, rather than beginning learning from a set level that might be beyond where they are at. This can help them to better understand the concepts they are taught, rather than moving ahead having not fully grasped basic knowledge (Banerjee, et al., 2007). Notably, much of the research on technology-enhanced personalised

remedial learning in LMICs has focused on mathematics (Banerjee, et al., 2007; Ignacio Casas, et al., 2014) and science (Gambari, et al., 2016). Ways in which personalised technologies might enhance remedial learning in other subject areas is currently understudied.

This is not to say that the literature on mathematics and science is conclusive. Indeed, although results on technology-supported personalised learning, for mathematics and science are promising, the research in this area in LMICs is also very limited (Major & Francis, 2020). Therefore, claims should be tentatively interpreted. Further, technology that uses programmes that can be most effectively adapted to students' learning level and pace (such as computers, tablets and smartphones) are often more expensive and less easily accessible than technology that are less adaptive, but are also less expensive (such as radio, television and basic or feature phones) (Piper, et al., 2016; Damani & Mitchell, 2020). It is these cheaper, less adaptive technologies that are often the most accessible in LICs (Damani & Mitchell, 2020). Therefore, while there is scope for personalised adaptive learning technologies to facilitate accelerated learning, they may not always be the most feasible option.

Access when there otherwise would be none

Another alternative, however, are those technologies mentioned above that may be less adaptive, but are more accessible in many LMICs. These technologies include radio and television (Damani & Mitchell, 2020; Watson & McIntyre, 2020) and basic or feature phones (Casswell, 2019). The poorest households in many LMICs

do not have reliable Internet access, with on 36% having any access at all due to insufficient infrastructure to allow for Internet access, or otherwise, access being too expensive for the average person (Vegas, 2020). Also unreliable and expensive at times is electricity, meaning that computing devices that require constant or frequent charging cannot be regularly used (Rozenberg & Fay, 2019). These problems are often worse in rural areas, where the reduced access to the Internet and electricity at home is exacerbated by the common reality that schools and community centres, where Internet and electricity might otherwise be accessed, are often further away from where children live than in urban areas (Aderinoye, et al., 2007). As such, low-tech, easy-to-access devices that facilitate learning are commonly the most accessible option.

Each of these types of low-tech devices have their associated affordances and challenges when it comes to speeding up learning and these will be briefly discussed in the following paragraphs. Notably, only radio and television, will be discussed below as there is a longer history of supporting literature on those topics; research on phones as an education tool in LMICs is a more recent, and emergent, field. Note that using mobile phone-based messaging apps, SMS (Short Message Service) and social media is the focus of another EdTech Hub rapid evidence review by Jordan and Mitchell (2020). Again, it should be noted that while there does not appear to be research in LMICs on how radio and television might specifically be used for learning within an accelerated learning programme, much has been written on how their use might facilitate accelerated learning. This is particularly through the pedagogical

characteristics and approaches described in Section 3.1, and especially, interactive and learner-centred pedagogy. The following discussion of their use for accelerated learning will therefore be presented through that lens.

Radio. Radio broadcasts can be a cost-effective way to deliver education at scale as many households already have access to radio, including children living in the most deprived and distant, or rural, locales and in areas with limited Internet connectivity and access to electricity (Damani & Mitchell, 2020; Anzalone & Bosch, 2005). Consequently, many countries across Sub-Saharan Africa, South-Asia and Latin America have developed and implemented radio broadcasts to help deliver education during the Covid-19 pandemic (World Bank, 2020b). Historically, the most popular pedagogical programmes designed with radio in mind fall under the umbrella of Interactive Audio Instruction (IAI) (Bosch, 2004; Potter & Naidoo, 2009; Anzalone & Bosch, 2005). IAI are educational programmes that are delivered using an audio-only format, involving interactive elements (such as questions, and leaving time for answers) – this focus on interactivity may lend radio to incorporation into accelerated learning programmes. These audio formats could be pre-recorded on CD or MP3 and delivered using a radio, or another playback device, or otherwise can be broadcast over the airwaves, in which case it is referred to as Interactive Radio Instruction (Damani & Mitchell, 2020). Notably, IAI is most effective when the instruction is facilitated by a trained educator using learner-centred approaches; approaches which interactive audio instruction can, itself, also be instructive in helping teachers develop (Damani & Mitchell, 2020).

Television. Radio is, however, limited in what it can offer students educationally (Damani & Mitchell, 2020). Whilst an audio-only format may be sufficient, or even more beneficial to some learners, particularly if they are deaf or hard of hearing, learning formats that incorporate visual elements may be more helpful in the delivery of complex lessons and for those who can see. Despite televisions being more expensive than radios, they are still quite common and accessible in LICs, and many educational programmes have already been designed for it, including using interactive (learner with the TV-programme, as well as through co-viewing with others) and learner-centred pedagogy (Watson & McIntyre, 2020). There is also encouraging evidence that educational TV programmes might be useful in enhancing learners' social and emotional learning – another important aspect of accelerated learning (Moland, 2019; Borzekowski, et al., 2019).

Importantly though, television, as well as interactive audio instruction, are largely cost-effective because of scale: when it can be used to deliver general education to many. Personalising educational television and radio content to the needs, and languages, of a few, can be expensive. Investment in more advanced technologies, such as computers and tablets, that allow access to a wider range of already-existing personalised content, may be a more sensible choice when complex lessons need to be delivered, and there is need for a high degree of personalisation by educational needs (Damani & Mitchell, 2020).

EdTech-facilitated support systems for learners

Finally, the efficacy of EdTech for supporting children's learning directly is not the only way in which technology might help to speed up learning. The pedagogical characteristics of, and approaches to, accelerated learning also deeply involve those adults who support learners. These include parents, caregivers, teachers and community members. Relatedly, technologies that support the adults by helping them to develop the knowledge, pedagogy, and skills to support learners' education, can also be useful for accelerating children's learning. Technology (radio) has, for example been used in raising awareness among community members, of the importance of education and the development of social attitudes enabling education, so that community members might be more supportive of children in the accelerated learning programme VAS-Y Fille! (International Rescue Committee (IRC), et al., 2017). It may also be an effective tool in teacher professional development; even for accelerated teacher professional development (Sharma, et al., 2018).

Beyond the use of technology in the education of the adults in children's lives, technology might prove useful in providing faster diagnostic educational-needs assessment: an important aspect of effectively running an accelerated learning programme. Once the answers to a question can be scored by a computer, grading can occur immediately, leading to faster test results and quicker, less labour-intensive assessment of learners (Faber, et al., 2017). Further, in a specific type of computer-based assessment – Computer Adaptive

Testing – that delivers questions according to the ability level of a learner, more precise diagnosis of learners' needs can be made in a shorter space of time (Martin & Lazendic, 2018; Gershon, 2005) – albeit with some concern over the validity of the tests as every student may take a different test. There is also evidence to suggest that learners have a better experience of being evaluated through computer adaptive testing; those who know less are not discouraged by being asked questions that are too difficult, and those who know more do not feel like they are wasting time answering questions that are too easy (Swierk & Tyrrell, 2015). That computer-based assessments also result in already digitised data, means that they can also help to speed up the process of programme monitoring and evaluation because data does not have to be manually entered into data analysis computer applications. Critically though, computer-based testing relies on familiarity with using computers and smart devices, as well as having access to them, which, as already noted, is not always possible in some LMICs (Martin & Lazendic, 2018). Further, there is limited evidence supporting their use as an assessment tool among children in LMICs. Computer adaptive tests can also be expensive to develop, as they require more specialised expertise for test development, and item calibration, than classical fixed-order tests (Martin & Lazendic, 2018). They may therefore not always be feasible.

4. Emerging evidence snapshots

Given the promise of accelerated learning, in and of itself,

and as supported by technology, it might be expected that many accelerated learning programmes have been developed as a response to Covid-19-related learning loss. However, no specific examples of accelerated learning programmes were found. This may simply be because insufficient time has elapsed for such programmes to be comprehensively developed, or because the language that the searches for this review were conducted in (English) is not the language used to publish descriptions of emergent programmes. Alternatively, literature may not yet have been published that describe those programmes where they might exist. Though not popularly documented, these programmes do, however seem to be an emerging priority for educational stakeholders. UNESCO (2020b) explains that, "Most of them [countries] are preparing remedial or accelerated learning programmes based on assessment of students' learning experience during school closures to ensure continuity of curriculum..." However, Gwang-Chol Chang, Chief of section of Education Policy at UNESCO, explained that those efforts face several challenges (UNESCO, 2020b).

Whilst there appears to be no literature describing specific programmes in the context of Covid-19, there is evidence of funding being made available to support the development of accelerated learning activities. Ethiopia, for example, has received a US$14.85 million grant from the Global Partnership for Education to support its response to learning loss due to Covid-19. The response is expected to include accelerated- and distance- learning activities (APO Group, 2020). Education Cannot Wait has also given emergency funds to various education providers to support their response to Covid-19

(Education Cannot Wait, 2020a; Education Cannot Wait, 2020b). Yasmin Sherif, director of Education Cannot Wait, notes that:

"This emergency investment empowers: Ministries of Education in developing catch-up programmes and condensed curricula to prevent loss in the school year; production of distance learning material for pre-primary, primary and secondary levels; home-based learning and special measures for children with disabilities; expansion of radio and television education; Covid-19 awareness raising for children, parents and teachers; disinfection of schools; access to improved water and hygiene facilities and supplies; psychosocial counselling; and, the continued payment of teachers' salaries during the crisis." (Sherif, 2020)

Notably as well, the use of accelerated learning, as an appropriate route to addressing learning losses related to Covid-19, is also a popular suggestion across the international education community (Mundy & Hares, 2020; Accelerated Education Working Group & Inter-agency Network for Education in Emergencies (INEE), 2020; Sarfraz, 2020; Azevedo, et al., 2020).

5. Synthesis

Given all that has been discussed concerning accelerated learning, a final question arises about whether accelerated learning should be used as a response to the Covid-19-related learning loss? The answer to this question is a qualified 'Yes'. The pedagogical characteristics of, and approaches to accelerated learning, outlined in this review, should be

considered in Covid-19 education recovery efforts. However, the number of aspects of accelerated learning that should be employed will vary by context. It is likely that helping students to catch-up on missed learning will involve at least some of the elements of accelerated learning discussed in this review.

Implementing a full accelerated learning programme in a short space of time is no small endeavour. It involves the implementation of diagnostic educational needs assessment, teacher professional development in interactive pedagogy, community, parental and caregiver awareness of how to be effectively engaged in student learning, as well as the creation of instructional material appropriate for an accelerated learning programme. Also critical is the provision of social and emotional support for learners, teachers and other supporting adults, especially considering the traumas associated with the pandemic. Whilst a full accelerated learning programme may not always be the most feasible choice for education in response to the pandemic-related learning losses, a scaled back programme may be. Deciding which elements of accelerated learning to include in a scaled-back programme will vary by the educational and psychological needs of the learners being targeted, the existing infrastructure and human resources to support accelerated learning, teachers' professional development needs, time and financial support.

The question can be extended to interrogate whether technology should be used in those programmes. The answer to this is a less clear 'Perhaps, but not necessarily'. Where infrastructure already exists to support technology-enhanced learning, or there are funds

available to support such, a technology-enhanced accelerated learning programme may be an appropriate response. However, there is evidence to suggest that large relative learning losses are related to a lack of motivation, not having books at home as well as not having sufficient support from primary caregivers, more so than EdTech (Sabates, et al., 2020). Therefore, while EdTech is still a worthwhile consideration in contexts where the infrastructure to support it does not yet exist, there should be more thorough consideration of whether available funds may be more appropriately allocated to other aspects of accelerated learning, than EdTech. These considerations might include condensing the curriculum and producing related paper-based materials and improving teacher professional development and community and caregiver engagement to enhance education delivery and support.

There remain significant gaps in our understanding of how children's accelerated learning might be enhanced through EdTech in LMICs, and especially in light of emergencies such as the present pandemic. Further research is therefore needed. Amongst those blindspots that remain to be substantially addressed are how, and whether, EdTech might be used to enhance children's social and emotional learning and safety, the types and affordances of EdTech that are most appropriate in accelerated learning programmes for students of different ages and cognitive development stages, and how and whether EdTech should be used in improving diagnostic needs assessment in accelerated learning programmes. Additional research into the best pedagogical approaches (learner-centred, teacher-

centred, a mixture, or something else entirely) for EdTech-facilitated remote learning, and for increasing community awareness and support of accelerated learning will also be beneficial.

Finally, it is worthwhile to note that while there is a fair amount of research in HICs on accelerated learning for 'gifted' children, and secondary school students seeking advanced tutoring to help them into higher education, these areas remain under-researched across LMICs. Much of the research on accelerated learning in LMICs focuses on children who are in need of foundational, primary education, but are over-age and/or out of school. It cannot yet be evidenced that an accelerated learning programme in a LMIC, that targets secondary or pre-tertiary education and children who are not over-age, will result in increased learning. The Covid-19 pandemic has highlighted the need for such research. There is a need to better understand how accelerated learning might be capitalised on for the 'average' or 'advanced' student, who has missed schooling, especially as facilitated by EdTech. Within all of those realms of further research, there is a need to additionally explore safeguarding concerns for children–such as protecting children online, data privacy, and other ethical considerations– especially as the use of EdTech grows across LMICs.

In sum, a specific, one-size-fits-all, prescription to an accelerated learning programme in response to Covid-19 learning loss cannot be provided. It is up to individual education providers to consider and weigh all options in light of available and sustainable resources to then decide the best route forward. However, the limited evidence on accelerated learning and EdTech does

suggest that implementing an EdTech-enhanced accelerated learning programme may be beneficial, and it is therefore worth considering it as an option for addressing Covid-19-related learning loss.

PART IV

MEDIA AND TECHNOLOGY

RADIO

Kalifa Damani and Joel Mitchell

Note that this chapter was first published as the following document, and is reproduced here under the terms of a Creative Commons Attribution 4.0 International licence: Damani, K. & Mitchell, J. (2020) *Radio: A rapid evidence review*. EdTech Hub. https://docs.edtechhub.org/lib/YMWE6FR6

Summary

This rapid evidence review (RER) provides an overview of the existing literature on the use of radio in education in low- and middle-income countries (LMICs). The present RER has been produced in response to the novel 2019 coronavirus (Covid-19), and the resulting widespread shutdown of schools. It, therefore, highlights transferable insights that may be applicable to educational responses resulting from the limitations caused by Covid-19. Established approaches to delivering distance education have renewed salience during this period because many students cannot access schooling in a school building due to social distancing requirements. As one of the longest-serving and most accessible types of educational technology (EdTech), and one that has had

some success in education delivery in an LMIC context that was affected by an epidemic, it is particularly useful to focus on radio (Barnett et al., 2018; Hallgarten, 2020b). Notably, the RER aims neither to advocate nor discourage the use of radio in education in response to the Covid-19 pandemic. Instead, it provides an accessible summary of existing evidence on the topic so that educators, policy makers and donors might make informed decisions about the potential of radio in education delivery.

The RER emerged from a systematic search for literature about educational radio from journals that feature education, social science and humanities disciplines. Grey literature was also explored. The main papers referenced within this RER are written in the last 20 years and focus on the education of children in LMICs using radio. However, literature that focuses on high-income contexts or that does not have child education as a key topic is also considered. Details on the inclusion criteria, as well as the associated limitations, are explained in the methodology section. The rapid nature of the review required a focused approach to literature discovery and a thematically guided process of analysis so that a timely response to Covid-19 might be provided. The search strategy was not designed to be exhaustive.

The findings of the thematic analysis of the included literature on radio for education are structured according to four themes:

1. **Pedagogies and modalities.** This theme discusses the pedagogical approaches and theory used in delivering educational radio, as well as how educational radio relates to various educational

outcomes.

2. **Topical content and interest in radio.** This theme explores the topical content that is delivered using educational radio, as well as the factors that influence students' and teachers' interest, or disinterest, in radio as a medium.
3. **Equity, access and participation.** This theme focuses on how, why and whether educational radio might be used to promote greater equity, access and participation in education.
4. **Data and consent.** This theme focuses on considerations of how data will be used, and issues of consent, when implementing an interactive radio initiative (IRI).

The key findings from this review are:

- Radio, and specifically IRI approaches, can be used not only to directly facilitate more child-centred and interactive pedagogical approaches in the classroom, but also to mediate better pedagogical approaches for educators unable to access training opportunities. However, there is limited evidence on how IRI, or educational radio more broadly, might be used by students in informal contexts– such as at home during the present pandemic. The pedagogical strength of educational radio approaches in the classroom can, however, be assumed applicable, at least to some degree, outside the classroom as well. This may be especially true when engagement with radio broadcasts at home is made as interactive as possible, such as when supplemented by phone-ins

and social media as available. Interactive, student-centred approaches should be considered when using educational radio broadcasting during Covid-19.

- Radio is most popularly used in teaching maths and language-related subjects. However, the evidence suggests that radio is likely to be more effective in teaching language-related topics than maths, and especially among younger children. The strengths that support radio instruction include radio's affordability, portability and the access it gives to those who cannot read. Amongst the weaknesses of radio is it being audio only and unable to be paused or replayed. Importantly, when using radio to teach any subject area at higher levels, it is worthwhile to explore how radio broadcasts might be supplemented so that teaching is more effective. This might be through the distribution of supportive print material to parents and students where relevant and appropriate, or, if feasible, the use of technologies with greater multimedia capabilities to supplement learning.
- Educational radio is a relatively cost-effective option in the long term for delivering educational content at scale and especially in communities with limited connectivity, digital literacy and electricity, and with hard-to-reach students, such as those in rural areas. However, employing it may involve significant upfront costs and its comparative cost-effectiveness is likely to reduce when the target population is small. Its sustainability further depends on a liberalised broadcasting infrastructure, stakeholder collaboration and commitment to initiatives by

successive governments, especially as more modern technologies become increasingly popular. There is therefore need to consider whether other technologies, or even the distribution of print-based resources, might be more cost-effective and feasible than radio during the present pandemic.

- Issues surrounding data storage, privacy and consent need to be carefully considered for initiatives that involve online and mobile-based interactive radio applications. As radio is increasingly accessed through online and mobile applications, it will be necessary to critically consider issues of privacy, storage and consent with respect to user-generated data. This concern currently has limited relevance to many LMIC contexts as such data is largely not being collected, and a great deal of access to radio is done through traditional, offline broadcasts. However, since radio is increasingly moving online, critical reflection on this concern is needed in preparation.

1. Introduction

The Covid-19 pandemic has led to greater reliance on distance learning methods for students and teachers. Physical distancing policies, to suppress the spread of the novel coronavirus, often advise that students and teachers cannot congregate in schools in the conventional manner. Broadcasting technologies, such as radio, can play an important role in tackling the educational challenges of Covid-19 by delivering education over distance and at scale. This RER provides a

summary of how radio has been used before and during the current pandemic. It does this in order to offer insight and evidence that can assist in the development and implementation of effective distance learning initiatives.

1.2. Purpose

Radio is widely considered relevant to Covid-19 education responses due its low cost, broadcasting speed, familiarity and accessibility, and history of tried and tested associated pedagogy (Bates and Bates, 2005). Understanding the evidence on how educational radio is applied in different contexts is crucial to informed decision-making in the Covid-19 response. This evidence review, alongside others, contributes to that emerging knowledge base and organises the most relevant literature into coherent themes for the consideration of key stakeholders in their own localised analysis of how to respond to the unique challenges of Covid-19.

1.3. Application

The insights presented in this RER are expected to be viewed as principles for the planning and implementation process of educational radio. The expectation is that readers will draw on their own expertise from their local context to apply the appropriate recommendations. The recommendations are not specific guidelines that can be applied universally. Patterns of good practice have emerged from the evidence on how, when and why radio can

and should be used, and it can be reasonably expected that many of the insights are applicable in the Covid-19 context. Additionally, the Emerging Evidence Snapshots provide relevant examples of how radio is currently being used in the Covid-19 response. Though the examples in that section are current and will not yet have been evaluated, they can be viewed alongside the literature in the previous sections. This can serve as valuable guidance on how educational radio might be used specifically to address the challenges of Covid-19.

1.4. Research questions

Three research questions guide the study:

1. What are the key emergent themes in the available literature on educational radio in LMICs?
2. What are the current initiatives using educational radio in response to the Covid-19 pandemic?
3. What are the key recommendations that can be drawn from the available literature to inform a response to the Covid-19 pandemic?

1.5. Structure of the RER

Following this introduction, the methodological approach is discussed, including details of the scoping review, the literature search, eligibility criteria and possible limitations of the methodology. Detailed findings are then presented under the four themes that emerged from a thematic analysis of identified literature. Emerging evidence on educational radio

interventions and projects is then presented. This section details recent examples of educational radio as a response to Covid-19, many of which have not yet been the subject of work studies published in academic or other outlets due to the recency of the interventions. Instead, this evidence was found through the EdTech Hub Helpdesk, as well as through word of mouth and searches of the news in LMICs. The report concludes by providing a synthesis of the findings from the literature and emerging evidence snapshots.

