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Educational technology for learners with disabilities in primary school settings in low- and middle-income countries: a systematic literature review

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ABSTRACT
Educational Technology (EdTech) plays a significant role in enabling learners with disabilities to access learning at school and reduce educational and social exclusion. It also enables them to enjoy the benefits of a full school curriculum and to participate in activities in different educational arrangements. The purpose of this review was to address the existing evidence of how EdTech is being used to support learners with disabilities in order to inform future research and policymaking. It sought to contribute to an evidence base of ways to reduce barriers to learning drawing on a systematic methodology to gather evidence pertaining to access to EdTech for primary school learners with disabilities aged 6–12 years. After a thorough examination of the literature, the final sample comprised 51 published articles (43 peer-review and 8 conference papers). The review revealed examples of positive outcomes of EdTech interventions being used, particularly in special schools; however, the evidence of their efficacy is weak. The use of EdTech for learners with disabilities in low- and middle-income countries requires further, robust and long-term research that considers the involvement of learners, pedagogy and curriculum design in order to understand its impact on improving educational experiences of children with disabilities.

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Introduction

Globally, there are more than one billion people who need one or more assistive products or devices (WHO, 2017). However, only one in ten people have access to such products, leaving many individuals unable to enjoy the levels of inclusion and participation they are entitled to (WHO, 2019). Educational Technology (EdTech) plays a significant role in enabling learners with disabilities to access learning at school and reduce educational and social exclusion. It also enables them to enjoy the benefits of a full school curriculum and to participate in activities in different educational arrangements. EdTech has been a missing link in the chain of prerequisites that enable children with disabilities to lead a life where they can enjoy and exercise their rights (UNICEF, 2016). Moreover, appropriately

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matched EdTech can play a powerful role in supporting children's learning, not only in ways of providing access but also in enabling them to build their self-esteem and to flourish at school.

Disability is a complex multidimensional concept which does not lend itself to a single definition. In helping us to conceptualise disability, we define it in accordance with the World Health Organisation's International Classification of Functioning, Disability and Health which considers disability and functionings as outcomes of interactions between health conditions (diseases, disorders and injuries) and contextual factors (WHO, 2002). Among contextual factors are the external environment (e.g. social attitudes, natural and built environment, products and technology) and internal personal factors (e.g. gender, age, social background, motivation and self-esteem), all of which can influence how much a person participates in society (WHO, 2002). Cultural and linguistic dimensions, legislative and political factors vary across contexts and sometimes within country contexts (Jeffrey & Singal, 2008). The United Nations Convention on the Rights of Persons with Disabilities (2006) also provides a helpful approach to conceptualising disability by encapsulating the dignity, autonomy and worth of persons with disabilities and enhances their visibility in society (Winter & Mazurek, 2017).

Most recent evidence suggests that only 5–15% of those who need assistive technology (AT) are able to obtain it in low-and-middle-income-countries (LMICs) (UNICEF, 2016). More recently, closures of schools due to COVID-19 have created additional threats to the education of learners with disabilities in LMICs, who are least likely to have access to the internet, accessible software and online learning materials (UN, 2020). A report published by the Inclusive Education Initiative (Mcclain-Nhlapo et al., 2020) notes that nearly 40% of disadvantaged learners in LMICs have been left entirely unsupported in their education, and among these, children with disabilities are disproportionately represented. The field of disability and EdTech, mirroring larger trends in disability and educational research, has remained dominated by international assertions of support through the Sustainable Development Goals (SDGs) (United Nations, 2015), but largely supported by anecdotal commentaries and strong personal assertions but little empirical evidence (Singal et al., 2019). EdTech has been hailed as a key mechanism to address these learning gaps, though is not without challenges, or unintended consequences (Muyoya et al., 2016). In spite of these barriers, it is important to understand whether and how EdTech is making a positive difference to the educational experiences and outcomes of learners with disabilities in LMICs.

Technology can be empowering, but it can also be frustrating and stigmatising when it is complicated to use and when users perceive that their devices look different from what other people use (Martinez & Scherer, 2018). Enabling and inclusive environments must begin with a fundamental belief in the equity and rights of all children and families, especially for those who are most vulnerable, including learners with disabilities. Thus, EdTech must address fundamental issues of equity and support effective inclusion for all, but it is also important to consider the complexity of meeting an individual's requirements with regard to achieving the right match with the individual. Although this review does not advocate a specific theoretical approach, it acknowledges the need for an approach or model that can provide appropriate guidance on how best to meet the current capabilities and preferences of the student within a learning context. For instance, the match of person with technology (MPT) model takes a person-centred approach to identify the personal and psychosocial characteristics, needs and preferences; environmental factors; and functions and features of the technology (Martinez & Scherer, 2018). A significant aspect of this model is the provision of education about assistive technology and the value that it can bring to the learning process, which can provide a helpful lens in addressing RQ2 below. Therefore, a good match of person and technology requires attention to aspects of and resources in the environments in which the technology will be used, the needs, expectations and preferences of the user, and the functions and features of the technology and service delivery process (Martinez & Scherer, 2018).

In undertaking this review, we posed the following main question: What can we learn from existing evidence about how EdTech is being used to support learners with disabilities aged 6–12 years in LMICs to inform future programme and policymaking? To unpack this main research question, we posed the following sub-questions.

RQ1. What types of research have been undertaken in LMICs to study the use of EdTech to support learners with disabilities?

RQ2. What kinds of EdTech are being used to support learning of children and young people with disabilities in LMICs contexts?

RQ3. What can we learn from the existing evidence?

RQ4. How can we build a research agenda for further development of this field?

We begin by discussing the methodology followed for this systematic review, highlighting the key findings and concluding with what we can infer at the methodological, implementation and research levels in taking this agenda forward.

Methodology

Systematic literature reviews are effective for mapping out areas of uncertainty, identifying where little or no relevant research has been done, and where new studies are needed (Petticrew, 2006). They are designed to avoid implicit assumptions and to encourage transparent methods of research that are guided by a clearly identified research question (Langan et al., 2013). To obtain a comprehensive understanding of what is known about how technology is being used to support the learning of children with disabilities living in LMICs, the principles for conducting and reporting systematic reviews recommended by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses – PRISMA and the Cochrane Handbook for Systematic Reviews and Interventions were followed (Higgins et al., 2021 Moher et al., 2009). The PRISMA guidelines involve formulating clear questions and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyse data from the studies that are included in the review.

The review team comprising three researchers, two with extensive experience of conducting research on issues of inclusive education with a particular focus on children with disabilities in LMICs, prepared a literature review protocol and undertook the review work between July and November 2020. The reviewers adopted a critical epistemological lens when surveying the literature, recognising that disability research utilises diverse qualitative and quantitative methodological approaches (Scott & Bhaskar, 2010). The conceptual model, outlined above, was used to inform data synthesis plans to ascertain the level of teacher support provided to the learner in acquiring required skills to access the curriculum and the learner's ability to use technology effectively and independently.

