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# Use of Assistive Education Technologies to Support Children with Visual and Hearing Difficulties in the East Asia and Pacific Region

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# Contents

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# Abstract

Evidence on the uptake, use, and impact of EdTech at scale on participation and learning among students with disabilities in low- and middle-income countries remains very limited. This report presents findings on access to EdTech for children with difficulties in hearing and vision in middle-income countries (MICs) in the East Asia and Pacific (EAP) region using three approaches: (i) a systematic regional literature review; (ii) interviews with 17 actors from the education technology private sector across the EAP region; and (iii) case studies from four countries: Vietnam, the Philippines, China, and Tonga. The main findings from the literature review are that most EdTech solutions in EAP MICs were applied at very small scale, with a focus on the tech testing stage, and only two of the 13 identified studies from a sample of 1,661 studies measured changes in student learning outcomes. The private sector interviews indicate qualitatively that most actors in this space are unaware of the needs of children with vision and hearing disabilities, and that other challenges such as profitability and general inequalities related to access to devices and high-speed internet receive the most attention. The case studies report no examples of national deployment of any assistive education technology, though there are multiple examples of small-scale digital approaches developed by individual schools or NGOs and shared locally or, in two cases, regionally. In looking at country contexts for the case studies, we found a lack of publicly available data on spending for assistive EdTech in EAP, a lack of data on (a) prevalence of disabilities among the student population, (b) student learning, and (c) student persistence in higher grades. We examine new data on policy-maker estimates of access and inclusion of children with disabilities, and find that despite support for inclusion, there is large scope for improving data collection, service delivery and access to assistive EdTech in MICs in the EAP region.

**Keywords:** EdTech, Child, Low- and Middle-Income Countries, Deaf, Blind, Inclusive Education, assistive technology

# Executive Summary

Assistive education technologies can be effective in supporting learning for children with disabilities and in reducing learning inequalities between children with and without disabilities, a major concern in EAP and globally. Despite strong household demand for assistive educational technologies and support from decision makers, evidence for large-scale use of EdTech with positive impacts on education participation or learning among students with disabilities in low-and-middle income countries remains very limited. This report focuses on hearing and vision because of their high prevalence, relative ease of identification, and the existence of multiple devices to support learning for children with these challenges.

This report aims to identify examples of assistive educational technologies used at scale for children with difficulties in hearing and vision in middle-income countries in the EAP region utilizing three approaches: (i) a systematic literature review to search for relevant assistive technologies documented in published journal articles; (ii) interviews with 17 actors from the education technology private sector across the EAP region; and (iii) case studies from four countries: Vietnam, the Philippines, China, and Tonga.

Overall, we find that despite support for inclusion, there is large scope for improving data collection, service delivery and access to assistive EdTech in MICs in the EAP region. Based on findings from a systematic literature review, the majority of the assistive educational technologies that met the inclusion/exclusion criteria of the search, were applied at very small scale. These assistive educational technologies typically focused on the testing stage and evaluated user experience. Only two of the 13 identified studies from a sample of 1,661 studies that were eligible for title and abstract screening, measured changes in student learning outcomes. The qualitative interviews with the private sector actors indicate that most actors in this area of interest are unaware of the needs of children with vision and hearing disabilities. With regards to perceived barriers for private sector development, interviewees also identified profitability, access to devices and high-speed internet as potential challenges in the sector. The case studies report no examples of national deployment of any assistive education technology, though there are multiple examples of small-scale digital approaches developed by individual schools or NGOs and shared locally or, in two cases, regionally. In looking at country contexts for the case studies, we found a lack of publicly available data on spending for assistive EdTech in EAP, a lack of data on prevalence of disabilities among the student population, student learning, and student persistence in higher grades.

We propose the following recommendations:

- **Data reporting.** Collecting and sharing data on children with disabilities is an essential role of schools, subnational and especially national governments to ensure that all children are learning. In order to improve enrollment and learning for these populations, it is essential to disaggregate types of disabilities and track learning over time and to regularly report and share the results.
- **Engaging the private sector.** In order for private-sector companies to identify and help address specific challenges, governments and multilateral organizations can conduct scoping studies, public-private sector dialogue mechanisms, and broader awareness campaigns. Financial incentives or assurances from governments can encourage more private EdTech players to enter this sector.
- **Engaging with NGOs, research groups, and multilateral organizations.** These groups have often developed expertise in providing services while addressing the market failure in meeting demand. They can be a source of feedback and experience as governments support taking proven solutions to scale.

***Photo:*** iStock Photo

# Glossary

- **Assistive Technology.** "An umbrella term for assistive products and their related systems and services. Assistive products maintain or improve an individual's functioning and independence, thereby promoting their well-being."[1] Examples include hearing aids, wheelchairs, and screen readers.

- **Assistive Educational Technology (Assistive EdTech).** Assistive products that support and enrich teaching and learning.

- **Disability.** "A disability is any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions). There are many types of disabilities, such as those that affect a person's: vision, movement, thinking, remembering, learning, communicating, hearing mental health and social relationships."[2]

- **Inclusive Education.** "An education system that includes all students, and welcomes and supports them to learn, whoever they are and whatever their abilities or requirements. This means making sure that teaching and the curriculum, school buildings, classrooms, play areas, transport and toilets are appropriate for all children at all levels. Inclusive education means all children learn together in the same schools."[3]

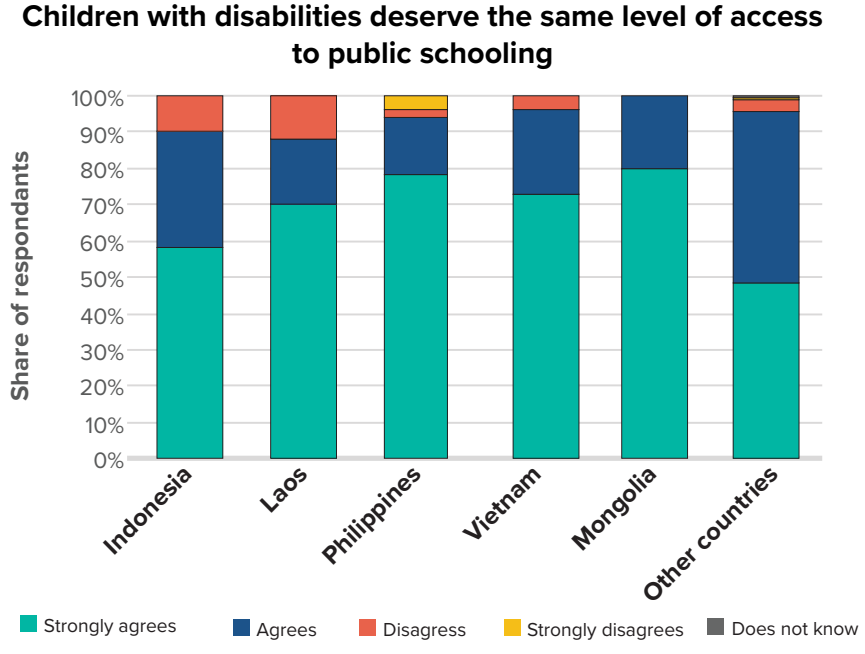
- **Special Needs Education.** "Education designed to facilitate the learning of individuals who, for a wide variety of reasons, require additional support and adaptive pedagogical methods in order to participate and meet learning objectives in an educational program. Reasons may include (but are not limited to) disadvantages in physical, behavioral, intellectual, emotional and social capacities."[4]

1 World Health Organization (2023).
2 Centers for Disease Control and Prevention (2020).
3 United Nations Children's Funds (2017).
4 United Nations Educational Scientific and Cultural Organization Institute for Statistics (2011).

# 1. Introduction

The United Nations Convention on the Rights of Persons with Disabilities (CPRD)–Article 24 recognizes the right of persons with disabilities to education (CRPD, 2006). In realizing this right, state parties shall ensure that persons with disabilities can have equal access to an inclusive and quality education as children without inequalities, providing reasonable accommodation based on individual's requirements. The CPRD forms the basis of broad support from decision makers towards inclusive education and accommodation. Based on an international survey of 602 decision makers from 12 countries (Figure 1.1), over 90 percent of the decision makers agree or strongly agree with the statement that children with disabilities deserve the same level of access to public schooling as children without disabilities. Within the East Asia and Pacific (EAP) region, for five selected middle-income countries (MICs)—Vietnam, Laos, Philippines, Indonesia, and Mongolia—the average level of support is higher than the average for other countries surveyed. Over 72 percent of the sampled decision makers from these five countries strongly agree with the statement which is higher than the 49 percent average of all other countries surveyed. In comparison, while overall support towards the education of children with disabilities is strong, fewer decision makers strongly support the need to make accommodations so that children with disabilities can be included in regular classrooms with children who do not have disabilities.

**Figure 1.1** Support for inclusive education in five EAP countries and globally



Despite the broad support, children with disabilities continue to experience barriers in accessing quality education. Compared to children without disabilities, children with disabilities are 49 per cent more likely to have never attended school, 47 percent more likely to be out of primary school, and 33 percent more likely to be out of lower secondary school (United Nations Children's Fund, 2021).

COVID-19 created more learning barriers for children with disabilities as countries were forced to change how students participated in education learning. Estimates suggest that the pandemic resulted in 1.6 billion students being out of school (United Nations Educational, Scientific and Cultural Organization (UNESCO) et al., 2020) . To limit learning losses, governments tried to include remote learning as part of their education response. However, children with disabilities were more adversely affected due to barriers in accessing the remote learning. The analysis of a joint UNESCO-United Nations Children's Fund (UNICEF)-World Bank questionnaire on national COVID-19 education responses shows that 40 percent of MICs did not include provisions to address the requirements of students at high risk of exclusion, such as children with disabilities (UNESCO et al., 2020). Similarly, an interview among education stakeholders from five countries—Bangladesh, Ethiopia, Kenya, Nepal, and Rwanda—found that, despite the multiple remote education responses to the pandemic, students with disabilities were hardest hit due to their limited access to the remote learning provided (World Bank, 2020).

Assistive education technologies (EdTech) can be effective solutions in supporting children with disabilities in learning, reducing the learning inequalities between children with and without disabilities; examples of low to high assistive EdTech are displayed in Table 1.1. However, despite strong household demand for assistive educational technologies especially after the COVID-19 pandemic, evidence on large-scale EdTech that affects either education participation or learning among students with disabilities in low-and-middle income countries remains very limited (World Bank, 2022a). One review of the evidence on assistive EdTech examined the ongoing efforts and challenges in Sub-Saharan Africa (Dinechin & Boutard, 2021), while another study looked at the practices and trends in assistive EdTech, but only in selected high-income countries (Hersh & Mouroutsou, 2015). Lynch et al., (2022) carried out a global literature review focusing on EdTech for primary school students in MICs across a wide spectrum of disabilities. The authors were only able to identify studies that were of small scale, with limited discussion on implementation, costing, maintenance, and training, which are all pressing questions when scaling up appropriate EdTech. At the country level, Hata et al. (2023) found that in Indonesia, around 39 percent of sampled teachers reported that they used JAWS (a screen reader software for children with visual impairment). Similarly, the study found that approximately 27 percent of the sampled teachers reported that they used text-to-speech software for students with hearing impairments. The use of computers, tablets, smartphones or projectors for students with hearing and/or visual impairments was high (84 percent and 77 percent respectively).

**Table 1.1** Continuum of technology from no/low to high tech

| Tech | Requirements for use | Maintenance | Electronics | Example |
|---|---|---|---|---|
| **No/Low** | Almost none | None/Little | None | Magnifiers<br>Audiobooks |
| **Medium** | Some training | Some | Some | Braille Notepad<br>Text to speech |
| **High** | Advanced training | High | Complex | Speech recognition<br>Touch screen devices |

This study aims to help fill this gap in the literature by focusing on the development and use of medium to high assistive education technologies—technologies that require batteries or electricity—to support the learning of children who have functioning difficulties with vision and hearing, across all stages of education, and are from the EAP region, including children from the Pacific Island Countries. This objective is achieved through a systematic review along with country case studies and data collection from private sector actors. These two disability-types were selected due to their high prevalence, possibility of identification, and the existence of multiple devices to support learning for children with these challenges, though we note the very wide range of individual experience and degree within these specific disabilities. We focus on medium- and high-tech solutions to both examine if the investments in distance learning during COVID-19 school closures benefited students with disabilities, and to respond to the interest of governments in EAP—a region that is home to 43.1 million children with disabilities, the second largest group of the world (United Nations Children's Fund, 2021). While previous studies focused on EdTech that supports learners with disabilities, the research is not EAP specific and either concentrates on children who have difficulties hearing (Beal-Alvarez & Cannon, 2014), or those who have difficulties with vision (Kelly & Smith, 2011). While previous studies focused on EdTech that supports learners with disabilities, the research is not EAP specific and either concentrates on children who have difficulties hearing (Beal-Alvarez & Cannon, 2014), or those who have difficulties with vision (Kelly & Smith, 2011).

Overall, we find that despite support for inclusion, there is large scope for improving data collection, service delivery and access to assistive EdTech in MICs in the EAP region. Based on findings from the systematic literature review, the majority of the assistive educational technologies that met the inclusion/exclusion criteria of the search, were applied at very small scale. These assistive educational technologies typically focused on the testing stage and evaluated user experience. Only two of the 13 identified studies from a sample of 1,661 studies that were eligible for title and abstract screening, measured changes in student learning outcomes. The qualitative

interviews with the private sector actors indicate that most actors in this area of interest are unaware of the needs of children with vision and hearing disabilities. With regards to perceived barriers for private sector development, interviewees also identified profitability, access to devices and high-speed internet as potential challenges in the sector. The case studies report no examples of national deployment of any assistive education technology, though there are multiple examples of small-scale digital approaches developed by individual schools or NGOs and shared locally or, in two cases, regionally. In looking at country contexts for the case studies, we found a lack of publicly available data on spending for assistive EdTech in EAP, a lack of data on prevalence of disabilities among the student population, student learning, and student persistence in higher grades.

The report is organized as the following. The second section is a systematic review that searched for journal articles published over the past 10 years on assistive education technologies for children with disabilities in the MICs of the EAP region. The third section provides a discussion on the private sector based on interviews with private sector actors. The fourth section includes four country case studies—China, Philippines, Tonga and Vietnam, which describes the educational context of each country for children with hearing and visual difficulties, and example Assistive EdTech solutions that were identified by the key informants. The last section concludes.

***Photo:*** iStock Photo

# 2. Existing Regional Assistive EdTech Research

In 2022, a systematic literature review[1] was conducted. The review found that there was limited research on the use of EdTech for children with visual and hearing impairments in the EAP region. Although a total of 1,661 studies were identified based on key search terms, only 13 of the 44 studies selected for full-text screening were retained and analyzed. Even after shortlisting only the most significant research to be included in the review, the selected few papers still had a focus only on small-scale testing of assistive Edtech. In addition, these studies had limited engagement with key stakeholders within the education system and no discussion with stakeholders outside the education system, such as government agencies. The review also found that only two studies discussed costs and only one study compared them with market prices. The evidence of the impact of EdTech on learning outcomes for students with disabilities was found to be extremely limited, indicating a need for further research in this area.

## Literature Review

The systematic review followed a pre-agreed protocol, which included four selection criteria for eligible studies: (i) the technology supported students aged 3 to 25 with disabilities in accessing education; (ii) the technology required electricity; (iii) the target population resided in an MICs in the EAP region; and (iv) the article was published in English within the past 10 years.