2. Methodology

The methodological approach for the primary systematic literature review is informed by the Cochrane Collaboration Rapid Reviews Methods Group interim guidance on producing rapid reviews (Garritty et al., 2020). This permits a rigorous and systematic approach, while defining the scope narrowly enough that it can be completed within a short span of time. Unlike other rapid evidence assessments, such as the Education Endowment Foundation's (2020) meta-analysis of other systematic reviews on remote learning, this RER is modelled on a systematic, thematic review of primary studies, reviews, grey and other literature. According to Higgins and colleagues (2019):

> "A systematic review attempts to collate all the empirical evidence that fits pre-specified eligibility criteria in order to answer a specific research question. It uses explicit, systematic methods that are selected with a view to minimizing bias, thus providing more reliable findings from which conclusions can be drawn

> and decisions made (Antman et al 1992, Oxman and Guyatt 1993)."

The research process therefore comprised a systematic sequence of scoping, searching and screening. In the scoping phase, the research questions and eligibility criteria were defined and a brief scoping review conducted to help elicit relevant search terms for the search queries. Then a focused set of searches was run within the relevant academic databases. The search results were then screened according to the inclusion criteria.

2.1. Scoping review

Unlike systematic reviews, the criteria for scoping reviews are not yet well-defined. However, these reviews are widely considered as representing a stage prior to a systematic review where the key concepts and ideas that define a field are explored and discovered in an iterative process (Daudt et al., 2013; Levac et al., 2010). Notably, the scoping review of this study did not aim to map out all the concepts, theoretical and otherwise, included in the scope of 'radio in education'. Instead, it had a more specific focus: to identify keywords and terms that had been used in studies that discuss 'radio in education'.

The scoping review process began by noting relevant keywords and terms that were already known to the authors to search for additional literature. The process was iterative, with the terms found in one article leading to searches for other articles that then revealed different, or the same, terms. Using this method, a list of 24 search terms were compiled (shown in the Annex). It is

important here to draw attention to the point that when a search term brought up an article with a relevant title, those articles were saved to be screened later alongside those that were found during the main literature search that is explained below.

2.2. Literature Search

The literature search began after establishing the search terms at the end of the scoping review. A searchable publication database (SPUD), that was previously developed by the EdTech Hub, was searched first. Other databases were also searched thereafter, namely Google Scholar, Scopus and JSTOR. The process used to arrive at the articles that were ultimately thematically analysed in this review is outlined in the Annex. It is important to highlight that unlike a more traditional systematic review process, which may screen all search results, the rapid review methodology used herein relied on a system of quotas. As such, only the top most relevant results (up to a maximum of the top 500 results), as ranked by each database used, were selected for the first round of title and abstract screening.

It is important to highlight as well that the results were not screened and ranked for quality or limited to peer-reviewed/academic publications. Relying solely on peer-reviewed academic articles would have resulted in a narrower, less generalisable review. Crucially, this would also have excluded a larger number of voices from LMICs due to systemic factors excluding many academic researchers in LMICs from mainstream peer-reviewed journals.

2.3. Screening and eligibility criteria

The title and abstract screening, as well as all subsequent screening, were conducted by two coders according to the eligibility criteria laid out in the Annex. It should be emphasised that the screening criteria were not absolute. While the majority of sources included for thematic analysis met the eligibility criteria, a number of sources that were deemed especially informative but did not meet all the inclusion criteria were also included. These exceptions were made when an article met all except one of the eligibility criteria. An exception, for example, might therefore be made if a study explored educational radio pedagogy for children, but was based on a high-income country context, or if a study explored educational radio among children in LMICs but was published more than 20 years ago.

Finally, snowball sampling searches and expert referrals were used to discover relevant literature. While the main thrust of the literature review involved a highly systematic approach, we recognised that some influential sources might not be captured through those searches alone. We therefore decided to search the reference lists of the most relevant papers found through the systematic literature review for additional sources. Further, members of the EdTech Hub research team were asked whether they knew of any educational radio literature that might be included in the RER. These two methods served to expand the literature and also as an important quality control step, validating the rapid searching strategy.

Upon completion of the literature search and screening process, 66 papers were selected and

thematically analysed. The thematic analysis was conducted by the same two coders who screened the literature. The groupings that emerged from that analysis were: pedagogies and modalities for teaching and learning, topical content and interest in radio, equity, access and participation, and data and consent. These four themes provide the structure and coherent organising principle for the discussion of the literature in the section titled 'Systematic review and thematic analysis findings'.

2.4. Emerging evidence snapshots

A separate evidence review was also conducted in addition to the systematic evidence review detailed above. This involved expert consultations, searches of news related to radio use during the Covid-19 pandemic, as well soliciting examples through the EdTech Hub's social media channels and Helpdesk. The emerging evidence snapshots detail current initiatives that specifically address Covid-19-related challenges using radio. This differs from the previously described review, which explored historic initiatives on educational radio and which found literature through a systematic approach. Using word-of mouth and news articles was determined to be an appropriate approach to collating evidence that is most relevant to the present pandemic. The intention is that the findings of the systematic review and the emerging evidence snapshots combined provide a balanced overview of educational radio as a response to Covid-19.

2.5. Theme identification

The search and screening process identified 66 papers for analysis. A thematic analysis of these papers led to them being classified into four themes, most of which have sub-themes. Those themes and sub-themes, which are discussed in depth in the Findings section of this review, are:

Pedagogies and modalities

- Enhancing the capacity of teachers
- Radio for in-class teacher training
- Narrative and immersive learning
- Techniques for learning

Topical content and interest in radio

- Topical content of educational radio
- Interest in radio among school populations

Equity, access and participation

- Cost and sustainability of educational radio
- Politics, policy and educational radio uptake
- Rural education
- Closing educational gaps for other marginalised populations

Data and consent

2.6. Limitations

There are some limitations to this review stemming from the rapid timeframe and the nature of available evidence. These include:

- The search and inclusion strategy. An inherent limitation of the RER is that the search and inclusion strategy is not, by design, exhaustive and therefore it is possible that not all relevant literature has been located and included.
- Limited comparative analysis. Another limitation of this RER is that it does not rely on rigorous comparative analysis to draw insights, but largely on narrative summaries. While an in-depth comparative analysis involving statistical and more comprehensive thematic analysis would certainly be helpful in the future, this was not possible given the diversity of the literature encountered and the time constraints of this review.
- The generalisability of the findings to the pandemic context. A final limitation of this RER is that the evidence found relates to diverse contexts which correlate, to differing extents, with the current Covid-19 crisis. Nonetheless, many of the contextual factors remain consistent, and parallel challenges can be instructive in this case.

3. Findings

This section provides an analysis of the literature, grouped into the four main themes which help to

structure the literature into a coherent narrative representing the breadth of important topics covered in the papers.

3.1. Pedagogies and modalities for teaching and learning

The literature related to the use of radio and related technologies in education adds particular value to the current review because of the pedagogical approaches that have been tested, refined and evaluated over half a century in a range of contexts with limited resources. Indeed, there are diverse pedagogical approaches associated with radio, with Interactive Radio Instruction (IRI) being the main approach around which educational radio has converged. In this review, 'educational radio' or 'radio' are terms used to discuss strategies for employing educational radio broadly. Distinction of the format of educational radio being referenced is made at times, and RIR is the strategy most commonly referred to. General strategies for in-classroom/formal and outside-classroom/informal, teacher/facilitator-directed and self-directed learning, that may not have a formalised theoretical name (such as 'IRI' has), are described as such where relevant. Some key insights found are that: radio can enhance the capacity of teachers; narrative and immersive example-based learning engages users and can be employed for behaviour change; and developing and refining specific pedagogical elements can improve engagement and learning outcomes.

3.1.1. Enhancing the teaching capacity of

teachers

One of the most fundamental and integral uses of radio in education and learning has been to enhance teaching capacity, whether through extending the reach of teaching to learners without, or with limited, access to teachers, or through improving the quality of pedagogical practices of existing teachers (Borton, 1977; Jamison, 1978; Burns & Trucano, 2006). The potential of radio to extend education to learners without, or with limited, access to teachers has been recognised since the inception of the medium (Keith, 1929; Bagley, 1930). This is further discussed in the later section on equity and access. The focus of this section is the use of radio to enhance teacher capacity to teach.

The pedagogical implications of radio on the teacher-learner interaction have received fuller attention since the late 1970s. In particular, the work of Borton on 'concomitant instruction', which he describes as "teaching to divided attention" (1977: p. 131) anticipates the diffusion of learning from primarily classroom-based contexts to a wide range of contexts. Similarly, Jamison extends Borton's focus to four categories across formal and non-formal education: "using radio to enrich learning, direct instruction, extending in-school education, and distance learning" (1978: p. 1). A range of formal and non-formal educational contexts are thus addressed with notable differentiation between contexts and pedagogical approaches where learner groups have different needs.

In formal classroom-based learning, the role of radio in supplementing the efforts of educators has mainly converged around interactive radio instruction (IRI). IRI

covers a range of pedagogical approaches which focus on interspersing audio content, delivered by radio broadcasts, with learning activities, exercises and stories encouraging student participation and interaction (Ho & Thukral, 2009; Potter & Naidoo, 2006; Bosch; 2004). Short and regular pauses during the broadcast allow students and teachers to interact, participate and respond. This strategy of instruction was previously used in, and inspired by, children's TV series such as Sesame Street (Bosch, 2004). The development of the radio component of IRI to include various multimedia inputs has adapted to emerging technologies (Hapeshi & Jones, 1992; Edwards et al., 2019; Chatterjee et al., 2019). The interactive element describes interactions with the teacher and other learners, employed to varying extents based on the nature of the content and context (Potter & Naidoo, 2006).

Related to IRI is Interactive Audio Instruction (IAI). Like IRI, IAI similarly allows for interaction and participation between students with each other, and with their teacher and enhances the capacity of teachers to teach larger, more engaged, classes. However, unlike IRI, it is not solely related to a radio broadcast, but instead incorporates all audio instruction, inclusive of and beyond radio. It can therefore refer to recorded audio that can be played at convenience, such as on a CD or an MP3 player, mobile audio, or broadcast audio. Notably, both IAI and IRI are commonly delivered in formal-educational settings, such as schools, or otherwise in informal settings with the facilitation of teachers or other specifically trained facilitators. Whilst the benefits of IRI are best received by students when facilitated by a teacher, students in informal and out-of school settings

can often still access IRI broadcasts once they have access to a radio and may be able to self-direct their learning or learn with the help of a facilitator in the family or community.

3.1.2. Radio for in-class teacher training

In the context of the aspiration of IRI to encourage enhanced pedagogy and improve teaching quality (Burns & Trucano, 2006), it must nevertheless be acknowledged that in the absence of interactive pedagogical elements and teachers trained to facilitate those interactions, IRI becomes simply a delivery mechanism for content. The quality of instruction is therefore only as good as the quality of the curriculum and content, and may reinforce teacher-centred approaches, albeit with the radio taking the place of the teacher (Burns & Trucano, 2006). Where practised in a manner pedagogically consistent with its philosophy, IRI can fulfil a dual role, however, in both mediating interactivity in the classroom and modelling interactivity for teachers to change their practice more generally. This creates a space for in-service teacher training in the classroom, which can then transform the pedagogical approach of teachers even when they are not basing their lessons around radio broadcasts. Burns and Trucano (2006) demonstrate how an IRI programme aimed at students in Guinea also benefited teachers' professional development, and Potter and Naidoo (2006) refer to the role of in-service teacher training as an evolving priority of a large-scale intervention in South Africa. While these articles both point towards the possibility of IRI not only facilitating pedagogical

changes in the classroom in their implementation but also catalysing changes in pedagogical behaviours more broadly, they do not provide sufficient evidence of its impact.

3.1.3. Narrative and immersive learning

Another pedagogical approach discussed in the literature involves the nature of the content of radio broadcasts. This takes into account particular learning contexts and may fit within a range of pedagogical approaches, including IRI, that might draw on narrative and story-based approaches and which build on the history of radio drama (Hapeshi & Jones, 1992). Notably,narrative and story-based approaches are not necessarily IRI- or classroom-specific, but can be applied in various radio-based instruction strategies both within and without classroom contexts, and which do not necessarily rely on interaction. Additional insight from the literature on digital storytelling is informative about the ways in which storytelling is central to cultural and personal forms of identity formation (Chatterjee et al., 2019). Radio is used not just for aural transmission of information but as a creative and engaging experience which encourages problem-solving in scenarios that are close to real-life scenarios. The context may also enable collaborative problem-solving and knowledge construction, which are key higher-order social learning skills (Rodero, 2012).

In the context of disruptions to education, radio can play a key role in encouraging learners to maintain engagement, especially where infrastructure is already in place, while also permitting relatively higher

autonomy for the learner, in cases where their dedicated learning time or space is reduced.

Split attention and multitasking are also discussed in Bauwens et al. (2019) in the context of understanding complementarities between social media and radio. While this paper is not explicitly focused on LMICs, it does describe the current and emerging realities around social media use, proposing greater integration with radio programming through planned interactions at intervals. The following section explores some of the approaches to learning in more depth, as well as the role of attention in learning. Scenario-based learning, which develops the idea of narrative into a participatory activity drawing the learners into participating in the narrative of the broadcast, was evident in two articles on educational radio responses to the Ebola crisis (Walker et al., 2016; Barnett et al., 2018). These two papers primarily discuss the same initiative in Sierra Leone, Pikin to Pikin Tok, which centred around educational messaging for behaviour change, particularly in relation to health practices which might limit the spread of Ebola. Barnett et al. (2018) emphasise in particular the need to work with existing groups with embedded relationships in the community in order to adapt quickly to a much larger scale of need.

3.1.4. Techniques for learning

Another category within the literature addresses specific techniques for learning. These papers are quite specific and focused on particular didactic strategies mediated by technology, such as spaced repetition for language learning (Şendağ et al., 2012), or employing humour to

enhance engagement with learning (McKenna, 1993). However, they also often make pedagogical assumptions about the scope of learning within subject areas and cognitive processes. Specifically, there is a widespread assumption that improving learning is a delivery mechanism problem and that packaging knowledge in a more attractive way allows learners to absorb it more effectively. Where these approaches may be more innovative is in their integration of non-didactic elements to enable learning. For example, McKenna (1993) discusses the role of humour and play in learning, while Rodero (2012), Şendağ (2018) and Elekaei (2019) discuss various ways in which stimuli affect attention and their effects on the learning process. While these papers do not provide adequate evidence for these approaches to enhancing cognitive acquisition, such as memorisation of vocabulary for language learning, the role of repetition is widely accepted (Şendağ et al., 2018).

3.2. Topical content and interest in radio

The included literature also discussed the content of educational radio programmes, as well as factors that were found to encourage or discourage teachers' and students' interest in radio programming. Three key insights emerged from the literature. The first is that educational radio is best suited to teaching language-related subjects and maths, and younger children. Secondly, radio's portability, transparency to people who cannot read, affordability, listeners' ability to carry out other activities while also listening to the radio, and the

general overviews radio programmes provide, make it preferable. Finally, the limitations of radio include the lack of accessibility to deaf users, its ephemeral nature, limited multimedia ability, the difficulty of monitoring its usage (such as through the collection of user-generated data), and its low interactivity.

3.2.1. Topical content of educational radio

This subsection focuses on the range of topics covered through educational radio in LMICs. The most commonly emerging topics converge on health (e.g. Barnett, et al., 2018 on Sierra Leone; Pappas-DeLuca et al., 2008 on Botswana), agriculture (e.g. Sasidhar, 2011 on India), the empowerment of different groups in society (e.g. Cheung, 2012 on women in Cambodia) and in terms of academic content, mathematics and language. Since this RER is intended to guide decision-makers' facilitation of academic education, the following discussion is limited to the use of radio for this specific purpose. Further, the majority of the literature on the academic content of educational radio relates to IRI use in schools and as guided by a teacher. With that in mind, many of the points raised in the literature are most applicable to in-school, teacher-guided learning; where the literature is not specifically referring to school-based IRI, this is highlighted. There is little evidence on the effectiveness of radio for children's self-directed distance learning, and so these insights are less applicable in such contexts.

At the inception of the dominant format of educational radio, IRI, in Nicaragua in the 1970s, mathematics was the focus subject (Bosch, 2004).

However, the subjects covered by IRI, and educational radio more broadly, have since increased, with language-related subjects (Potter, 2007; Odera, 2011–speaking on classroom-based, supplementary radio broadcasts) coming to dominate the sphere alongside maths (MacKinnon & MacKinnon, 2010). Ho and Thukral (2009: p. 52), in analysing the impact of IRI on marginalised populations, concluded that, "the largest effect sizes were observed in English, followed by local language literacy, mathematics, and finally social studies. Also of note, the greatest amount of information (i.e., records) was available for English and the least for social studies." Mathematics and language-related topics, perhaps dominate as a factor of the higher rate of success there is in teaching those subjects, or perhaps as a factor of them being core subjects (Leary & Berge, 2007). Interestingly though, while both topics have been successfully taught using radio, there appears to be a shift occurring in the topic that dominates the IRI sphere, and educational radio more broadly: whereas mathematics was the main subject in the past, language-related topics appear to be the primary focus more recently.

The shift from maths to language

In 2004 Bosch reviewed 30 IRI initiatives and found an even split between those which included mathematics (12) and those that included a language-related topic (12), with the remainder focused on science, teacher education and health. However, it appears that more recently the emphasis of IRI and educational radio more broadly has shifted towards language-related education.

Indeed, the searches conducted for this RER resulted in a majority of language-related papers.

The reasons for this apparent skew towards using educational radio for teaching language-related topics are not yet well-evidenced and more research is needed. The analysis below alludes to some of the potential factors which may be influencing this transition, and there are indications that it may simply be because language-related topics are those in which IRI can be most effective (Ho and Thukral, 2009).

Using radio for teaching language-related content

Levine and Franzel (2015), speaking on the utility of radio for classroom-based language-related learning, suggested that the lack of visual imagery on radio encourages students who are learning to write to think about telling rich stories using only words. A medium like radio can help students think in a more focused manner on language without the 'distraction' of imagery. The lack of visual references may prove more problematic in maths, particularly as the subject gets more advanced. Yelkpieri and colleagues (2011), in their study on radio for education both in classrooms and at home, found that secondary school students in Ghana used educational programming on television more than they did on radio in part because radio did not include the visual aids needed for teaching complex calculations — a key part of later-stage maths. Further, Ho and Thukral (2009) found that while older students (Grade 4) consistently benefited from language-related IRI, the results were less stable for them with respect to maths. Importantly,

Ho and Thukral (2009) found that younger primary level students generally benefited more from IRI, on average across all subjects, than older students did.

The language-related topics that were found in the articles reviewed for this RER included literature, particularly in the form of storytelling (Leguy & Mitsch, 2007– speaking on at-home/informal learning, with and without older family or community members joining in), English language (Perraton, 2000; Potter, 2007; Potter & Naidoo, 2006; Yelkpieri et al., 2011–speaking on classroom- and home-based radio learning; Odera, 201–speaking on classroom-based, supplementary radio broadcasts; Nekatibeb & Tilson, 2004; Alaro, 2007), writing (Levine & Franzel, 2015–speaking on classroom-based radio instruction) and speaking (Osorio et al., 2019–speaking on students, in a formal educational setting, creating a radio programme). Finally, it should be noted that the clear focus on using radio for language-related learning and maths does not mean that no instances of radio being used in other subject areas were found. Though not based in an LMIC context, Wathen and colleagues (2010) found that students from a predominantly African-American, low-income, urban high school benefited from participation in a science education radio programme. The students called into the programme from school, during their class-time, and it was found that the level of questioning by students improved significantly after participation.

Interest in radio among school populations

Another sub-theme that emerged from the analysis of the literature concerned the aspects of radio that

fostered interest or disinterest among students and teachers. The first section presents the reasons behind disinterest in radio, and the second follows with its strengths. Notably, the literature in the section focuses less on IRI and classroom-based instruction, and more on radio as a format more broadly.

Reasons for lack of interest in radio

One of the key reasons for disinterest in radio is its audio-only format (Mangal & Mangal, 2009). While this can be a strength as well, as indicated in the previous discussion of the 'distraction of visual elements', an audio-only format of education delivery may not hold the attention of some students. Yelkpieri and colleagues (2011), after studying secondary school students in Ghana, explained that those students favoured educational programming on television over educational programming on radio because television combined both the visual and the aural. TV allowed students to better follow complex lessons by using on-screen aids (an example of which are mathematical calculations), or to follow by lip-reading when they did not hear a word, and it also helped students feel a greater sense of community with fellow students when other students were shown on the TV broadcast. The audio-only format of radio can also make it inaccessible to students and teachers who are deaf or have other special educational needs (SEN). Bates and Bates, discussed educational radio broadly and further noted that radio tends to provide more general knowledge and instruction for a broad audience, rather than the more personalised instruction which is sometimes desired. Other inherent educational

limitations within radio as a broadcast medium are that it is ephemeral (Bates and Bates 2005), has limited possibilities for tailored repetition (Elliot & Lashley 2017; Christina and Louge 2015) and only allows genuine interactivity through additional services such as phone-in (Bates and Bates 2005) or social media (Gavaza & Pearse, 2019). As an analog broadcast medium, radio usage also can not be monitored from the point of transmission which limits the potential for data collection.