Eligibility criteria

We took our starting point as all articles in peer-reviewed English language journals and extended to include peer-reviewed conference proceedings to capture potentially important ongoing work in LMICs. The inclusion criteria specified aspects of study characteristics that addressed the review questions and for deciding on what articles to include in the review. The specific focus was on studies with participants who were learners with disabilities attending primary level schooling (aged 6–12 years) in LMICs. It aimed to capture research undertaken in the intersecting areas of disability and educational technology; hence, we were mindful not to make any assumptions about preferred research designs when setting the eligibility criteria for included studies. Being conscious of the fact that the field of disability research tends to be dominated by qualitative studies (and in many instances comprising small samples) with few randomised control trials (RCTs), large-scale, and/or longitudinal studies (Singal et al., 2019), we decided not to prioritise one design type over another. In addition, study outcomes were not pre-specified; instead, an exploratory approach was used to identify the types of outcomes reported from EdTech disability research; as the goal was to determine the state of evidence in this context. The eligibility criteria for including studies in the review and information sources used to retrieve articles are described in an inclusion and exclusion

Table 1. Inclusion and exclusion framework.

Quality	Inclusion criteria	Exclusion criteria
Population	Special needs learners attending mainstream and special schools at the primary level (6–12 years) Teachers working with special needs learners. Parents supporting special needs learners.	Special needs learners older than 12 years (secondary school age and older) Teachers and parents of special needs learners older than 12 years.
Outcomes	All outcomes arising from investigating the use of EdTech to support learners with disabilities	Outcomes unrelated to the use of EdTech to support learners with disabilities
Study Designs	All studies designed to investigate how EdTech is used to support learners with disabilities e.g. RCT, quasi-experiments, case-studies, surveys, etc.	Studies with ill-specified research designs
Geographical location	Low- and middle-income countries based on World Bank Group list	High-income countries
Type of publications	Primary Sources Empirical peer-reviewed journal articles Empirical peer-reviewed conference-papers Secondary Sources	Guidance reports which do not include research evidence but are commentaries of what should be done.
Search engines	EdTech Hub Searchable Publications Database (SPuD) which comprised articles from 2007–2019 pooled from the following five major academic journal databases: ProQuest, Web of Science, Scopus, Directory of Open Access Journals (DOAJ), Education Resources Information Center (ERIC). Additional search of ERIC and Scopus for publications between 2019-July, 2020 publications only to cover 2020 publications not covered in SPuD.	Other search engines were not searched.
Date	2007–2020	Older than 2007
Language	English	Any other language

framework presented in Table 1. Elements of inclusion criteria, participant/problem, intervention, comparison, outcome, and study design (PICOS), recommended in the Cochrane Handbook for Systematic Reviews and Interventions were considered but not all elements were relevant given the focus on both qualitative and quantitative evidence (Higgins et al., 2021).

Information sources

Multiple information sources were used for identifying relevant studies. Automated searches were conducted using the electronic "Searchable Publications Database (SPuD)", which is a database developed internally by EdTech Hub that aggregates literature and publications focused on the use of technology to support teaching and learning in LMICs. SPuD searches the following databases: ProQuest, Web of Science, Scopus, Directory of Open Access Journals (DOAJ), Education Resources Information Center (ERIC). SPuD supports automatic searches by applying lengthy search strings comprising of a main "keyword" along with multiple options, such as "geographic country / regions (gd)", "technology education / other (TE / TO)", "population education / other (PE / PO)", "development terms (DT)".

The search results from SPuD were downloaded into the referencing manager "Zotero" using Research Information Systems (RIS) export, where the literature screening was conducted. At the time of the review, SPuD contained work published from 2007–2019. Whilst opportunistic, the time-line coincides with the period, 2005–2009, marking significant differences in educational research including revising curriculum for educational technology (Bozkurt, 2020). To ensure that the review is up to date, complementary searches were carried out in ERIC and Scopus targeting the period 2019–2020.

Search strategy

The search strategy involved generating a list of key words and phrases relating to disability, EdTech and the population of interest. The keywords generated included: 26 disability terms covering categories of blindness, deafness, intellectual impairments and physical impairments; 16 EdTech-related terms that described technological devices as well as inclusive education approaches used to support the learning of children with disabilities; and 16 relevant keywords to capture the population of interest and the contextual parameters of the review (see Table 2). The Boolean strings used were based on combinations of disability and technology terms, such as "deaf" AND "assistive technology" and "deaf" AND "enabling technology".

Selection process

One reviewer screened the title and abstract of each paper as part of the study selection process. In full-text screening, parallel independent assessments of all the manuscripts were performed by two researchers to determine if they should be included in the review. This involved assessing adherence of each study to the eligibility criteria (refer to Table 1). Studies were checked on relevance of content which involved verifying

Table 2. List of keywords and phrases.

Disability terms	Technology terms	Population terms
blind	assistive technology	student
low vision	enabling technology	pupil
partially sighted	inclusive technology	child
visually impaired	adaptive technology	children
deaf	assistive devices	learner
hard of hearing	assistive aids	early childhood
hearing impairment	"augmentative and alternative communication (AAC)"	primary school
deaf-blind	"universal design for Learning (UDL)"	special school
multi-sensory impairment	"one laptop per child (OLPC)"	resource centres
intellectual impairment	mobile handheld devices	parents
intellectual disability	smartphones	principals
learning disability	tablets	teachers
slow learners	laptops	special needs teacher
mental retardation	tv	special teacher
autism spectrum disorder	radio	resource Teacher
"attention deficit hyperactivity disorder (ADHD)"	ICT	"special education needs coordinator (SENCO)"
cerebral palsy		
dyslexia		
dyspraxia		
physical disability		
physical impairment		
physically challenged		
disability		
disabled		
impair		
impaired		

that all the studies sufficiently addressed the use of educational technology to support the learning of primary school-age children with disabilities. Joint discussions were conducted to achieve a consensus where there was a lack of agreement.

Data collection process

Two of the reviewers were involved in the process of extracting data from individual articles. Extracted data were recorded in a pre-defined data extraction form comprising background information for each study, including location, sample size, duration of intervention, and framing of the study in relation to the dual model providing "access to learning" and teaching "learning to access", as well as key study findings and any limitations. The data generated information about the study characteristics and were used to conduct more in-depth analysis and synthesis of the dataset.

Study risk of bias assessment

Inferences about study bias were assessed by making judgements about methodological adequacy. "Adequacy" of the research to the scientific process involved assessing the extent to which the research process was reasonably reported in each paper for all types of research designs, methods and data analysis. Based on judgements of study rigour and quality, studies were judged as either adequate or inadequate. A high-level holistic assessment approach was undertaken given the heterogeneous nature of disability research in LMICs. The general guidelines for reporting primary empirical research studies in education (the REPOSE Guidelines) informed this process and involved one of the authors checking whether each article reported the aims, rationale, design, contexts, methods, results, and conclusions of their study (Newman & Elbourne, 2004). The appraisal has nine elements and an article is coded as inadequate if one or more elements were not reported upon. A second author re-appraised 10% of the articles (*n* = 5). This high-level appraisal approach supported our intention to be inclusive of different research designs and methods and was sensitive to research from different academic traditions and country-specific contexts which are known to have challenges with capacity building in training local ethics oversight, research implementation, and reporting of findings (Camp et al., 2009).