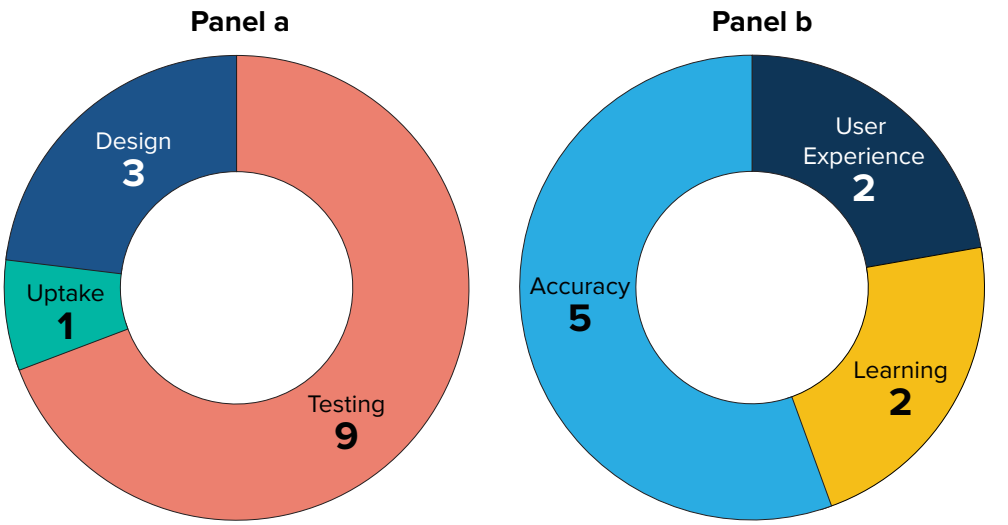
The selection process began with a web search of three databases—Web of Science, ProQuest, and ERIC—from which 1,661 studies were retrieved. Using the inclusion/exclusion criteria, two screeners independently reviewed the titles and abstracts of the studies identified in the first round. A third screener reviewed the identified studies when there was a disagreement. This process led to the exclusion of 1,617 studies and the inclusion of 44 studies deemed eligible for full-text reading. During the final step of the selection process, 31 additional studies were excluded, resulting in a final sample of 13 relevant studies that met all inclusion criteria. The agreement rates between the two screeners were high, reaching 93 percent for the title and abstract screening, and 80 percent for the full text screening. Two-thirds of the studies were conducted in Malaysia and Thailand, with the remaining studies focused on the Philippines and Indonesia. The majority of the studies (61.5 percent) assessed solutions aimed

1 The full literature review can be found from Annex A.

at supporting children with visual impairments, while just 30.8 percent investigated solutions for children with hearing impairments, and only one study looked at tailored solutions for both. Almost all studies (69.2 percent) focused on software programs for children with sensory impairments, with just a handful of studies (23.1 percent) concentrating on hardware and one on both hardware and software programs. Around half of the included studies focused on children's language development or literacy, while 23.1 percent focused on math/sciences, and the remaining studies (23.1 percent) focused on general access to educational content. Beneficiaries are most likely students enrolled in primary education (46 percent), with 30.8 percent of the studies focusing on students enrolled in secondary or tertiary education, and 15.4 percent of the studies that did not specify the age range of the study sample.

One primary interest of the systematic review was to identify EdTech products that effectively improved either children's learning outcomes or access to education. However, the majority of the studies focused on either the design of a prototype/content/platform (3), or its testing (9). One study concentrated on the provision and uptake of assistive technologies and EdTech among students with difficulties in hearing and/or vision in the context of tertiary education in Northern Thailand, but did not aim to assess the impact on student learning outcomes. Only two studies measured student learning outcomes. Figure 2.1 provides a breakdown of the nine studies that evaluated the EdTech by the type of outcome they collected, such as the users' experience, learning outcomes, and satisfaction with the EdTech.

**Figure 2.1** Support for inclusive education in five EAP countries and globally



## Limited Evidence and Gaps in Research

The findings of the systematic literature review conducted on EdTech for children with visual and hearing impairments in the MIC EAP region reveal a shortage of evidence and knowledge in this domain. Only five out of the 24 middle income countries in the EAP region had relevant studies available, indicating that nearly four-fifths of EAP MICs have no published studies on this subject. In addition, none of the Pacific Island Countries met the review's criteria for published studies on EdTech and learning for children with visual and/or hearing difficulties.

This limited evidence in the MIC EAP region that emerges from the current systematic literature review resonates with results from a mapping of inclusive education programs in the EAP region (United Nations Children's Fund East Asia & Pacific, 2020). In particular, the review highlights that provision ranges from very limited to non-existent, with availability being systematically higher in special schools. In this regard, a technical report on the West Pacific region underscores that the provision of assistive technologies is limited for persons with disabilities, particularly those with low vision, as well as that the procurement of these products receives almost no funding from governments (World Health Organization Regional Office for the Western Pacific, 2020).

The low representation of research on assistive EdTech in the MICs in the EAP region starts with the lack of information on children with disabilities. The challenge of using EdTech to assist children with visual and hearing difficulties begins with diagnosis. To take one example for which we have data, in Vietnam, where newborn screening is mostly unavailable, 98 percent of children's hearing losses are first diagnosed by their parents. Even then, the diagnosis happens late, on average at the age of 34 months (X. T. Nguyen et al., 2019). The overdue diagnosis often leads to delays in language development, which is apparent in the 42 percent literacy rate among youth with hearing impairment (from 15- to 24-years-old), compared with the 95 percent literacy rate among the general population (United Nations Population Fund, 2011). The more up-to-date data do not segregate between different disabilities, but highlights that people with disabilities aged 15 and over have a literacy rate of 74.43 percent, whereas people without disabilities reach the rate of 94.31 percent (General Statistics Office of Vietnam, 2019). These statistics highlight the importance of identifying children with disabilities to provide them with access to specialized services in the first few years of the child's life, including EdTech.

In most cases, the solutions that this systematic literature review identified concern the design and testing of software programs rather than hardware, a finding that aligns with the work of Lynch et al. (Lynch et al., 2022). This finding also aligns with recommendations from the (Global Education Evidence Advisory Panel, 2020), which defines software programs that can be adapted to meet learners' levels and requirements as a cost-effective solution to improve learning.

## Emerging Solutions in EdTech

While evidence of EdTech for children with visual and hearing impairments in the MIC EAP region is limited, some studies provide evidence that new approaches are being embedded and used to design novel EdTech solutions. For instance, Lopez et al. (2021) integrated learning through play, and then tested a device that helps children with visual impairment to identify letters and short words in braille in the Philippines. The team designed a device that helps children with visual impairment to identify Tagalog letters and short words in braille. To win the spelling game, students need to place "sticks" into place holders to display the correct braille letters. Importantly, the device does not require additional hardware such as computers, speakers, cameras, or direct assistance for its use, which makes it easily accessible in low-resource settings.

Also in the Philippines, Arbes et al., (2019) tested the use of a text-to-braille translator tactile storyboard with 3D printing for blind students and those with severe vision difficulties. The translator transforms 2D images into 3D models and enables a text-to-braille feature embedded into the storyboard. While 3D printers remain expensive, the increasing number of open-source 3D printers may broaden the potential future use and uptake of this solution, which could be replicated and standardized. tested the use of a text-to-braille translator tactile storyboard with 3D printing for blind students and those with severe vision difficulties. The translator transforms 2D images into 3D models and enables a text-to-braille feature embedded into the storyboard. While 3D printers remain expensive, the increasing number of open-source 3D printers may broaden the potential future use and uptake of this solution, which could be replicated and standardized.

There are also emerging solutions in terms of software that are worth highlighting. For example, Akmeliawati et al. (2014) developed software that can process Malaysian and English sign languages into either text and/or voice output. This software can provide real-time translation with 80 percent accuracy for isolated signs but only 55 percent for sentences. To tackle the learning difficulties in terms of mathematics and sciences, Wongkia et al. (2012) developed a built-in math reading app for Thai students and teachers. This app is an add-in for Microsoft Word, which is much more accessible for teachers and students than those that are built on more complicated computational languages, such as Latex. Teachers can create handouts and assignments using Microsoft Word. At home, students download the files and use the add-in feature to complete assignments and practice. developed a built-in math reading app for Thai students and teachers. This app is an add-in for Microsoft Word, which is much more accessible for teachers and students than those that are built on more complicated computational languages, such as Latex. Teachers can create handouts and assignments using Microsoft Word. At home, students download the files and use the add-in feature to complete assignments and practice.

Even with the solutions identified above, the systematic search revealed several gaps in the literature. First, there is limited evidence of how EdTech has been used at scale to

support children with visual and hearing impairments. This is clear when looking at the breakdown of studies by development stage and sample size. Similarly, while studies analyzed in this review discuss the adaptation and modification of content to improve users' experience and understanding, there is no discussion on the linkages with national curricula, which is a concern and in line with results from (Lynch et al., 2022). Furthermore, almost all papers presented and discussed the engagement of users, schools and teachers in content development, piloting and hardware prototyping. However, the literature review failed to identify any study that considers and discusses the wider engagement with the education system and other relevant stakeholders.

Second, few studies reported the costs and procurement of EdTech. Only two studies discussed explicitly the cost implications of the EdTech solutions being proposed, with only (Pan-Ngum et al., 2013) providing a cost comparison with the solutions that were currently provided to the school where the testing took place. While the majority of the studies included software, which implied low to free cost per additional user, cost data on maintenance, updates and training are still crucial. As such, the lack of evidence on costing further complicates the discussion on the economic viability of EdTech, as well as on its sustainability. The majority of the studies included software, which implied low to free cost per additional user, cost data on maintenance, updates and training are still crucial. As such, the lack of evidence on costing further complicates the discussion on the economic viability of EdTech, as well as on its sustainability.

Third, the systematic review was unable to identify any studies that demonstrate EdTech effectiveness in improving the educational outcomes of children with hearing or vision difficulties. Among the seven studies with data on sample size and outcomes, only two studies measured academic outcomes (Arbes et al., 2019; Techaraungrong et al., 2017). In these two studies, the sample sizes were too small for statistical inference (<15 participants). The majority of the studies evaluated user experience or accuracy. For example, the study from (Akmeliawati et al., 2014) evaluated the number of words that were correctly translated from real-time sign language. This extremely limited empirical basis highlights a major knowledge gap in the research literature, and aligns with findings from other non-EAP focused systematic reviews that looked either on children with difficulties in hearing (Beal-Alvarez & Cannon, 2014) or vision (Kelly & Smith, 2011).or vision (Kelly & Smith, 2011).

This systematic review has several limitations. First, the literature review used databases and search criteria which limited the results to articles published in English, hence the exclusive representation of English-language articles in the final report. Although there is an international preference for publishing in journals with high impact ratios which typically are in English, this limitation in the selection criteria means we may have missed good quality research that were published exclusively in languages other than English. Second, the review focused on medium-to-high levels of EdTech for children with hearing and visual difficulties. Low-tech solutions that do not require electricity, for example eyeglasses, were not included in the review. Future studies may include local languages and low-tech solutions as well.

# 3. Private Sector Perspectives

## The Assistive EdTech Space: A Private Sector Perspective

The EdTech sector has grown tremendously in the past decade, with the COVID-19 pandemic providing further growth impetus (e.g; The Economist, 2022). The accelerated digitalization of many services—including education—resulted in the rapid expansion in terms of both customers and services of existing EdTech players, and the establishment of dozens of new ones. However, it is not clear that this expansion of services and service providers extends to learners with disabilities. There are an estimated 43.1 million students with disabilities in the EAP region (United Nations Children's Fund, 2021). In absolute terms, this is a large market with untapped potential. However, evidence suggests that access to assistive technologies, particularly those that could be provided in by EdTech players, still lags significantly behind demand. Learners with disabilities are the most likely to be out of school and at high risk of dropping out and tend to have lower levels of learning than their peers (World Bank, 2020). Available evidence presented in this paper on coverage indicates a massive gap between effective supply and demand.

To better understand what is happening in this space, we spoke with 17 EdTech founders, leaders, EdTech experts and investors in the EAP region, including but not limited to Vietnam, Indonesia, Thailand, Singapore, and the Philippines (see Annex B for a complete list). Private sector leaders were selected based on existing professional networks of the research team, as randomizing from a larger list of known firms and then e-mailing senior representatives was considered unlikely to generate positive responses, based on prior experience (Bhardwaj et al., 2020).

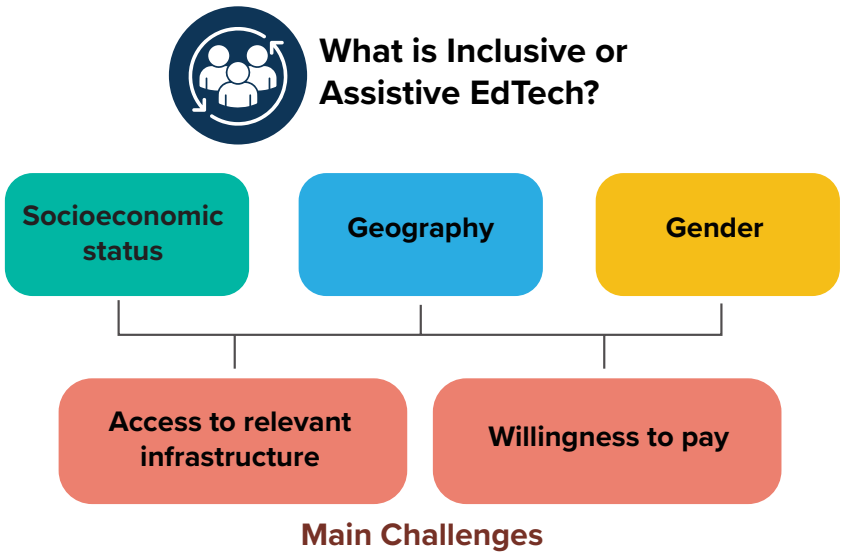
The focus of EdTech providers in the past couple of years has been on increasing scale, and on price and product differentiation. More recently, the focus has also shifted to include customer base consolidation and sustained revenue generation—challenges that were present prior to the pandemic but were perhaps masked due to the pandemic as EdTech operations increased exponentially in response.

Based on interviews conducted for this study, the interpretation by EdTech service providers and investors of the term 'Inclusive' or 'Assistive' EdTech is centered primarily on inclusion of economic status, geography and gender. Within these three categories, the primary focus area as identified by 13 of 17 respondents is on differentiation of products and pricing to be more inclusive of economic status, namely reaching lower-income customers. The term 'Assistive EdTech' was associated by interviewees with

software that adapts the difficulty level to learners' levels of understanding, a broader conception that doesn't necessarily focus on inclusion of students with disabilities. Seventy-seven percent of the investors, startup leaders and EdTech experts interviewed for this study had simply *not considered disabilities as a space where EdTech could expand and scale*. Four leading experts in the EAP EdTech sector referred to a hierarchy of inclusiveness structure that typically has defined the boundaries for EdTech engagement with various marginalized groups (Figure 3.1, below). Moreover, all study participants noted that they believed they were already addressing the idea of 'inclusivity' in its broadest sense via EdTech services targeted at broad audiences.

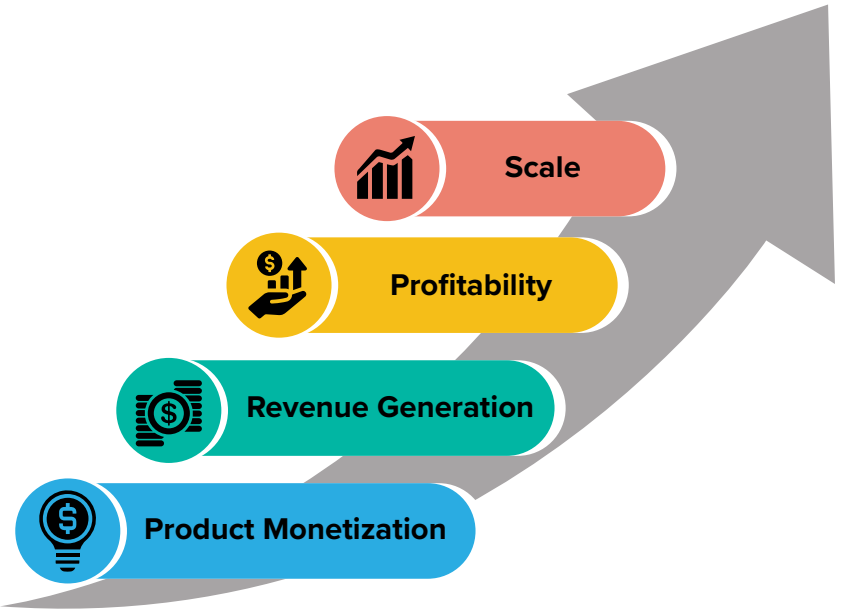
All interviewees agreed that, despite the rapid expansion and evolution of the EdTech over the past couple of years (MarketsandMarkets, 2021), the sector was still undergoing a process of discovery and consolidation, especially in terms of identifying mainstream business models, target markets, market access and pricing. In a stark reflection of the state of the assistive EdTech sector, all interviewees struggled to name any product or player in the disability learning space. In some instances, some interviewees were able to share anecdotes of interventions made in the EdTech learning disability space, but these were all small scale and the common theme across all such examples was that the catalyst was personal circumstances that necessitated the creation of assistive technology options (United Nations Children's Fund, 2022).