It is perhaps for these reasons that radio is losing its appeal for some young students today (Negara & Amal, 2017; Yadav & Kharate, 2017; Pedrero-Esteban, Barrios-Rubio & Medina-Ávila, 2019). They increasingly see radio as an unimportant format for accessing educational content, with secondary school students in Mumbai, for example, preferring textbooks and online formats instead (Yadav & Kharate, 2017). Even though engagement with audio-only content remains high, that engagement is largely with respect to music, rather than spoken educational content. Further, that engagement with music is increasingly being done through online streaming, where accessible, rather than through radio (Pedrero-Esteban, Barrios-Rubio & Medina-Ávila, 2019). Notably though, whilst online educational content, or even music streaming, is increasingly popular, radio still remains a popular and important format for youth who have limited cheap Internet access and who live in rural areas. Whether young students prefer radio or not therefore depends largely on their local and socioeconomic context.

In light of the affordances provided by other technologies, Naidoo and Potter (2008) emphasise the

need to consider whether radio might best be used instead in combination with other technologies. Though there is limited research on how radio might be supplemented by newer, more advanced technologies, such as social media, for education delivery in LMICs, there is promise in increasing the effectiveness and reach of radio if used alongside other EdTech.

Reasons for interest in radio

There is also significant emphasis within the literature on all the aspects of education through radio that serve to foster interest amongst students and teachers. Notably, this subsection does not focus on broader interest or strength in radio formats, such as due to its large-scale purported cost-effectiveness or policy, but instead on the first-hand experience of using and accessing it for learning or teaching.

Findings indicated that students who favour radio do so because: it is more affordable than television, it is often accessible with batteries and not dependent on mains electricity, it can be listened to while doing other things, it is highly portable, and it has lots of relevant educational content (Yelkpieri et al, 2011). The economic and social stability of Ghana and its relatively higher financial outcomes should be considered, as these findings may not apply in more challenging contexts.

Osorio and colleagues (2019) also explored Colombian students' perceptions of educational radio, specifically when used as a strategy to develop English speaking skills. They found that students generally had a positive perception of the radio programme they participated in and found it engaging. A final reason for interest in radio

was highlighted by Christina and Louge (2015: p.4) who, speaking on Early Childhood Development (ECD) in 2015, explained that:

> "Audio content, particularly when delivered over radio, also makes learning more transparent for families and community members, who may otherwise not understand what their children are learning if they themselves cannot read. This transparency is a particular advantage in contexts where ECD is newly available, as parent support and buy-in is critical to increasing ECD access."

3.3. Equity, access and participation

The use of radio for equity, access and participation in education is another theme that was explored by the literature. Four sub-themes emerged in the literature discussing this topic, all of which may in some ways relate to radio's longevity as an EdTech intervention. These themes are discussed in turn and relate to: the cost and sustainability of educational radio; politics, policy and educational radio uptake; rural education, and closing education gaps for other marginalised populations. Notably, in the section, educational radio is spoken about in broad terms, but where it is especially important to highlight, it is noted whether a finding refers to IRI or another educational radio format. The five key findings are summarised below.

Firstly, educational radio is a relatively cost-effective option for delivering educational content at scale. However, it may not be the best option when the target population is small. Secondly, educational radio initiatives are more effective when policy allowing

decentralised broadcasting is in place and there is thorough planning on what the country's broadcasting framework can realistically deliver. Thirdly, the sustainability of educational radio programmes relies heavily on stakeholder collaboration and commitment to educational radio initiatives by successive governments and in the face of newer technologies. Fourthly, educational radio, especially classroom-based IRI, has had particular success in closing education gaps between rural and urban populations; this is both in terms of access and quality. Finally, the success in closing education gaps extends beyond the rural/urban divide to other gaps as well, such as between boys and girls, and for certain special educational needs populations.

3.3.1. Cost and sustainability of educational radio

Perhaps chief among the reasons for radio's popularity as an educational medium is its relative cost-effectiveness (Barnett et al., 2018; Trucano, 2010; Eastmond, 2000; Ali, 2015) and sustainability (Bosch, 2004). In part because of this, educational radio has long received support from donors, including from the Education Development Centre (EDC, 2015; Trucano, 2010), the Inter-American Development Bank (Trucano, 2010), USAID (Teas & Tilson, 1989; Trucano, 2010), DFID (Aderinoye, 2008), the Japanese International Cooperation Agency (Aderinoye, 2008) and the UN (Aderinoye, 2008). Various national and regional governments have also shown support, including Ethiopia (Nekatibeb & Tilson, 2004); Zambia and Nigeria (Aderinoye, 2008) ; Sierra Leone (Barnett et al., 2018);

India (Vyas, et al., 2002), and Guyana (MacKinnon & MacKinnon, 2010).

The relative cost-effectiveness of radio

The cost-effectiveness of radio is especially evident when compared to other educational technology interventions such as television, tablets or laptops. Unlike those more recent EdTech innovations, many more people already have access to radios (Aderinoye, 2008). This means that radio has the potential to be a highly accessible agent of education delivery. Further, unlike more recent technologies, which have had mixed results in terms of learning outcomes and questionable sustainability (Bulman & Fairlie, 2016), radio has a proven track record of having a positive impact on students' learning in many LMICs (Trucano, 2010) as well as having multiple examples of programmes that have operated in a sustainable manner (Bosch, 2004). The relative cost-effectiveness of radio can also help ensure that access to education, both in formal and informal educational settings, is maintained even when financial or other limitations result in a shortage of trained and skilled teachers (Ali, 2015). Only a few teachers are needed to reach many students when radio broadcasting is used, and students may be able to self-direct their learning at home if they do not have access to classroom-based education. A more detailed analysis on the impact of radio on student outcomes can be read in the above section on 'pedagogies and modalities for teaching and learning'.

While educational radio's relative cost effectiveness is relatively well evidenced, Bosch (2004) notes that some

projects still fail because of prohibitive recurrent costs. Radio is cost-effective when compared with most other EdTech, but it still entails significant upfront implementation and maintenance costs. Bakshi (2011) notes that the cost-effectiveness of radio, specifically IRI, is dependent on achieving scale, because the fixed costs remain similar regardless of the number of listeners. In a comparison of the cost-effectiveness of IRI and CD/MP3-based interactive audio instruction (IAI) in India, Bakshi found that the IAI intervention was cheaper than the IRI intervention. However, the IRI intervention reached a larger number of students. Overall, the cost per user of implementing IRI was cheaper than IAI. The cost efficiency of IRI is only achieved when large numbers of students are reached, and so IAI can provide a more cost effective option when the target group of students is smaller, such as those speaking a minority language or who might be otherwise marginalised. Beyond the broadcaster fees specific to broadcast radio, Bakshi highlighted associated costs including creating the content/programme design, producing the content, training instructors, printing related material, distribution, audio devices, and monitoring and evaluation. Solutions for reducing the cost of educational radio include exploring avenues for partnerships across countries or states, especially when they share the same language (Bakshi and Jha, 2013; Anzalone & Bosch, 2005).

The Education Development Centre (EDC) (2015), detailing the challenges associated in making radio and audio instruction more sustainable in both formal and informal schools, based on the RISE and ZTUR projects in Zanzibar, echoed some of the considerations also highlighted by Bakshi and Jha (2013). Namely, they

highlighted the need for support for: fixing old radios and buying new ones, related continuous teacher professional development, integrating programmes into existing curricula and lesson timetables, printing materials, monitoring and evaluation, and students with special educational needs.

Although radio's cost-effectiveness is among the top reasons for its uptake, it can also counterintuitively be a barrier. Trucano (2010) notes that it is sometimes the case that international donors prefer to invest in interventions that they believe would otherwise not be financed because of their expense. Therefore, because radio is relatively cheap, donors sometimes avoid investment in the medium, leaving it to local governments and other smaller organisations, and instead prefer focusing on more expensive technologies. The relationship of politics, policy and educational radio uptake, including the involvement of governments and international donors, is discussed more in the following section.

3.3.2. Politics, policy and educational radio uptake

As noted above, governmental and donor will to support radio for education was another important theme in the literature. Political and policy support for educational radio is multifaceted, involving the implementation of suitable broadcasting policies, stakeholder collaboration, and commitment to educational radio across time – both in the face of new technologies which may appear more 'progressive' and changes in administration. The

literature that explored those issues is presented in the following paragraphs.

Broadcasting policy

A governmental consideration, if educational radio uptake is to be successful, is broadcasting policy with regard to centralised versus decentralised delivery of educational radio programming. There appears to be no clear answer in the literature as to the most effective approach and the reasons behind this. Educational radio broadcasts can be more targeted if programmes are delivered by a local provider, but a centralised national broadcaster may reach more people, albeit with potentially less relevant content. Despite the lack of a clear answer on whether programmes should be local or not, there is clear recognition in the literature regarding the importance of financial provision for decentralised broadcasting. Berman (2008: p. 5), notes on this issue that, "A key enabler of the rural radio movement in Africa has been the liberalisation of radio waves, although some countries (e.g., Namibia, Uganda, and Zambia) provide rural radio programmes from a centrally controlled radio network." Others have noted the importance of reform to open up the broadcasting sector to competitive and community provision, and to provide a centralised communications regulatory environment. Regardless of the broadcast infrastructure in place in a country, planning and thorough consideration is needed about how educational radio might be delivered in any particular broadcasting context (Anzalone & Bosch, 2005).

Stakeholder collaboration

The need for sustained, flexible and considerate stakeholder collaboration was another issue raised in the literature (Alaro, 2007; Barnett, 2018; Naidoo & Potter, 2007). These different stakeholders include governments, donors, radio broadcasters, implementing partners, teachers, parents and students. Barnett and her colleagues (2018) wrote at length on multisectoral collaboration on radio in Sierra Leone after the Ebola epidemic. They described the Pikin to Pikin Tok radio programme, which ran during a period of school closure. Listening groups were established, within which children engaged in facilitated discussion related to the radio programme. There were both formal and informal listening groups, with their trained facilitator commonly being school teachers. Children who could not attend a listening group session were still able to listen at home and call-in to the programme, as were children who were part of the listening groups. When schools reopened, some teachers continued to use the programmes as part of their in-class lessons. The researchers, after an evaluation of Pikin to Pikin Tok, highlighted factors involved in successful collaborations between stakeholders in educational radio, as well as challenges. Crucially, they stated that successful collaboration involved: "Sustained commitment and flexibility from all partners, during and after the crisis [...] Adaptability in response to changing contexts [and...] Expanding the multistakeholder network effectively" (pp. 124–127). Regarding the challenges faced and lessons learnt, they noted the need for on-going adaptation and innovation, monitoring of impact, the close involvement and

education of donors, local coordination mechanisms, and "evolution based on continuous feedback, with children at the heart." (pp. 128).

Naidoo and Potter (2008) also spoke on challenges associated with monitoring impact and the related need for donor flexibility. They explained that many donors require specific evaluation requirements, often involving measurement-driven impact assessments of learning gains. However, at times those evaluations do not allow flexibility in responding to unplanned demands from other stakeholders or allow for other methodological programme assessments that are less measurement-driven, but which may take other social and political problems into consideration.

Commitment to radio

A final point on politics, policy and educational radio uptake relates to consideration of the commitment to educational radio, particularly in the context of newer technologies, changes in government administrations, declining funding and its focus on rural populations. Trucano (2010) notes that among the political barriers to educational radio uptake was radio being seen as old technology, with the potential to damage the image of the government as progressive or modern. He further raised the issue of new governments discontinuing programmes initiated or previously overseen by the last government. This concern was also previously highlighted by Bosch (2004) and Anzalone and Bosch (2005). Regarding the scale of programmes, Naidoo and Potter (2008) highlight the difficulties in whether or not to commit to large-scale programmes in the context of

declining support from donors. They considered whether it was justifiable to take a 'leap of faith' and proceed with a large-scale programme in the hope that the impact might be worth it, or instead to focus on a smaller initiative that was more feasible in the long run but might have a smaller impact.

Rural education

That educational radio programmes are often focused on rural areas where less people live might also be a barrier since there is less scope for a government to enhance their influence if they target less populated areas as opposed to more populated ones. Similar sentiments were echoed by Berman (2008: p.4) who noted that:

> "Overall, as in India, the successes of educational radio in China have been overlooked and the movement has been allowed to wane, spurred by the promise of new technologies such as TV and the Internet, and by a general lack of investment in rural education, which is the main target of radio programmes."

Using radio to help give access to, and improve the outcomes of, education in rural areas was commonly discussed in the literature (Ali, 2015; Eastmond, 2000; Berman, 2008; Aderinoye, 2008; Nekatibeb & Tilson, 2004; Leary & Berge, 2007). Ho and Thukral found that IRI helped bridge urban-rural achievement gaps in mathematics and English, though evidence of closing gaps in local language literacy was less conclusive. Nekatibeb and Tilson (2004) described how IRI increased learning gains equally in urban and rural Ethiopian primary schools. Cheung (2012) also wrote on the matter,

explaining the utility of radio for increasing children's primary school attendance in rural Cambodia, and Jumani (2009) explored the positive effect of radio in rural Pakistan.

Opportunities for education are commonly centred around urban and suburban geographies, with children in rural areas commonly only having access to poorly trained teachers who quickly move on from the profession (Ho & Thukral, 2009). Radio has proven to be one route to solving that problem. Adding to this, Nekatibeb and Tilson (2004) explain that IRI eliminated differences in learning gains that were the result of differences in teachers' levels of experience. Ali (2015: p.2) further explained how,

> "In rural areas especially, regular and frequent face-to-face classes are difficult to organize though (sic) lack of teachers and the often thin scatter of students for higher level classes. [...] educational radio broadcasts can again be used providing continuity through the long periods when teacher and student cannot meet, with the added advantage of the best radio teachers being used."

Finally, it is important to note that although radio is a crucial tool for rural education, this should not mean it is excluded from use in urban contexts where it can be also highly effective (Naidoo and Potter 2008).

Closing education gaps for other marginalised populations

The use of radio to improve learning outcomes is not, however, constrained to closing gaps between 'rural' and 'urban', but between other marginalised and privileged

groups as well. These marginalised groups often include girls, children in fragile states, out-of-school children, nomadic children (Aderinoye et al., 2007), orphans and otherwise vulnerable children (Ho & Thukral, 2009; Aderinoye, 2008). Nekatibeb & Tilson (2004) emphasised the positive effect of IRI on girls' education by noting that girls learnt more through IRI than boys did in Ethiopian primary schools. Bakshi (2011) highlights the promise of radio for delivering education to the physically and visually impaired, while the Education Development Centre's International Development Division (2010) note that IRI has helped increase learning outcomes among students in scheduled castes in India.

3.4. Data and consent

In the previous subsection on the weaknesses of radio, it was noted that radio does not allow teachers to monitor usage, unlike other electronic formats that may allow for the gathering of usage metrics and other data (Christina and Louge, 2015). However, that analysis may only apply to traditional broadcast radio rather than radio accessed through an online portal or mobile device. Schweighofer and Schmautzer's 2019 paper discusses the latter. Their paper does not directly focus on educational radio, but instead on interactive radio more broadly and within the context of General Data Protection Regulation in Europe. Despite not being directly focused on educational radio in LMIC contexts, the ethical considerations raised in the paper are still worth considering.

They discuss the extent to which informed consent is needed for online interactive radio initiatives, especially in the context of the storage of personalised data and monitoring. This issue is especially pertinent to

interactive radio via an internet-based platform, such as through a website or mobile applications. Notably, 'interactive radio' online has different connotations than in its traditional sense where the interactivity is typically between people in a physical classroom – the interaction with online radio may often be virtual. When interactive radio is accessed through online platforms, whether in a school setting or at home, unique identifiers may be accessed and stored by radio service providers so that content is more personalised to the individual, but that also raises privacy concerns. While this issue is not pertinent to interactive radio in its most traditional sense, it may be a greater concern in the future as radio is increasingly accessed through online platforms and by individual students and teachers for personalised learning and monitoring.

4. Emerging evidence snapshots

The previous section focused on past initiatives and research on educational radio. It largely converged around the use of radio in formal, teacher-/facilitator-directed educational contexts as there is limited research outside those contexts. However, this section explores how educational radio is being used in response to the Covid-19 pandemic; a time during which many schools and other formal educational settings are closed. It highlights applied evidence, outside the academic literature, that is based in current programmes and which predominantly describes learning in informal, self-directed or family and community facilitated contexts. Firstly, an overview is presented of the technologies

currently being used in response to Covid-19, with particular focus on the comparative use of radio against, and alongside, other technologies. Secondly, examples of current educational radio initiatives are highlighted.

4.1. The comparative use of Radio during Covid-19

The preceding systematic review detailed reasons why radio might be considered for use in educational contexts, with key reasons being its cost-effectiveness, accessibility in rural areas and track record of positive effects on learning outcomes. Those strengths are especially pertinent to low-income countries where more recent, and expensive technologies are less prevalent than in high-income countries and therefore less applicable to the Covid-19 response. Although Vegas (2020) showed that low-income countries are the least likely to have any distance-learning response to Covid-19 at all (less than 25% of those countries have any provisions in place), she also noted that some do. About 4% of low-income countries use radio only for distance-education delivery during Covid-19, and about 9% each use either TV and radio or a combination of online, TV and/or radio. Radio is therefore the most popular singular form of distance-education delivery in low-income countries.

However, the context in middle-income countries is different. In middle-income countries, there is much greater provision of distance-learning during Covid-19; just over 75% of lower-middle income countries, and just over 80% of upper-middle income countries, provide

distance education. Further, Internet access, as well as TVs are more common within those populations. Relatedly, there is much less of a singular dependence on radio and online education delivery, in combination with TV and radio, dominate. This is closely followed by the use of online education on its own. Much fewer middle-income countries rely on TV alone, with an even smaller number relying on a combination of TV and radio. Middle-income countries that use radio alone to deliver education during the present pandemic are scarce (Vegas, 2020). More recent technologies, though more expensive – and in the case of online learning, with a shorter history of empirical backing for positively affecting learning outcomes– allow for more advanced educational interactions than broadcast radio does. These interactions extend beyond the aural to include the visual (an aspect of TV and online) and the ability to pause and resume lessons at one's own pace (online). This can make those newer technologies more engaging, and when appropriately designed, more accessible to those with special educational needs. The choice of more advanced technologies for distance-education delivery during Covid-19, in countries that can afford them and already have the infrastructure in place, is therefore readily justified.

4.2. Examples of new educational radio initiatives

This section provides several examples of new educational radio initiatives. A more comprehensive list of initiatives can be found in a World Bank brief "How

countries are using EdTech (including online learning, radio, television, texting) to support access to remote learning during the COVID-19 pandemic" (World Bank, 2020b).

4.2.1. Argentina

The Ministry of Media and Public Communication, alongside the Ministry of Education jointly prepared a radio broadcast called Seguimos Educando that is being aired on Radio Nacional. The programmes target students from pre-school to secondary school using stories, song and talks. Pre- to primary school topics include, at different stages, Music, Natural Sciences, Social Sciences, Physical Education, Sex Education, Language and literature and Mathematics. Secondary school students are taught the Arts, Physical Education, Chemistry, History, Geography, Philosophy, Language and literature and Mathematics (Ministry of Education Argentina, 2020).

4.2.2. Democratic Republic of the Congo

An educational radio programme called Okapi Ecole was launched in the DRC in April to help give access to education to millions of Congolese children during the Covid-19 pandemic. The broadcast focuses on teaching Mathematics, French, Reading and Writing for primary school students. Health and environmental education are also taught. Broadcasts for secondary school students focus on Mathematics, French Technology as well as three groups of sciences (Computer, Life and

Earth). The programme is currently expected to last at least six months (UN Info, 2020).

4.2.3. Guyana

The Guyanese Ministry of Education has listed a number of educational resources on its website to assist in education delivery during the Covid-19 crisis. Amongst those resources are radio broadcasts on six radio stations using IRI to teach grades 1 to 3. Broadcasts geared to grades 3 to 6 are also aired on one radio station (Ministry of Education Guyana, 2020).

4.2.4. South Sudan

In South Sudan, interactive radio broadcasts on English Language, Math and Sciences, for primary and senior students, are being presented on Radio Miraya (UNICEF, 2020; Mold, 2020). The initiative launched in May. Awut Deng Acuil, Minister of General Education explained that, ""Education is a right for all children. In this difficult and uncertain time, education becomes much more important, particularly for girls and children with disabilities, who are most hit by this pandemic. I therefore do urge all our children, especially my daughters to take this opportunity and attend lessons on radio"" (UNICEF, 2020). The initiative was developed by the Ministry of General Education and Instruction and UNICEF and is scheduled to run for at least 6 months.

4.2.5. Rising Academies

There are noteworthy examples where Open

Educational Resources (OER) for radio allows users to edit content to suit their particular contextual needs. An example of such free, editable content, produced specifically for educational radio, is that of Rising Academies. Their curriculum, originally geared to Liberia and Sierra Leone, is called Rising on Air and is now freely available to whoever might need it in a format for broadcast radio. Rising on Air is a 20-week programme of ready-to-air radio scripts that covers literacy/language arts and numeracy/maths from pre-school through to secondary school. Teacher professional development content, as well as safeguarding and health information to help ensure children's safety during the Covid-19 pandemic, are also provided (Rising Academies, 2020). The scripts can be freely edited to suit the local contextual needs of education providers and students, and can be re-recorded in local languages and accents so that the content might be more relatable and better understood. Rising Academies additionally record and broadcast educational radio to students in Sierra Leone who are currently learning from home. Motivated by the lack of research on educational radio in informal settings, they are working alongside the Centre for Global Development to evaluate that implementation of educational radio in informal settings. They expect to report on students' learning outcomes, as well as the successes and challenges of educational radio in informal settings, upon the completion of the programme and their associated research.