Synthesis methods

A thematic matrix was developed to synthesise the research using Nvivo 12.0 software and agreed upon by the team members using evidence recorded in the data extraction forms. Thematic analysis of the final selected articles was undertaken to identify their main outcomes and contributions. To understand the factors around "access to technology" and "teaching learning to access", main and sub-themes were inductively generated during the coding of the studies by one reviewer. A second reviewer conducted an internal data checking or validation exercise and independently coded a random sample (20%) of studies to ensure agreement on the thematic categories and the evidence included in those categories. Codes were continually refined to ensure that the interpretations were thorough and consistent across the articles. Finally, node clusters were generated for similar methods, approaches, and keyword-in-context into auto-generated subthemes.

Results

First, we report the results of the study selection after literature screening, a quantitative summary of the research landscape focusing on study characteristics such as geographical location, gender disaggregation, and age ranges. We then share the findings for RQ1 by reporting on the type of research designs across different studies, and RQ2 by describing the type of technology matched to impairment group. The results of the synthesis addresses RQ3 which asks "what can we learn from the existing evidence"? We focus on the more substantial themes generated from the research synthesis, including an examination of what the evidence highlights in relation to EdTech and specific impairment groups, and then discuss studies that investigated the role of teachers and parents.

Study selection

The results of the study selection process are depicted in the PRISMA flow diagram presented in Figure 1. Initial pre-screening yielded 20,163 sources. After de-duplication and title screening, 340 studies were retained. We carried over 187 articles for full-text screening. Full-text assessment resulted in studies being selected with 95% agreement between two of the study authors. Consensus discussions were held to resolve disagreements (n = 10 papers) after independent full-text assessment of the articles based on the eligibility criteria.

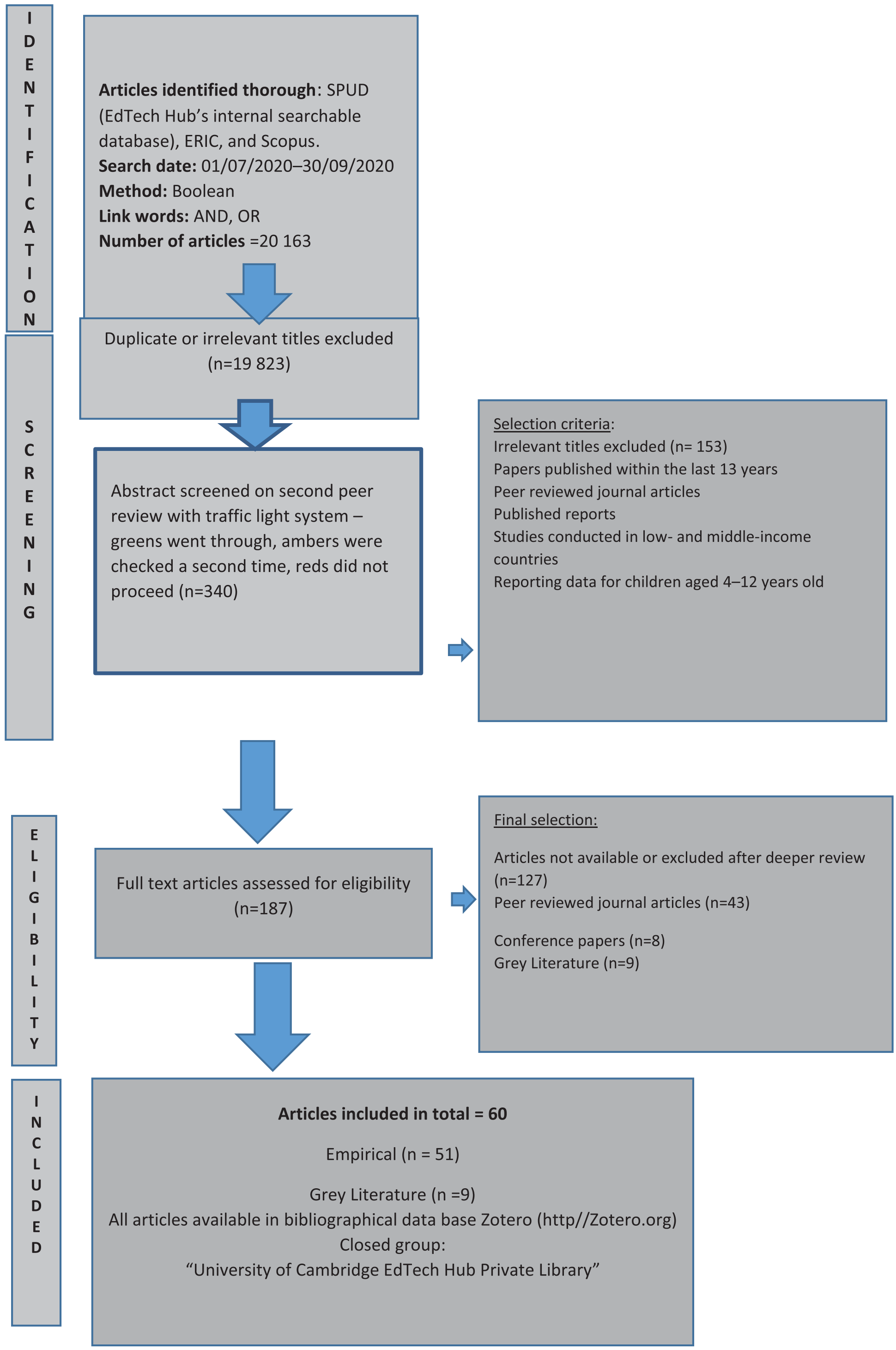

Figure 1. PRISMA flow diagram of study selection.

Study characteristics

(i) Geographical location

The 51 papers included in the review (43 journal articles and 8 conference papers) represent work being undertaken across 27 LMICs[1]: Asia ($n = 27$), Africa ($n = 16$), South America ($n = 6$), Europe[2] ($n = 2$). As a transdisciplinary area of study, EdTech and assistive technology (AT) can be found within and across a diverse range of disciplines such as education ($n = 24$), health ($n = 11$), computer science ($n = 7$), engineering ($n = 4$) and other multidisciplinary journals ($n = 5$), which suggests that a substantial amount of the research exploring technology solutions in education for children with disabilities is happening outside of the mainstream education field.

(ii) Gender

The majority of studies did not provide a breakdown of male and female participants in their studies; instead they reported findings for total number of participants only. The ten studies which gave a breakdown had twice as many male as female participants (for example, Nanavati et al. (2018): 39 boys and 18 girls; Joy et al. (2019): 17 boys and 11 girls; Ampratwum et al. (2016): 23 boys and 12 girls). In the only study which surveyed teachers' knowledge and use of AT in Nigeria, out of a total of 433 teachers around 35% ($n = 153$) were female.

(iii) Age ranges

Even though our search was specifically focused on primary school years (commonly viewed as between 6 and 12 years), age range of the participants varied in the final set of papers. The school-level categorisation of papers taking into account learners' ages include primary ($n = 20$), and a combination of primary and secondary participants ($n = 7$), whereas a significant number of papers did not provide this level of descriptive information ($n = 24$[3]). The wide range of age groups captured is not surprising given that most of the studies took place within special schools, which often have learners entering late into formal primary schooling (at around 9 years) and remaining there until they are older.