**Figure 3.1** Interviewees identified multiple types of inclusiveness along with multiple challenges




***Source:*** Authors' own analysis derived from interviews and desk research.

**Figure 3.2** Current priorities in the EdTech sector

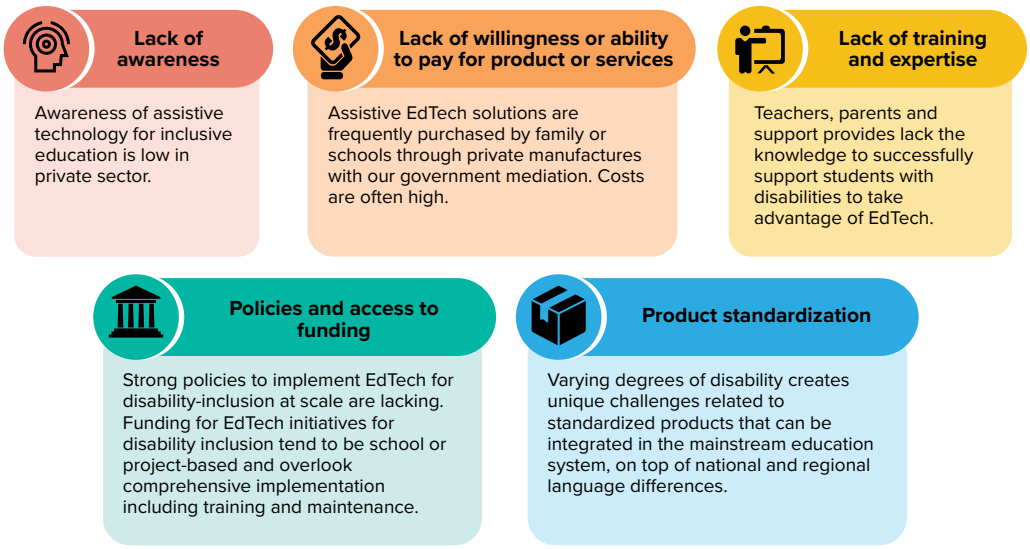



***Source:*** Authors' own analysis derived from interviews and desk research

## Challenges

Private sector perceptions captured for this research regarding the assistive EdTech sector are also a function of the challenges that they have faced when trying to scale and grow the mainstream EdTech sector. For example, an understanding of market size is very difficult without data and other sources of information. Calculating market size accurately can be very challenging, even for the mainstream EdTech segment, as various factors are involved in segmenting the market. And, therefore, gaining an accurate picture of the market size is even more difficult in the assistive EdTech market segment, which is a subset of the broader EdTech market. It is hard to generalize the definition of the market for students with disabilities, as it involves a wide spectrum in terms of the degrees of disability, diversity in age groups, demographics, and geographic locations, etc. Study participants identified four main challenges associated with the assistive EdTech segment (Figure 3.3). These challenges were: (i) insufficient knowledge about the target market; (ii) a lack of knowledge about the types of solutions available and the types of solutions needed; (iii) concerns about commercial viability in the assistive EdTech segment; and (iv) confusion about the type of business model that might work in the assistive EdTech segment.

**Figure 3.3** Challenges affecting the assistive EdTech sector




***Source:*** Authors' analysis based on interviews, desk research and (World Bank, 2022a)

### *A lack of understanding and awareness about the market*

Our interviews with EdTech players in the EAP region revealed that a major challenge is related to their understanding of the actual market size and the *perceived* market size. The *perceived* market size of EdTech players for assistive EdTech was much smaller than the estimated actual market size. There are not enough data to accurately calculate the market size so, in the absence of evidence, various interviewees assumed it was small, and eight out of the 13 largest EdTech players and regional investors stated "the market is too small for us to enter" or "the market is too small for us to consider investing." They also pointed out that if one accounts for intra-segment marginalization in terms of socio-economic status, geography and gender, these further market segmentation challenges compound the existing issues of lack of access and lack of supply.

The other main challenge that interviewees identified relates to market knowledge and an understanding of the spectrum of disabilities. EdTech players interviewed for this research were unclear regarding the type of disabilities that could be supported by assistive technologies, and what level of product differentiation would be required. Given that there is a wide spectrum of student (and teacher) disabilities, the EdTech solution to the variety would mean that the market size again would be smaller than first anticipated and would be fragmented in nature. These issues further limit scale and revenue generation.

Eleven out of 17 interview participants were unaware, or had very limited knowledge, of the different types of assistive technological solutions available. In earlier studies the

low level of awareness regarding assistive EdTech solutions did not improve drastically following the onset of the COVID-19 pandemic, despite the rapid expansion of the overall EdTech sector (World Bank, 2022a).

### *Lack of commercial viability*

The EdTech sector globally, and especially in the EAP region, faces the key challenge of how to grow with profit. The interviews with EdTech industry leaders suggested that one of the main constraints is the user's willingness and/or ability to pay. While the EdTech sector expanded rapidly during the first two years of the pandemic, especially in terms of the user base, the transformational shift in terms of changing the reluctance of customers to pay for online educational services does not appear to have occurred in any structural sense, as noted during the interviews conducted with EdTech founders and investors in the EAP region. For example, industry revenue for the EdTech sector in Indonesia is less than US$120 million (Innovation Factory & Ravenry, 2020), despite it having the second-largest market in EAP after China, which is a 100 billion market (Yu & Shen, 2022). Given that it has been challenging to monetize services in the EdTech space as a whole, all three of the EdTech investors who were surveyed for this study expressed concerns over how services in a smaller and more specialized segment would be monetized. For private sector financing, especially in the form of venture capital, the monetization of products and the return on investment are critical elements when making any investment decision space as a whole, all three of the EdTech investors who were surveyed for this study expressed concerns over how services in a smaller and more specialized segment would be monetized. For private sector financing, especially in the form of venture capital, the monetization of products and the return on investment are critical elements when making any investment decision.

In addition to challenges related to revenue generation, all of the EdTech investors and service provider interviewees expressed concerns over the costs involved in establishing assistive EdTech products. High creation costs, coupled with an inability to charge premium prices and to scale-up operations, were a repeated concerns of the survey of EdTech players. Earlier studies complement this finding by providing evidence that assistive EdTech products (both hardware and software) were often unaffordable for both families and schools (see for example,(World Bank, 2022a)).

### *Business model—localization is key*

Only three out of the all the private sector EdTech interviewees have considered entering the assistive EdTech sector. Our researchers and interviewees noted that it was difficult to identify for-profit private sector companies operating in the assistive EdTech sector in the EAP region. One of the discussions held for this research indicated that those that are operating in the assistive space tend to be either small-scale players that were established to fill gaps experienced due personal circumstances (mostly

CSR or grant funded) or as a part of a service offering by a large, long-established education company looking to increase service offerings. In one case, the interview respondent noted that, even as a dominant player in the market, they struggled to design a sustainable and successful business model for their EdTech product for students with disabilities.

It is still unclear whether the most appropriate business model for scaling assistive EdTech is business-to-customer (B2C), business-to-business-to-customer (B2B2C), business-to-business (B2B) or business-to-government (B2G) (following Bhardwaj et al., 2020). EdTech players from our sample were unsure about the best approach for the assistive EdTech segment, because there is no existing industry benchmark or examples of companies that are successfully operating at scale in this sector.

Study participants noted that, even more so than in the case of the traditional EdTech sector, a localized business model was likely appropriate for the assistive EdTech segment. Not surprisingly, the existing regulatory framework can significantly influence the mode of engagement or dissemination strategy in that geography. For instance, in countries where there is significant government involvement in the education system (for example, in Indonesia and Japan), the B2G or B2B2C route may be needed in the initial stages of engagement and dissemination because the customer acquisition cost for B2C can be too high before the product has created a tangible impact, and a need that can encourage the end-user to pay for the products or services. Barriers to entry in the traditional EdTech sector are typically magnified in the assistive EdTech segment because of the niche nature of the product/solution, and the complexity that requires a learning curve for large-scale adoption. Study participants also noted that B2G and B2B (to schools) business models are typically more fraught with challenges, due to the need to adhere to issues with pedagogy, national curriculum requirements and bureaucratic red-tape.

### *Product standardization*

Another challenge linked in some ways to finding the most appropriate business model was related to the varying attitudes to disabilities across the EAP region. In most of the EAP region, there still exists a stigma associated with disabilities. For example, children with disabilities are 49 per cent more likely to have never attended school than children without disabilities (United Nations Children's Fund, 2021). This makes entering the market with the right business model, products and prices very difficult because, even though there is a market need, there might be inertia in adopting the solution. In addition to this, varying degrees of disability also create unique challenges related to the standardization of products, limiting the possibility of integrating the solution into the mainstream system.

### *Policy and access to funding*

All the EdTech service providers surveyed for this study noted that attracting private sector funding was difficult in the 'traditional' (non-assistive) sector and that they assumed that it would be even more challenging in the assistive EdTech segment. The difficulty in attracting funding for the assistive EdTech segment is further compounded by a lack of existing policy supporting growth (commercial and non-commercial, such as financial incentive or CSR benefits for EdTech services providers that want to expand into the space or have existing products/services for students with disabilities). Policy intervention is likely to catalyze the sector and encourage more private sector players to create solutions to target the market for students with disabilities and, therefore, will encourage investors to engage in the sector. One of the discussions held for this research indicated that most of the funding for EdTech initiatives for disability inclusion is usually project-based and overlooks comprehensive implementation (including training and maintenance) and, therefore, it is not able to achieve scalable impact/implementation.

### *Lack of training and expertise*

Several interviewees shared their perception that teachers, parents and support providers currently lack the expertise and knowledge of inclusive-education and about the assistive EdTech solutions to successfully support students with disabilities and to take advantage of and access EdTech. This makes marketing products difficult. This impression is borne out in the literature, for example, that the assessment and evaluation of disabilities is considered to be a major hurdle to appropriate integration of EdTech (World Bank, 2022a). Assessment of student needs is necessary for two main reasons: (i) to understand the learning needs of the children with disabilities; and (ii) to determine the amount of resources to allocate to address the needs (World Bank, 2022a). Similarly, for ongoing improvement of inclusive education interventions, evaluation is needed but in many MICs in the EAP region neither assessments nor evaluations are being conducted in a systematic manner. A key driver of this piecemeal approach to assessment and evaluation of student disabilities is linked to a lack of training and expertise of teachers and support from the broader education system (Chakraborty & Kaushik, 2019). Teachers are often at the frontline in terms of assessments and evaluations, but they lack the knowledge/expertise and an expert referral system for disabilities, creating a significant roadblock in advancing assistive EdTech solutions.

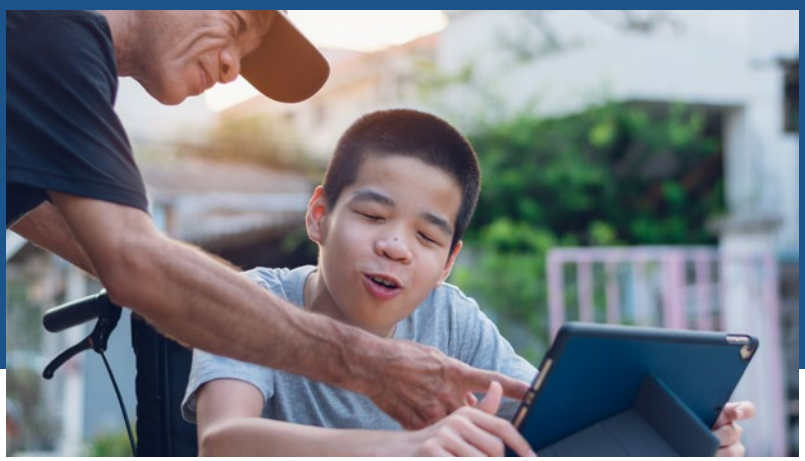
## Recommendations to Address Market Failure

Faced with these challenges, a multi-faceted approach is needed to create and eventually grow the assistive EdTech sector. According to the study participants, the current circumstances in the EdTech sector do not lend themselves to unilateral interventions from the private sector. The participants noted that two approaches made

most sense as the assistive EdTech sector is still in their very early stages: (i) direct government intervention; and (ii) encouraging increased private sector participation through inclusion in corporate social responsibility (CSR) frameworks, incentives and/or policy level changes.

The traditional EdTech sector underwent a transition through various phases before it started to resolve the problems of access, scale, and quality. It went through a stage of market creation and market shaping, followed by government invention and policy level changes to broaden the market before the private sector ventured into the space and created of a variety of growth opportunities. A similar series of steps may be needed to fully develop the assistive EdTech sector in the EAP region, and address the challenges and gaps mentioned above: (i) market creation: awareness (knowledge and engagement); (ii) market shaping: multi-stakeholder involvement for the co-creation of solutions; (iii) market broadening: government intervention to encourage private sector participation; and (iv) demonstration of commercial viability. Details on these promising approaches are discussed in detail in the conclusion.

***Photo:*** Adobe Stock



# 4. Assistive EdTech Country Case Studies

Inclusive education for students with hearing and visual impairments is a crucial aspect of ensuring that all students have access to education, as stated by UNESCO (Hunt, 2020). However, these students often face unique barriers to accessing education due to a lack of appropriate support and adaptations. Technology has the potential to play a key role in removing or reducing these barriers by providing innovative solutions that can help to create inclusive learning environments.

The systematic review found that there is limited evidence of EdTech being applied at scale in EAP MICs. To further understand the reasons behind the underutilization of EdTech for children with profound visual and hearing difficulties in EAP, interviews were conducted with schools and government officials from four countries: Vietnam, China, the Philippines, and Tonga. Four countries were selected to examine a range of challenges and success in the provision of assistive EdTech; as a high performer in education among middle-income countries, Vietnam was expected to have strong examples of successful use of assistive EdTech at scale. China was also expected to have multiple positive examples given its dominance in the EdTech sector, and the Philippines were selected because of its population size and availabilities of multiple EdTech examples. Tonga was selected to identify assistive EdTech practices in Pacific Island countries.

Through these four case studies, we explore the challenges and successes of implementing assistive EdTech, as well as identify strategies that have been effective in promoting the inclusion of students with hearing and visual impairments in the classroom. In addition, we examine the policies and initiatives that either have been, or that should be, implemented to promote the use of assistive EdTech for students with hearing and visual impairments in each country.

With varying education systems, the four countries face different challenges in supporting children with visual and hearing difficulties to obtain adequate learning. In countries with high enrolment rates to basic education, the main challenge is to ensure that adequate learning. In countries with very few children with visual and hearing difficulties who are enrolled into basic education, the challenge is to locate out-of-school children, understand the reasons for low levels of enrolment, and create a more accessible educational environment for this population of interest. In three of the four countries, there are emerging EdTech programs at the school or regional levels. In some cases, these programs are self-funded by schools, indicating the high levels of demand from teachers, parents, and children with profound visual and hearing impairments in using assistive EdTech.

The findings of this chapter provide valuable insights for policy makers, educators, and other stakeholders in the field of assistive education for students with hearing and visual impairments. By highlighting the challenges and successes of implementing assistive EdTech for these students, this chapter contributes to the broader discussion of effective strategies for promoting their inclusion in the classroom.

# Vietnam

## *Country context and prevalence*

In 1986, Vietnam started the political and economic reform known as “Doi Moi”, which shifted the centrally planned economy to a socialist-oriented market economy (Melanie Beresford, 1988). This contributed to a remarkable transformation of Vietnam from one of the poorest countries in the world into an MIC over the ensuing decades. Since instituting Doi Moi and associated reforms, Vietnam has experienced rapid economic development with annual GDP per capita growth ranked among the fastest in the world. Today, Vietnam is an MIC with a GDP per capita of US$3,694 (World Bank, 2021b).

Since the early 1990s, the Government of Vietnam has worked to develop policies and action plans to ensure access to education and the inclusion of children with disabilities into mainstream school programs (UNICEF, 2015). Although there have been several attempts toward this goal, children with disabilities continue to face challenges in accessing quality education. Based on the latest available national census, only 66.5 percent of primary school-aged children with disabilities attended school, compared with 96.8 percent of the national average. Less than one-third of children with disabilities go to upper secondary schools, compared with nearly two-thirds of children without disabilities. Only 0.1 percent of people with disabilities in Vietnam obtain a bachelor’s degree (General Statistics Office of Vietnam, 2019).