5. Synthesis

The findings of the thematic analysis and systematic review, as well as the emerging evidence snapshots, need to be reflected upon together. The present synthesis critically discusses the research presented in both of those sections in light of addressing the challenges of Covid-19. The discussion is closely aligned with the themes established earlier in the present RER and offers recommendations on how and when educational radio might be used. Links across themes are highlighted so that there might be a more comprehensive awareness of the significance of educational radio during and beyond the present pandemic.

5.1. Pedagogies and modalities

Amongst the many reasons highlighted for the longevity of educational radio is its success at enhancing teaching capacity in LMICs and enabling teacher professional development on more effective pedagogies. In formal education settings, teacher professional development on student-centred learning has been enhanced primarily by IRI. IRI has also been instrumental in helping teachers to effectively hold the attention of large classrooms of students when there is a chronic shortage of teachers. In informal settings, educational radio broadcasts have been able, and are being used, to assist in student education at home, where it can provide teaching on subjects when otherwise there might be none. It is this use in informal settings that is particularly

pertinent to the Covid-19 crisis, as many students must access education outside the typical bounds of school. However, it is also within informal contexts that there is less evidence on the effectiveness of educational radio and the most appropriate pedagogical tools to apply.

Given the limited understanding of how radio might be used as a distance-education tool in informal settings, more research needs to be done on how the pedagogy of educational radio in formal classroom settings might best be employed outside it. There are teaching tools that might be reasonably employed for student learning at home though. These include the use of storytelling, which is an engaging way to capture the attention of younger learners, and impart knowledge. This is especially so when storytelling is cognisant of the cultural context, group identities and oral histories of a group of learners. Apart from and within storytelling, the use of didactic strategies during broadcasts, such as spaced repetition for language learning, and the use of humour to increase engagement are tools that might also be effectively employed in the physical absence of teachers. Coupled with tools that allow greater interactivity between student listeners and broadcast educators during broadcasts, such as phone-ins and social-media or text messaging, distance-learning through radio might be made to be closer to the experience of real-time, interactive classroom learning.

Importantly though, there has been limited exploration of the combined usage of these tools within LMICs, and it is also not clearly understood which tools are the most effective for different student age-groups. It is also important to consider that whilst Internet access, to allow social media interactivity during radio

broadcasts, might be less of a concern in middle-income countries, the same cannot be said for some low-income countries, and especially within rural contexts, where electricity and Internet access can be expensive and unreliable and therefore not easily available. In low income countries therefore, and especially amongst the most marginalised amongst them, options for phone-ins and text messaging to supplement radio broadcasts, and increase interactivity, should also be considered.

5.2. Topical content and interest

The pedagogical strength of radio is the basis upon which it is employed in teaching various academic topics. Another benefit of radio is that it allows for inclusion in the learning process, such that students, and parents or guardians who cannot read, can still engage with that academic content. This is of particular salience during the Covid-19 pandemic when much of students' academic learning takes place at home, and sometimes with help from parents who cannot themselves read.

Whilst the delivery of academic content through radio can take several formats, the most developed format of radio for delivering academic education is IRI. IRI began with a focus on mathematics, but has expanded to include a wealth of subject areas such as the sciences, arts, and language-related subjects. The application of radio to educational challenges during Covid-19, such as in the previously described examples of Argentina, the DRC and South Sudan, illustrates this topical breadth. Despite the broad topical application of radio, in recent years, it has most commonly been used in teaching

language-related topics. Whilst it is evident that radio might be effectively used in teaching language-related topics broadly, there is less evidence on the specific aspects and educational levels of language that radio might be most effectively used to teach.

More research is needed on radio's applicability to teaching sight- or tactile- based aspects of written language, or indeed of any subject-area, as it is possible that the aural format may at times render it ineffective for certain topics. That broadcast radio is only aural is one of several weaknesses; it also suffers from being ephemeral, such that it cannot be paused and repeated so that learners might move at their own pace, it may be less engaging, offers less means of interaction for SEN students than some other educational technologies, and has seemingly reduced effectiveness at secondary level. Despite these limitations, the accessibility and often cost effective nature of educational radio means that it is worth considering as part of a national education delivery strategy.

In light of this need to consider radio, particularly for contexts where other forms of education delivery are less easily accessible during and beyond the Covid-19 pandemic, it will be crucial to develop programmes that thoughtfully build on the strengths of radio and compensate for its weaknesses, including combining it with other technologies, such as television, online or mobile applications. The emerging evidence snapshots showcased that this is already taking place in several LMICs, though there is little evidence as yet regarding the extent to which radio and other technologies are being used to supplement each other on the same programme, as opposed to teaching different

programmes entirely. Finally, the distribution of print material, including and beyond textbooks, for students and parents may be another effective route to supplementing educational radio programming in some contexts.

5.3. Equity, access and participation

Radio's relative cost effectiveness, accessibility and sustainability have been key reasons stated for its adoption throughout this review. Despite the inherent challenges of radio, it often remains amongst the most feasible options for education delivery in low income countries, particularly in a pandemic and associated school shut-down. Within these contexts it is a particularly important educational tool for rural communities and communities with limited or no digital literacy. It is also important for communities with limited or no access to electricity, or other broadcasting and internet infrastructure. However, it is necessary to remember that although educational radio is relatively cheap and easy to use once operational, it still has significant associated upfront costs. This means investing in educational radio should be part of a long-term strategy, and should be designed for implementation at scale.

Educational radio broadcasting costs in countries or communities that do not already have the relevant infrastructure and resources in place may include the creation of radio-specific content. This is significant as the effectiveness of educational radio relies heavily on thoughtful curricula, pedagogy and content. Whilst

some broadcast content is already available and free to use, other OER content for broadcast radio is limited, both in terms of the languages and topical content available. Costs also include paying broadcasters, training educators to deliver the programme, and at times the costs of supplementary print materials (for students, teachers, parents and broadcasters). The development of liberalised broadcasting infrastructure, as relevant, should also be considered, as well as efforts to bring governments, donors and other educational stakeholders on board in support of radio.

5.4. Data and consent

Though the type of broadcast radio referred to throughout the majority of this review refers to literature on traditional radio, radio is increasingly being accessed through online and mobile portals. In light of this reality, and future possibility, it is essential that there is deeper consideration of how mobile and online data, related to online radio, should be used and stored. The ability to access, and therefore the risk of misusing personal data can increase when radio is accessed online, and therefore safeguards need to be put in place to ensure that users' confidentiality, usage data and other personal information are protected.

TELEVISION

Joe Watson and Nora McIntyre

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Summary

This rapid evidence review (RER) gives an overview of the recent literature concerning how the use of educational television might support children's learning in low- and middle-income countries (LMICs). In this review, educational television is defined as television designed with research-based knowledge of how children use and understand television that systematically incorporates academic or social curricula into its content. In low-income contexts, educational television material could be delivered through videos played in schools that are supported by corresponding teacher guidance (e.g. the Mexican school-based Telesecundaria programme), or broadcast on public channels (e.g. the Tanzanian

animation, Ubongo Kids). As such, certain educational television projects are capable of functioning even in circumstances where access to formal schooling facilities is restricted. This review therefore provides information that is particularly valuable in the context of the Covid-19 pandemic.

This RER began with a semi-structured search of the academic literature. Literature searching was conducted in a focused manner to ensure that those responsible for Covid-19 response strategies received relevant information in a timely fashion (see methodology). All literature identified through this search that was retained for analysis was: relevant to educational television use, concerned children between 3 and 18 years, and published in the past 20 years. Further, the majority of this literature came from LMICs. These inclusion criteria are provided below (see Literature searching approach and eligibility criteria).

The selected educational television-focused literature was thematically analysed, leading to four core findings:

1. **Academic outcomes.** The studies suggest that educational television can benefit children's learning outcomes in core subjects.
2. **Socio-emotional outcomes.** The literature indicates that both social reasoning skills and attitudes towards impairment could be improved by watching appropriate shows.
3. **Factors surrounding television viewing.** This review examined the social context of watching television and viewing television-based content on multiple media platforms (or multi-platform viewing). The limited material published on this suggests it is

possible that exposure to educational content on multiple platforms can provide educational advantages over watching television alone. Further, children in LMICs frequently watch shows with others, a practice called co-viewing. Co-viewing could provide both direct and indirect benefits when co-viewers are engaged (involved in commenting on, judging and explaining television content).

4. **Access and cost effectiveness.** The evidence suggests that access to educational television content is relatively high in LMICs. Research also indicates that television interventions can provide a cost-effective approach to raising learning outcomes, although further investigation in this area is required.

The findings concerning academic outcomes (Theme 1) and socio-emotional outcomes (Theme 2) suggest that quality educational television initiatives are an appropriate option to policymakers seeking to improve core learning and socio-emotional outcomes in the context of the Covid-19 pandemic and associated widespread shutdown of schools. A thematic analysis of Theme 3 literature suggests (among other things) that interactive co-viewing could augment child learning from educational television use. The literature relevant to Theme 4 suggests that appropriate television-based interventions could improve these outcomes among large numbers of children in a cost-effective manner, yet programmes created for at-home viewing might be less accessible for those in rural areas.

1. Introduction

Broadcast technologies like television currently play a particularly important role in delivering education. Physical distancing policies employed to stem the Covid-19 pandemic are limiting school attendance. This has led to increased focus on the potential for education technology to help sustain learning. This review focuses on educational television use with regard to core learning outcomes, socio-emotional concerns, factors surrounding television viewing and cost effectiveness. We hope to further an understanding of educational television use which supports policymakers, practitioners and caregivers who are considering the application of television-focused initiatives in the current global context.

1.1. Purpose

In this review we consider how educational television might support children's learning during the Covid-19 pandemic and beyond. Educational television use is considered a useful focus due to the potential effectiveness (e.g., Borzekowski, 2018) and scale (e.g., Watson et al., 2021) of initiatives centred on this platform. This television-focused review is situated alongside other RERs carried out by the EdTech Hub, which concern radio use, girls' education, refugee education, personalised learning, and equity in education. It is envisaged that the recommendations stemming from this review will inform readers on why and how educational television might be employed in LMICs.

These recommendations should, however, be used to supplement readers' own context-specific knowledge (where appropriate) and is not presented as general advice to be applied homogeneously.

1.2. Research questions

Two research questions guided the study:

- What are the key emergent themes in the available literature on educational television use in LMICs?
- What are the key recommendations that can be drawn from the available literature to inform policy on educational television use during the Covid-19 pandemic and beyond?

1.3. Structure of the RER

The next section of the RER explains the methodology, describing the initial topic scoping process, literature searching approach and eligibility criteria. Findings across four themes are then presented in section 3. Section 4 concludes with a series of recommendations for decision makers.

2. Methodology

The methodological approach for this review was informed by the Cochrane Collaboration Rapid Reviews Methods Group interim guidance on producing rapid reviews (Garritty et al., 2020). This permits a rigorous and

systematic approach, while defining the scope narrowly enough that it can be completed within a short time span. This RER is a review of primary studies, in contrast with some other rapid evidence assessments such as the Education Endowment Foundation's (2020) review of systematic reviews on remote learning. After defining the research questions and eligibility criteria, a brief scoping review was conducted to help elicit relevant search terms for our search queries. Details of both the search-term scoping review, as well as the eligibility criteria for the discovered literature, are provided below.

2.1. Initial topic scoping

The literature searching process began with topic scoping. Topic scoping is a process conducted prior to carrying out a full rapid evidence or systematic review in which the key concepts and ideas that define a field are explored and discovered (Daudt et al., 2013; Levac et al., 2010). Notably, topic scoping is not intended to map out all concepts addressed in the literature. Instead, it has a more specific focus: to identify keywords and terms that have been used in studies concerning the use of educational television.

The scoping process began by recording potentially relevant keywords and terms already known to the authors, which were then used to search for literature. The process became iterative, with the terms found in one article leading to searches for other articles that then occasionally revealed new terms. Using this method, a list of search terms was compiled (see Annex). It is important to note that when a search term brought up

an article with a relevant title, those articles were saved to be screened later alongside those that were found during the main literature search.

2.2. Literature search and eligibility criteria

The process used to arrive at the articles that were thematically analysed in this review is shown in the Annex. The process began with literature searching, which was conducted using a structured approach based on the search terms established through topic scoping. These search terms were input to the Searchable Publication Database (a resource developed by the EdTech Hub of over 3 million records to date) and the following search engines: Google Scholar, Web of Science and the Education Resources Information Center. Two other supplementary methods were used to find literature: snowball searching from the reference lists of key sources and informal within-team interviews. Snowballing and interview-based search methods were employed in acknowledgment that some important sources might be missed through structured approaches alone.

After literature searching, literature screening was conducted according to the eligibility criteria laid out in the Annex. Literature was not excluded based on quality or peer-reviewed/academic status. While this might mean that findings do not always rely on the most rigorous research, examining exclusively academic, peer-reviewed literature would have caused the RER to be narrower and less generalisable and to have taken fewer

voices from LMICs into account (as there is less of an academic publishing culture in LMICs than high-income countries). The screening process did, however, involve the exclusion of articles written prior to 2000. This decision was made to ensure that the cited literature was relevant to an ever-evolving technological landscape (Fisch, 2017). Further, the included literature focused exclusively on children between 3 and 18 years. This age range is intended to encompass all children that can meaningfully engage with educational television. As such, this range is inevitably broad. Such breadth is susceptible to criticism, as the media content of interest to preschoolers and late adolescents differs starkly (Valkenburg & Piotrowski, 2017). However, the selection of a wider age range enabled the use of studies from LMIC contexts to support most points made in this review. LMIC studies are prioritised in accordance with the research focus of the EdTech Hub, under which this review is produced. Key educational television research concerning high-income countries is only used to support arguments where LMIC-focused literature remains sparse.

Upon completion of the literature search and screening process, 46 papers were thematically analysed. This analysis helped address the first research question by uncovering the following four themes: academic outcomes; socio-emotional outcomes; factors surrounding television viewing; and access and cost effectiveness. Each theme is discussed in turn below.

2.3. Themes

A thematic analysis of all papers identified through literature searching and exclusion (outlined below) led to the development of four overarching themes. Within three of these themes, the literature was divided into two subthemes. The themes and subthemes discussed below are:

Educational television for academic outcomes
Educational television for socio-emotional outcomes

- Social reasoning
- Impairment-specific attitudes

Interactive co-viewing and additional EdTech platforms

- The social context of television viewing
- Television viewing through multimedia platforms

Accessibility and cost effectiveness of educational television interventions

- Rural and minority access to television
- Cost and cost effectiveness

3. Findings

In order to address the second research question concerning policy recommendations, this review provides findings on the four themes listed above that emerged from the literature on educational television use.

3.1. Educational television for academic outcomes

Research attention has predominantly focused on the relationship between educational television use and academic outcomes. To consider this research, this review focuses on evidence concerning numeracy and literacy. It is acknowledged that some educational content might concern alternate academic topics such as science (e.g. Bill Nye the Science Guy and Ubongo Kids). Numeracy and literacy are, however, considered to provide a worthwhile focus given (a) their prevalence across the educational television literature focusing on academic outcomes and (b) their ability to predict wider academic success as well as other developmental outcomes (Letourneau et al., 2013; Psaki et al., 2017). In this section we report findings from 12 research articles identified through literature searching.

3.1.1. Findings and implications summary

- The included studies concerning educational television suggest that it is generally capable of supporting academic outcomes in low-income contexts.
- The research evidence features both controlled and naturalistic designs. The positive results from differing types of study are persuasive evidence for the efficacy of educational television use.
- Educational television best supports learning by making both the narrative and educational content as clear as possible. Effective television programmes

also keep the narrative and educational content closely related to one another.

Educational television has regularly been found to make notable improvements to children's learning in LMICs. This statement is strongly supported by evidence concerning Sesame Street and its international adaptations. Sesame Street is considered to be a key component of the educational television landscape, as the programme and its 30 international versions are broadcast in 150 countries (Matza, 2019). A meta-analysis comprising 16 Sesame Street evaluations in LMICs suggested an average effect of d = .29 (Mares & Pan, 2013). Since this meta-analysis, evidence has continued to emerge for the potential benefits of this show (Borzekowski et al., 2019). Confidence in positive findings concerning Sesame Street is afforded by the controlled designs used in the cited research: studies in Mares & Pan's (2013) meta-analysis primarily comprised laboratory and quasi experiments; Borzekowski et al. (2019) randomised schools' exposure levels and ensured Sesame Street was completely novel to all study participants. Further, research involving educational television use in unmanipulated home-viewing contexts is also available. This is provided by studies which use caregiver (e.g., mother) reports of Sesame Street viewership in a longitudinal design (Lee, 2009) and children's ability to recognise characters in a cross-sectional approach (Rimal et al., 2013).

Beyond Sesame Street, different programmes appear to have supported academic outcomes in LMICs. Akili and Me is an educational animation for early years children broadcasting across 40 countries in sub-

Saharan Africa. This programme appears to promote both literacy (b = .29 for letter identification, b = – .77 for 'English skills') and numeracy outcomes (b = 23 for shape knowledge, b = .64 for number recognition, b = 1.13 for counting) among children in Tanzania (cited statistics, Borzekowski et al., 2019b) and Rwanda (Borzekowski, 2018). Educational animation has also been helpful for numeracy (b = .13) among Tanzanian viewers (age 6-16) of Ubongo Kids (a popular show which, like Akili and Me, is televised in 40 countries: Watson et al., 2021). Considering these studies together gives compelling evidence that international versions of Sesame Street and certain other educational television shows aid academic outcomes. Caregivers and policymakers should therefore be aware that certain educational television initiatives could provide a means of supporting children's academic development both during and after the Covid-19 pandemic.

It must be recognised, however, that certain programmes might promote academic outcomes to a greater extent than others. Efficacious educational television may possess one or more aspects of programme design. A show may have been produced in a developmentally appropriate manner by targeting relevant skills for a narrow age range (consultation with Deborah Nichols, 2020). Alternatively, a show might be built on strong theoretical principles such as the 'capacity model' (Linebarger & Piotrowski, 2010): this model proposes that viewers' learning capacity is determined by (a) their processing of narrative, (b) their processing of educational content and (c) the distance between narrative and educational content (Fisch, 2004). For example, the efficacy of Ubongo Kids in improving

academic outcomes can be explained in terms of maximising child comprehension (Watson et al., 2021), in accordance with the capacity model. Ubongo Kids' creators conduct regular formative research to ensure that the programme material is presented in a clear manner so as to reduce processing demands (Fisch, 2004). Ubongo Kids also uses the same characters in each episode which reduces narrative processing demands by ensuring that children have pre-existing programme knowledge (Piotrowski, 2014). Additionally, stories are interwoven with educational content, minimising the distance between narrative and educational content (Fisch, 2004). Practitioners involved in the creation of educational content should take care that their programme design processes are likely to promote academic outcomes. Caregivers can assess potential usefulness of television programmes using criteria offered by the capacity model.

3.2. Educational television for socio-emotional outcomes

The benefits of educational television can go beyond academic outcomes to encompass other outcomes that are pivotal to child development: namely, socio-emotional outcomes. The holistic perspective on learning is crucial, not only to ensure that EdTech initiatives for international development are building rounded citizens for the 21st century, but also because such socio-emotional dimensions are strongly associated with successful learning in core subject areas (e.g., Lei et al., 2018). Accordingly, we report the

associations found between educational television use and improved socio-emotional outcomes. Socio-emotional learning can be defined as:

> "the process of developing the ability to recognize and manage emotions, develop caring and concern for others, make responsible decisions, establish positive relationships, and handle challenging situations effectively" (CASEL, 2005, p. 1).

The identified educational television research concerning socio-emotional outcomes (comprising ten items) broadly relates to two distinct topics: socio-emotional outcomes and impairment-specific attitudes. Socio-emotional outcomes concern children's interpersonal outlook, including attitudinal patterns that relate to inclusiveness, cooperation, peer pressure, bullying and conflict (sub-theme 1). Impairment-specific attitudes are patterns of socio-emotional responses to those with disabilities and medical conditions in particular, such as HIV or AIDS (cf. Mares & Pan, 2013 for precedence of this classification, sub-theme 2).

3.2.1. Findings and implications summary

- Studies in South Asia and sub-Saharan Africa have suggested that educational television can support the development of prosocial skills such as sharing, cooperation and conflict resolution.
- Such findings should inform both caregivers and policymakers that prosocial reasoning can be enhanced through exposure to appropriate educational television.
- Viewing educational television shows featuring

characters with disabilities has promoted positive attitudes towards those with medical conditions, including physical disabilities and HIV/AIDS.

- Policymakers and caregivers might therefore encourage child viewership of educational television shows using contextually appropriate characters to deliver prosocial messages.