Risk of bias in studies

A total of 33 studies met the minimum criteria of adequate reporting of research methods based on the REPOSE Guidelines and 18 studies were appraised as inadequate. The elements of the research that were not adequately described were in relation to describing the sample ($n = 11$), sampling strategy ($n = 8$), the context ($n = 5$), and conclusions ($n = 5$), for example, not drawing conclusions that follow from results. There was 100% agreement on the proportion of articles (10%) that were appraised by two assessors.

RQ1. What types of research are being undertaken in LMICs to study the use of EdTech to support learners with disabilities?

The studies reviewed adopted diverse research designs, such as: software evaluations ($n = 17$), surveys ($n = 12$), case studies ($n = 7$), quasi-experiments ($n = 7$), RCTs ($n = 1$), mixed methods ($n = 3$), cross-sectional studies ($n = 3$), and ethnography ($n = 1$). Significantly, the highest number of studies involved software design and an evaluation for deaf learners (*n* = 12) to teach sign language, basic mathematical concepts, and lip-reading. It is also important to highlight the high number of studies that used a combination of survey methods (such as questionnaires) to collect data about learners' and teachers' understandings and uses of technology. By contrast, only one study drew on an ethnographic design (Nanavati et al., 2018).

The duration of data collection, in studies where it was mentioned, ranged from less than one month (*n* = 6), less than three months (*n* = 10), and greater than three months (*n* = 8). A significant number of studies had small sample sizes, ranging from less than 5 (*n* = 5), less than 10 (*n* = 9), from 10 to 20 (*n* = 9), between 21 and 40 (*n* = 10), and greater than 40 (*n* = 17). Six studies targeted teachers only and eight studies had a combined sample of learners, teachers and/or administrators.

RQ2. What kinds of EdTech are being used to support learning of children and young people with disabilities in LMICs contexts?

Studies covered 11 different types of impairments or conditions or grouping of impairment, which are based on specific terms used in the papers, i.e. hearing impairment (*n* = 20), visual impairment (*n* = 15), special education needs or special needs education (SEND / SNE) (*n* = 5), dyslexia (*n* = 4), autism (*n* = 3), cerebral palsy (*n* = 2), general disability (*n* = 1), physical disability (*n* = 1). There is considerable variation in the number of studies

Table 3. Studies mapped against impairment and country.

Impairment	Country	Research papers
Deaf (hearing impairment) (*n* = 20)	Namibia, Iran, Tunisia, Mexico & Colombia, Pakistan, Turkey, Thailand, India, Turkey, Kenya, Pakistan, Indonesia, Columbia, Nigeria	Abiatal and Howard (2019); Ahmadi et al. (2015), Bouzid et al. (2016), Cano et al. (2018), Farooq et al. (2015), Goker et al. (2016), Iam-Khong and Suksakulchai (2011), Joy et al. (2019), Karal (2015), Kiboss (2012), Parvez et al. (2019), Masitry et al. (2013), Muljono et al. (2019), Muñoz et al. (2018), Nanavati et al. (2018), Nittaya et al. (2018), Ramos-Ramirez and Mauricio (2019), Techaraungrong et al. (2017), Wicha et al. (2012), Zahra et al. (2018),
Visual impairment (*n* = 15)	Ghana, Brazil, Nepal, India & UK, Eritrea, Thailand, Philippines & Canada, Malawi, Kenya, Bangladesh	Ampratwum et al. (2016), Alves et al. (2009), Gnyawali et al. (2012), Gothwal et al. (2018), Gyawali and Moodley (2018), Joshi et al. (2008), Kalra et al. (2009), Lopez et al. (2019), Lynch et al. (2014), Lynch et al. (2011), Mukherjee et al. (2014), Nahar et al. (2015), Nkiko et al. (2018), Yalo et al. (2012), Senjam et al. (2020)
SEND/SNE (*n* = 5)	Nigeria, Egypt, Thailand	Ajuwon and Chitiyo (2015), Al-Gawhary and Kambouri (2012), Lersilp et al. (2018), Onivehu Adams et al. (2017), Pitchford et al. (2018),
Dyslexia (*n* = 4)	Morocco, Malaysia	Benmarrakchi et al. (2017), Mohamad et al. (2017), Pandey and Srivastava (2011), Tariq and Latif (2016),
Autistic spectrum disorders (ASD) (*n* = 3)	China	Hu and Han (2019), Hu et al. (2020), Sankardas and Rajanahally (2017),
Physical disability (*n* = 3)	Kenya, Ecuador, Brazil	Kamau (2017); Alvarado-Cando et al. (2019), Martins et al. (2019)
Disabilities (*n* = 1)	Ethiopia & Thailand	Schiemer and Proyer (2013)

for different types of impairment, with sensory impairments representing over two-thirds of the total papers ($n = 40$).

Table 3 maps the impairments and the country where the studies took place and provides a reference to the article. Studies across all the impairment groups provided some details of how the technology created new opportunities for learning for learners with different impairments: autism (Sankardas & Rajanahally, 2017), deafness (Parvez et al., 2019 Techaraungrong et al., 2017; Zahra et al., 2018), dyslexia (Benmarrakchi et al., 2017; Mohamad et al., 2017), visual impairment (Gothwal et al., 2018 Joshi et al., 2008) and physical disability (Alvarado-Cando et al., 2019). In some studies (for example, Al-Gawhary & Kambouri, 2012; Lersilp et al., 2018) a broad range of impairments (SEND/SNE) were recruited in an intervention study therefore making it difficult to judge whether the intervention had benefited a specific impairment group or had broadly improved learning opportunities across the group.

The next sections summarise the nature of the research and highlight key learning, where pertinent and feasible. We then present cross-cutting themes emerging in the literature, focusing on the role of teachers and parents, as highlighted in the research studies.

Deaf and hard-of-hearing learners

The highest number of studies identified were for deafness and hearing impairments ($n = 21$). As is the case with visual impairment (discussed below), all these studies took place in special schools using small sample numbers of learners. With the exception of a study by Muñoz et al. (2018), which included deaf/hard-of-hearing learners in the development and testing of software, all studies were published in engineering, science and technology journals with an emphasis on testing a software program for accessibility and usability, with little reference to pedagogy or the national curriculum.

(i) Use of social media to aid communication

Four studies reported on learners' preferences in relation to AT and social media, with some indication of improved learning "process", "opportunities" and "achievements" but nothing specific to the learning outcomes linked to the school curriculum or to the ECC (such as learning sign language). For instance, Zahra et al. (2018) used a survey design to find out what mode of communication and software 362 deaf/hard-of-hearing children aged 10–20 years were using while attending special education centres and schools in Pakistan. Around 50% of the children said they use Skype, Facebook, SMS and email to communicate at school. Farooq et al. (2015) found a clear difference in the learning achievements of deaf/hard-of-hearing learners who use "high-tech" AT (smart phones) in comparison to low-tech AT (sign language cards), but very little is said about the actual differentiated learning experiences and in relation to those learners who used high and low tech.