In 2016, Vietnam had screened and identified about 1.3 million deaf people and a non-sighted population of 900,000, including children and adults, of a population of 94 million in 2016 (General Statistics Office of Vietnam, 2019). UNICEF identified the main barriers preventing children with disabilities from accessing education in Vietnam as a lack of specialized school facilities, limited training for teachers, and inconsistencies in the definitions of disabilities between different sectors (United Nations Children’s Fund Viet Nam, 2015). This becomes apparent early on in their school life, as only 2 percent of primary schools and lower secondary schools have facilities that meet the needs of children with disabilities, and only one in seven teachers has received training on disabilities (General Statistics Office of Vietnam, 2019). Together, this leads to many children with disabilities being left out of the

classroom, failing to complete primary or secondary school, and missing out on the opportunity to claim their rights to a meaningful education.

### *National policies*

In previous years, Vietnam has made strong commitments to support people with disabilities. Before signing and ratifying the Committee on the Rights of the Child (CRC) in 2007 and 2014, Vietnam enacted the Ordinance on Disabled Persons in 1998, which was then replaced by the 2010 Law on People with Disabilities. The Government also issued a National Action Plan to support inclusion for the period 2006–2010 and numerous decrees that aimed to provide robust protection to persons with disabilities (United Nations Children's Fund Viet Nam, 2015).

The 2010 Law on People with Disabilities made it illegal for educational establishments to refuse to accept people with disabilities to study in their institutions. Instead of denying entry, people with disabilities were to be given priority in student recruitment. They were also entitled to exemption from or reduction of school fees and other training-related payments. In practice, people with disabilities do in fact have access to special scholarships and support for study means and materials (Nguyen Thuy, 2018). Regarding EdTech, Article 43 stipulates that the "State shall have preferential treatment policies in tax, credit and other incentives for research and production of assistive devices to support persons with disabilities to access and use information technology and communications services" (*Law No. 51/2010/QH12 on Persons with Disabilities*, 2010).

Despite these policies, many Vietnamese universities have not invested in campus facilities and infrastructure to make their learning environments inclusive. Teachers in mainstreams schools have not been systematically trained to teach information technology to hearing or visually impaired students, and therefore learning through technology is only done at special schools or associations for the blind. Students with disabilities face difficulties and obstacles in terms of the accessibility and availability of appropriate learning resources, which causes negative impacts on their learning and ability to do academic research. This situation requires both national and ministerial bodies, as well as institutional managers, to allocate adequate financial resources and have sufficient policies to invest (Nguyen Thuy, 2018).

Increased access to education and learning remains one of most obvious benefits of EdTech based on global studies and experience (e.g., (Bando et al., 2017; Ma et al., 2020; Naik et al., 2020; Snilstveit et al., 2021) With a substantial population of children with disabilities living in Vietnam, it is surprising that assistive EdTech has not yet appeared in the Vietnamese EdTech market. Instead, current EdTech companies in Vietnam focus on three key products and services: (i) digital content provision targeting learners of various age groups; (ii) learning management systems; and (iii) integrating advanced technologies, such as Augmented Reality, Virtual Reality, and AI to learning (D. Nguyen, 2022).

### *Positive deviants: Vietnam Quality Improvement of Primary Education for Deaf Children*

The Vietnam Quality Improvement of Primary Education for Deaf Children (QIPEDC) project aimed to emphasize the importance of creating and maintaining a conducive learning environment for deaf children at home and in their communities (World Bank, 2022b). The project design took into consideration the exponential growth of disruptive technologies, especially in communications and education, by including in the project design educational technologies, such as e-learning and mobile learning in designing teacher training programs, animated visual learning materials, and a Vietnam Sign Language dictionary for deaf children in primary education. These materials were stored publicly on virtual platforms so that they could be remotely accessed from various digital devices, such as tablets, laptops and smart phones. The Vietnamese Ministry of Education and Training agreed to make the project materials available nationwide and promote their existence through their media outlets to ensure that they would continue to deliver benefits for teachers and students after the project closure.

The project worked to improve the learning outcomes of 1,929 deaf children in 20 out of 68 provinces and cities, and laid the foundations for continued quality improvements in the future. The deaf students' learning results far surpassed the annual targets of a 50 percent pass rate, with 96 percent of students passing their end-of-semester tests. The learning outcomes were achieved through a comprehensive approach focusing on teaching methods, materials, and pedagogical support. The revised learning materials included supportive videos for 150 mathematics and Vietnamese language classes, and 4,000 Vietnamese Sign Language lexicons that were recorded and made available through a searchable video database on a Ministry of Education and Training website.

### *Digital learning at Nhat Hong Center for the Blind*

The Nhat Hong Center for the Blind in Thu Duc supports learning for 340 children with vision impairments. The center uses computers with self-developed specialized software to enable blind students to read, write and access digital resources online. The Center's comprehensive approach aims to support vision-impaired children already in preschool and continue the support all through high school. The Center also supports the acquisition of special skills at higher education level.

The Center is familiar with tackling challenges common to vision-impaired students through EdTech solutions. One such approach is related to revising Vietnamese national textbooks, which tend to have several pictures and tests that are based on those pictures. The Center has designed braille picture software and makes use of devices with special paper that converts images into tactile paper. For preschool-aged children the Center has created digital-learning environments that offer opportunities for joyful learning in history, typing, and spelling. The in-house software solutions assist blind students to write mathematic and scientific syntax. The software also supports teachers so that they can grade the test papers of the visually impaired.

### *Education transformation and a way forward*

According to the 2030 Agenda for Sustainable Development, the Ministry of Education and Training planned for three pillars in Vietnam's education transformation: (i) transformation of the governance system; (ii) environmental transformation (i.e., renovating the classrooms); and (iii) digital technology. The aim is to develop a shared vision, commitment and alignment of actions across constituencies to transform education in Vietnam. The path to transform the inclusive education sector has not yet been clearly laid down, although suggestions from key policy makers include systematic training of public education teachers on assistive EdTech, production of accessible learning materials (audio and e-books), providing subsidized or free EdTech to disabled students, and increasing access to learning for students in remote areas by providing both devices and training in using EdTech to access digital resources.

Most of the assistive EdTech tools identified under this case study were developed locally, and benefited only a small number of students. One such solution was developed and used by a non-profit school for the blind, where special software tools had been built to allow 340 vision-impaired students to access screen contents through a screen reader. The software was maintained by the school and, although available to other institutions, was still only used within that school. The other offered digital-learning resources to primary school-aged deaf children.

Vietnam's overall EdTech market is growing at an impressive pace. CoderSchool, a start-up providing online programming classes, announced that it had received US$2.6 million Series-A funding, and ELSA, an app for learning English, had called for US$15 million at a Series B round (H. L. V. Nguyen, 2022). The online education sector is estimated to reach US$3 billion by 2023 (H. L. V. Nguyen, 2022). With the right incentives, inclusion might be taken on board by some of the vast number of startups, as Vietnam is now the third-most-active startup ecosystem in Southeast Asia, behind only Singapore and Indonesia (H. L. V. Nguyen, 2022). Until that happens, too many children with disabilities remain out of the classroom, fail to complete primary or secondary school, and miss out on their rights to a meaningful education.

In order to move forward with assistive education technologies for Vietnam, the start-up ecosystem needs to be better understood. This includes the Vietnamese education technology supply and business models, enabling infrastructure, human capacity, and education policy and strategy. This should be approached through a feasibility study covering these areas to provide a robust analysis of the opportunities, challenges, costs, and benefits of introducing assistive EdTech approaches in Vietnam with attention to design, evaluating impact, and effective scaling strategies.

# The Philippines

## *Country context*

The Philippines has a long history of addressing the needs of individuals with disabilities. The country ratified the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) in 2008 and has been working to implement its provisions. The Philippines also has a Magna Carta for Persons with Disabilities, which was enacted in 1992, which guarantees the rights and welfare of persons with disabilities and aims to remove barriers to their full participation in society. However, despite these efforts, the country still faces many challenges in addressing the needs of individuals with disabilities, particularly in terms of access to education (Department of Education of the Republic of the Philippines, 2022a). A lack of infrastructure, resources, and trained personnel in schools have been identified as major barriers for children with disabilities to access education. In addition, cultural attitudes and stereotypes toward individuals with disabilities often perpetuate discrimination and marginalization.

## *Prevalence*

There are multiple estimates on the prevalence of all types of disability in the Philippines. The National Disability Prevalence Survey estimated that 6 percent of population aged 15 to 39 have a disability (Philippines Statistics Authority, 2016). A prevalence level was also estimated by the Department of Education in 2010, with 5.49 million children, or 13 percent of the total children population, having special needs (The Philippine Star, 2014). There are no available data that specifically estimate the number of children with visual and hearing difficulties. Access to education for children with disabilities is still very limited given the estimated prevalence level, which ranges from 6 to 13 percent. Out of the 28 million students enrolled in basic education[2] in the Philippines for the academic year 2019/20, there are about 360,000 students with disabilities, making up 1.34 percent of the total enrolment (Department of Education of the Republic of the Philippines, 2022a).

The COVID-19 pandemic impacted enrolment for all children, but especially those with disabilities. For school year 2021/22, only 127,000 students with disabilities were enrolled, indicating a reduction of enrolment for children with disabilities of over 65 percent (Philippine News Agency, 2022), compared with 2 percent for the

2. Basic education in the Philippines includes one year of kindergarten, six years of elementary education, four years of junior high school, and two years of senior high school.

total number of children enrolled.[3] Furthermore, there are no data on the percentage of students with disabilities who are able to access different levels of education, both within and outside of basic education. The Government of the Philippines has made concerted efforts to keep the overall student dropout rate low, despite the challenges of the pandemic, with around 97 percent of all students able to complete primary school and 86 percent of the population able to complete junior high school (Department of Education of the Republic of the Philippines, 2022a). However, we were unable to find public data that provide information on how learning levels of students with disabilities, or how well they transition between levels within the education system.

### *National policies*

Over the past two years, the Government had issued several policies to support children with disabilities in accessing education, building on existing legislation. The Alternative Learning Act 2020 provides learning opportunities for out-of-school children with special cases,[4] as well as adults who were not able to complete their basic education, to obtain different levels of learning (Republic Act No. 11510). Children with disabilities within the Alternative Learning System are offered a special program.[5] In 2022, the Inclusive Education Act was passed to support learners with disabilities. This policy aims to provide students with disabilities free and appropriate public early and basic education, as well as appropriate support based on their needs (Republic Act No. 11650). This law mandates that each city and municipality will establish at least one Inclusive Learning Resource Center of Learners with Disabilities (ILRC). The ILRC is intended to serve as a one-stop shop for students with disabilities, offering services such as screening, assessment, development and provision of teaching materials, and referral. In each ILRC, there will be appropriate assistive devices and equipment. According to the Inclusive Education Act, the ILRC is meant to establish a multidisciplinary team (for example, visual specialists, sign language specialists, developmental pediatricians, and guidance counselors). Detailed technical guidelines on implementation have yet to be issued.

Early screening and assessment are needed to enroll children with disabilities into the education system. In 2022, the Department of Education issued the Child Find Policy to better identify students with disabilities aged 3 to 24, and toddlers under the age of 3 (Department of Education of the Republic of the Philippines, 2022b). The goal of this policy is to locate children with disabilities who were never enrolled in school. To achieve this, public school administrators and teachers are expected to engage with the Barangay[6] to conduct home visits, persuading parents to enroll their children into

3. For school year 2021/22, there were 27,232,095 students enrolled. In comparison, for school year 2019/20, there were 27,798,114 students enrolled.
4. Out-of-school children with special cases are defined as "school-aged children who are not enrolled in elementary or secondary school due to special cases such as economic, geographic, political, cultural, or social barriers, including learners with disabilities or conditions, indigenous peoples, children in conflict with the law, learners in emergency situations, and other marginalized sectors.".
5. In contrast to formal education that is classroom based, the ALS offers education is usually offered in community learning centers, multi-purpose hall, libraries or at home. The ALS is managed by learning facilitators.
6. A Barangay is the smallest political unit in the Philippines.

the education system. Screening guidance is provided through the Child Find Policy. Administrators and teachers are also expected to support parents in obtaining referrals for specialized consultations and assessments.

In terms of monitoring and evaluation, the Department of Education has set ambitious targets to support students with disabilities in accessing basic education, and created a framework to improve equity (Department of Education of the Republic of the Philippines, 2022a). By 2030, the net enrolment rates (NERs) for all students, with and without disabilities, in elementary and secondary education will reach 99 and 98 percent, respectively. In school year 2019/20, the NERs for all students are 93.87 and 83.27 percent, respectively. While there is no specific enrolment target for children with disabilities in the Development Plan, these targets aim to improve all children's access and indicate the Government's commitment to providing education for all Filipino children. To measure equity, learning progress and outcomes of students with disabilities are grouped into a larger category, namely children from disadvantaged situations.[7] These targets are yet to be decided, but will include indicators such as transition rates, retention rates, and percentages of learners obtaining different levels of skills (functional literacy, numeracy, and 21st century skills).

While the Government has set ambitious goals and action plans, public spending for special education has yet to increase. In September 2022, the Department of Education issued a statement stating that the department has proposed a budget of PHP 532 million[8] (about US$9.842 million) for the Special Education Program in 2023, but this budget was not considered in the National Expenditure Plan (Department of Education of the Republic of the Philippines, 2022b). The Department of Education therefore needs to finance the 2023 Special Education Program through other means, suggesting that implementation of these new policies is going to be a major challenge.

### *Private sector*

As of November 2022, there are no publicly listed Filipino companies that offered EdTech, for children with and without disabilities.[9] However, although the Government has not reported estimates on the size of the EdTech market, with around 28 million students enrolled in basic education (Department of Education of the Republic of the Philippines, 2022a), the EdTech market in the Philippines is expected to be large. One leading private company is Edukasyon.ph, which offers online tutoring services for students aged 4 to 16. The company also established a large database that contains information with over 13,000 senior schools, 80,000 courses and 4,000 scholarships, to

7. Children are considered in a disadvantaged situation if they are or are experiencing any of the following: living in geographically isolated areas, attending a Last Mile School, have disabilities, seeking asylum or refuge, persons of concern, belong to marginalized groups because of their identify (for example, indigenous peoples), being at risk of dropping out, or living below the poverty line.
8. In 2022, on average, PHP 1.00/ US$0.0158.
9. A basic search was conducted on November 2, 2022, in the Philippine Stock Exchange, searching for companies listed under the Education subsector. There were four companies publicly listed under this subsector: Centro Escolar University, Far Eastern University, iPeople, and STI Education Systems Holdings. All four companies did not mention EdTech in their company descriptions.

help over 50,000 students apply online and choose their school of interest (WISE-Qatar, 2021). This database helped the company win the 2016–17 World Innovation Summit for Education (WISE) EdTech Accelerator Initiative. Another example is the School-in-a-Bag project, which was initiated by Smart Communications Inc. In each kit, there is one laptop, five tablets, one hard drive, one LED TV, one solar panel, one smart phone, and one prepaid pocket Wi-Fi. The devices are preloaded with digital educational content to support children and teachers residing in remote areas (Smart Communications, n.d.). No information on the efficacy in terms of learning impacts of these products is available. Overall, information on the private sector children with visual and hearing difficulties s limited in the Philippines. However, the Government recognizes the importance of engaging with private sector on assistive education.

In the Inclusive Education Act, the Government highlighted the importance of engaging the private sector in providing education for children with disabilities. The Inclusive Education Act states that there will be incentives to promote private sector participation. Any donation from the private sector in favor of the Department of Education for learners with disabilities are entitled for tax reduction under the RA No. 8525 Adopt-A-School Program, which "allows for additional deduction from the gross income equivalent to 50 percent of such expenses" (Republic Act No. 11650).

### *Local EdTech programs for children with visual and/or hearing difficulties*

The Gabay Project is a three-year inclusive program supported by USAID, with a total value of PHP 92.3 million[10] (about US$1.78 million), that aims to support children with visual and/or hearing difficulties. The local implementing partners include Resources for the Blind and Better Hearing Philippines. The program established Inclusive Education Community Resource Centers in central schools of selected provinces. The centers support teachers in producing teaching and reading materials. Each center is equipped with appropriate devices, such as braille readers, tablets with software for deaf students, and braille typewriters. The project also supported the development of a sign language dictionary for the early years (kindergarten to grade 3 level word lists). The dictionary can be distributed via a portable storage device or print. In 2016, the Department of education encouraged mother tongue teaching for children in the early grades (Department of Education of the Republic of the Philippines, 2016). Therefore, students who are hearing-impaired often learn four sign languages, namely Filipino, English, Tagalog, and a local language. With 19 main languages and 182 living languages in total (Eberhard et al., 2022), teaching in children's mother tongue is especially challenging for students with hearing difficulties. The Sign Language Dictionary developed in response to the 2016 Mother Tongue Policy is based on the curriculum of the Department of Education. The project also supports the training of community health workers in assessing children for visual and hearing difficulties. Children are then referred for diagnosis and for education enrolment support.