3.2.2. Social reasoning

Educational television productions have often sought to improve socio-emotional outcomes. For example, Sesame Street endorses inclusivity through displays of peaceful cooperation among learners with observable diversity, including ethnicity and religion (Moland, 2020). In particular, engaged exposure to educational live action television has been found to help children to respond appropriately to challenging socio-emotional situations according to research on Sesame Street in India (Borzekowski et al., 2019). In the data collection for this study, children were shown picture cards that simulated challenging situations including bullying, peer pressure, conflict resolution, good versus bad touch, jealousy and getting lost. Participating children were then asked to indicate how they would handle the hypothetical situation (Borzekowski et al., 2019). The socio-emotional influence of exposure found corresponding support in Tanzania as it was positively associated with measures of empathy (or emotion recognition), cooperation and sharing (Borzekowski & Macha, 2010). These results suggest to policymakers and caregivers that certain educational television initiatives

are capable of advancing children's social reasoning skills.

3.2.3. Impairment-specific attitudes

Educational shows in LMICs have consistently sought to promote favourable attitudes towards those with medical conditions (Mares & Pan, 2013). This is shown by their frequent inclusion of differently abled characters. In Bangladesh, children have viewed the UNICEF animation series, Meena, and the local variant of Sesame Street, Sisimpur, both of which featured disabled characters in key roles (Šiška & Habib, 2013). Similarly, a Canadian co-production of Sesame Street, Sesame Park, included a Muppet character called Katie, who used a wheelchair due to her physical disability. The manner in which these characters were included in Meena, Sisimpur and Sesame Park has demonstrated the normalcy of interaction between those who are differently abled. This point is supported with regard to Sesame Park. When children observed the natural interactions between Katie and other characters in Sesame Park, they became increasingly able to "identify with [those possessing physical disabilities] and see them as accomplished and valuable members of society" (Segal et al., 2002, p. 373).

Educational programmes that appear to address impairment-specific attitudes have frequently concerned HIV/AIDS. Tanzanian children with greater exposure to Kilimani Sesame were more likely "to say that an HIV positive child could play with others and that they would invite an HIV positive person into their home to share a meal" (Borzekowski & Macha, 2010, p. 302).

Similarly positive effects on HIV/AIDS understanding have been unearthed for television content such as Junction Juniors, a soap opera segment of the Kenyan show, Know Zone (de Block, 2012). Discussion of pilot Junction Juniors content where a daughter found that her mother had HIV led a caregiver to suggest that the content benefited viewers' HIV/AIDS understanding both directly and indirectly. Direct benefit was reportedly delivered as the show provided children with additional information on the condition. Indirect benefit was provided as Junction Juniors facilitated discussion on a topic that children and their caregivers could otherwise have been too embarrassed to address.

These findings have several implications. Policymakers should continue to support educational programmes that seek to promote respect towards, and positive perceptions of, those with medical conditions and disabilities. Caregivers could also become more confident that educational television viewing helps their children act in a more appropriate manner towards others (regardless of impairment). Lastly, practitioners responsible for content creation should continue to integrate characters that have medical issues pertinent to viewers' cultural contexts. Indeed, there appears to be ongoing progress in this regard: popular educational programmes have recently introduced characters who have autism (Julia in Sesame Street) and albinism (Amani in Ubongo Kids, as discussed in Watson, 2020).

3.3. Interactive co-viewing and additional EdTech platforms

Co-viewing and supplementing children's educational television viewing with access to other EdTech platforms (e.g., educational apps) could help viewers to make the most of educational television. Considering how the effects of educational television viewing might be amplified is especially relevant during the Covid-19 pandemic, as television viewing is likely to become a more popular activity. The literature concerning factors around television use derive from 14 studies and can broadly be divided into two sub-themes. Namely, the social context of television viewing (sub-theme 1) and the use of multiple platforms including television to access educational material (multi-platform viewing: sub-theme 2).

3.3.1. Findings and implications summary

- Co-viewing can occur in both school and home contexts. This co-viewing can bring about direct benefits, if question-based discussion of televised content shifts the child-viewer's learning experience from a passive to an active one. Indirect benefits can also be obtained if adult co-viewers are guided on how to deliver (non-televised) educational content to children from television shows.
- In accordance with these findings, practitioners should develop educational television shows in ways that promote interactive co-viewing, and policymakers should seek to support projects that

engender interactive co-viewing experiences.

- It is increasingly likely that televised content will also be accessed through additional media platforms. The limited research available on children supplementing television-based learning through access to other EdTech suggests that this could be a better way of engaging with educational television than watching television content only, but more evidence is needed.
- While the available literature concerning multi-platform access to television content suggests this to be positive for television viewing, the corpus currently appears too scarce to inform policy. Policymakers and practitioners should therefore continue to investigate the delivery of television-based interventions on additional platforms.

3.3.2. The social context of television viewing

Educational television has often been viewed in the company of others: a practice known as co-viewing. In school settings, television co-viewing might have occurred with a teacher. In the home setting, children could have co-viewed programmes with their own or a friend's caregiver. Lower-income caregivers and their children in American contexts could even be perceived to interact with television in a manner similar to how middle- and upper-income families interact with books (Linebarger et al., 2013). Interactive co-viewing (i.e., active mediation, Buijzen & Valkenburg, 2005) is where co-viewers comment on, judge and explain television content, which is likely to provide several important

benefits to learners. It has been recognised that interactive co-viewing "can change the otherwise 'passive' viewing experience into one where children actively question content" (Lackner 2000, p. 6; Lillard et al., 2015). Additionally, where adult-led questioning occurs, children could have been benefited to a greater extent from exposure to educational television. Research has suggested that open-ended questioning from a co-viewing adult concerning (a) mathematics or (b) the storyline and socio-emotional issues promoted learning among child viewers (Morgenlander, 2010). There could also have been indirect benefits. For example, adults might have taken child learning-centred ideas from episodes co-viewed with children and then used these ideas to support later child learning away from the television. This point is reflected in Cahill and Bigheart's (2016) suggestion that school librarians should apply ideas from educational television shows to their storytime sessions. In the context of Covid-19, it is acknowledged that co-viewing opportunities are now likely to be limited outside of children's immediate households. Yet, it could remain beneficial for practitioners to develop educational television programmes in ways that facilitate interactive child-caregiver or child-sibling co-viewing. Policymakers might also support those educational television projects that promote interactive co-viewing practices appropriate to applicable social distancing guidelines.

Certain environments could be more supportive of beneficial child-caregiver or child-sibling co-viewing. Such environments might involve a shared engagement in programme content among co-viewers (Wang, 2014). The likelihood of shared engagement could be increased

by watching television content in a setting absent of "food/snacks, toys [and non-co-viewing] adults' talking" (Wang, 2014, p. 28). Regarding child-caregiver co-viewing, an adult's educational background and expertise with the televised subject matter would also affect the likelihood of beneficial co-viewing (Fisch, 2004). Adult co-viewers watching educational television with children could therefore attempt to create an environment facilitative of co-viewing and even familiarise themselves with the broadcast educational content, if they were aware of this before viewing.

3.3.3. Television viewing through multimedia platforms

Another factor that might affect television viewing is whether programme materials are also accessed through different media platforms. This is an important consideration, as programme makers have strived to research the integration of educational television content with new technologies (Ballagas et al., 2011). Accordingly, children have become "increasingly able to experience the content of their favorite television programs on multiple platforms" (Lavigne et al., 2012, p. 117). Indeed, children are becoming more likely to choose an alternate media platform to television to consume their educational television content, particularly in America (Nichols, 2020). However it should be noted that there is a relative scarcity of research concerning multiplatform educational programming (Anderson et al., 2013).

The literature indicates that learning is supported when educational television viewing is supplemented by

access to other EdTech platforms. Experimental research concerning Cyberchase suggested that the programme's effects were more consistent among those exposed to both online games and videos than either platform separately (Fisch et al., 2010; Fisch et al., 2014). These positive findings correspond with research indicating that learning from a non-technological project was enhanced by exposure to an intervention involving video content and associated online games delivered simultaneously (Flagg, 2016). The cited articles could suggest that the viewing of televised material on multiple EdTech platforms supports learning, yet these articles come from a corpus that is too scarce to inform policy. As such, policymakers and practitioners should encourage or carry out further investigation. Practitioners responsible for the creation of televised content should seek to provide quality educational material (noting the principles described above in the section, 'Educational television for academic outcomes') that can be used on the most popular platform in any given context.

3.4. Accessibility and cost effectiveness of educational television interventions

This section examines the educational television literature regarding access and cost effectiveness. These are issues of persistent importance to educational policymakers, which have likely assumed even greater relevance after the inception of the Covid-19 pandemic. The economic implications of Covid-19 could mean that

policymakers responsible for allocating educational resources are now operating within tighter budget constraints. It is also now vital to focus on the accessibility of educational interventions, given the widespread school closures which reduce the current opportunities for regular formal schooling. The research falling under Theme 4 has been organised into two subsections: access to educational television among rural and minority populations (sub-theme 1), and the costs and cost effectiveness of educational television (sub-theme 2). In covering these topics, we present information from 12 articles identified through literature searching.

3.4.1. Findings and implications summary

- Television programmes intended for at-home viewing are a viable means of delivering educational content to low-income contexts. The identified literature suggests that household television access is widespread in low-income settings. It is not, however, ubiquitous and viewership of educational shows might be greater among those in urban environments.
- Television-based projects involving both technology provision and teacher support have been shown to contribute to the reduction of educational inequalities within low-income countries.
- While cost-effectiveness analysis concerning educational television initiatives has been scarce, the single recent result identified suggests that a Tanzanian-produced television show has been highly cost-effective.

- These findings indicate that appropriate educational television interventions are a viable option to policymakers seeking to carry out high-value interventions in LMICs. Accordingly, policymakers might consider increasing access to television technology in rural areas and schools (in a manner complicit with appropriate social distancing policies due to Covid-19).

3.4.2. Rural and minority access to television

The identified literature frequently considers access to educational television. Articles report that levels of television ownership are relatively high across low-income nations. One example is in Tanzania with 24% of children aged 6-16 living in households with a television (Watson et al., 2021; see also Engle et al., 2011; Mares & Pan, 2013; Trucano, 2005). In most LMICs, broadcast technologies (like television and radio) reach larger audiences than internet-based EdTech. Correspondingly, there are a large number of viewers of both television and specific educational television shows. Analysis of a national survey of Tanzanian children suggested that one in six had recently viewed the locally produced educational television programme, Ubongo Kids (Watson et al., 2021). Additionally, almost half of a national sample collected in Bangladesh viewed television every day (Khan et al., 2007, as cited in Mares & Pan, 2013). It must be acknowledged, however, that television viewership and access are not ubiquitous in either of these countries. Despite the reach of broadcast media in low-income contexts, potential investors in

television interventions should seek to verify that this pattern applies to their operating context (which could, for example, be more conducive to the delivery of television-style content on mobile platforms). Moreover, viewership of broadcast television might be more common among children in urban areas. Among the regular television viewers in Bangladesh, 83% of children in urban locations and 58% of children in rural locations watched the local version of Sesame Street, Sisumpur (Mares & Pan, 2013, p. 141). Policymakers considering investing in television programmes intended for home viewing should examine levels of television access both nationally and between urban and rural areas. These could have important implications: the high country-wide viewership levels in Tanzania and Bangladesh do not exclude the possibility that home-viewing television interventions could benefit rural areas to a lesser extent. As such, policymakers should exercise care such that EdTech investments do not exacerbate within-country educational inequalities (for further discussion of this concept, see Kelley-Salinas, 2000).

These considerations notwithstanding, it is possible that television initiatives can promote equitable access to educational resources. This appears to have been a key objective during the inception of television in India, where the medium originally focused on "the cause of the marginalised" (as demonstrated by the Kheda Communication Project: Shitak, 2011, p. 1). The Kheda Communication Project involved the provision of 650 television sets across 400 villages. This initiative might be described as an "innovative experiment in using television for empowerment and participatory rural development" (ibid, p. 9). This description reflects the fact

that the television initiative covered "controversial subjects such as caste discrimination [and] alcoholism" of interest to multiple age groups, which were created through participatory programme making (ibid). Policymakers and practitioners should therefore recognise that where educational television interventions are supported by the provision of appropriate technologies, they could conceivably increase access to educational opportunities in an equitable manner.

Further, where educational technologies are used appropriately, these "could contribute to solving traditional learning gaps, reducing the educational lag of the adult population, and consolidating a national education system that offers quality services to all sectors of society" (Kelley-Salinas, 2000, p. 25). To support this point, it should be recognised that the Telesecundaria programme in Mexico has been operational for 52 years and currently forms the basis of education in 6 out of 10 public high schools (Gobierno de Mexico, 2020).

The key elements of the Telesecundaria course are a 15-minute television programme shown in class, accompanying textbooks and teacher guides, and the active involvement of the teachers themselves. The programme has contributed to substantial increases in student enrolment in Mexico where, twenty years ago, it was noted that the Telesecundaria "appears to be the only way to serve a growing, scattered, and diverse potential population of middle school children" (Kelley-Salinas, 2000, p. 33). The longstanding efficacy of the programme might be attributed to the fact that it (among other things) uses appropriate technologies,

requires community participation, and involves extensive and continuous teacher training (Kelley-Salinas & OECD, 2000). The success of Telesecundaria suggests that policymakers could support the use of appropriate television learning within school-centred projects (in accordance with schooling restrictions in the context of Covid-19) to support a reduction in within-country inequalities. More specifically, policymakers could favour those television-based projects that involve both community participation and ongoing teacher training, as the success of previous projects has been attributed in part to these features.

3.4.3. Cost and cost-effectiveness

Reference to the low cost and high cost-effectiveness of educational television initiatives is common in the research literature. (Borzekowski, 2018, p. 58), for example, recognises that "television in developing countries can serve as a cost-effective way to influence and affect learning". It is also noted that television-based initiatives have relatively low ongoing costs (Trucano, 2005). When considering learning in out-of-school contexts, these assertions correspond with the identification that existing television ownership in LMICs is significant (e.g., Engle et al., 2011). This means that educational shows can be accessed by large numbers of home viewers, without the need for new technologies to be purchased.

Despite frequent reference in the literature to educational television being a low-cost intervention, only a few sources (published after 2000) give cost data. Among the multiple annual cost estimates available for

the Mexican Telesecundaria project, the most recent estimate (for 1997) was just under USD$1,170 per pupil (identified by Perraton, 2005). Using data from a slightly earlier time (1996), Telesecundaria schools were found to be "no more than 16% more expensive per student" than general lower secondary schools, despite Telesecundaria schools having far lower student/class ratios (Wolff et al., 2002, p. 147). Additionally, Brazil's Telecurso programme for school leavers attempting to take primary and secondary exams cost approximately $26 per student (for the entire course: Wolff et al., 2002). Telecurso, like Telesecundaria, went beyond the delivery of televised material, as it also involved teacher supervision and the provision of complementary written materials. Conversely, a non-published study concerning community screenings of the Indian variant of Sesame Street reported per-person per-screening costs of around 16 cents (Batada et al., 2016). This project involved episode screenings from televisions atop repurposed vegetable carts, brought to urban locations by local performers. Lastly, data concerning the broadcast of Ubongo Kids in Tanzania suggested that its per-person per-year costs were approximately 1 cent (Watson et al., 2021).

While the limited cost estimates identified appear disparate, the differences could be explained by the nature of television interventions. Higher cost estimates have concerned television interventions involving both teaching staff and the distribution of accompanying learning materials (Perraton, 2005; Wolff et al., 2002). The project involving screening of the Indian Sesame Street co-production involved neither of these features (Batada et al., 2016). Similarly, the very low per-person estimate

identified for Ubongo Kids was based only on the costs surrounding the provision of televised content (Watson et al., 2021). Accordingly, policymakers should understand that the educational television interventions with the lowest costs per person are those that involve only the provision of television content. Yet even school-based television interventions (where appropriate during the Covid-19 pandemic) could be recognised as relatively low cost given that the Telesecundaria project was found to be comparable in price to conventional schooling, despite student-teacher ratios being lower.

It might also be recognised that comparing (or estimating) the costs of educational television programmes is dependent on (desired) programme quality. High quality content will typically cost a greater amount (Piotrowski, 2020). This might be due in part to the requirement for an iterative programme development process, where cases in which produced content found not to be enjoyable or educational informs the revision of television material (Nichols, 2020). This said, programme makers could seek to increase the likelihood of creating quality content from the outset by considering the appropriate research evidence, aligning the curriculum with the way that children learn and accounting for the local context (ibid).

Recent literature providing cost-effectiveness information relating to educational television programmes has been particularly scant (Mares & Pan, 2013). Various articles concerning educational television viewership that claim to give cost-effectiveness information provide insufficient data to compute an effect relative to amount spent. This was the case in both Wolff and colleagues' (2002) discussion of the

Telesecundaria programme and Batada, Banerjee and Subramanian's (2016) examination of a Sesame Street co-production in India. Only one piece of research (post-2000) was identified that provides a cost-effectiveness comparison featuring a television intervention (Watson et al., 2021). This article suggests the cost-effectiveness analysis estimate for the ongoing operations of Ubongo Kids to be considerably superior to those for all other forms of (non-television) interventions calculated using the same method. It must be recognised, however, that this finding concerned a specific television show in one low-income nation and was partially derived from a cross-sectional model (which could be considered less precise than approaches using longitudinal data). Those responsible for policy during the Covid-19 pandemic and beyond would therefore benefit from additional cost-effectiveness analysis findings featuring different shows, contexts and methods of establishing influence. If subsequent research were to support the identified Ubongo Kids finding, policymakers should recognise that educational television interventions provide a highly cost-effective means of improving learning outcomes.

4. Recommendations

Through analysis of the educational television literature, four core recommendations emerged concerning the use of educational television during and after the Covid-19 pandemic:

- Policymakers and caregivers interested in

promoting children's academic outcomes should consider employing educational television. This is supported by evidence concerning educational shows broadcast to home viewers in different parts of the world.

- Similarly, viewing appropriate educational television content can advance socio-emotional outcomes. The creators of television programmes who are interested in socio-emotional development might seek to pursue this objective through the integration of characters with differing levels of ability.
- Research suggests that the effects of educational television on child learning outcomes could be enhanced by interactive child-adult co-viewing. Teachers and caregivers could attempt to engage in co-viewing, although social distancing policies and limited school access during the Covid-19 pandemic might restrict co-viewing opportunities involving members of different households.
- Policymakers could consider educational television initiatives when seeking to promote resource allocation, as the (limited) literature suggests that programmes intended for home viewing are highly cost effective. Policymakers should, however, take care that their support of such initiatives does not exacerbate within-nation inequalities, as viewership of educational shows in rural households is likely to be low compared to urban households.

It is hoped that these recommendations can supplement the context-specific knowledge of educational policy makers interested in educational

television, practitioners operating in the television sector, and caregivers seeking to understand whether and how their children should watch educational shows.

MESSAGING APPS AND SMS

Katy Jordan and Joel Mitchell

Note that this chapter was first published as the following document, and is reproduced here under the terms of a Creative Commons Attribution 4.0 International licence: Jordan, K. & Mitchell, J. (2020) *Messaging apps, SMS, and social media: A rapid evidence review*. EdTech Hub. https://docs.edtechhub.org/lib/XHBPFYVC

Summary

This rapid evidence review (RER) provides an overview of existing research on the use of mobile phone-based messaging (including SMS, and messaging through apps such as WhatsApp) to support education in low- and middle-income countries (LMICs). This topic was chosen as the focus for a RER in response to the Covid-19 pandemic and school closures, as this form of technology has been adopted as part of some countries' methods of providing continuing education during closures and disruption. As such, the overall purpose of this document is to summarise the existing research literature around messaging, so that the existing

evidence can be used to inform ongoing responses to the pandemic. The findings are intended to be of use to educational decision makers, including donors and those in government and NGOs, to inform responses to the current pandemic.

Furthermore, the review findings suggest that this is a growing research topic in LMICs, which has received increasing attention in recent years. Given the practical examples which the RER draws upon, the findings and recommendations are also anticipated to be of interest to other education stakeholders (e.g. researchers and school leaders). This review will also be useful for advancing the field more generally, beyond the immediate response to the pandemic and building resilience for the future.

The RER was undertaken using a transparent, systematic approach to conducting a literature review, and guided by the following research question:

What is known about how social media and messaging apps can be used to effectively support education in LMICs?

Although the topic at hand has not been extensively explored in the academic literature at present, there is some evidence to suggest that messaging can be a cost-effective mechanism to enhance learning outcomes. Structured according to three themes, the findings of the analysis reveal the following insights:

1. **Supporting student learning:** How messaging can be used to directly support students' learning. Particular clusters emerged around two sub-themes: interacting with peers and other students, peer tutoring and collaborative learning; and

interacting with teachers, through content delivery, teaching and assessment.

2. **Teacher professional development:** How messaging can be used to support teachers' professional development, both pre-service and in-service. The studies discussed in this section include structured support and prompts, and informal communities of practice.
3. **Supporting refugees' education:** Messaging has been particularly useful in this context, both in terms of providing continuity of educational experience, and building new educational networks.

The key findings and recommendations from this review are:

- Messaging can be used in a range of learning activities, through a combination of sharing educational materials, with interaction between pupils, peers, caregivers and teachers. Use is more often focused on making use of the potential for the technology to foster interactions, rather than just as a way to deliver content alone. Interventions often combine multiple elements; likewise, messaging could be used as an interactive complement to broadcast media. To allow for flexibility and greater reach, materials should be designed in ways which are not platform-specific and can be adapted for different tools. Assessments and strategies can be adapted from face-to-face and telephone-based instruction. There is a trade-off in efficacy and cost here; for example, telephone-based interactions can be more effective but are more expensive, while

messaging is lower cost and more readily scalable.