(ii) Software programs to teach sign language

Seven studies piloted software programs to teach sign language or integrated sign language into presenting a variety of learning materials. Sample sizes ranged from only a few learners ($n = 3$) in Malaysia to a much larger group study ($n = 141$) in Thailand. For instance, Ahmadi et al. (2015) piloted a software program to help to support the hygiene health (such as washing hands, bathing, oral and ear hygiene) of deaf and hard-of-hearing learners in seven primary schools in Tehran, Iran. The multimedia software programs included educational videos with sign language, guiding images, and subtitles with simple short sentences, as well as deaf-specific designed animations. Joy et al. (2019) rigorously tested an app to teach sign language (language not specified) using Android phones in a school for the deaf in Kerala, India. Positively, learners were able to use the same picture books for learning vocabulary in sign language as those used by spoken language learners.

In a revealing ethnographic study of a school for the deaf in India, Nanavati et al. (2018) found differences between teachers' expectations of deaf/hard-of-hearing learners' speech and language therapy goals and what software games were offering. Specifically, teachers described their approach to speech therapy as involving a binary distinction between learners who "can't speak" and those who "can try [to speak]" and they placed greater expectations on better matching of what the technology can do with the specific pedagogical difficulties the children were experiencing at school.

In terms of helping learners to acquire vocabulary in sign language, Wicha et al. (2012), in one of the largest sample sizes ($n = 141$) in Thailand, developed a Total Communication with Animation Dictionary (TCAD) which helped deaf/hard-of-hearing learners in primary schools to acquire English vocabulary and improve their retention skills using sign language, finger spelling, lip-reading, picture captioning, reading, writing and vocabulary in Thailand.

(iii) Use of apps to teach maths

We identified three studies that tested mobile apps to teach maths using sign language to learners in Pakistan, Thailand, Namibia and Kenya. Parvez et al. (2019) studied how a mobile app is using Pakistan Sign Language (PSL) to teach maths to 192 deaf participants aged 5–10 years at two special schools in Islamabad, Pakistan. Results showed better performance of participants who used the mobile apps when learning basic mathematical concepts. Techaraungrong et al. (2017) designed and tested a multimedia resource to develop arithmetic (counting, subtraction and addition) skills with 11 deaf/hard-of-hearing learners in Grade 1 compared with teaching counting, addition and subtraction using a conventional teaching approach in Grade 1 (aged 7 years) in two boarding schools for deaf learners.

Learners with visual impairment

Assistive technology provides support in a number of domains including access, communication, independence, learning and mobility and is one of the most developed areas of EdTech, ranging from low-vision devices (LVDs) to sophisticated screen-reading software programs and refreshable braille displays for blind users. Studies used a mixture of surveys ($n = 3$), RCTs ($n = 1$), interventions ($n = 3$), and pilots of how mainstream and AT are used in the classroom. Significantly, nearly all the 19 studies took place in a special school setting. The following sub-sections highlight some of the key findings from these studies.

(iv) Use of low-vision devices in special schools

Five out of the 19 studies investigated the use of LVDs (such as reading stands and hand-held magnifying glasses) in special schools, and although they do not look at specific learning outcomes, they do indicate the urgent need for all children attending special schools to receive regular comprehensive eye assessments which include screening for potential deterioration of vision as a result of eye condition and appropriate match of LVDs based on correct diagnoses.

Joshi et al. (2008) conducted a study in Nepal at two special schools for learners who are blind and one school for learners with special needs in Kathmandu Valley and found that around a third (33%) of the 62 learners screened at the special schools actually had low vision rather than total blindness. All these children were provided with LVDs to access print instead of braille. The teachers noticed the learners' "significantly elevated confidence" in their academic performance compared with before the devices being prescribed. In one of the largest studies involving 779 learners aged 6–24 years with low vision attending integrated schools in 38 districts of Nepal, Gnyawali et al. (2012) found that LVDs were either damaged or misplaced (64%), with 32% of learners feeling discomfort while using the device, 18% having been given inadequate instructions on how to use the device, and 14% having been provided inappropriate lighting and sitting arrangements.

In a survey of 250 learners with visual impairment who use AT in India, Semjan et al. (2019) found that teachers lacked awareness of the benefits of AT in accessing learning materials. There were also concerns about the cost of ATs, which may have contributed to the low take-up of LVDs in ten schools for the blind in Delhi, India. The results revealed that most learners were using braille slate and stylus (almost 100%) and handheld audio recorders (96%) even though those with some residual vision could have benefited from LVDs. Other devices were poorly used, ranging from nil (typoscopes[4]) to 55% (voice-activated computer screen-readers).

(v) Use of mobile devices and apps to support learning

In an RCT conducted in India, Gothwal et al. (2018) measured the impact of tablet computers on the education of 40 learners (20 in the UK and 20 in India) aged 10–18 years with low vision, with a specific focus on independent access to educational materials in India and the UK. The participants quickly learnt to operate an iPad in a classroom compared with the use of closed-circuit television. They found the iPad convenient as a single device that could be used for multiple tasks such as reading, accessing the internet, and watching videos. Finally, a study by Nahar et al. (2015) explored the use of a low-cost application (mBRAILLE) on an Android mobile phone to teach the writing of braille in Bangladesh, which could lead to a major shift in how braille is taught to learners with visual impairments. This study affirms that traditional AT (braille writing frames and stylus), which have been used in classrooms across Bangladesh over the past 50 years, remains too expensive for many schools. This innovation sensibly responds to the increasing use of low-cost Android mobiles in Bangladesh by introducing a program that helps learners to master writing braille. It also points out that it does not replace ways of learning how to read braille, which continue to remain the remit of the teacher.

(vi) Learners with dyslexia

Four studies were identified that explored technological solutions to assist learners with dyslexia. In Morocco, Benmarrakchi et al. (2017) evaluated the usability of an interactive educational mobile learning game to study and improve fundamental skills such as reading, writing, comprehension, Arabic orthography, short-term memory and concentration of eight learners aged 8–10 years with dyslexia using tablets in a primary school. The study provides details about the potential benefits offered by the use of ICT for dyslexic learners by focusing on the actual design of an adaptive mobile learning game, which, it claims, directly matches the learning styles of dyslexic learners through the use of advanced digital technology. However, there is little evidence to support these claims in the article. In a separate study in Malaysia, Mohamad et al. (2017) explored the use of tactile letters for teaching the alphabet in the form of an app (LetterReflex Mobile Application Educational Software) on an iPad with four children with dyslexia. The app was reported to have helped children to overcome common letter reversals in a game format that is inviting, engaging, interactive and user-friendly. Again, more evidence through assessment could help to justify this claim.

In India, Pandey and Srivastava (2011) explored the use of Tangible Interactive Blocks (Tiblo Tiblo) with a group of children (number not provided) aged 8–10 years, with which they are able to record their own voices while problem solving. The e-blocks can record and play back up to 10 seconds of pre-recorded sound and can be physically connected to other similar blocks in any orientation, with modifiable colours, sounds, and visuals. Learners appreciated hearing their voices retelling their stories, but no learning outcomes were measured or reported in the article.