10. In 2019, on average, PHP 1.00/US$0.0193.

As of March 2022, the Gabay project has supported children with visual and/or hearing difficulties from 178 schools. The project reached 3,451 children with sensory disabilities (directly by supporting children enrolling in the education system or assessing children for their degrees of disability, or indirectly through teachers or primary caregivers participated in training), and 375 teachers (both from special education and mainstream education).

### *Policy discussion*

The Government's determination to support children with disabilities, including those who are experiencing difficulties with vision and/or hearing, is demonstrated through the Inclusive Education Act and the Basic Education Development Plan, expanding the supply of services and increasing households' demand for education. From both the supply and demand sides, EdTech can be applied to better support children with visual and/or hearing difficulties in accessing education.

One key area for policy action is to provide guidance on the implementation of ILRC and strengthen policy implementation to encourage private sector participation for assistive EdTech for students with special needs. One of the possible entry points for collaboration with private sectors on assistive EdTech is through the establishment of ILRC. Based on RA 11650, the Department of Education in collaboration with the local government units (LGUs) will initially establish and provide maintenance of at least one ILRC in each city/municipality. However, as funding support from the LGU greatly depends on local priorities and availability of funds, and establishing ILRCs will require significant investment, participation from the private sector can play a vital role. Private companies, as part of their corporate social responsibility (CSR), are encouraged to take advantage of the incentives (tax reduction) set forth under RA 8525 Adopt-a-School Program. To successfully deliver this program at scale, additional standards and guidelines are needed to ensure that services are provided in a standardized and appropriate way. Due to the large variation in population size among the municipalities, one key challenge for the Department of Education is developing multiple standards that can meet the local need. For example, how much equipment should be purchased to support a municipality with 1 million people? Such standards and guidelines are important for transparent and successful procurement. These standards can be combined with routine market get-togethers whereby suppliers and buyers (teachers, staff and government officials) are brought together, enhancing buyers' knowledge on what is available in the market, signaling for strong demand in this field, ultimately reducing the possibility of bidding failures in competitive procurement. Another challenge is to select and train the supervisors. The ILRC creates demand for skilled supervisors to manage the program. However, due to the shortage of qualified special education staff, it is likely that some supervisors will have a background in general education. In-service training is therefore needed to support the supervisors.

Another key action would be to scale up successful practices from NGOs and development partners, and encourage innovation. The Gabay Project provides an

example of the value of leveraging expertise from the development partners and NGOs in championing the use of assistive EdTech. As the Gabay Project was already implemented in 178 schools, the Department of Education can study what aspects of the project can be scaled up and then push for its adoption. The Department of Education, in collaboration with the interagency committee managing the startup communities in the country, can open call for early innovators in assistive EdTech as stipulated in Republic Act 11337 or the Philippine Innovative Start Up Act, where partnership between government agencies and innovators is encouraged and supported. In addition, support for foreign startup innovators is provided in the Philippine Innovative Start Up Act to attract an international presence in the Philippine market.

Screening, collecting, and publishing data on types of disabilities and level of enrolment for students in the national Education Management and Information System is essential for private and public actors to understand the scope of the needs and formulate approaches to improve enrolment and learning levels. The Child Find Policy aims to locate out-of-school children with disabilities, conduct screening and then enrolling children with disabilities into the education system. Based on the current policy, teachers and school administrative staff are the main implementors. While hosting open-days and school visits encourages children in receiving screening, home-visits are needed to locate all out-of-school children with disabilities, including those experiencing profound hearing and/or vision difficulties. In the Gabay Project, the screening was completed by trained community health workers, who were able to reach the households at the village level. Connecting the Education Management and Information System (EMIS) between the Department of Health and Department of Education is therefore crucial to locate out-of-school children with disabilities. The 2030 Basic Education Development Plan specifies that the Department of Education will measure how well students from disadvantaged situations are accessing education and their learning outcomes. However, disaggregated data on type of disability and level of enrolment (grade) are not currently reported. Overall, a strengthened EMIS is essential to understand the remaining gaps in policy to support children with visual and hearing difficulties in accessing education and obtaining the appropriate levels of learning.

## China

### *Country context*

China has the second-largest education system in the world, with over 250 million students enrolled in primary, secondary and higher education (National Bureau of Statistics of the People's Republic of China, 2021). The education system in China is

characterized by a small central ministry, and strong regional and local government bodies. This decentralized structure has led to significant variation in educational policies and practices across different regions of the country. In terms of compulsory education, covering primary and junior secondary, China has over 213,000 schools and more than 10 million teachers (Ministry of Education of the People's Republic of China, 2020). The country has made significant progress in increasing enrolment in primary and secondary education, with a near-universal enrolment rate. However, there are still disparities in education quality and access, particularly for students from rural or minority communities.

Education for children with disabilities is an area that China has been working to improve, but still faces challenges. The country has a large population of students with disabilities and has made efforts to increase access to education for these students through policies such as the Regulations on Education for Individuals and Disabilities (*Canjiren Jiaoyu Tiaoli [Regulations on Education for Individuals with Disabilities]*, 2017).

### *Prevalence*

China has around 37.8 million people registered with at least one form of disability, with around 1.1 million people under the age of 14 (China Disabled Persons' Federation, 2021). Profound visual difficulties affect 4.2 million people, while profound hearing difficulties affect 3.2 million people. There are 20 million with physical disability. These are the three most prevalent forms of disability in China (China Disabled Persons' Federation, 2021).

The provision of basic rehabilitation and appropriate assistive devices reached over 80 percent of the total population (State Council of the People's Republic of China, 2021b). There were 0.32 million people who had received tactile sticks and visual aids, and 0.32 million people who received cochlear implants or hearing aids (China Disabled Persons' Federation, 2021). However, due to lack of data, there is limited information on the coverage of rehabilitation services and assistive devices for school-aged children.

The Ministry of Education reports on an annual basis, the number of students with disabilities enrolled in the education system, which is disaggregated by sex, grade level, and type of disabilities. Among the 0.92 million children with disabilities who were enrolled in the education system, around 36 percent of them are attending special education schools (Ministry of Education of the People's Republic of China, 2022a). Around 42,000 children with visual impairment and 93,000 children with hearing impairment are enrolled in the education system (Ministry of Education of the People's Republic of China, 2022b).

However, there is limited data on enrollment rates, drop-out rates, completion rates, and learning outcomes. I Ministry of Education reported that more than 95 percent of the children with disabilities are enrolled in basic education (primary and junior high

school education) (Ministry of Education of the People's Republic of China, 2022a), which is not disaggregated by sex or type of disability. Outside of basic education, there is no available data on the enrolment rate of students with special needs. The enrolment rate of students with visual and hearing difficulties is expected to be low for education beyond basic education. In 2021, among the 0.92 million students with disabilities who were enrolled in the educational system, only 7,000 students were enrolled in high school education (about 0.08 percent) (Ministry of Education of the People's Republic of China, 2022a). Besides data on the number of students enrolled, there are no monitoring data that measures students' learning levels so, while it appears that almost all students are enrolled in basic education, there is limited understanding of how much they are learning.

### *National policies*

The Ministry of Education has announced its 14th Five-Year Action Plan for the Development and Enhancement of Special Education (2021–2025),[11] which aims to improve special education (*Teshu Jiaoyu*) through three channels: access, quality and financial support (Ministry of Education of the People's Republic of China, 2022c). First, by 2025, the enrolment rate of basic education for students with disabilities is planned to reach 97 percent. Enrolment rates in preschool, high school, vocational high school and tertiary education will also be increased (but from an undefined base). Second, to improve teaching quality, there will be further development of teaching curricula and teaching materials, diversification of education models, establishment of a quality evaluation system, and further integration among special education, general education, rehabilitation, and technology. Third, funding toward special education, including special education schools and children with disabilities who are enrolled in mainstream education, will be increased, reaching RMB 7,000[12] (about US$1,085) per person per year before 2025. Students with disabilities from poor households will be eligible and prioritized for free high school education.[13]

### *Private sector*

There are limited data on how large the private sector is for students with visual and/or hearing difficulties in China. In 2016, the Ministry of Civil Affairs estimated that the

11. This Action Plan was developed jointly by the Ministry of Education, the National Development. In response to the current situation of special education development in China, the Ministry of Education, the National Development and Reform Commission, the Ministry of Civil Affairs, the Ministry of Finance, the Ministry of Human Resources and Social Security, the National Health Commission and the China Disabled Persons' Federation. The China MoE uses the term "Special Education" (*Teshu Jiaoyu*) as a broader term for education of children with special needs. It includes children who are enrolled in mainstream classrooms, special education schools, as well as special classes attached to mainstream schools.
12. In 2021, on average, US$ 1.00/RMB 6.45.
13. Note that this policy has been implemented since 2016 and will continue to be. This policy waives all tuition and miscellaneous fees of students from families who are registered as poor households and are enrolled in public general high schools, including students with disabilities from non-registered families with financial difficulties. Subsidies will be given to eligible students in private schools in accordance with local standards for the same type of public schools.

Chinese market for all types of rehabilitation and assistive devices,[14] was around RMB 430 billion[15] (about US$64.8 billion), an estimate that includes RMB 330 billion (about US$49.7 billion) in goods and RMB 100 billion (about US$15.1 billion) in services (Ministry of Civil Affairs of the People's Republic of China, 2016). However, there are no data on how large the market is for school-aged children with special needs, particularly those with visual and/or hearing difficulties.

The private education market in China has contracted significantly since 2021 because of the policy that regulated private tutoring and the EdTech sector more broadly. The new policy aimed to ease the excess burden of students who are enrolled in compulsory education by curbing excessive homework and off-campus tutoring (State Council of the People's Republic of China, 2021a). Local governments stopped approving new institutions that provide off-campus tutoring for curriculum subjects in basic education. Existing institutions should be registered as non-profit institutions. Furthermore, companies that offer curriculum subject-tutoring are no longer allowed to be publicly financed. As a result, the market price of major private EdTEch companies dropped sharply as the new policy became known.

Despite the new policy on private tutoring, the EdTech market remains significant in China. Currently, there are 33 companies that are listed on the Chinese stock market. In total, these companies are worth over RMB 328 billion[16] (about US$48.8 billion). The largest publicly listed EdTech company is iFlyTEK (*Xunfei Keji*), which is a leading company in intelligent speech and AI. iFlyTEK provides technology and services to schools. For example, it developed the Smart Marking System, the English Listening and Speaking Platform, and the Big Data Precise Teaching System. The company excels in speech recognition, translating even Chinese dialects to text. However, because there is no publicly listed company that mainly provides EdTech to students with visual and/or hearing difficulties, there is little information on how large the private market is for this specific sub-population.

We found no evidence of development for any student-focused assistive technology in recent years, but the COVID-19 pandemic did create new demand for technology in the broader market, some of which can also be helpful for students with visual and/or hearing difficulties. For example, recent advancement in real-time audio processing enabled Tencent Meeting to produce clear audio in virtual meetings. In addition, in collaboration with EarTech, the companies jointly developed a new cochlear implant that greatly improved listening experience in noisy scenarios—speech clarity and understandability improved (TechWeb, 2022) and whistling effects were reduced—at a price intended to be competitive with imported models.

14. This estimate includes assistive devices used for all age groups and are devices used in daily settings, including those used for education and rehabilitation.
15. In 2016, on average, US$1.00/RMB 6.64.
16. This value is calculated using the closing price of October 18, 2022. In 2022, on average, US$ 1.00/RMB 6.72.

## *Assistive EdTech used in Chinese schools to support children with visual and hearing difficulties*

To understand newly emerged practices that use EdTech to support children with visual and/or hearing difficulties, the Teacher Educational Center under auspices of UNESCO from Shanghai Normal University investigated practices at two leading special education schools in Shanghai, China. The purpose of the interviews was to understand the challenges, emerging technology, scale, financing, and sustainability of using EdTech to support the target population of interest. The two schools are Shanghai School for the Blind (*Shanghai Mangtong Xuexiao*) and Shanghai No.1 School for the Deaf (*Shanghai Diyi Longya Xuexiao*). Some notable practices are highlighted in the paragraphs below.

### Better management of student data

One challenge identified by the Shanghai School of the Blind was that the school wanted to digitalize student data for better management.[17] Students were routinely assessed for education and rehabilitation purposes, and the traditional paper format was inefficient in tracking and monitoring students' progress over time. The school developed an online platform that stores screening reports, produces individualized training, and hosts teaching and rehabilitation training materials for users. This platform is publicly available to all students with visual difficulties in primary and secondary schools (regardless of the type of schools that they are enrolled in) and can be accessed via computer web browsers, mobile devices (Android and iPhone). Registered students are screened across 11 domains: visual functioning, orientation and mobility, sensory integration, language development, gross motor development, fine motor development, cognition, social adaption, mental health, vocational skills and health care. Teachers are required to input screening results across the 11 domains. The platform then generates an assessment report and automatically classifies students into three categories: (i) in need of training; (ii) in need of partial training; and (iii) no training needed. Teachers then use the assessment report to general an individualized rehabilitation program. This process is adjusted and/or repeated until the goals are achieved.[18] Teachers are encouraged to upload teaching and rehabilitation materials on the platform. The cost of developing this platform in 2013 was around RMB 200,000[19] (about US$32,520), and the cost of maintaining the platform is around RMB 6,000 (about US$976) each year. In terms of scale, this platform has been promoted and used by 73 students with visual difficulties from 56 different schools in Shanghai.

17. A similar challenge was identified by the Shanghai No.1 School for the Deaf. The school developed a similar online platform that helps teachers, health-care professionals, and student manage their education and rehabilitation records. The platform also acts as an open-source library, with contents developed by teachers or health experts.
18. For students who are enrolled in blind schools, compared to students with visual difficulties who are enrolled in mainstream education, the biggest difference in using the platform is that the former students will also have an individualized education plan.
19. In 2013, on average, US$1.00 / RMB 6.15.

### More efficient screen navigation by using tablets

Traditionally, to support students with visual difficulties, schools connected desktop computers with touch display monitors and screen-reading software. However, screen readers typically read through all information on the web page or document, therefore creating redundant or superfluous information for the students (e.g., advertising). To address this, the Shanghai School for the Blind procured iPads and braille display devices. Additional training is needed to use the new technology. For example, during the training session, students learned about finger gestures used in the Voice Over feature, while teachers were taught how to create iPad-friendly teaching materials using Keynote and iBooks. The school then compiled good quality teaching examples and shared them across the school, covering core curriculum subjects such as Chinese, English, physics, history, and geography. Overall, the cost of renovating three iPad classrooms[20] was around RMB 300,000[21] (about US$47,770) and RMB 250,000 (about US$39,809) to purchase 25 iPads. Meicheng Technology Co. provided technical support and equipment maintenance, which cost around RMB 60,000 (about US$9,554) per year.

### Sign Language App to reinforce learning and enable self-paced learning

To support primary school students in learning the Chinese Sign Language, the Shanghai No.1 School for the Deaf developed the LeXue Sign Language App. This app was used as a supplement material for teachers and students. Based on the national textbook for students from grade 1 to 5, the app content consisted of 70 units across 30 topics. Each unit contained three learning sections and four exercise sections. Using the video clips and photos, students are able to learn words, phrases, and sentences. To practice, students would need to match pictures with the corresponding signs. The app also allowed students to record their signs and compare with the standardized and correct signs uploaded onto the app. Besides the textbook content, the app had 1,200 words and their corresponding sign language, which students can use for further learning. The average time use is 150 minutes. Most of the users are students from the Shanghai No.1 School for the Deaf.

## *Policy recommendations*

In order to understand needs and successes, it would be helpful if the Government collected and made public disaggregated monitoring data on a regular basis. Currently, the Ministry of Education reports on students' enrolment rates in basic education for the entire population. Disaggregated data, including by different forms of disability, are important to know how many students with disabilities are accessing different levels of education. Besides enrolment data, standardized literacy and

20. The renovation cost included the cost of rewiring and equipment purchases (i.e., routers, Apple Box, HDMI splitters, charging cabinet).
21. In 2015, on average, US$1.00 / RMB 6.28.

numeracy tests are also important to understand how much learning is actually obtained. At the school level, there is a strong demand for an integrated monitoring system—storing student assessment data, rehabilitation data, rehabilitation plan and teaching plan into one platform.