- Messaging can be an effective way of supporting teachers, both in terms of providing activities such as lesson plans, and motivation. Initiatives which deliver lesson plans and guidance have been shown to foster a wider range of classroom practices, and show good potential to be applied at scale. Messaging is relatively low cost and teaching materials could be tailored to the local context. In terms of supporting teachers' professional development, messaging has been shown to be an effective way of maintaining contact and support in addition to in-person training. Materials adapted for messaging can also have a wider reach through being readily circulated among colleagues, and sharing of knowledge through informal communities of practice.
- Caregivers are key gatekeepers to mobile phone access. The role of parents and caregivers is particularly important in relation to supporting younger learners. Messaging is not only a way to send materials – using messages to send reminders and suggested activities can help to get parents and caregivers actively involved in using materials with children. Culturally-relevant design of materials and local languages can help promote this.
- The use of messaging to support refugees highlights its flexibility and resilience – which may be useful for ongoing disruption and uncertainty in the pandemic and beyond. Refugees' education faces multiple disruptions; the flexibility of messaging has contributed to its use in these complex circumstances. As such, this flexibility

could also be used to build resilience in terms of being able to switch between modes of teaching – from face-to-face to distance education – if incorporated into a plan for ongoing or emergency school closures. Planning ahead would be required, such as ensuring that schools hold up-to-date mobile numbers, and have educational materials in forms which would be readily deployed this way.

- There is some evidence to suggest that messaging may promote equity. For example, the studies include examples which have been successful in remote and rural areas, supporting SEND students, refugees, and promoting girls' education. However, the equity gains may not be universal – contextual factors will need to be considered carefully. Inequalities could be exacerbated if the technology is not accessible to all, either through general availability of the technology, or different ways in which access is mediated (for example, gatekeepers may hold stereotypical views in terms of gender and technology use). The success of many of the interventions is due in part to the familiarity of the technology, but the design of interventions should not assume that everyone has access and instead consider how to reach those who would be excluded.

1. Introduction

As a result of the Covid-19 pandemic, school closures have affected learners across the globe at an unprecedented scale. The need for social distancing, to

disrupt the spread of the virus, led to approximately 90% of school-aged learners being affected by school closures (David, et al., 2020).

1.1. Background

In the immediate responses to Covid-19 school closures in low- and middle-income countries (LMICs), broadcast media has been a major focus. Adopting a combined approach of making educational content available through radio, television and online platforms, has frequently been used, in order to maximise the number of learners which can be reached during school closures, across a range of levels of technology access and online connectivity (Vegas, 2020).

A number of evidence-based guidelines have been published to provide guidance in effective practices around the use of educational radio or television broadcasts (Damani, & Mitchell, 2020; International Rescue Committee, 2020; Richmond, 2020; Watson, & McIntyre, 2020; World Bank, 2020c). However, in the responses to Covid-19 school closures, examples have emerged of using messaging apps (such as WhatsApp, Facebook Messenger, or simply SMS) as a low-connectivity mechanism for educational content delivery, and to support peer interactions, as part of countries' crisis responses alongside broadcast instruction (see Table 1).

Table 1: Examples of countries which have used WhatsApp in Covid-19 responses and policies.

Bhutan	Teachers are using WhatsApp and social media to "assign students with specific chapters to read and a set of questions to respond to. Students are required to answer the questions and send an image of their answers back to teachers to assess." (World Bank, 2020b).
Cayman Islands	WhatsApp for teachers to communicate directly with parents and students, alongside a range of online platforms, broadcast and paper materials. (Center for Global Development, 2020; Cayman Islands Government, 2020).
Dominican Republic	"WhatsApp groups are giving specific support to teachers and parents and provide helpful content." (Center for Global Development, 2020; Cobo, Hawkins & Rovner, 2020; World Bank, 2020b).
El Salvador	"A national call center (accessible via email and WhatsApp) was set up to provide support to parents and students in delivery of educational activities." (Center for Global Development, 2020; Cobo, Hawkins & Rovner, 2020; World Bank, 2020b).
India	Teachers to provide academic support via Whatsapp and over the telephone. (Center for Global Development, 2020; Nath, 2020).
Jamaica	"School-based initiatives using Google Suite, Schoology, Edmodo, Zoom, Skype, WhatsApp, etc. are in place and supported by the Education Officers" (World Bank, 2020b).
Kyrgyz Republic	"Students and teachers will be provided by SIM-cards for free access to the education app, education web pages and to use WhatsApp for free communication." (Center for Global Development, 2020; EdTech Hub, 2020b; World Bank, 2020b).
Malawi	The Ministry of Education, Science and Technology will continue to co-ordinate staff using WhatsApp (EdTech Hub, 2020b; Republic of Malawi, 2020).

Nicaragua	In addition to a multi-platform response, "WhatsApp and social media are key coordination and communication channels" (Cobo, Hawkins & Rovner, 2020).
Peru	A WhatsApp number has been created to answer questions related to the wider provision of content, through the Internet, television, and radio, via the Aprendo en Casa initiative (Perú Ministerio de Educación, 2020; World Bank, 2020b).
West Bank and Gaza	The Ministry of Education is encouraging teachers to use Facebook, WhatsApp to communicate with students. (EdTech Hub, 2020b; World Bank, 2020b).

While the examples shown in Table 1 indicate that messaging is being used as part of Covid-19 emergency responses, they are likely to represent only a small fraction of how the technology is currently being used in practice. Messaging is likely being used in a great deal of initiatives at more localised levels – from individual teachers, to schools and districts – as individuals adapt to the current situation. Two examples of programmes where WhatsApp is currently being used to facilitate delivery of resources to teachers and support communication between teachers are the IGATE-T project in Zimbabwe, and the ZEST teacher development programme in Zambia (Buckler, et al., 2020; Power, 2020). In Sierra Leone and Liberia, the Rising Academy Network responded quickly to the crisis, repurposing existing content for use through radio, television and SMS in the 'Rising on Air' programme (Lamba, & Reimers, 2020). The RER focuses on completed, published research, although it is important to note that examples of how messaging has been used

in the current crisis are likely to be published in the future.

1.2. Purpose

To date, we are not aware of any recent reviews or briefings which have focused on this medium. This may be particularly valuable as the examples encountered so far suggest that this technology offers particular advantages in terms of facilitating pedagogical approaches which make use of the interactivity – potentially between learners, teachers and caregivers – and may also address equity concerns. However, as the use of messaging is already being adopted in Covid-19 responses, there is a risk that its use will be led by the technology and not informed by previous research or effective practice. This RER is intended to fill this gap by examining the existing research literature on this topic. Note that the focus here is specifically upon how messaging may be used directly in relation to school-aged learners, and indirectly through teachers' development; Higher Education and other forms of adult education are outside the scope of this review.

1.3. Application

This RER provides an overview of the existing research literature about how messaging can be used to support school-aged learners and their teachers in LMICs. Furthermore, practical insights from the existing literature will be discussed. The document will inform educational decision makers, including donors and

those in government and NGOs, about the potential to use messaging in responses to the current pandemic, and beyond. Findings and recommendations are also anticipated to be of interest to other education stakeholders, such as researchers and school leaders.

1.4. Research question

The following research question guided the study:

What is known about how social media and messaging apps can be used to effectively support education in LMICs?

1.5. Structure of the RER

The RER is structured around three main sections, following this introduction. In Section 2, the methodological approach is discussed, including the search strategy, inclusion and exclusion criteria and study limitations. In Section 3, detailed findings from the included studies are discussed, according to three main themes which emerged from the identified literature. This report concludes by providing a summary of findings and recommendations in Section 4.

2. Methodology

The methodological approach is informed by the Cochrane Collaboration Rapid Reviews Methods Group interim guidance on producing rapid reviews (Garritty, et al., 2020). Rapid evidence reviews are intended to be

undertaken quickly, to provide an overview of the research landscape around a particular topic of current interest. As such, the approach is akin to a scoping review, which in turn shares some characteristics with systematic reviews; both involve taking a logical, rigorous approach to searching and synthesis across the research literature (Colquhoun, et al., 2014; Pham, et al., 2014). However, scoping reviews differ in that the goal is typically to profile the current status of a field, and identify gaps, rather than evaluate the evidence in relation to a specific, bounded question (Arksey, & O'Malley, 2005).

Scoping reviews follow a similar protocol and are explicit in documenting the process of literature searching, screening, and the reasons why studies have been selected for inclusion. This section sets out how this process was undertaken for this rapid evidence review.

2.1. Literature search and inclusion criteria

Literature searches were carried out in August 2020, using four of the main scholarly databases (ERIC, Google Scholar, Scopus and Web of Knowledge). The search string which was used, and the number of records returned per database, are shown in the Annex. The criteria for inclusion and exclusion of studies, and the steps in the process from initial searches to final selection of studies for inclusion, are also shown in the Annex.

In the first round of screening, the criteria were applied at the level of title and abstract. If in doubt, any

borderline cases were carried over to the next round of screening, which considered the full text. The most frequent reasons for exclusion were being focused on health rather than education, or focused on higher education rather than school-aged learners or teachers. Additionally, some further studies were identified when reading full texts through snowball sampling, and recommendations from others. This yielded further relevant studies, particularly reports, which would not have been found via academic databases, and very recently published works.

2.2. Limitations

There are two main limitations to this review. First, the searching and screening processes were undertaken rapidly. While the process has been documented and recorded in a manner akin to a systematic review protocol, which gives a level of rigour above a simple ad hoc literature review, a full systematic review would entail a more thorough and critical assessment of the evidence presented in the studies. Furthermore, as part of this compromise, the searches do not claim to be exhaustive. Given that major advances in consumer mobile telephone technology have been made in the last decade, studies published prior to 2010 were excluded. Searches were only undertaken in English, across a selection of major academic databases, primarily because these are indexed only in English – however the results themselves included articles written in other languages. On one hand, a focus on academic databases will mean that the results are likely to have

been peer reviewed; however, on the other hand, a focus on this literature isn't going to pick up on interventions which took place but were not evaluated, or results went unpublished. Grey literature was not sought, although some major works were found by snowball sampling.

Second, at present, there is not a large body of rigorous empirical research literature associated with this topic. As a result, this review is quite descriptive in nature, with a greater focus on the ways in which this type of technology is being used to support education, rather than being able to draw comparisons about learning gains, for example. Quality of the studies – neither in terms of the quality of the intervention, or of the published articles – was not assessed as part of the screening criteria. Nonetheless, the trends in publication dates and use of messaging in Covid-19 responses would suggest that this is a topic around which there is growing interest, and as such, this review should be useful to help move the field forwards.

It is also important to note that while the reason for undertaking the review is to be able to inform responses to the Covid-19 pandemic, findings will not necessarily transfer easily to the current crisis.

2.3. Theme identification

As a result of the screening process, 45 studies were identified for inclusion. Bearing in mind the overall research question of 'What is known about how social media and messaging apps can be used to effectively support education in LMICs?', and the distribution of

topics addressed by the studies in the sample, the following themes and sub-themes were identified:

Supporting student learning

- Peer tutoring and collaborative learning
- Content delivery, teaching and assessment

Teacher professional development

- Structured prompts and coaching
- Communities of practice

Supporting education in refugee contexts

- Continuity of educational experience
- New educational networks

The studies will be reviewed in the next section, with the discussion structured around the themes.

3. Findings

3.1. Supporting student learning

Within the theme of pedagogy, there are two sub-themes, according to the types of interaction underpinning the educational activities in each. Student to student interactions are first discussed in 'peer tutoring and collaborative learning', and student and teacher interactions are discussed in 'content delivery, teaching and assessment'.

3.1.1. Peer tutoring and collaborative learning

Peer tutoring draws upon examples in which messaging has been used as a communication medium to facilitate tutoring of school-aged learners by undergraduate student 'tutors'. 'Peer tutoring' as a term lacks clarity to an extent, as the models here typically connect high school students not with each other, but to university undergraduates in relevant subjects. It is distinct from other sections of this theme in that activities which facilitate interaction between learners are discussed in terms of 'collaborative learning', while interactions between learners and teachers are discussed under 'content delivery, teaching and assessment'.

One of the earliest interventions included in this review is an example of peer tutoring. The 'Dr Math' initiative started in South Africa in 2007, with a focus on fostering mathematics skills in school children, running through the mobile phone-based MXit messaging platform. In addition to connecting school children to peer tutors (undergraduates from the University of Pretoria), the system also provided "single-user text adventure games, multi-user arithmetic competitions, multi-user algebra skills competitions, multiple choice quiz competitions, and static lookups for information such as definitions and formulae" (Butgereit, et al., 2010, p.1).

MXit was also used as a platform to support wider Science, Technology, Engineering and Mathematics (STEM) education (Beyers & Blignaut, 2015), however, the platform declined in popularity and the Dr Math initiative ceased activities in 2013. Despite this, a recent survey suggested that there is still a potential role for

peer tutoring for high school students' education in South Africa. Reflecting on the demise of Dr Math, Budree and Hendriks (2019) note that WhatsApp is now the most popular platform and would be suitable for this purpose. However, they recommend making any initiatives as "platform agnostic" (Budree, & Hendriks, 2019, p.619) as possible – that is, designing initiatives and materials in a way such that they could be easily repurposed to be run through different platforms or communication channels – in order to avoid similar problems.

Campbell (2019) documents a recent project inspired by Dr Math, and carried out using WhatsApp. The aim of the initiative was to improve South African high school students' understanding of mathematics. Groups of five high school students in Cape Town townships were connected to undergraduate student tutors from the University of Cape Town via WhatsApp groups, using the following model:

> "Tutees asked tutors mathematics questions when they were stuck on homework problems. Tutors responded with explanations and leading questions. To encourage communication in the group, weekly messages were sent by a project manager to tutors to share with tutees. The messages included a challenging mathematics question, study tips and encouragement of aspirations to attend university." (Campbell, 2019, p.1025)

The paper reports on three years' experience of the programme, which has used a design-based approach initially based on peer-tutoring principles (Topping, & Ehly, 2001) and refined iteratively as a result of research activities. Although the study does not investigate the

impact of the activities upon learning outcomes, it provides practical design principles for facilitating peer tutoring via WhatsApp, in relation to communication and organization; scaffolding, error management and cognitive conflict; and emotional factors that influence learning (see Campbell (2019) for further details and principles within these categories).

A smaller group of studies addresses interactions between classmates, in collaborative learning activities, although large scale or robust evidence is lacking. Çetinkaya (2019) reports on a small-scale experimental design to test the efficacy of a problem-based learning activity undertaken by Grade 9 mathematics students in Turkey, using a WhatsApp group and a virtual stock exchange app. The group who received the intervention performed better in the post-test than the learners in the control group. Feedback from participants was also sought, and the students who received the intervention showed high levels of agreement that it had been a positive experience and that they would be willing to use WhatsApp for educational purposes again. Advantages of using WhatsApp included "Learning anytime anywhere, resource and material sharing, organizing activities for academic purposes" (Çetinkaya, 2019, p.73). Also focusing on teaching mathematics, Jere et al. (2019) consider the use of WhatsApp to support a small group of South African Grade 12 students (the study focused upon a single group, comprising 10 students and one teacher). Findings suggest positive experiences of collaborative learning, sharing resources and extending educational time beyond the classroom, although the analysis is limited.

Focusing on the use of social media (including

WhatsApp) to support learning English as a second language in a South African school, Rwodzi, et al. (2020) investigated the experiences of six teachers and 12 learners. Similar to other studies, the sample is small and analysis is limited, but building group communication and being able to use multiple modalities to communicate and share information are identified as benefits. Suhaimi et al. (2019) also examine the use of WhatsApp in language learning, in the context of eight Grade 6 primary school pupils in Malaysia. It provides an interesting example of how an existing teaching activity – the 'Curriculum Cycle', which comprises four stages for writing lessons – was adapted for use through WhatsApp. Although the students showed an increase in scores in the post-test, the sample was too small to be conclusive.

Della Líbera and Jurberg (2020) present a case study of using WhatsApp to facilitate discussions within a group of 13 visually-impaired students and three teachers in Brazil, using mobile devices equipped with assistive technology (AT). Students reported a preference for mobile devices with AT, being easier to use than computers. Over the course of 11 weeks, the group was used successfully to facilitate discussions around a range of health-related topics, and with varying levels of individual engagement. While the study is small-scale and not rigorously evaluated, it is interesting to note the example of using WhatsApp to support visually-impaired learners.

These studies suggest that there are potential benefits for collaborative learning through apps such as WhatsApp, although the scope and rigour of the studies included here is limited. While there is likely to be a

greater body of knowledge associated with understanding collaborative learning through messaging in higher education settings, there is a need for further research in relation to school-aged learners (notwithstanding the relevant legislation and age restrictions, and potential safeguarding concerns).

3.1.2. Content delivery, teaching and assessment

This theme explores two ways in which more formalised support and educational provision can be facilitated through messaging. First, messaging as a medium to distribute educational materials; and second, activities which allow students to interact with teachers. It is notable that there is a greater focus in the research literature on the latter. Models which allow learners to communicate with teachers are technically similar to peer tutoring, although less informal and more frequently linked to formative assessment.

The MobiLiteracy Uganda Program is a robust example of delivering content through messaging (Pouezevara, & King, 2014). The program was designed with the goal of enhancing literacy in primary school pupils (Grades 1 and 2), by delivering audio content and SMS support. It was deployed and evaluated during 2013. Although the program did not involve interaction with teachers through messaging, it was highly reliant on active support to learners from parents, which is particularly important to note for reaching younger learners. 168 parents, across eight schools in a district of Kampala, participated in the study. Parents were assigned to one of three experimental groups:

- Group A – Mobile phone content: Provided with a mobile phone and the MLIT 91-day SMS+audio product delivered to the phone daily.

- Group B – Paper-based content: Provided with a paper-based version of MLIT, which is a printout of all of the audio and text messages delivered to Group A.

- Group C – Control group receiving one-time verbal literacy message: Not provided with any literacy materials or support. At the time of assignment into the different groups, provided with a brief, one-time verbal message to support children's literacy (Pouezevara, & King, 2014, p.vi)

The groups receiving the intervention – whether by mobile (A) or paper (B) – showed increased learning gains in comparison with the control group (C). A key finding from the program was that while the medium of instruction did not lead to significant differences in learning outcomes, the material did empower parents to actively support their childrens' education (Pouezevara, & King, 2014).

The role of parents and caregivers is a key part of any intervention supporting education in the context of home rather than school, as adults are gatekeepers to mobile phone access in many contexts. In the Covid-19 pandemic, where schools have been completely shut, the role for parents and caregivers in facilitating their children's education – and how to support them in this role – has been brought to the fore. Simple text-message-based reminders have demonstrated improvements in promoting reading with young children (Mayer, et al., 2019; York, et al., 2018), although these studies were carried out in a high-income context.

This 'nudging' in education has been shown to be most effective when interventions are aligned with participants' beliefs and behaviours (Damgaard, & Nielsen, 2018), which calls for a greater focus on how it can be used in a wider range of contexts. Madaio et al. (2019) consider how such interventions could be adapted for low-literacy caregivers, through interviews with parents in Côte d'Ivoire. The interviews revealed that parents are keen to be involved and already play a role in supporting their childrens' literacy development, although levels of literacy vary, and they expressed a preference for French. Although the study is based on a small sample, the authors make practical suggestions for designing potential interventions, including drawing on culturally-relevant examples when designing activities, and designing for interaction and support with a wider group than parents alone, such as siblings and other peers (Madaio, et al., 2019).

While Pouezevara and King (2014) did not find significant differences between paper and mobile-based delivery, it is difficult to judge whether this finding would apply in other contexts, as further studies which directly compare the learning impact of delivering content through messaging alone are rare. One example is Dehghan et al. (2017), who conducted a small-scale intervention which compared delivery of content through textbooks and WhatsApp, and found no significant difference in test scores between both groups.

Other uses of messaging can be more interactive, such as using messaging for simple formative assessments. Note that although the studies included in this section of the review fall outside of the time period for inclusion

in the analysis here, Valk et al. (2010) review several early mobile learning-based pilot studies in LMICs in Asia. SMS is used for assessment in several of the case studies in the review (Valk, et al., 2010).

In the context of the Covid-19 pandemic, Angrist et al. (2020a) present the results of a randomised control trial of an intervention using phone calls and SMS messages to support education during school closures in Botswana. This builds on previous work using phone call-based assessments; while SMS may not be suitable for all types of assessment, elements of oral assessments (such as the Early Grade Mathematics Assessment, EGMA) could be adapted for text messages and potentially be more cost effective (Angrist, et al., 2020b). The study was conducted with a sample of 4,500 families with children in Grades 3 to 5, conducted over a period of 4 weeks. Alongside a control group, families were assigned to one of two intervention groups: "we provided "two low-tech interventions: (a) one-way bulk SMS texts with multiple numeracy "problems of the week" and (2) SMS bulk texts with live phone call walkthroughs of the problems on a 15-20-minute phone call" (Angrist, et al., 2020, p.5). Both interventions resulted in significant learning gains compared to the control group. Learning gains were measured by performance on an ASER (Annual Status of Education Report) test; both interventions showed marked improvements, while those who received SMS and a phone call showed a greater improvement than SMS alone. Similar to MobiLiteracy, the intervention also increased parental engagement.