(vii) Learners with physical disabilities

We found few studies that looked at EdTech for learners with physical disabilities. Technology that matches this heterogeneous group of learners is very broad and tends to focus on physical mobility devices, which are an essential part of being able to access learning. One notable study conducted in Kenya investigated the use of mobility devices and educational resources for children with physical disabilities in a specialist primary school (Kamau, 2017). The sample size constituted 30 children with physical disabilities (the majority of whom had cerebral palsy), 30 parents and 4 teachers. Around 54% reported that they provide mobility/assistive devices such as callipers, walkers, wheelchairs and crutches, which enable their children to participate in various play activities at home, and 21% provide devices for use at school. About 33% of the parents believed that teachers should take responsibility for providing child mobility or AT.

(viii) Learners with autistic spectrum disorders

Only three studies for learners with autistic spectrum disorders (ASD) were identified. This small number of studies may reflect the current situation where diagnosis of autism is still relatively difficult in many LMICs (Durkin et al., 2015). Furthermore, technology for this group often falls within the higher-tech range – for example, virtual reality (VR) programs – which requires specific teacher development and reliable technical support to ensure good quality access for the learner. Two of the studies in China piloted a teacher instruction application, namely (Leap Motion-based) Computer Aided Instruction (CAI), with three learners aged 6–7 years with ASD (Hu & Han, 2019), another worked with four children aged 9–11 years (Hu et al., 2020), and a final one examined the use of an AAC app on an iPad with 20 children with ASD in India.

As mentioned previously, we also noted studies in the literature which specifically focused on the role of teachers and parents of children with disabilities. These studies are discussed in the next two sections.

(ix) Role of teacher knowledge and use of EdTech

Evidence from the review identified 12 studies that used a range of survey-based research methods to gain an insight into the amount of knowledge teachers have of even the most basic technology used in the classroom. All the studies reported significant gaps in levels of knowledge about how AT can be used to support teachers in teaching the curriculum to learners with visual impairment, deaf/hard-of-hearing learners and those with SEND. This is particularly concerning given that most of the studies were conducted in special schools where technology can help give access to areas of ECC such as braille, mobility and orientation and sign language. For instance, schools for learners with visual impairment in Nigeria would benefit from a range of technologies that reproduce braille in both tactile and auditory formats (Ajuwon & Chitiyo, 2015). Onivehu Adams et al. (2017), examining teachers' attitudes and competency in the use of AT in Nigeria, found that teachers did not know enough about the benefits of technology and identified gaps in teachers' knowledge and competency in the use of AT for students with speech disorders, visual impairments, hearing impairments, physical impairments and emotional and behavioural disorders. Similarly, they emphasised the urgent need for the improved production of AT by using the broad range of raw materials and human resources that are available in Nigeria. Lynch et al. (2011), in a study from Malawi of specialist teachers for visually impaired learners, found that they did not necessarily have access to specialised teaching materials outside large population centres, and access to mechanical braille writers (such as the Perkins Brailler) was rare. Similar results were noted in a study on the use of technology in the classroom in Sao Paolo, Brazil, where Alves et al. (2009) found that 95% of the 58 teachers who taught learners with visual impairment – and 76% of the teachers who did not teach these learners – did not use information technology for teaching purposes.

Mukherjee et al. (2014) found that some of the senior teachers in India had a "mind set" of not welcoming new technology and felt more comfortable using traditional methods even after acknowledging the limitations of these methods. Younger teachers, however, seemed to be more receptive to change and were more willing to be trained on how to use new technology in the classroom.

Other studies (for example, Onivehu Adams et al., 2017; Schiemer & Proyer, 2013 Senjam et al., 2020;) have made a case for pre-service and in-service professional development to support teachers to integrate technology more successfully, moving beyond theory to focus on providing teachers with opportunities to practise new skills so that they gain confidence in using the technology in their teaching practice. The point was also made by Ajuwon and Chitiyo (2015) in a survey of 165 educators (including 141 special teachers) working in public schools in Nigeria who found that teachers were willing to integrate AT in their teaching if they had specific training on how to use it.

(x) Role of parents in supporting children's use of EdTech

Moving on to the involvement of parents, conversely, few studies ($n = 5$) involved consultation and participation of parents or carers in the development and piloting of new software or AT. Those studies that included parents' views and participation showed reduced rates of abandonment of devices and greater parental "buy-in" with the use of technology for learning purposes. Farooq et al. (2015) found in Pakistan that parents' perceptions about the use of AT by their children positively affected the educational performance of their children. They concluded that AT are "good tools" for learners with hearing impairments as they increase the overall learning opportunities and independence of children. These are important outcomes in terms of helping learners to transition to being able to use the technology for "access to learning" and to "learn to access" as shown in our dual model (Figure 1). In a study in Kenya, Kamau (2017) found that parents took an interest in the provision of mobility and educational resources for learners with physical disabilities. There were instances where parents and teachers disagreed about who should be responsible for the provision of mobility devices to support school attendance and participation in school activities. The small amount of evidence points to improvements in several key learning areas (such as communication, mobility, confidence levels) for learners with disabilities when parents were involved in the support and monitoring of the devices or programs.

An emerging tension noted in a few of the studies was around who should pay for some of these technologies, for instance mobility devices (such as wheelchairs, walkers, crutches and callipers) which will enable some children/young people to access school. There were clear differences in opinion about who is responsible for sourcing some of these devices, i.e. the school or the parents/carers, and indeed whose remit it falls under nationally, i.e. the Ministry of Education or the Ministry of Health.

Finally, in Thailand, Schiemer and Proyer (2013) found that financial constraints often restricted parents from providing EdTech, not only at school but also at home. Other parents did not even consider the use of EdTech as it seemed out of reach due to low income. If everyday communication with their child is sufficient without technology (for example, by using pen and paper, easy gestures, lip-reading), most parents do not see the need for AT. Onivehu Adams et al. (2017) recommend that the Nigerian government should make AT accessible, available, and considerably subsidised so that administrators of special needs learners can purchase it easily. Affordability, as a key consideration, emerges in many contexts in this review.

RQ3. What can we learn from the existing evidence?

In the review, we observed the absence of longitudinal ethnographic, participatory action research as well as large-scale RCT methodologies that linked evidence of the application of technologies to enhancements or changes in children's learning outcomes. There was a dominance of studies that conducted testing and evaluation of software programs, particularly on sign language, with little or no engagement with the curriculum, learner engagement or learning outcomes.

Very few studies attempted to measure or explain changes in learning outcomes due to the introduction of a new device or an intervention; much of the focus on improving "engagement" and "learning" was assumed to be a secondary effect of these outcomes. As a result, any measurable outcomes in the studies could be attributed to a "novelty effect" where learners reacted positively to receiving a device or a new intervention regardless of its benefits (Hew & Cheung, 2013). Over half of the studies simply reported the utility of using technology, with little suggestion for use in different contexts or other impairment groups or age groups. Moreover, only a few ($n = 7$) studies explicitly noted the impact on academic learning outcomes (such as improvements in maths scores or increased knowledge of vocabulary), which were seen as secondary to the main technological elements of the studies centred around accessibility, usability and acceptability. A possible reason for this could be attributed to the type of journal the paper was submitted to (for example, engineering, computer science, educational), as these journals more often publish feasibility studies and software evaluations.