While the private EdTech market had contracted since 2021, it remains large, especially for business models that target schools. The products of iFLYTEK provide examples of EdTech that can support teachers in test marking, as well as in developing teaching plans. The Sign Language App, which was funded by the Shanghai No.1 School for the Deaf, further showed that there is strong demand by schools to use EdTech to support students and teachers. Clear guidelines on specific types of EdTech that are allowed for public listing and business registration are crucial for encouraging the private market in supporting learners with profound visual and hearing impairments.

## Tonga

### *Country context*

Inclusive education in Tonga has been a focus in recent years, as the Government and education stakeholders have recognized the importance of providing equal access to education for all children, including those with disabilities. In 2013, the Ministry of Education and Training in Tonga issued the 2013 Education Act, which stated the country's determination to ensure that all children, including those with disabilities, have access to quality education (The Kingdom of Tonga, 2013). The policy also outlined the need for teacher training and the provision of appropriate resources and support for children with disabilities. Furthermore, in 2014, the Government of Tonga and UNICEF signed a Memorandum of Understanding on the rights of children with disabilities, which emphasized the importance of inclusive education as a means of achieving social inclusion and equity. The Government of Tonga has also been working with regional and international organizations, such as the Pacific Community (SPC) and the Government of Australia, to improve inclusive education in the country, providing support for teacher training, resource development, and policy implementation.

### *Prevalence*

Tonga has limited educational data on children with visual and hearing difficulties—the most recent data that reports such information is from 2018 (Tonga Statistics Department, 2018). Around 7.6 percent of the Tonga population has a least one form of disability (Tonga Statistics Department, 2018), which is equivalent to around

7,800 people.[22] Among the various forms and degrees of functional disability, around 0.4 percent of the children aged 5 to 17 experience visual difficulties, and around 0.7 percent experience hearing difficulties.[23]

Assistive devices are not widely used in Tonga despite the large demand. For example, only 2.7 percent of the persons 5 years and older with visual difficulties reported that they used tools for braille reading; only 1.7 percent of this population use a speaking device or touchable; and 1.0 percent of this population used recording devices (Tonga Statistics Department, 2018). For persons 5 years and older with hearing difficulties, 35.9 percent reported using devices for lip reading and 10.6 percent reported using cochlear implants (Tonga Statistics Department, 2018). However, demand for assistive devices is large. For example, 16.6 percent of the sampled people with visual difficulties stated that they needed tools for braille reading but were not using any, while 28.9 percent of the people with hearing difficulties reported that they needed speaking devices or touchable but were not using any (Tonga Statistics Department, 2018).

Tonga has made huge achievements in expanding compulsory education for the general population. The net enrolment rates (NERs) for primary education and secondary education reached 87.9 and 74.9 percent in 2020, respectively (United Nations Educational, Scientific and Cultural Organization Institute for Statistics, 2022). However, there is still a disparity gap in accessing compulsory education between those with disabilities and those without. Around 5.8 percent of the people without disabilities had never attended school, whereas 8.1 percent of people with disabilities had never attended school (Tonga Statistics Department, 2018). For children who had never attended and had a functional disability, their disability was the most dominant reason for not attending school. It is worth noting that once learners with disabilities enroll in primary education, it is likely that they will also enroll in junior high school. In fact, for around 66.5 percent of students with disabilities, their highest education level attained is secondary education (Tonga Statistics Department, 2018). In comparison, for those without disabilities, this percentage is around 59.3 percent (Tonga Statistics Department, 2018).

We were unable to find enrolment data for children specifically with profound visual and hearing difficulties. For children with disabilities, access to education had expanded since 2007. The program for students with disabilities started with one class in one selected primary school. Currently, there are 43 students with disabilities enrolled across multiple locations. However, based on our interview with a representative of the Ministry of Education in Tonga, few students with profound hearing difficulties are enrolled in the education system, while no students with profound visual difficulties are enrolled. For children with hearing difficulties, 10 children are enrolled.

22. In 2018, total population reached 103,199 in Tonga.
23. In the *Tonga Disability Survey Report*, it is estimated that there are 30,644 children aged 5 to 17 in total. By multiplying the prevalence estimates with the total population of children aged 5 to 17, we estimate that there were around 120 children aged 5to 17 experiencing severe difficulties with vision and around 210 children experiencing profound difficulties in hearing.

## National policy

Tonga's first national Inclusive Education Policy was developed in 2007, and an Inclusive Education pilot classroom was established. Tonga also signed the UN Convention on the Rights of Persons with Disabilities (CRPD) the same year, but has not ratified the CRPD (United Nations Economic and Social Commission for Asia and the Pacific, 2021). Children's right to access education, including children with disabilities, was stated by law in the 2013 Education Act (The Kingdom of Tonga, 2013).

There are two policies at the national level that aim specifically to support children with disabilities. The 2004–2019 Education Policy Framework included goals to ensure that children with special needs are able to access education (Ministry of Education and Training of the Kingdom of Tonga, 2003).[24] In this policy, the Ministry of Education and Training outlined activities such as: providing a special-needs component in pre-service teacher training; providing teachers of children with special needs professional development programs; and reviewing existing curriculum and developing appropriate learning materials and equipment. The second policy is the 2007 National Inclusive Education Policy, which proposed to pilot Inclusive Education Classrooms in selected primary schools (Ministry of Education and Training of the Kingdom of Tonga, 2007). However, in both policies, there are no specific and measurable targets for both children with disabilities (for example, enrolment rate or dropout rates) and teachers of children with disabilities (for example, specific teacher qualifications).

## Existing use of EdTech to support children with visual and hearing difficulties

While Tonga has expanded its education program for children with disabilities, there is little to no technology available for children with visual and hearing difficulties. Furthermore, we were unable to find any evidence of a locally private EdTech sector for children with visual and hearing difficulties. In October 2021, there was a training course to build the capacity of teachers and educators in conducing needs assessments, selecting and using appropriate assistive technologies to support learning for students with disabilities. However, teachers had challenges applying the skills that were targeted in their daily practice. For example, World Bank recommendations on in-service teacher training include tailoring the training to individual teacher needs and follow-up coaching sessions in school to support skill development and implementation, none of which was provided. There is also severely limited access to assistive teaching and learning materials, further hindering teachers' ability to effectively use tools to address learning needs of children with disabilities.

29 The 2014–2019 Education Policy Framework defines people with special learning needs as those who are physically handicapped (those who require wheelchairs, for instance), the visually impaired (the blind or near sighted), those with hearing impairment (the deaf), those with speech defects, and those with intellectual disabilities, and also those who are emotionally disturbed.

There is a pressing need to help teachers and parents learn sign language, which could be supported through remote, hybrid or in-person training. Sign language has not been widely adopted by people with hearing difficulties—10.3 percent of the people with hearing difficulties do not use any sign language (Tonga Statistics Department, 2018). Very few teachers are able to use the official Tongan sign language, which is closely related to Australian Sign Language, and there are only four special education teachers teaching at the primary school level who can use sign language. There are no teachers who can sign any language in secondary education. Teachers often resorted to encouraging lip reading, as parents often do not speak the official sign language and/or use their own signs at home.

### *Policy recommendations*

There is a need to explore alternative learning models to increase the enrolment of children with profound visual and hearing difficulties. Although the expansion of the Inclusive Education Pilot Classroom had improved children with disabilities in accessing education, the single special education class is located at the township level of an eastern district, which means that children residing in western areas and in the outer islands will experience difficulties in accessing these programs. Learning from lessons learned in the Philippines, Tonga can explore alternative learning models that are not based in classroom settings. For example, mobile teachers can provide learning in community centers or in selected home. Teachers or facilitators could also provide printed materials for self-paced learning.

Besides identifying children with visual and hearing disabilities and enrolling them into the basic education system, teachers will need to receive structured training to prepare for the increased enrolment, with frequent follow-ups and assessments. While high tech solutions can be used for teacher training, any solution (i.e., provision of printed sign language books) that aims to support teachers of children experiencing profound visual and hearing difficulties would be beneficial.

*continues on page 38*

## Box 4.1 Spotlights on Cambodia and Indonesia

The Cambodia General Education Improvement Project (World Bank, 2021c) includes support for K–12 students with disabilities. The project promotes the use of phone apps to ensure standardized screening (Pertralex Hearing Aid App and Eye Exam) conducted by trained teachers to identify vision and hearing challenges among the students. This early detection system allows schools and local authorities to identify students with hearing and vision challenges, and to connect them through their parents or guardians to providers to support academic achievement and minimize student dropout risks.

As of March 2023, teachers in 614 schools have screened 227,502 students with the phone-based apps. The program has helped identify students in need of hearing aids which are produced in-country and inexpensive glasses available locally. **For preschool students, the project team piloted the app-based screening and found that it was quite challenging using those apps among the kids aged 3–5. The project is working with teachers to innovate the screening processes (e.g. using shapes and colors of different sizes for visual tests and calling names at different loudness from different angles across a range of frequencies to test hearing).** The project aims to support the government to reach 1,645 schools, or about 15 percent of all schools by the end of academic year 2024–25, and so while still just getting started, represents a helpful connection between tech, children with disabilities, and education.

The recently published **Assistive Technologies for Children with Disabilities in Inclusive and Special Schools in Indonesia** (Hata et al., 2023) found very limited use of assistive technology for children with disabilities, especially in inclusive schools. Analyses of both quantitative and qualitative data indicated that teachers struggled to effectively use assistive technology due to lack of teacher training and provision of tech. The study notes an absence of regulations and understanding of school-level issues at the national level. The central government appeared to often assume teachers could handle assistive tech issues independently, which was not the case from the teacher's perspective.

T**eachers' use of assistive tech was directly related to its availability in schools and corresponding teacher training.** Hence, the study recommends focused teacher training, provision of assistive technology, accessible guidelines, and additional technical support for teachers. The study emphasized the need for a significant shift in government regulations, procurement processes, teacher training, and support mechanisms, aiming to improve not only access to assistive tech but also educational outcomes, ultimately aiming to reduce the inequality experienced by children with disabilities in Indonesia (Hata et al., 2023)

# 5. Conclusion and Recommendations

There are large and important numbers of students with visual and hearing impairments in EAP MICs who are either not in school, or in school and learning less than they could. Assistive EdTech can help these children build their human capital and learn in order to maximize their potential and help them more productively participate in the economic and social life of their country and the world. The severe lack of research on this topic that this study identifies means that governments and other decision makers at the regional, national and school levels lack the evidence they need to support effective investments in assistive EdTech. This lack of data collection and public reporting is a major challenge for the region (Figure 5.1).

We identify below a series of actions that can be taken by governments, the private sector, community organizations, and researchers, as well as by the World Bank and other international partners to increase development, access and use of appropriate assistive education technology in EAP. In terms of priorities, governments can improve measurement and publicly report on the challenges faced by students with disabilities, going beyond policy commitments and frameworks to regularly producing actionable data. Our research found that some solutions do exist at the local level; a key challenge is identifying low-cost ways to diffuse those solutions nationally and internationally where applicable. Finally, we suggest specific actions for the private sector and civil society, as well as multilateral institutions such as the World Bank to encourage uptake and scale.

In identifying priorities for action for assistive EdTech, it is important to acknowledge that there are also lower-tech hardware solutions such as hearing aids and eyeglasses that have long been available. These 'low-tech' solutions are underutilized in MICs in the EAP region. Any effort to increase access to assistive high-tech can be linked with a broader strategy to increase access to already-proven low-tech solutions such as eyeglasses and hearing aids at national and regional scale. Analysis of low-tech solutions as well as assistive tech for other disabilities beyond vision and hearing, along with studies published in languages other than English, represent important areas for future research.

**Figure 5.1** Lack of data collection and reporting is a major challenge for the region

| Country | Publicly available data on number of students with disabilities enrolled (annual) | Including learning achievements | By grade | By type of disability | By sex | Source(s) |
|---|---|---|---|---|---|---|
| **China**[25] | ✓ | ✗ | ✓ | ✓ | ✓ | Ministry of Education, The Pe'ple's Republic of China |
| **Philippines**[26] | ✓ | ✗ | ✗ | ✗ | ✓ | Department of Education, Republic of the Philippines |
| **Vietnam**[27] | ✗ | ✗ | ✗ | ✗ | ✗ | |

## Public Sector

### *Data and awareness*

**Collecting and sharing data on children with disabilities is an essential role of schools, subnational and especially national governments to ensure that all children are learning.** Regularly collecting and sharing anonymized data on students with disabilities is essential for developing targeted, inclusive educational strategies that cater to their unique needs. This data-driven approach enables schools and

25 The Ministry of Education of the People's Republic of China reports on a yearly basis, the number of students with disabilities enrolled, by type of functional difficulties, sex, and grade level. The Ministry of Education of the People's Republic of China reports on a yearly basis, the number of students with disabilities enrolled, by type of functional difficulties, sex, and grade level.

26 The annual enrollment data that is reported by the Department of Education does not include statistics on children with disabilities. However, basic enrolment data of student with disabilities is widely available through media. Latest official statistics can be found in the Basic Education Development Plan 2030, in which the Department of Education reported the School Year 2019–20 enrollment number of children with disabilities, by sex. Note that the Department of Education included the learning achievements of children with disabilities as an important indicator in the Basic Education Development Plan 2030.

27 Vietnam does have publicly available data on the enrollment rate of children with disabilities through the Multiple Indicator Cluster Survey (MICS). The MICS dataset is publicly available for further analysis and contains student enrollment data (by functional difficulties, age, sex, and grade level), and basic literacy and numeracy skills. Since the MICS is a household survey based on a representative sample, the dataset can also be used to understand the rate of children with disabilities that are out-of-school, and how well students with disabilities are progressing within the education system. However, because the MICS was not collected annually (1996, 2000, 2006, 2010–2011, 2013–14, 2020–21) and is sample based rather than census based, this row is selected as "No".

policymakers to monitor progress, address disparities, and allocate resources effectively, ultimately fostering an equitable learning environment for all students.

This study found data on enrolment for two countries but found no data on learning across basic and secondary education for children with vision and/or hearing difficulties for China, the Philippines, Tonga or Vietnam. The fact that children with disabilities in EAP MICs are not clearly represented in many national education statistics in a way that leads to specific support, and that no data are available in many cases after primary education, is an important barrier to service provision both by the public sector and other actors.

In order to improve enrollment and learning for these populations, it is essential to consistently categorize different types of disabilities and track them over time in Education Information Management Systems (EMIS). This could be done using the ten categories proposed by UNICEF (2021). Along with other countries in the region, Tonga, Vietnam, and the Philippines lack publicly available and regularly published enrolment and learning data for children with specific disabilities, making it difficult for public sector decision makers, the private sector, non-profit organizations and research institutions to understand the scope of the challenge. This is an essential first step in providing adequate services. Furthermore, existing EMIS' could be leveraged to collect information and monitor provision and access to assistive device and more specifically to EdTech (following UNESCO, 2019). The EMIS in Fiji (FEMIS) provides a good example for the region as it disaggregates data on students by disability (type and degree) using the Washington Group/UNICEF Child Functioning Module (CFM).[28] FEMIS also tracks services and accommodations and the associated costs (Mont & Sprunt, 2019). Another example is the Ministry of Education of the People's Republic of China which reports yearly the number of students with disabilities enrolled, the type of functional difficulties, gender, and grade level though not the learning achievement.

### *Addressing the intersection of disability and EdTech*

**Addressing the intersection of disability and EdTech requires orchestrating multiple actions as part of a comprehensive strategy.** Addressing the needs of individuals with disabilities in education hinges on strong collaboration among all stakeholders, including governments, educational institutions, the private sector, NGOs, and local communities. By pooling resources, expertise, and perspectives, stakeholders can devise innovative and tailored solutions to enhance accessibility and inclusivity in education.

Effective procurement is an essential starting point, with governments establishing transparent processes that prioritize accessibility and ensure that all acquired EdTech

28. The disability disaggregation package, including guidelines and forms of the Fiji Education Management Information System (FEMIS) is available from the UNESCO/IIEP website https://planipolis.iiep.unesco.org/es/node/6483

solutions are suitable for students with disabilities[29]. Solutions must be tailored to the local context and cultural nuances to guarantee their relevance and effectiveness. This entails close collaboration with local stakeholders, including educators, families, and the disabled community, in the design and implementation phases.

**Quality assurance and capacity building go hand-in-hand, since ensuring the quality of EdTech solutions necessitates investment in the professional development of educators.** This enables them to effectively integrate these tools into the learning process and adapt their teaching methods accordingly. Ongoing training and support should be provided to help educators stay current with technological advancements and pedagogical best practices.