In addition to providing robust evidence of efficacy, the study is also notable in that it considers cost

effectiveness of the intervention, relative to other potential measures:

> For the SMS-only treatment arm, the total cost by the four-week juncture was about $3,200 USD. For phone calls, the marginal cost above the bulk text message was $17,800. This equates to $2.13 per child reached in the SMS group and $14 dollars per child reached in the phone and SMS group. Given average treatment effects of 0.16 and 0.29 standard deviations, this translates to $13.3 USD per standard deviation gain in learning for the SMS-only group and $48.28 USD per standard deviation gain in learning for the SMS and phone group.
>
> These estimates are cost-effective relative to the literature. We make comparisons using a $50 benchmark which yields a 1 standard deviation gain for our phone and SMS treatment. As a comparison, conditional cash transfers in Malawi yielded an extra 0.01 standard deviation per $50; an extra contract teacher and streaming by ability yielded 0.47 standard deviation gain per $50 in Kenya; and remedial tutoring in India yielded an effect of 0.65 standard deviation gain per $50. These comparisons suggest both low-tech interventions tested are cost-effective relative to other popular and effective interventions in the education literature. (Angrist, et al., 2020, p.25)

Also related to assessment, Zualkernan et al. (2014) present findings from an EdTech intervention undertaken with 24 schools in Pakistan. While the main form of technology used was satellite-linked tablet computers, SMS were used to communicate the results of learners' assessments to parents, community workers, and educational administrators (Zualkernan, et al., 2014).

For activities such as multiple choice practice questions, responses can potentially be automated.

Poon et al. (2019) deployed and evaluated an intervention providing practice exam questions through WhatsApp and SMS to students at three Francophone high schools in Cameroon. Students responded to practice questions posed via SMS or WhatsApp, and received correct answers, feedback and further questions in response from the quiz manager. Engagement with quizzes was higher through SMS in comparison to WhatsApp; for the latter, students were more reliant on parents as gatekeepers to smartphones. Although learning outcomes were not measured, benefits to students included being prompted to study, including discussing the quizzes with their peers as a result. Limitations included the extent to which content matched their schools' requirements, unfamiliarity with interacting with automated messaging, and the need to design systems which users (and gatekeepers) will trust (Poon, et al., 2019).

Although the discussion in this section has considered content delivery and teacher support separately, both can be combined through SMS. An example of this model is Eneza Education, which operates in Kenya, Ghana and Cote D'Ivoire. Its 'Shupavu291' product is a mobile phone-based educational platform, which provides learners with curriculum-linked educational materials, quizzes, and allows users to submit questions to teachers, via SMS (Kizilcec, & Goldfarb, 2019). Being SMS-based, the platform is intended to serve rural and marginalised communities, and currently serves approximately five million users (ibid.). Research by the company suggests that it is successfully reaching lower-income households, and that users perceive the platform to be beneficial (Eneza Education, 2018).

Although comparisons are not made with alternative or pre-existing models of provision, Kizilcec and Goldfarb (2019) analysed a large dataset of Kenyan Shupavu291 users (n=942) in order to identify predictors of student success when using the platform. Factors associated with higher quiz scores included: possessing a stronger growth mindset; gender (higher quiz scores associated with female students); higher school grades; and greater satisfaction with the learning environment. The impact of receiving help depends on the source; those who "receive study help from parents or a tuition teacher have lower quiz scores than those who receive help from friends or classmates" (Kizilcec, & Goldfarb, 2019, p.5), which may support the value of student-student communication through messaging. The authors conclude that the efficacy of products such as Shupavu291 could be enhanced by designing interventions and nudges to also promote a growth mindset in learners (e.g. O'Rourke, et al., 2014).

Also using Kenyan Shupavu291 data, the authors examine patterns of disengagement and re-engagement with the platform. Similar to engagement with Massive Open Online Courses (MOOCs), a large proportion of learners do not use features of the platform after initial enthusiasm; in contrast with MOOCs, however, Shupavu291 users are more likely to resume use at a later date (Chen, & Kizilcec, 2020). This may be because use is linked to school-based studies and the academic calendar, as the authors also reported increased use within school holidays and examination preparation in a third study (Kizilcec, & Chen, 2020).

Examining patterns in use of the Shupavu291 platform in further detail, Kizilcec and Chen (2020) present a

thorough statistical analysis of a large-scale dataset (93,819 Kenyan students in Grades 6, 9 and 12) to identify patterns and clusters in how students interact with the platform. Research questions addressed engagement over time, whether this differs according to grade, and looking for differences between the ways in which more and less active students use the platform. As Shupavu291 content is aligned to the curriculum, use varies according to the school year; higher levels of activity are associated with self-directed study in school holidays and in preparation for examinations. Some students demonstrate greater engagement and use throughout the year. Only minor differences in engagement were observed according to grade level.

> We find that Kenyan students use mobile learning to complement formal schooling, bridge gaps in instruction, and prepare for standardized exams. The majority of students use it as a short-term study resource for a day. A smaller subset of students use it over extended periods like a low-cost tutor, and they exhibit promising learning behaviors and performance, even though we do not find formal evidence of learning gains in this study. (Kizilcec, & Chen, 2020, p.162)

While the study provides insights into how the platform is used to complement formal schooling, the authors did not find evidence to suggest that use of the platform is associated with enhanced learning outcomes.

3.2. Teacher professional development

The use of messaging to support teachers – either in pre-service training, or continued professional development – emerged as one of the main themes in the literature. Articles within this theme will be discussed according to two sub-themes. The first sub-theme includes instances where the technology was used to provide more structured support to individuals through text prompts, while the second sub-theme includes instances where the technology was used more informally to promote interaction within groups and build communities of practice.

In several of the initiatives reviewed in this section, the role of messaging serves to support teachers in their classroom practices. In the context of the current pandemic, where in-person teaching has been suspended, such models would not be directly transferable. However, there is still some scope to apply elements in the current context. Although teachers are less likely now to be in the classroom, messaging could be used to connect teachers – however their roles have been adapted in the current crisis – to provide a supportive network in uncertain times, distribute repurposed educational materials, and share emergent practices. Professional development activities, and prompts for reflection, could be used to keep teachers engaged while not actively in schools. This could be particularly important to distribute information in preparation for schools reopening, for example.

3.2.1. Structured prompts and coaching

This sub-theme comprises a small number of studies, which are notably rigorous and provide evidence that this type of intervention can have positive impacts for teachers and learners. Simple but effective strategies to enhance teachers' practices and motivation have been demonstrated using SMS (McAleavy, et al., 2018).

In the SMS Story initiative, SMS was used to deliver daily content, including stories and lesson plans, to English teachers. The project was initially evaluated in Papua New Guinea (Kaleebu, et al., 2013), and subsequently replicated in India (Pratham Education Foundation & Voluntary Service Overseas, 2015). In Papua New Guinea, the initiative was trialled with 42 Grade 1 and 2 teachers across 20 schools in remote areas. Data collected mid intervention showed an increase in a range of classroom practices. Practical reflections include discussion of how to reduce the costs of mass SMS; timing of sending messages earlier, so teachers have more time to prepare; and ways to incorporate a wider range of media (Kaleebu, et al., 2013). The impact on learners was assessed in the intervention in India, which included over 2,400 students, from Grades 4 to 8, across 50 schools, including an intervention and a control group for comparison (Pratham Education Foundation & Voluntary Service Overseas, 2015). At the end of the study, pupils in the intervention group were found to have increased gains on a range of reading measures, compared to the control group. Given the effects and low cost, the authors of that study conclude that the intervention could be rapidly adopted at scale. Their recommendations for future development include:

Developing stories and lesson plans tailored to different local settings; incorporating more text book materials into the stories; and considering a wider range of technology (WhatsApp is given as an example – but with a caveat to also ensure means of distribution to teachers without smartphones) (Pratham Education Foundation & Voluntary Service Overseas, 2015).

'English in Action' was a professional development program to support English teachers in Bangladesh (Power, et al., 2012). Mobile devices were used to distribute materials to teachers, initially piloted with files loaded on to MP3 players, and later distributed through pre-loaded SD cards. Part of the initiative involved piloting the use of SMS messaging in addition to the materials, "to encourage teachers to try out activities in their classrooms and reflect upon successes and challenges" (Power, et al., 2012, p.511). However, the lack of support from mobile phone providers for Bangla language SMS, and the character limits at the time, limited the efficacy of the messaging component.

Another initiative, the 'Leadership for Learning' (LFL) program, was undertaken in Ghana, with a focus upon the professional development of school leaders (Swaffield et al., 2013). As part of the program, SMS messages were sent via Skype as a way to communicate with the cohort of 175 participants. Messages were sent on Mondays during term time, from an LFL program Skype account, to participants. The messages sent from LFL comprises five types: "announcements; prompt to thought or action; request for feedback – open; request for feedback – 'yes'; and sharing participant response" (Swaffield, et al., 2013, p.1298). Nearly all of the messages prompted responses from participants, to

varying degrees. Although as a pilot, the study did not evaluate the impact of the activity on participants' learning or practice, the engagement and discussion was promising. The authors note that this approach has the potential to easily scale to support much larger training programs.

Brion (2019) also presents a study focused on educational leadership training in Ghana, instead using WhatsApp as a communication channel. Following short face-to-face training sessions, 23 participants joined a WhatsApp group. Conversation triggers were sent to the participants as a group, in order to sustain discussion about the training after the sessions. Interviews were held with participants to determine whether they felt that this had been successful. Reported benefits included being reminded about the training contents, networking, enhanced motivation and peer learning. Note that this study is included in the current sub-theme because of the use of discussion prompts; however, it is also related to the next section as the interaction initiated was a group, and the author notes that it could be considered a community of practice (Brion, 2019).

Two projects provide rigorous evidence of the benefits of using messaging as part of a blended approach to teachers' professional development activities. Jukes, et al. (2017) evaluated part of the Health and Literacy Intervention (HALI) project, focusing on the activities undertaken with teachers, which had an overall goal of improving literacy in Grades 1 and 2 at government schools in Kenya. The literacy intervention involved supporting teachers through three activity types: provision of sequential semi-scripted lesson plans; a

three day training workshop for teachers; and continued support for teachers for two years, by text messaging.

> Ongoing support for teachers for two years through weekly text messages providing brief instructional tips and motivation to implement lesson plans. Teachers also received credit of $0.50—around 50 Kenyan shillings—each week for their mobile phones. A total of 200 Kenyan shillings over the course of a month represents about 1% of the 16,662 Kenyan shillings starting salary for primary school teachers. (Jukes, et al., 2017, p.451)

The efficacy of the intervention was measured using a cluster randomized controlled trial research design, across a substantial sample (101 schools, half assigned to control and half to the intervention, equating to approximately 2,500 children in total). A range of educational assessments were used to measure students' progress toward a range of literacy-related outcomes. Classroom observations and interviews with teachers were also conducted. The analysis showed that the intervention led to a change in classroom practices, and sustained positive impacts in terms of most of the measures of childrens' literacy after two years. Furthermore, the beneficial impacts were greater for girls (Jukes, et al., 2017).

SMS was used in a similar way as part of the Malawi Early Grade Reading Activity project (Kipp, 2017; Nyirongo, et al., 2018), to support continued development after training sessions. SMS was used as a potential way to extend and complement the beneficial effects of coaching, with SMS being a cost-effective, scalable way to maintain contact between sessions. Over a period of 6 weeks following training, at least three

messages were sent to teachers per week, covering topics including "encouraging specific practices, reminders about student behavior, and encouragement and motivation" (Nyirongo, et al., 2018, p.136). The study also presents a discussion about the relative cost effectiveness of SMS. Although early results suggested that the SMS campaign had a positive impact (Kipp, 2017), the efficacy of the SMS intervention was, however, inconclusive, due in part to the fact that a number of the teachers receiving the messages then shared them with others (Jukes, et al., 2017).

Mtebe et al. (2015) present a study in which SMS-based quizzes were used to assess teachers' subject knowledge, following a training programme, in Tanzania. 486 teachers took part, over a period of eight weeks. Few teachers scored highly, and most of the participants disagreed that the initiative had improved their knowledge and skills, was convenient, or enjoyable. This is attributed in part to technical issues around reliability of receiving SMS on time, and limitations of the format (Mtebe, et al., 2015). Assessment alone, without feedback and support, may not be an effective use of the technology.

3.2.2. Communities of practice

This sub-theme is distinct from the previous section as the emphasis is on communication within groups of teachers, in order to share experiences and build communities of practice. The earliest paper within this sub-theme describes an intervention at Stellenbosch University, South Africa. Part of the teacher training programme involved telematic sessions; WhatsApp was

used in order to compensate for the lack of interaction within the sessions (Ndlovu, & Hanekom, 2014). A qualitative analysis of conversations and feedback from 73 trainee teachers in mathematics and science suggests that this is an effective way of building teachers' subject and pedagogical knowledge, and networking between teachers (Ndlovu, & Hanekom, 2014). Also focused on trainee teachers in South Africa, Mabaso and Meda (2019) present a small-scale qualitative analysis of how two lecturers and 16 students use WhatsApp to support their training and teaching. In addition to being useful in order to relay practical and logistical course-related information from lecturers to student teachers, it was also perceived to be useful in collaborative learning, and providing students with a further way to discuss their course with the lecturers (Mabaso, & Meda, 2019). Similarly, the perceived value of contact and interaction with lecturers is highlighted by Habibi et al. (2018), in their study of 42 student teachers' use of social networking tools (including WhatsApp and Telegram, as messaging services) in Indonesia, while undertaking teaching practice.

Moodley (2019) offers a further example of how WhatsApp can be used to build communities alongside formal TPD. The sample comprised 18 teachers in a rural part of South Africa. The group actively discussed curriculum and assessment issues, and demonstrates the potential of WhatsApp for continued monitoring of in-service teachers, particularly in rural areas. Issues of TPD may be particularly important in rural areas, where teacher shortages may be more acute than in urban areas, and there may be fewer opportunities for TPD. The use of WhatsApp as part of a wider professional

development and monitoring programme is also the focus of Nedungadi et al. (2018), in a rural setting in India. The 'AmritaRITE' programme "uses a model of remote teacher monitoring and support using a combination of two specially-designed apps for attendance and student assessments, along with WhatsApp to send photos and text regarding daily attendance, assessment records, activities like yoga, community services etc." [sic] (Nedungadi, et al., 2018, p.120). Focusing on the WhatsApp component, the analysis drew upon a large sample of messages (8,968) from 26 participants. Topics discussed aligned with the project's goals of enhancing attendance, teacher empowerment and community engagement (Nedungadi, et al., 2018).

Different communication tools can have different affordances for teacher training. Sun et al. (2018) report on an intervention to promote communication and interaction between pre-service teachers in China. 78 students were asked to use one of two communication tools (discussion posts via Moodle, or messaging via WeChat) as part of a learning activity, and then used the other tool for a second activity. Students were asked to choose their preferred tool for a third activity. While Moodle use was found to be associated with a greater degree of collaborative learning and knowledge exchange, greater social interaction occurred via WeChat (Sun, et al., 2018).

Further examples reinforce the potential benefits for messaging apps and social media to foster informal professional networks, in Pakistan, Bhutan (Impedovo, et al., 2019) and India (Wolfenden, et al., 2017). Both also highlight the link between networks and sharing of Open Educational Resources (OER). Much larger

informal communities can be better supported by other forms of social media, as messaging groups are not open to organic internet traffic in the way that Facebook groups are, for example. See Bett and Makewa (2020) for an example of how Facebook groups can be used for similar purposes – to build support, and enhance subject and pedagogical knowledge – at a much larger scale. It is also worth noting that online community groups can also benefit caregivers of children with special educational needs; for example, Cole et al. (2017) examine the use of a WhatsApp group to support caregivers of children with autism in South Africa.

3.3. Supporting refugees' education

The third cluster of studies which emerged from the literature search includes instances where messaging has been used to support refugees' education in LMICs. Research on use of EdTech among refugees relevant to the context of the Covid-19 education crisis has been addressed by the United Nations High Commissioner for Refugees (2020), the Education Development Trust (Hallgarten, et al., 2020) and others, including within the EdTech Hub's series of RERs (Ashlee, et al., 2020). The reality of compounded crises in the lives and education of refugees is widely recognised within the sector. Disruption to refugee education by Covid-19 represents just such a challenge, albeit significantly different from double displacement, refugees returning to conflict zones or crises faced within camps. Across these contexts, refugees have employed technology to access information about continued educational opportunities

as well as to open doors to new opportunities where the displacement or crisis they have faced has closed a preferred education pathway.

This section focuses particularly on the ways that messaging and social media have enabled those choices for refugees. The resilience demonstrated by refugees and the communities supporting them in the face of ongoing fragility and instability indicates a range of possible responses for other stakeholders in the current crisis of Covid-19-related education interruption. This theme explores the lessons that can be applied to Covid-19 education response from this literature on the experiences of refugees with social media and messaging related to EdTech, building on the findings from the previous rapid evidence review on refugees (Ashlee, et al., 2020).

The following sections draw upon the studies identified through the literature search to build on the findings of Ashlee, et al., (2020) with specific reference to messaging applications and social media, in highlighting the particular importance of these tools in two primary areas. The first sub-theme focuses upon communicating with learners, parents and teachers about opportunities which maintain continuity of education. The second addresses the potential for this form of technology to be used to open up broader horizons of educational opportunities, where previous education pathways are closed.

3.3.1. Continuity of educational experience

This sub-theme reflects the importance of communication in maintaining continuity and stability

in the midst of displacement and crisis. Social media and personal messaging, which are often accessed on personal devices, provide crucial information to groups who are otherwise marginalised, and not given up-to-date information (Dahya, et al., 2019; Bellino, & the Kakuma Youth Research Group, 2018). Addressing these gaps in access to information for young people (and girls particularly) reduces uncertainty and anxiety, allowing learners and their families to focus on their education. In refugee contexts where security is a major concern, the use of messaging to keep learners and their families aware of incidents is another example of messaging being used to develop a sense of stability, which is key for creating an enabling environment and mindset for learning (Sork, & Boskic, 2017).

In addition to supporting learners and their families, messaging also supports teachers. As noted in Ashlee, Clericetti and Mitchell (2020), in refugee contexts many educators are not formally qualified teachers. Peer support has therefore been one approach to addressing this. In the Kenyan "Teachers for Teachers" programme reviewed by both McAleavy, et al. (2018) and Mendenhall, (2017). The purpose of the programme was to "provide teachers with support and expertise that geographical limitations would otherwise prevent" (McAleavy, et al., 2018, p. 40). The role of mentor teachers in this process allowed the programme to break down not only the physical isolation of teachers, but also reinforced their teacher identity by connecting teachers socially with other teachers.

> The mentors' role was to connect teachers in groups of four to five through WhatsApp and Facebook, which they then used to facilitate discussions on good

> practice and provide advice on issues participants were facing in the classroom (McAleavy, et al., 2018, p. 40-41).

The importance of these programmes in supporting teachers is not only evident in their own well-being and improved practice, but in improved relationships and communication with students (Mendenhall, 2017, p. 9). In an in-depth look at a specific group of refugee teachers using messaging to enhance their teaching practices, Motteram, et al. (2020) analyse the WhatsApp messaging history of 18 teachers in Za'atari camp in Jordan. Their findings were that 45% of messages sent over a 7-month period engaged with the teachers' professional development, while 30% related to organisation and 25% on personal messages (Motteram, et al., 2020). This demonstrates that a balance of needs are addressed through social messaging platforms, and that the personal nature (given they are accessed on personal mobile devices) allows a fluidity between seeking professional and personal support.

The parallels between the physical and social isolation by refugee teachers, and current challenges of Covid-19-related social distancing are clear, and the need to maintain continuity of identity for teachers is an important area for building up resilience.

3.3.2. Social media and education system renewal

While it is ideal to maintain continuity both for refugee learners and teachers, as part of ensuring greater stability for communities facing displacement and crisis, this is not always possible. This sub-theme addresses

literature looking at system-wide recovery in the face of educational disruption, and the new educational pathways that may open when continuity of education provision is broken.

Shekaliu, et al., (2018) focused on the mobilisation of host communities to support refugees in education through Facebook in Malaysia. The Facebook messenger platform allowed the refugees to interact with the local community and receive tutoring support in a way that broke down barriers and tensions that often arise between refugee communities and host communities. The expansion of social networks across these two communities, and the improved communication also provided opportunities for integration and a broadening of educational horizons for the refugees.