Furthermore, there was only one RCT that compared the outcomes from teaching one group using technology with those of a non-intervention group or "control" who were taught with more conventional classroom instruction. The majority of study designs relied mainly on seeing learners with disabilities as a "single (or homogenous) group" in spite of the levels of severity that exist within an impairment group. In many instances, it was difficult to conclude whether the changes in learners' levels of engagement were due to the introduction of the technology, the teaching intervention or the "novelty effect". It is important to acknowledge here that true experimental comparisons can be difficult to manage and not easily achievable in many education settings, particularly in many low-income countries.

Whilst additional AT resources were provided as part of an intervention, any positive change might simply be attributable to the additional inputs or the time spent on tasks rather than the technology being the mediating factor (Kirkwood & Price, 2013). This is an implication for studies conducted in the classroom where it can be very difficult to isolate specific outcomes because of the difficulties in controlling variables such as learning outside the school environment or school attendance rates.

Significantly, over half of the studies ($n = 32$) were short-term, running for less than six months and thus leaving little time to measure the effect of the technology or the intervention. Ostensibly, learning is temporary in nature in that deeper understanding of new concepts, ideas and practices may not become apparent until sometime after the intervention. Therefore, perspectives regarding evidence are not just methodological but also include different views about learning, whether this is characterised as qualitative changes in development relative to the individual, i.e. a learner's ability to use a new device, or quantitatively in terms of "exit behaviours", i.e. the capacity for a learner to use the same device for multiple tasks in different environments (Kirkwood & Price, 2013).

Evidence suggests that a significant number of studies focused on shorter-term objectives of only providing access to technology and making suitable adjustments to their learning environment with little involvement of the beneficiaries and teachers in the research design. This was the case for studies published in health- or engineering-related journals, which tended to focus on the development and piloting of software and evaluation of new technology and not on their capacity to support learner proficiency and independence. These studies tended to overlook aspects of learner involvement, sustainability of impact and, most importantly, strong linkages with educational goals of increased classroom engagement and improved learning outcomes. Only a handful of studies deliberately addressed the issue of getting the right fit and connecting it closely to the learner's curriculum needs with the involvement of teachers and parents. Moreover, none of the studies looked at ways of building longer-term strategies of independence and self-advocacy as part of the study.

Finally, considering the small number of studies that took place in mainstream settings, it is difficult to form any firm conclusions on the extent of implementation of impairment-specific AT in mainstream classrooms.

Discussion

Our findings demonstrate clearly that EdTech (including AT) is not a narrow, homogenous group of interventions but encompasses a broad range of technology which can be used in a variety of ways (such as through individual, blended or mixed learning) and at different educational settings (for example, special schools, mainstream schools) and also at home. We use this section of the review to discuss the implications of the findings on the field of EdTech for children with disabilities in their primary years and implications for further development of this field in new research (RQ4)

Implications of implementing EdTech to reduce barriers to learning

Overall, given the significance of EdTech and education of children with disabilities, there was very little evidence of studies and evaluations involving educational interventions that met the inclusion criteria for this review. The primary focus of many studies was on the use of EdTech to support factors of entry into learning, with little or no real exploration of the impact of these interventions on children's engagement, levels of independence and their participation within school settings. Furthermore, studies did not refer to any of the disability models, discourse on disability rights, or any of the global commitments, (i.e. the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD)). While some researchers argued that they had consulted learners and teachers in the design process, there was a lack of evidence on this important consultative process with the beneficiaries, namely, the learners. There was also considerable variation in the number of studies for different types of impairment group. For instance, sensory impairments (deaf and visual impairment) combined represented over two thirds of the total papers ($n = 40$). This would also explain why the studies were principally located in special school settings and for the high number examining the use of AT for learners with visual impairment (such as low-vision devices) or mobile phone apps to teach sign language to deaf learners.

Our analysis identified close relationships between a specific impairment group and a type of technology that supports learners in their learning and functioning. This is significant in that it shows that the more "traditional" forms of impairment-specific AT (such as teaching braille maths) are still considered to be essential to access expanded core curriculum (ECC) and thus increase learners' participation in the core curriculum. The introduction of AT has, indeed, created changes in perceived capabilities, and levels of confidence (Kamau, 2017). The obvious lack of assessment process of ensuring the appropriate matching of the learner with the AT was not built into the study designs apart from an RCT which measured the impact of tablet computers on independent access to educational material, in children and young people with low vision in India (Gothwal et al., 2018).

Critically, few studies engaged with the impact of EdTech on children's literacy, numeracy, or other key functional skills (such as activities of daily living); rather, the absence of engaging with these important outcomes was indicative of the unique focus on the use or acceptability of the technology. While evidence is limited, a key argument coming through the review was that learners require focused tutoring in relation to developing their "specialist" EdTech skills (for example, how to use as a computer screen-reader), in order to be able to access the core and expanded core curriculum (ECC).

There was some emerging evidence of how learners' levels of confidence and well-being had improved because of accessing technology, which had created new opportunities for learning and for socialising with peers. It is difficult to verify these claims, but the broad agreement across the studies indicates some similarities in how learners are embracing the technology and experiencing new ways of engaging with learning and, most importantly, forming and bonding friendships in and out of school.

One of the most significant findings is the proliferation of mobile technology, especially the use of Android phones, which is beginning to transform the way children learn at school. With a growing shift from using PCs to mobile and portable devices, investing in apps for phones, when sustainable, has additional benefits for all learners. In spite of this breakthrough, studies in the review tended to have a rather narrow view of their use. Used in creative ways, the same technology could also support daily living activities at home and increase opportunities for independent living into adulthood. A more expanded, holistic vision could allow this technology to be used outside the school for non-academic tasks such as playing games and socialising with friends using social media. In addition, this creates greater flexible movement of the technology with the learner, rather than the learner always being restricted to where the technology is located (for example, a PC in a classroom).

Although there were small but encouraging findings from at least four studies involving the use of mobile phone apps to enforce teaching and practice of indigenous sign languages for deaf learners in countries like Pakistan, authors, critically, did not take the opportunity to explore ways of building on these new and exciting opportunities for learning in future research implementation projects. Moreover, there were no examples of interventions being replicated in other towns or cities or in other parts of the same country, or even recommendations at the end of the studies to do so.

The review also highlighted a number of issues that affect the successful implementation of EdTech for learners with disabilities in LMICs by noting that both recurring and non-recurring costs needed to be factored into disability-inclusive education budgets but there was no indication of what these costs amount to in the evidence base. A small number of studies made explicit calls to invest more in local resources rather than in high-cost technology which may not match the local or cultural context of the community. Onivehu Adams et al. (2017) highlighted the need for AT to be shaped by the use of raw materials and human resources that are available within a country – a consideration which needs to be kept in mind as we move forward. For example, in their study of testing new software to support braille literacy of blind learners in India, Kalra et al. (2009) noted that an application "must be affordable to people at the base of the economic pyramid who live on less than US $2 a day". The high cost of AT devices still has significant impact on teachers' decision to purchase more costly AT, in spite of their proven use. This was the case where teachers were reluctant to purchase additional braillers (writing frame and stylus) for children in special schools in Bangladesh (Nahar et al., 2015). Moreover, some traditional AT (for example, braille frames and stylus), which may have been used in classrooms for over 50 years, still remains too expensive for many low-income countries, thus paving the way for cheaper, more high-tech solutions to take their place in schools. It is important to note that high-tech solutions are not always appropriate for learners who have difficulty with physical movement or being able to actually hold a device and manipulate the buttons (for example, a child who experiences difficulties with fine motor movement).