Pedagogical adaptation and support are crucial to ensure that curricula are inclusive and cater to the diverse needs of all learners. This may involve adjusting lesson plans, incorporating differentiated instruction, and providing additional resources and accommodations for students with disabilities. Raising awareness about the importance of accessible EdTech and its potential to transform the educational experiences of individuals with disabilities is another key component. This could involve public awareness campaigns, workshops, and targeted initiatives that involve both the general public and key stakeholders in the education sector.

Data collection and monitoring are integral to evaluating the success of implemented strategies and identifying areas for improvement. Governments should establish robust data collection systems that track the progress and outcomes of students with disabilities, while also ensuring data privacy and security. This information can then inform evidence-based policymaking, resource allocation, and targeted interventions to continuously enhance the inclusivity and accessibility of educational systems.

### *Taking existing solutions to national scale*

**We found no examples of national assistive EdTech programs in EAP MICs**. We originally sought to bring to light the excellent research and positive programs with national reach in assistive EdTech in EAP MICs. We did find two examples of sub-national assistive tech programs, one in China and one in the Philippines, though both of these are limited to fewer than 200 schools. One key approach for national governments to take would be to examine existing solutions used by individual schools and local NGOs for children with visual and hearing impairments, and invest to make these available to all children in the country. In many cases, software has been developed and is available for free or very low cost, and the hardware is commonly available.

29. An ongoing World Bank project seeks to address this problem via an interactive *Decision Making Tool for Tech-Enabled Disability Inclusive Education (TEDDIE) Interventions.* The TEDDIE tool is currently being piloted in two selected low and middle-income countries and aims to estimate the cost of EdTech and the additional actions needed to implement inclusive education given the unique country contexts. Accurate cost-estimates including the cost of implementation and training of the EdTech tool are critical for effective procurement. More information about the TEDDIE tool can be found here: https://blogs.worldbank.org/education/understanding-costs-accessible-edtech-solutions-learners-disabilities

In order to foster a more inclusive and accessible educational landscape, it is crucial to consider the broader elements and enabling environment for assistive EdTech solutions. By incorporating principles of Universal Design for Learning (UDL), these solutions can support quality learning for all students, including those with disabilities. National governments should prioritize building a robust infrastructure, including accessible digital platforms and reliable internet connectivity, to facilitate the widespread adoption of accessible EdTech solutions. Furthermore, they must engage in capacity-building efforts to train educators in the effective use of these tools and adapt curricula to cater to diverse learning needs. Public-private partnerships can also play a pivotal role in fostering innovation and leveraging resources for assistive technology development. By addressing these broader elements and championing the principles of UDL, governments can ensure that every student has equal access to quality education and the opportunity to thrive in an increasingly interconnected world.

## Engaging the Private Sector

To overcome the current lack of investment in developing new assistive EdTech, and low levels of deployment of existing assistive EdTech in MICs in EAP, several approaches to engage the private sector look promising: market creation, market shaping, multi-stakeholder involvement for co-creation of solutions, market broadening and demonstration of commercial viability.

### *Market creation: Improving market knowledge and raising awareness*

**For private-sector companies to identify specific challenges and their scope, governments and multilateral organizations can conduct scoping studies, public-private sector dialogue mechanisms, and broader awareness campaigns.** All private sector study participants agreed that there is a distinct lack of knowledge regarding the scale of the problem and an understanding of the actual target market. While in absolute terms the number of children with disabilities appears to be sufficient for venturing into this segment, all participants were concerned about the level of fragmentation with the target given the wide spectrum of disabilities requiring differentiated products and teacher training to deliver relevant services. Potential overlap with other sectors, for example rising populations of visual and hearing-impaired individuals as the population of EAP MICs ages, means that there may be even larger demands for these products. The main recommendation for addressing this challenge is to mobilize multiple channels among other actors in the assistive EdTech space, such as governments and multilaterals, to improve market knowledge and raise awareness.

### *Market shaping: multi-stakeholder involvement for co-creation of solutions*

As this sector is still in the early stages of development in EAP MICs, an integrated approach with multi-stakeholder involvement could be very helpful in creating solutions

and expanding their use. Establishing an association or forum with the key public, private and NGO stakeholders in this domain at the national level could be an essential first step. The consortia could include specialist technology providers, researchers and organizations working in this sector (multilateral organizations and NGOs), as well as teachers, and connect them with EdTech players and education companies. The platform could serve the purpose of enabling information and knowledge exchange to co-create or germinate innovative solutions. Such a platform could be supported by entities that are actively driving this agenda and have the resources and convening power to initiate dialogue (examples of such entities would be multilateral organizations).

### *Market broadening: government intervention to encourage private sector participation*

Policy thinking and policy level changes could be helpful to broad and deepen the market. This can involve financial incentives or assurances from governments to encourage more private EdTech players to enter this sector. One of the major concerns shared by interviewees in this study when it comes to allocating resources to a new product segment is the question of: (i) how to sell the product; and (ii) will the users be able to pay for the product. The cost of assistive EdTech represents a significant barrier to accessing and scaling existing technology. An EdTech startup might not have the timeframe and resources to commit to such a cause or prioritize solutions for students with disabilities if they do not have a clear line of sight to return on investment. Market broadening policies and subsidy programs, such as the *Prakerja* (Pre-employment Card) program in Indonesia[30], were a key reason for the large uptick in the EdTech upskilling market by incentivizing many private sector companies to create solutions.

Another initiative that governments could implement is to provide opportunities and support innovative solutions by EdTech players that are able to demonstrate evidence-based results for their pilot products. To scale such solutions, governments could work with large education companies or large enterprises with some financial independence and willingness to bear some risk.

### *Addressing the concerns about commercial viability and scale*

- Focus on attracting impact investors rather than seeking venture capital in the short-run
- Explore co-financing options
- Delay discussions about scalability

30. The *Prakerja* (Pre-employment Card) program aims to support job seekers by providing online professional development programs. Beneficiaries will receive digital money to buy online training packages through the *marketplace*. The program had raised a budget of IDR 20 trillion (~ USD 1.3 billion) for 2021 and successfully incentivized the private sector to develop education and training programs. https://www.prakerja.go.id/tanya-jawab/tentang-kartu-prakerja

Private sector involvement in the assistive EdTech segment is, in part, predicated on positive returns on investment, i.e., commercial viability. This is particularly the case in terms of attracting investors to not only help new entrants into the market but also to ensure financial sustainability in the medium to longer term. One interesting finding was that all study participants agreed that the private sector financing, especially venture capital financing would be very difficult to attract in the early years of the engagement in the assistive EdTech segment. In the specific case of venture capital, the major hurdle in attracting interest was scalability and shorter horizons in terms of generating acceptable returns. In this regard, the study participants suggested that, rather than focus effort on venture capital, it would be better to focus on attracting impact investors that are less concerned with returns on investment and commercial viability (at least in the short to medium term).

Study participants also suggested that the gap in financing could partially be plugged via co-financing and incentives from governments. At this stage, where existing EdTech players in the EAP region are still facing profitability and sustainability challenges, it is unlikely that the private sector would be willing to be responsible for investments without significant support.

While there are significant valid concerns about scalability in the assistive EdTech sector, study participants agreed that this would perhaps only be resolved in the medium to longer term. In the initial foray into the assistive EdTech segment it would be more prudent to focus on identifying the target market first, then thinking about the solutions for those particular markets (markets distinguished by the type of disability), and then finally thinking about scale.

## Community Organizations and NGOs

**In many of the cases reviewed for this study, NGOs, religious groups and community organizations were leading the provision of assistive EdTech services.** These groups have often developed expertise in these services in the process of trying to address the market failure in meeting the demand. These groups are often included members of the community of persons with disabilities, or have close connections to them. They can be a source of feedback and experience as governments take solutions to scale. The engagement of organizations of persons with disabilities for instance is Criterion 1 for the World Bank's Disability-Inclusive Investment Project Financing (IPF) in Education, and is part of the practice in other examples. The other three criteria are as follows: Analysis, which necessitates the inclusion of a disability and disability-inclusive education examination in the Environmental and Social Assessment (ESA). This analysis should be succinctly summarized in the Sectoral and Institutional Context of the project appraisal document. Inclusive Project Design is another criterion, requiring the project to incorporate at least one inclusive design feature in a general education activity, or at least one specific activity aimed at benefiting and empowering learners with disabilities, a strategy known as the twin-track approach. The final criterion is Monitoring/Reporting, which mandates that the project, during its implementation

phase, should gather and provide feedback on both the process and outcomes for project beneficiaries with disabilities (World Bank, 2021a).

The expertise and legitimacy of these community organizations and NGOs can be included as resources, partners or representatives in government and private sector attempts to scale up assistive EdTech, depending on the situation.

## Research Community

**This paper identifies major gaps in the research of assistive EdTech in EAP MICs, which require more interest and financing to effectively address.** There are some excellent studies examining EdTech use and student learning outcomes, including Mo et al. (Mo et al., 2020) who compare government implementation with NGO implementation of EdTech in China, Clark et al. (Clark et al., 2021) looking at online learning during COVBID-19-based school closures also in China, and Ito et al. (Ito et al., 2021) looking at math-focused EdTech in Cambodia. Some of these evaluations are at scale (e.g., (Bianchi et al., 2022), which includes millions of students who received the intervention). There is no inherent reason preventing high-quality, large-scale research to examine learning improvements using EdTech for children with disabilities. This would require both researcher interest and financing, preferably with the engagement of local government and the private sector. Research consortia should include local representatives of both the community of persons with disabilities and the research community, to help ensure appropriateness, applicability of findings and, where possible, to expand national capacities to engage in this area of work.

## World Bank and Multilateral Partners

**In addition to current work in this sector, the World Bank has committed to making all education-sector investment loans "disability-inclusive" by 2025 (World Bank, 2018).** As most education projects already include an EdTech component, we expect many of these projects will consider investments in assistive EdTech. A key part of these investments, and those of other partners such as the Asian Development Bank, UNICEF and others could be the national deployment of software and the hardware as well as the system-building for detection, referral, training, maintenance and national scaling of assistive EdTech from the most basic eyeglasses through hearing aids and computer-based assistance.

There is a gap between local solutions, civil society, the private sector and national governments. Multinationals can play the role of advocating for improved data, scale-up of services and development of new solutions.

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# 7. Annex A: Systematic Literature Review

The systematic literature review was conducted in three phases: search, screening, and analysis. By searching three online databases—the Web of Science, the Education Resources Information Center (ERIC), and ProQuest—a total of 1,661 studies were identified based on key search terms (see the Methodology Section), and then screened for eligibility and relevance based on titles and abstracts. We selected 44 studies for full-text screening and, of these, 31 studies were eventually excluded. These studies were not considered for further analysis as we found that either they were outside the EAP region, or they did not focus on the target group of children with disabilities of this review, or they were assessing secondary data and information (i.e., literature reviews). As a result, just 13 studies out of the 44 that went through full-text screening were retained and analyzed for the current systematic literature review. The small number of studies indicates this is an under-researched topic.

The analysis of this cluster of 13 studies shows that they tended to be very small-scale applications focused on the testing stage of EdTech, with small sample sizes ranging from as few as five students to a maximum of 74 students. Students and teachers were engaged in the design and testing of the EdTech. However, there were limited discussions with key stakeholders within the education system, such as parents and civil society. In addition, there was no documentation of the discussion with stakeholders outside the education system, for example, with the ministries of health or the ministries of social protection, which are important for enrolling and keeping students in school, as well as for the broader uptake and use of EdTech.

**Table 7.1** Continuum of technology from no/low to high tech

| Tech | Requirements for use | Maintenance | Electronics | Example |
|---|---|---|---|---|
| **No/Low** | Almost none | None/Little | None | Magnifiers Audiobooks |
| **Medium** | Some training | Some | Some | Braille Notepad Text to speech |
| **High** | Advanced training | High | Complex | Speech recognition Touch screen devices |

Importantly, the review found that only two studies included any indications of costs, and only one study compared costs in relation to market prices. Such discussions are key to evaluating the viability of scaling up strategies and their sustainability over the medium and longer term. In terms of impact, out of those studies measuring student learning outcomes associated with the use of EdTech (9), two only assessed changes in learning outcomes of users. Our review finds the evidence base for assistive EdTech in EAP to be extremely limited, suggesting that further research is needed to examine the impact of EdTech on both educational enrolment and on learning outcomes for students with vision and hearing disabilities, especially at scale.

## Literature Review Methodology

The current systematic literature review was conducted based on a pre-agreed protocol, which encompasses the selection criteria, the online repositories, the terminologies for the web search and study selection processes.

We assessed each study or case study against four inclusion criteria: (i) the technology[31] supported students aged 3 to 25[32] (either directly by supporting the child, or indirectly by supporting parents, teachers or supporting staff) with difficulties in hearing and/or vision, in accessing education or learning; (ii) the technology required batteries or electricity; (iii) the target population resided in an MIC from the EAP region;[33] and (iv) the study was published within the past 10 years (January, 2012, to April, 2022) and was written in English. A study/paper was therefore considered eligible for screening if it met all four selection criteria.

Considering the limited evidence emerging from previous reviews, the current systematic review neither prioritized a specific research design, nor considered the presence of a control group/comparison group as an inclusion criterion. Likewise, the presence of data on outcome measures such as academic achievements, cognitive measures, and education enrolment, which are rather scarce, was not considered a reason for exclusion. Nonetheless, studies that attempted to evaluate changes in student learning outcomes associated to the use of EdTech were marked for further analysis.

Relying on the four selection criteria listed above, a search was conducted using three online databases, namely, the Web of Science, the Education Resources Information

31. In this paper, education technology is defined as a systematic way of designing, carrying out and evaluating the total process of learning and teaching in terms of specific objectives and employing a combination of human and technical resources to bring about more effective instruction (UNESCO glossary).
32. In some instances, studies did not report the specific age (range) of beneficiaries. Nonetheless, some of these studies included references and details on the learning environment, which could confirm that beneficiaries were students. In cases where the age (range) was not provided but it was clearly stated that students were the main beneficiaries, papers were retained for further analysis.
33. This list is based on the 2022 World Bank Country Classification. It includes: American Samoa, Cambodia, China, Fiji, Indonesia, Kiribati, Korea, Dem. People's Rep., Lao PDR, Malaysia, the Marshall Islands, Micronesia, Fed. Sts., Mongolia, Myanmar, Papua New Guinea, the Philippines, Samoa, the Solomon Islands, Thailand, Timor-Leste, Tonga, Tuvalu, Vanuatu, and Vietnam. The full list of eligible countries can be found here: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

Center (ERIC) and ProQuest. The keywords used for the web search were ("blind" OR "deaf") AND (EdTech OR "Alternative and Augmentative Communication" OR "Assistive Technology" OR "Assistive Device" OR "Assistive Aid" OR "Learning Aid") AND (Education OR School OR Teacher OR Student) AND "Country Name". Studies retrieved using this combination of keywords from the above-mentioned databases were stored in a harmonized database, including the name of the publication and the year, the authors, along with the respective abstract and the name of the online source, where this was found.

Having compiled an Excel spreadsheet with all the entries from these three databases, two screeners verified separately the relevance of the studies, assessing them against the five inclusion criteria using the agreed Protocol. The two screeners then independently reviewed the titles and abstracts to identify eligible studies. In case of disagreement on a study, an independent third screener reviewed the title and abstract to determine the inclusion or exclusion of the case. After a first screening based on the content of the abstract, studies deemed eligible were downloaded for full text screening. Once again, two screeners read through the full text of each article and assessed them separately, bringing in a third screener to reconcile any disagreements. As part of the eligibility and study selection process, the two screeners extracted a set of variables to summarize and compare systematically the content of the studies deemed relevant (see Results Section).

## Literature Review Results

The first part of this section reports on the study selection process and its outcome. The section then provides descriptive statistics on the studies included in this systematic literature review. Descriptive statistics provide information on the target group of these studies and the type of EdTech that the study focuses on, as well as whether the application was related to a specific school subject. In the final part, this section assesses the findings in relation to the research questions stated in the introduction.

Figure 7.1 provides an overview of the study selection process. Based on the web search of three databases, 1,661 studies were retrieved and details on the authors, titles and abstracts downloaded into a database. Most of the studies were identified through the Web of Science database (1,384), followed by ProQuest (223) and ERIC (54). Before moving to the screening of titles and abstracts, the team of two screeners ensured that no duplicates were downloaded from the three different databases. The team of screeners then assessed titles and abstracts of each entry to identify studies that met all inclusion criteria. This process led to the exclusion of 1,617 studies, which means that 44 studies were deemed eligible for the full-text reading. While collecting key variables for each study, the team of screeners excluded in this last step of the selection process 31 studies, resulting in a final sample of just 13 relevant studies that met all the inclusion criteria. The agreement rates between the two screeners were high: the agreement rate reached 93 percent for the title and abstract screening, and 80 percent for the full text screening.