A broader approach including both Facebook and WhatsApp is examined in Alfarah, & Bosco (2018) regarding recovery efforts in Syria. The research methodology included qualitative case studies as well as social media discourse analysis of three programs: Nafham, Jusoor and UNICEF in Arabic. One function that distinguished the use of social media in these programmes from that of others was the collection, management and sharing of data to provide regular feedback. For example Nafham ran a poll asking:

> حسب معرفتك بنفهم في الوقت الحالي.. تفتكر ايه اكثر حاجة محتاجين تشتغل عليها مع بعض في نفهم علشان تحسّن من إفادتها للمجتمع؟
>
> According to your knowledge of Nafham in the current time.. Which do you think is most needed that we work on together in Nafham so that we can improve its benefits for society. [Author's translation] (Alfarah & Bosco, 2018, p. 57)

Note that within the text of Alfarah and Bosco (2018), (which is in Spanish) the translation provided is “Según tu opinión… ¿Cuál de las siguientes opciones sería prioridad y necesaria para que podamos junto ayudar a la sociedad?” this translation of the Arabic is not entirely accurate, and should be in English “ According to your knowledge of Nafham in the current time.. Which do you think is most needed that we work on together in Nafham so that we can improve its benefits for society.” The option “Professional [development] workshops” was the most widely chosen response.

This poll on their closed Facebook group “Crowd Teaching” allowed Nafham to discover that the teachers in their project need professional development opportunities – which was otherwise difficult for them to find out due to embargoes on tech companies in Syria limiting their access to survey applications (Alfarah & Bosco, 2018, p. 57). Social messaging applications can circumvent such regulations due to their vast transnational influence which allows them to work outside of prevailing legal jurisdictions. However, their primary social function also means they are not seen as ‘threatening’ software by those who might limit their reach.

In addition to collecting data, social media was used to share results, as in the case of Jusoor’s whatsApp group in which the head teacher encouraged his colleagues with their positive results:

> “لازم تكونو فخورين بالانجاز...مثال من صف من الصفوف ،،، فيكن تشوفو التقدم50%
> وانو ما في حدا اقل من ”
>
> You must be proud of the results… an example from one of the classes …. and you can see the progress and

> it is that no one is less than 50% [Author's translation] (Alfarah & Bosco, 2018, p. 56)

Note that within the text of Alfarah & Bosco (2018), (which is in Spanish) the translation provided is "Tenéis que estar orgullosos de vuestro trabajo. Un ejemplo de uno de los clases y podéis ver la evolución de los resultados. Todos más del 50%."

These examples of ad hoc, spontaneous data management through social media indicate an innovative appropriation of social platforms in challenging circumstances to re-establish educational systems which have faced complete disruption. Alongside the other examples of social media and messaging use in refugee education, these examples commend the innovative use of existing tools to enable both learners and teachers to continue in their roles.

4. Summary and recommendations

This rapid evidence review shows that there is a growing body of academic literature around the use of mobile phone-based messaging – including basic SMS, and messaging through social media and apps – to support education in LMICs. 45 studies were identified through a systematic search and screening of the academic literature. Many of the studies included in the sample were published within the past three years. However, since the use of messaging to support the education of school-aged children is not well established, there is not yet a substantial body of rigorous research to build

upon. The majority of papers included in the thematic analysis were small-scale interventions, and their impact on education not fully evaluated. A full quality assessment of papers was not applied, in order to allow as wide a range of relevant research-informed examples to be included as possible, given that a relatively small number of studies were uncovered by the literature search. As a topic which is becoming a more frequent part of educational interventions, and indeed part of national responses to Covid-19-related school closures, this review will be a useful reference tool for advancing the field.

Notwithstanding the limitations of the RER approach and variation in rigour in the included studies, the articles reviewed suggest that the use of messaging can have positive effects for education in LMICs.

- Messaging can be used in a range of learning activities, through a combination of sharing educational materials, with interaction between pupils, peers, caregivers and teachers. Use is more often focused on making use of the potential for the technology to foster interactions, rather than just as a way to deliver content alone. Interventions often combine multiple elements; likewise, messaging could be used as an interactive complement to broadcast media. To allow for flexibility and greater reach, materials should be designed in ways which are not platform-specific and can be adapted for different tools. Assessments and strategies can be adapted from face-to-face and telephone-based instruction. There is a trade-off in efficacy and cost here; for example, telephone-based interactions can

be more effective but are more expensive, while messaging is lower cost and more readily scalable.

- Messaging can be an effective way of supporting teachers, both in terms of providing activities such as lesson plans, and motivation. Initiatives which deliver lesson plans and guidance have been shown to foster a wider range of classroom practices, and show good potential to be applied at scale. Messaging is relatively low cost and teaching materials could be tailored to the local context. In terms of supporting teachers' professional development, messaging has been shown to be an effective way of maintaining contact and support in addition to in-person training. Materials adapted for messaging can also have a wider reach through being readily circulated among colleagues, and sharing of knowledge through informal communities of practice.
- Caregivers are key gatekeepers to mobile phone access. The role of parents and caregivers is particularly important in relation to supporting younger learners. Messaging is not only a way to send materials – using messages to send reminders and suggested activities can help to get parents and caregivers actively involved in using materials with children. Culturally-relevant design of materials and local languages can help promote this.
- The use of messaging to support refugees highlights its flexibility and resilience – which may be useful for ongoing disruption and uncertainty in the pandemic and beyond. Refugees' education faces multiple disruptions; the flexibility of messaging has contributed to its use in these

complex circumstances. As such, this flexibility could also be used to build resilience in terms of being able to switch between modes of teaching – from face-to-face to distance education – if incorporated into a plan for ongoing or emergency school closures. Planning ahead would be required, such as ensuring that schools hold up-to-date mobile numbers, and have educational materials in forms which would be readily deployed this way.

- There is some evidence to suggest that messaging may promote equity. For example, the studies include examples which have been successful in remote and rural areas, supporting SEND students, refugees, and promoting girls' education. However, the equity gains may not be universal – contextual factors will need to be considered carefully. Inequalities could be exacerbated if the technology is not accessible to all, either through general availability of the technology, or different ways in which access is mediated (for example, gatekeepers may hold stereotypical views in terms of gender and technology use). The success of many of the interventions is due in part to the familiarity of the technology, but the design of interventions shouldn't assume that everyone has access and consider how to reach those who would be excluded.

An area which was notably lacking in the sample of studies and would benefit from further discussion is the issue of safeguarding. In some of the studies, parents raised concerns about childrens' use of mobile phones. In the context of the Covid-19 pandemic, childrens'

online safety is a concern given the speed at which various activities have moved online (UNICEF et al., 2020). This is not a reason to discount this medium entirely, but does call for a more detailed discussion of how risks can be mitigated and the role that parents, caregivers and teachers can play in doing so.

The review also highlights the need for further research. By focusing on published academic research, the RER does not draw upon projects which are currently in progress and have not had findings published yet. Given the shift to remote and distance education necessitated by the pandemic, there is likely to be further research on this topic published in the future. For example, The EdTech Hub is currently supporting work with The Open University (UK) to conduct novel research building on a recent project to use mobile phones to share children's learning activities and activate local support, to understand how this has provided an equitable alternative in light of Covid-19 while schools in Zimbabwe are closed (Power, et al., 2021). While the studies here all suggest that the use of messaging has good potential for promoting a range of positive outcomes for education in LMICs and times of crisis, both for learners and teachers, further robust evidence is required to take the principles demonstrated in small-scale studies to larger programs at scale.

PART V

ANNEXES AND BIBLIOGRAPHY

ABBREVIATIONS AND ACRONYMS

AEWG Inter-Agency Accelerated Education Working Group
ASER Annual Status of Education Report
AT Assistive Technology
CAI Computer-Assisted Instruction
Covid-19 Coronavirus 2019
CPD Continued Professional Development
CTS Cognitive Tutoring Systems
EdTech Educational Technology
EGMA Early Grade Mathematics Assessment
EiE Education in Emergencies
ELS eLearning Sudan
ERIC Education Resources Information Center
HE Higher Education
HIC High-income country
IAI Interactive audio instruction
ICT Information and Communication Technologies
IfD Institute for Development
IOM Internal Organisation for Migration
INGO International Non-Governmental Organisation
ITS Intelligent Tutoring Systems
LIC Low-income country
LMIC Low- and middle-income country
MOOC Massive Open Online Courses
ODL Online and Distance Learning
OER Open Educational Resources

PBEA 'Peacebuilding, Education and Advocacy in Conflict-Affected Contexts' Programme

PRISMA Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PSS Psychosocial Support

PtPT Pikin to Pikin Tok

RCT Randomised controlled trial

RER Rapid evidence review

SEND Special Educational Needs and Disabilities

SMS Short Message Service

TaRL Teaching at the Right Level

TIGER These Inspiring Girls Enjoy Reading

TVET Technical and Vocational Education and Training

UNESCO United Nations Educational, Scientific and Cultural Organization

UNHCR United Nations High Commissioner for Refugees

ANNEX

Education in emergencies

Search terms

Search strings	Terms searched in combination with others
EdTech-related terms	EdTech, education technology, educational technology, ICT, digital learning
Emergency-related terms	Conflict, crisis, emergencies, war, disaster, natural disaster, natural hazard, epidemic, pandemic, earthquake, tsunami, virus
Education-related terms	Education, school, school closure, emergency online schools, higher education, disaster education, university
Specific countries searched	Syria, Yemen, DRC, Haiti, Nepal
Specific emergencies searched	Ebola, cyclone idai, typhoon haiyan, cholera

Inclusion and exclusion criteria

Criterion Type	Inclusion Criteria
Setting	Emergency or post-crisis
Education	Primary and/or secondary
Geography	LMICs
Literature type	All
Date	2009–2020

Screening process

Total returned results through searches [not unique results]: 1,126,859. (Excluded: 845,144)

Studies deduplicated: 281,715 (Excluded: 253,543)

Studies screened on title: 28,172 (Excluded: 28,099)

Studies selected on title and abstract: 73 (Excluded: 44)

Studies selected on full text for thematic analysis: 29

Girls education

Search terms

Numbers in brackets show the number of records returned by searching Google Scholar (an asterisk denotes searches restricted to records published since 2008), followed by the number of records which were included following screening.

- “girls education” ICT (3430, 7)
- “girls education” ICT (2670, 35)*
- gender primary “education technology” Africa

(8,730, 0) *
- “girls education” “education technology” (435, 3)
- GEC ICT (4540, 0)
- “girls education” “technology” “developing countries” (7220, 7)*
- “girls education” “ICT for Education” (63, 2)
- “girls education” “digital learning” (156, 6)
- allintitle: “ict” “girls education” (1, 1)
- “girls education” “ed-tech” (29, 0)
- ODL girls education (2570, ~8)
- “education for girls” “ICT” (1170, 3)*
- “girls education” computer aided learning (2650, 26)*
- “girls education” “distance learning” (1100, 0)*
- “girls education” “ICT Africa” (26, 3)*
- “girls education” “ICT South Asia” (0, 0)*
- “girls education” “ICT South America” (0, 0)*
- gender divide “primary education” ICT (16900, 15)*
- ICT4E girls (451, 0)

Inclusion and exclusion criteria

Criterion type	Inclusion criteria
Education	Primary and / or secondary
Geography	LMICs
Literature type	All
Date	2000–2020

Screening process

Total studies found through searches: 52,141

Studies screened on title and abstract: 90 (Excluded: 52,051)

Studies screened on full text: 67 (Excluded: 28)

Studies included for thematic analysis: 39

Refugee education

Search terms

- refugees
- refugee education
- EdTech refugees
- “education technology” refugees
- “refugee education” ICT
- “refugee children” AND “education technology”
- technology refugees school
- blended learning refugees
- “blended learning” refugee education
- “education technology” forced displacement
- forced displacement EdTech
- “meducation” refugees
- “online education” refugees
- teacher “professional development” AND refugees AND technology
- “distance learning” refugee children
- protracted displacement “education technology”
- OERs refugee education
- “mobile learning” “refugee education”
- “education technology” refugee integration
- refugee education technology
- refugee education ICT
- “psychosocial support” AND “education technology”

AND refugees
- "psychosocial support" AND "ICTs" AND "education" AND "refugees"
- "social emotional learning" AND "education technology" AND refugees
- "socio-emotional learning" AND "education technology" AND refugees
- "SEL" AND "ICT" and "refugees"

Inclusion and exclusion criteria

Criterion type	Inclusion criteria
Education	Primary and / or secondary
Geography	LMICs
Literature type	All
Date	2008–2020

Screening process

Total studies found through searches: 817,782
Studies screened on title and abstract: 155 (excluded: 80)
Studies screened on full text: 75 (excluded: 42)
Studies included for thematic analysis: 33

Personalised learning

Search terms

Numbers in brackets show the number of records

returned by searches, followed by the number of records which were included following screening.

Source: Google Scholar

- "Personalised Adaptive Learning" (132, 2)
- "Personalized Adaptive Learning" (619, 3)
- "Personalised technology-enhanced learning" (34, 4)
- "Personalized technology-enhanced learning" (76, 12)
- "Technology-enhanced personalised learning" (18, 6)
- "Technology-enhanced personalized learning" (30, 18)
- "Personalised TEL" (13, 5)
- "Personalized TEL" (11, 3)
- "Personalised learning environment" (593, 20)
- "Personalized learning environment" (3490, 5)
- "Teaching at the right level" (266, 5)
- "Combined Activities for Maximized Learning" (15, 1)

... ("Edtech" OR "Education technology" OR "digital learning" OR "eLearning" OR school) AND ("africa" OR "LMIC" OR "developing world" OR "developing country*" OR "ICT4D" OR "global south") [combined with terms below]

- "Personalised education" AND (160, 6)
- "Personalized education" AND (626, 6)
- "Personalised learning" AND (1810, 6)
- "Personalized learning" AND (3660, 5)
- "adaptive learning" AND (6910, 1)
- "adapting learning" AND (396, 5)
- "Differentiated learning" AND (1310, 8)
- "Computer-assisted instruction" AND (6160, 27)

- “Computer-assisted learning” AND (8130, 10)
- “Computer-aided learning” AND (1530, 3)
- “Intelligent tutoring system” AND (765, 5)
- “Exploratory learning environments” AND (33, 0)
- “Adaptive Educational Hypermedia” AND (112, 2)
- “Adaptive hypermedia” AND (414, 1)
- “Personalised Adaptive Learning” AND (7, 3)
- “Personalized Adaptive Learning” AND (43, 3)

Source: SPUD

- Teaching at the Right Level (2, 2)
- TARL (43, 0)
- personalised (534, 4)
- personalized (255, 2)
- adaptive learning (42, 3)
- intelligent tutoring system (76, 8)
- computer assisted learning (20, 4)

A total of 38,335 records were identified through searches, which was reduced to 198 after screening.

Inclusion and exclusion criteria

Criterion type	Inclusion criteria	Exclusion criteria
Population	Involving elementary and/or secondary school students (ranging from 5 to 19 years old) based in LMICs	Involving learners in higher or tertiary education only
Intervention	Falling under the broad 'umbrella' of technology-supported personalised learning	Studies focusing on access to technology with little consideration for how this is personalised to the needs of learners, or personalised learning with no use of technology
Outcomes	Reporting effects on academic performance (e.g. measured by grades or performance on tests) or relating to student needs/ preferences (e.g. motivation to learn)	Focusing on the development and testing of software with no learner data
Study design	Describing primary empirical research (i.e., acquired by means of observation, experimentation or survey), both quantitative and qualitative	Reviews and meta-analyses or providing a 'lessons learned' account without presenting any empirical evidence
Date	Published 2006–2020	
Language	English-language only	

Screening process

Total studies found through searches: 38,335

Studies screened on title and abstract: 198 (excluded: 136)

Studies screened on full text [including snowballed]: 62 (excluded: 38)

Studies included for thematic analysis: 24

The full data description spreadsheet is available here.

Accelerated learning

Search terms

The following search string was used for initial literature searches:

(accelerated adaptive learning; accelerated curriculum; accelerated e-learning; accelerated education programme; accelerated instruction; accelerated learning; accelerated learning; accelerated learning children; accelerated learning children; accelerated learning programme; catch-up learning; complementary education; intensified learning; intensive learning; rapid learning children; Rehabilitation education children; remedial education technology; speed school; speed up learning using technology; technology for accelerated education; accelerated teaching children)

Source	Search terms	Records returned	Studies screened	After title and abstract screening*
GS	accelerated learning	930000	500	98
GS	accelerated learning children	141000	500	76
GS	catch-up learning	257	257	18
GS	complementary education	3400	500	18
GS	speed school	2090	500	6
GS	technology for accelerated education	767000	500	45

Source	Search terms	Records returned	Studies screened	After title and abstract screening*
SCOPUS	accelerated adaptive learning	34	34	2
SCOPUS	accelerated curriculum	314	314	15
SCOPUS	accelerated e-learning	40	40	3
SCOPUS	accelerated education programme	265	265	62
SCOPUS	accelerated instruction	167	167	11
SCOPUS	accelerated learning	5068	500	36
SCOPUS	accelerated learning children	113	113	15
SCOPUS	accelerated learning programme	284	284	45
SCOPUS	intensified learning	304	304	4
SCOPUS	intensive learning	4195	500	36
SCOPUS	rapid learning children	705	500	13
SCOPUS	Rehabilitation education children	153	153	1
SCOPUS	remedial education technology	200	200	46

SCOPUS	speed up learning using technology	141	141	10
SCOPUS	accelerated teaching children	67	67	5

After the title and abstract screening, 99 studies were later removed after deduplication. This brought the total number of studies that were found through the above searches, that were screened on full text, to 416.

Inclusion and exclusion criteria

Criterion type	**Inclusion criteria**
Age	Under 18 years
Geography	LMICs
Literature type	All
Date	2000–2020
Topic	Studies exploring accelerated learning and intensified learning for disadvantaged, and average, learners. Notably, studies on accelerated learning for 'gifted' learners were excluded.

Screening process

Total documents found through searches: 1,855,797

Documents screened on title and abstract: 6,339 (excluded: 5,824)

Deduplicated documents screened on full text (416)

and documents found through snowballing (31) (excluded: 352)

Documents included for thematic analysis: 95

Radio

Search terms

- Radio
- Radio education
- Education radio
- Interactive radio
- Distance Education
- Interactive media
- Interactive radio instruction
- IRI
- Rural education radio
- Rural education
- Radio storytelling children
- Learning at home
- Interactive multimedia instruction
- School radio
- Public services radio access
- Educational broadcasting
- Educational broadcasting radio
- Community radio broadcasting
- Participatory communication education
- Out-of-school radio
- Teaching with radio
- Audio-based distance education
- Educational audio podcast
- Concomitant instruction

Inclusion and exclusion criteria

Criterion Type	Inclusion Criteria
Education	Under 18 years
Geography	LMICs
Literature type	All
Date	2000–2020

Screening process

Total studies found through searches: 3,346,320

Studies screened on title and abstract: 10,286 (excluded: 10,056)

Studies screened on full text: 230 (excluded: 164)

Documents included for thematic analysis: 66

Television

Search terms

Searches were conducted using combinations of the following terms:

Educational television, Learn, Attainment, Outcome, Gain, Intervention, Ability, Capacity, Capability, Impact, Effect, Co-viewing, Co-discussion, Sesame Street, KnowZone, Akili, Ubongo, marginalised, equity, rural, developing countries, Latin America, out-of-school, socio-emotion, SEL, Teacher, School, multimedia, platform, multiple platforms, transmedia. Psychosocial, executive function, problem solving, collaboration, self-regulation, RACER, MELQO

Inclusion and exclusion criteria

Criterion type	Inclusion criteria
Age	3–18 years
Geography	LMICs
Literature type	All
Date	2000–2020

Screening process

Total studies found through searches: 586,107

Studies screened on title and abstract: 2,545 (excluded: 2,507)

Documents included for thematic analysis: 46

Messaging apps and SMS

Search terms

The following search string was used for initial literature searches:

("skype" OR "telegram" OR "whatsapp" OR "social media" or "sms" or "text messag*" or "facebook") AND ("education" OR "school") AND ("africa" OR "LMIC" OR "developing world" OR "developing countr*" OR "ICT4D" OR "global south" OR "refugees")

Number of records returned from database, and number included after first round screening.

	Total results	Included after title and abstract screening
ERIC	279	22
Google Scholar	2390*	25
Scopus	662	98
Web of Knowledge	369	48

*The first 30 pages – 300 items – of results were screened. Not all of the results were screened because (a) Google Scholar includes a high proportion of non-peer reviewed and grey literature, and (b) records are returned in order of 'relevance'.

Note that additional sources were found via snowball sampling from included studies, and recommendations.

Inclusion and exclusion criteria

	Inclusion criteria	Exclusion criteria
Population	Involving elementary and/or secondary school students (ranging from five to 19 years old) based in LMICs. This can include out-of-school children (e.g. refugees), and perspectives of those involved in supporting school-aged pupils (e.g. teachers, parents, caregivers)	Exclude any studies focused on HICs Exclude studies where the focus is on tertiary education, higher education, TVET, or other forms of adult education (exception: teacher training and professional development)
Intervention	Must be focused upon the use of WhatsApp, social media, SMS, or other forms of mobile-based messaging apps for educational purposes	Exclude studies which make only passing reference to this (e.g. levels of phone use/ ownership by students), or do not have an explicit link to education (e.g. health interventions)
Study design	Studies must be empirically-based, presenting research findings and evidence	Exclude theoretical papers, position papers, review papers or opinion pieces
Date	Published between 2010 and the present day (mid 2020)	Published before 2010

Screening process

Studies screened on title and abstract: 1,610 (excluded: 1,417)

Studies deduplicated: 193 (excluded: 32)

Studies added from snowball sampling and recommendation: 16

Studies screened on full text: 177 (excluded: 132)

Studies included for thematic analysis: 45

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