Limited local awareness of AT or purchasing capacity can lead to few incentives for countries to engage in production. A small number of studies (Semjan et al. 2019; Lynch et al., 2014; Onivehu Adams et al., 2017) acknowledged that local production may not be cost-effective where local markets are small and duty and import taxes associated with AT can discourage local companies to import materials, equipment or assistive products (Lynch et al., 2014). Unless the design of an assistive product meets a child's needs and preferences and is appropriate in their physical, social and cultural environment, there will continue to be a low demand for products (Mulholland et al., 2000).

The evidence also indicates that learners are benefiting from the technology through the multi-pronged focus of "entry", "engagement" and "empowerment" (Singal, 2013). The inclusion of children with disabilities in educational systems is a significant challenge facing policymakers in many LMICs, thus a multi-pronged approach to Ed Tech intervention is also essential. Current literature indicates that there are obvious signs of the first two approaches developing well (at least in some groups of learners) and forming important foundations for the learner. It is also important to ensure that EdTech interventions develop a strong sense of self-worth and well-being so that the learner continues to use the technology on a regular basis, takes ownership of it and is able to self-advocate (in the present and in the future).

Finally, in this section a consistent theme that emerged across the review was the lack of awareness, confidence and adequate training among teachers of even the most basic technology. Teacher development programmes were not incorporating high-quality competency and skills training to improve their digital literacy (for example, looking at ways to use mobile technology more creatively within the core and expanded core curriculum) and for teachers to acquire their own practical experience. There was a very obvious issue of adequate time and space not being built into studies to allow for reasonable consultation with teachers about the design and implementation of EdTech studies (for example, purpose of study, type of technology, integration into learning situation, and relevance to the curriculum). This included discussions about the viability of the proposed EdTech in the learning settings (for example, the extent that apps or software can be installed onto devices where there is a lack of power supply). Such discussions can form the basis of moving from small-scale, design-centred studies to larger-scale, multi-country studies that measure the impact of technology on learning outcomes.

Building a research agenda in EdTech for the future

The use of technology can often create differences in educational and policy opinion but, when implemented well, has the potential to transform the educational experiences of learners with disabilities in LMICs. There is a real opportunity to build on the existing knowledge base by bringing together the expertise of educators, scientists, teachers and service providers who are charged with investigating important questions, and by agreeing on both short and long-term goals linked by common concerns related to reducing barriers to education for learners with disabilities in LMICs. With this in mind, we set out below a small number of recommendations on how the research community can respond to increase the evidence base on how EdTech can be used to support the education of diverse groups of learners in LMICs.

There needs to be better alignment of EdTech research with global commitments set out in the UN Sustainable Development Goal to ensure true implementation of the UNCRPD, and to ensure adequate universal access to assistive technologies in particular. Research that goes beyond the issue of access to focus on quality learning experiences for children with disabilities is critical in future studies. We also see an urgent need for research to take a multi-dimensional view of EdTech in the education of children with disabilities with a focus on entry, engagement and empowerment in school.

The review reports a significant disparity in the evidence base across different impairment groups, which needs to be recognised and suitably addressed. Additionally, more thought needs to be given to intersecting variables, such as gender, location (rural/urban), and socio-economic status of learners, which can have a pronounced impact when designing new EdTech interventions in LMICs. There is a need for rigorous research designs, including RCTs and strong participatory (action research), comparative, user-based methods, with sufficient sample sizes, conducted over longer time frames and leading to more robust results, which, in turn, will inform effective policymaking and programme implementation.

In line with the previous recommendation, researchers need to pose more pertinent questions such as *how* and *which* technology is the most useful when it comes to facilitating the learning process. Robust research is needed to evaluate the conceptualisation, design, testing, and impact of appropriate technology in relation to different environmental conditions (such as gender; age; location – urban, peri-urban, and rural; public/private schools; curriculum area) to meet the needs of the full range and diversity of learners with disabilities in LMICs.

Fundamentally, there needs to be greater involvement with user groups, including learners with disabilities and their teachers in the design and implementation of EdTech studies (regarding, for example, purpose of study, type of technology, integration into the learning situation, and relevance to the curriculum) and EdTech initiatives. This includes discussions about the viability of specific types of EdTech in learning settings, which can form the basis of moving from small-scale, design-centred studies, to larger-scale, multi-country studies that measure the impact of technology on learning outcomes. Lastly, funders will need to allocate sufficient funding and time for the development of research capacity within research institutions, particularly those in low-income countries where evidence has been limited.

Conclusion

Overall, the review revealed a paucity of published research that addresses how, when and what type of technology should be introduced to the learning process of children with disabilities. There is still a need to reduce barriers to children's learning by identifying new approaches to how learners with disabilities can access information to develop their knowledge, confidence and diverse skills. One potential approach to help to conceptualise fair and equal access to education, is to apply the MPT model which provides a helpful lens to understand the value that EdTech can bring to the learning process of learners with disabilities in LMICs. This type of matching can be adapted accordingly as learners develop a range of other independent skills, such as increased ability to use technology effectively.

Finally, although the EdTech focus in this review was on entry factors to accessing learning, we should not miss the opportunity to support and nurture wider learning goals for children with disabilities. In an era where discussions are focusing on children's continued lack of learning, EdTech offers an opportunity to assist all learners with disabilities with better access to the curriculum. These twin goals are in line with the vision of the UNCRPD and the SDGs.

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Notes

1. Studies can be further classified into low-income, lower-middle income, and upper-middle income countries. Studies from low-income countries (n = 3) were all from Africa (Eritrea, Ethiopia, Malawi). Studies from lower-middle-income countries (n = 11) were from Africa (Nigeria, Ghana, Kenya, Egypt, Tunisia, Morocco) and Asia (Bangladesh, India, Pakistan, Philippines, Nepal). Studies from upper-middle-income countries (n = 13) were from South America (Mexico, Columbia, Brazil, Ecuador); Asia (Indonesia, Malaysia, Thailand, Peru, China, Iran); Africa (Namibia); and Europe (Turkey). (https://data.worldbank.org/country/XO).
2. The two studies from Europe were undertaken in Turkey, which is a middle-income country.
3. The holistic judgement of adequacy to the research process allowed some studies with missing data to be included in the report, thereby facilitating a broader selection of studies to obtain a fair representation of the educational technology practices happening with children with disabilities from LMIC contexts and inform immediate policy and research priorities being set for the region.

4. Typoscopes screen out excess information and glare on a page, allowing the user to concentrate on the line they are reading.

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