**Figure 7.1** Flow diagram of the study selection process

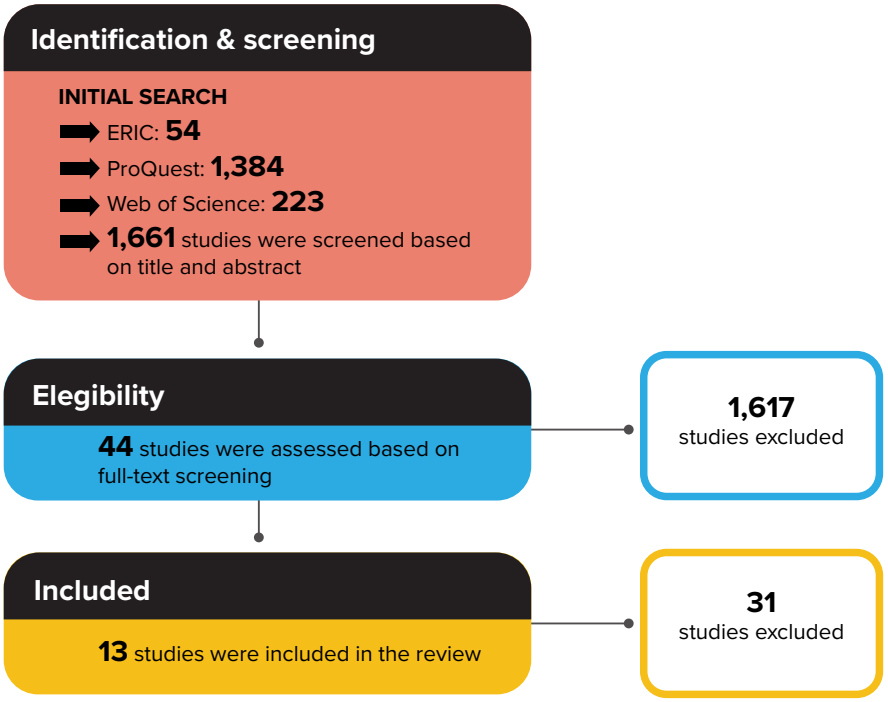



Table 2 provides an overview of the geographical location of the studies that were identified for the current systematic literature review (listed in alphabetical order). The regional evidence base is so limited that two-thirds of all of the studies identified in the review were carried out in only two countries, namely Malaysia (6; 46 percent) and Thailand (4; 31 percent). The remaining studies focused on the Philippines (2; 15 percent) and one in Indonesia. During the selection process, the team of screeners retrieved for each study data on the age of the subjects, the functioning difficulty being targeted, being either vision or hearing or both, as well as the type of EdTech (hardware or software or both), and the learning target of the EdTech.

**Table 7.2** Studies by country, number and percentages

| Country | N | % |
|---|---|---|
| Indonesia | 1 | 7.7 |
| Malaysia | 6 | 46.2 |
| Philippines | 2 | 15.4 |
| Thailand | 4 | 308.0 |
| **Total** | **13** | **100.0** |

Table 3 provides descriptive statistics on these variables for the 13 eligible studies in this review. The age range of students in the 13 studies shows that about 46 percent of the studies focused on primary education. Only four studies (30.8 percent) discussed and assessed the use of EdTech in secondary or tertiary education, whereas two studies (15.4 percent) did not clearly specify the age of the learners testing the proposed EdTech solution.

While the current review focuses on sensory impairments, the interest of these studies and their respective applications were skewed toward children who experience difficulties with vision rather than hearing. Eight studies (61.5 percent) assessed solutions aimed at supporting sight exclusively, while just four studies (30.8 percent) investigated solutions supporting visual impairments. Only one study looked at tailored solutions for these two groups of learners.

EdTech applications and solutions in these 13 studies explored the use of hardware and/or software programs. Table 3 shows that almost all studies (9; 69.2 percent) focused on software programs for children with sensory impairments. Just a handful of studies concentrated on hardware (3; 23.1 percent) and only one looked at both hardware and software programs. The focus on software programs holds across studies that concentrated on either children with hearing difficulties or those with vision difficulties.

Finally, the majority of studies in this review looked at EdTech to support language/literacy (7; 53.8 percent), while three studies focused on math/sciences (23.1 percent), and the remaining studies (3; 23.1 percent) focused on general access to educational content.

The key question we set out to address in this research concerns the development and use at scale of medium to high EdTech for children with difficulties with vision and/or hearing. We therefore categorized studies based on the development stage of the EdTech being assessed and this breakdown is provided in Figure 7.2, Panel a. Figure 7.2 shows that the studies focused on either the design of a prototype/content/platform (3), or its testing (9). Just one study concentrated on the provision and uptake of assistive technologies and EdTech among students with difficulties in hearing and/or vision in the context of tertiary education in Northern Thailand (Lersilp, 2016). However this 2016 study did not aim to assess the impact of EdTech on student learning outcomes, as it concentrates on mapping the provision of, and access to, EdTech, among other assistive products. Likewise, studies (3) that discussed the design of EdTech solutions did not measure any student learning outcomes because of the preliminary stage of development of their products. Only those studies focusing on the testing of EdTech (9) measured student learning outcomes in relation to the use of the EdTech. In this regard, Figure 7.2, Panel b, provides a breakdown of the studies that dealt with the testing of EdTech (Panel a, “Testing”) by the type of outcome they collected.

**Table 7.3** Summary of descriptive statistics

| Study Characteristics | | N | % |
|---|---|---|---|
| **Target Age (Years)** | < 6 | 1 | 7.7 |
| | 6–12 | 6 | 46.2 |
| | 13+ | 4 | 30.8 |
| | NA | 2 | 15.4 |
| **Target group** | Hearing Difficulties only | 4 | 30.8 |
| | Visual Difficulties only | 8 | 61.5 |
| | Both | 1 | 7.7 |
| **Type of Technology** | Hardware only | 3 | 23.1 |
| | Software only | 9 | 69.2 |
| | Both | 1 | 7.7 |
| **Learning target** | Math/sciences | 3 | 23.1 |
| | Language/literacy | 7 | 53.8 |
| | General | 3 | 23.1 |
| **Total** | | **13** | |

***Note:*** Basic characteristics of all the studies included for the literature review. The righthand columns display the total number of studies with each characteristic and group percentages. In total, there are 13 studies that met the inclusion criteria.

Figure 7.2 also shows in Panel b what the studies were looking at when testing the proposed EdTech solution. As such, Figure 7.2 considers studies that were classified into three phases: design, testing, or uptake. Out of the nine studies that tested the use of EdTech, two papers discussed the users' experience only, as both studies concentrated on the early stages of development of an interactive assistive courseware. In five out of nine studies that carried out a testing of EdTech, the authors looked at the accuracy of the solutions that they developed, for exampl7e, the number of words that the EdTech solution could accurately translate from sign language to text. Only in two cases did the research assess student learning outcomes by comparing groups of students using the EdTech solution under assessment with students without the support of the assistive learning technology.

**Figure 7.2** Studies by development stage (Panel A, Full sample), and measured outcome (Panel B, Studies on testing only)

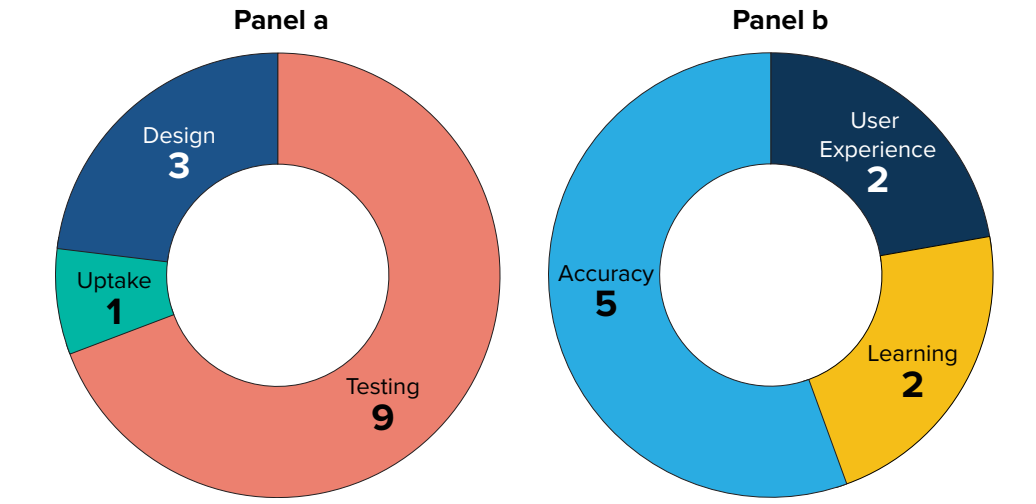



Table 7.4 displays the mean sample size and method of evaluation for studies testing the use of EdTech, which provided details on their sample sizes. Among the nine studies that collected quantitative outcomes (Figure 7.2, Panel b), two studies did not report their sample size. Table 7.4, therefore, provides summary statistics for the seven studies with available information. The average sample size is about 21 participants, and the median is 11. These statistics show that the scale of the studies was rather small, with strong and negative implications for external validity. Furthermore, because only two studies measured student learning outcomes (i.e. test results, language development, cognitive development, literacy), the average effect size was not possible to measure across the group of studies. In order to understand the role of EdTech in enhancing the meaningful participation of children with visual and hearing impairments in education, greater emphasis on assessing the relationship between the use of EdTech and learning outcomes is needed.

**Table 7.4** Summary statistics for studies testing the use of Edtech, which provide available information on number of participants

| Study Characteristics | % |
|---|---|
| Number of studies that contained information on sampling | 7.0 |
| Number of studies that measured academic outcomes | 2.0 |
| Sample size mean | 20.6 |
| Sample size standard deviation | 25.8 |
| Sample size median | 11.0 |

***Note:*** The table displays whether the study reported sampling method and sample size, whether the study measured academic outcomes (i.e., the test results, language development, cognitive development, literacy), the mean sample size and the median sample size.

## Literature Review Discussion

The results presented in Section III show that the evidence and knowledge on the development, use and impact of medium to high EdTech to enhance learning of children with visual and/or hearing impairments at scale are scarce and highly concentrated geographically. We identified studies from only five countries out of the 24 categorized as MICs in the EAP region (World Bank, 2022c), meaning we found no published studies in this field for almost 79% of MIC EAP countries. Importantly, this literature review could not find published studies meeting our criteria on EdTech and learning for children with difficulties with vision and/or hearing for any of the Pacific Island countries.

This limited evidence from MICs in the EAP region that emerges from the current systematic literature review resonates with results from a mapping of inclusive education programs in the EAP region(United Nations Children's Fund, 2020). In particular, the review highlights that provision ranges from very limited to non-existent, with availability being systematically higher in special schools. In this regard, a technical report on the West Pacific region underscores that the provision of assistive technologies is limited for persons with disabilities, particularly those with low-vision, as well as that the procurement of these products receives almost no funding from governments (World Health Organization Regional Office for the Western Pacific, 2020).

The low representation of research on assistive EdTech in the MIC countries in the EAP region starts with the lack of information on children with disabilities. The challenge of using EdTech to assist children with visual and hearing difficulties begins with diagnosis. To take one example for which we have data, in Vietnam, where newborn screening is mostly unavailable, 98 percent of children's hearing losses are first diagnosed by their parents. Even then, the diagnosis happens late, on average at the age of 34 months (X. T. Nguyen et al., 2019). The overdue diagnosis often leads to delays in language development, which is apparent in the 42 percent literacy rate among youth with hearing impairment (from 15- to 24-years-old), compared with the 95 percent literacy rate among the general population (United Nations Population Fund, 2011). The more up-to-date data does not segregate between different disabilities but highlights that people with disabilities aged 15 and over have a literacy rate of 74.43%, whereas people without disabilities reach the rate of 94.31% (General Statistics Office of Vietnam, 2019). These statistics highlight the importance of identifying children with disabilities in order to provide them access to specialized services in the first few years of the child's life, including EdTech.

In most cases, the solutions that this systematic literature review identified concern the design and testing of software programs rather than hardware, a finding that aligns with the work of Lynch et al. (2022). This finding also aligns with recommendations from the Global Education Evidence Advisory Panel (2020) , which defines software programs that can be adapted to meet learners' levels and requirements as a cost-effective solution to improve learning.

Some studies provide evidence that new approaches are being embedded and used to design novel EdTech solutions for children with visual and hearing impairments in the region. For instance, Lopez et al. (2021) integrated learning through play, and then tested a device that helps children with visual impairment to identify letters and short words in braille in the Philippines. The team designed a device that helps children with visual impairment to identify Tagalog letters and short words in braille. To win the spelling game, students need to place the "sticks" into the place holders to display the correct braille letters. Importantly, the device does not require additional hardware such as computers, speakers, cameras, or direct assistance for its use, which makes it easily accessible in low-resource settings.

Also in the Philippines, Arbes et al (2019) tested the use of a text-to-braille translator tactile storyboard with 3D printing for blind students and those with severe vision difficulties. The translator transforms 2D images into 3D models and enables a text-to-braille feature embedded into the story board. While 3D printers remain expensive, the increasing number of open-source 3D printers may broaden the potential future use and uptake of this solution, which could be replicated and standardized.

There are also emerging solutions in terms of software that are worth highlighting. For example, Akmeliawati et al. (2014) developed software that can process Malaysian and English sign languages into either text and/or voice output. This software can provide real-time translation with 80 percent accuracy for isolated signs but only 55 percent for sentences. To tackle the learning difficulties in terms of mathematics and sciences, Wongkia et al. (2012) developed a built-in math reading app for Thai students and teachers. This app is an add-in for Microsoft Word, which is much more accessible for teachers and students than those that are built on more complicated computational languages, such as Latex. Teachers can create handouts and assignments using Microsoft Word. At home, students download the files and use the add-in feature to complete assignments and practice.

While some solutions were identified, the systematic search revealed several gaps in the literature. First, there is limited evidence of how EdTech has been used at scale to support children with visual and hearing impairments. This is clear when looking at the breakdown of studies by development stage (Figure 7.2) and sample size (Table 7.4). Similarly, while studies analyzed in this review discuss the adaptation and modification of content to improve users' experience and understanding, there is no discussion on the linkages with national curricula, which is a concern and in line with results from Lynch et al. (2022). Furthermore, almost all papers presented and discussed the engagement of users, schools and teachers in content development, piloting and hardware prototyping. However, the literature review failed to identify any study that considers and discusses the wider engagement with the education system and other relevant stakeholders.

Second, few studies reported the costs and procurement of EdTech. Only two studies discussed explicitly the cost implications of the EdTech solutions being proposed, with only Pan-Ngum et al. (2013) providing a cost comparison with the solutions that were

currently provided to the school where the testing took place. While the majority of the studies included software, which implied low to free cost per additional user, cost data on maintenance, updates and training are still crucial. As such, the lack of evidence on costing further complicates the discussion on the economic viability of EdTech, as well as on its sustainability.

Third, the systematic review was unable to identify any studies that demonstrate EdTech effectiveness in improving the educational outcomes of children with hearing or vision difficulties. Among the seven studies with data on sample size and outcomes, only two studies measured academic outcomes (Arbes et al., 2019; Techaraungrong et al., 2017). In these two studies that measured proxies of academic outcomes, the sample sizes were too small for statistical inference (<15 participants). The majority of the studies evaluated user experience or accuracy. For example, the study from Akmeliawati et al. (2014) evaluated the number of words that were correctly translated from real-time sign language. This extremely limited empirical basis highlights a major knowledge gap in the research literature, and align with findings from other non-EAP focused systematic reviews that looked either on children with difficulties in hearing (Beal-Alvarez & Cannon, 2014) or vision (Kelly & Smith, 2011).

***Photo:*** Generated using Adobe Firefly

# 8. Annex B: Subjects Interviewed for Private Sector Survey

**Table 8.1** Interview and discussion participants

| | Name | Organization | Designation | Geographic focus |
|---|---|---|---|---|
| **Edtech Startup and Education Companies** | | | | |
| 1 | Tu Ngo | Yola | Co-founder & Chairwomen | Vietnam |
| 2 | Rohan Monga | Zenius | CEO | Indonesia |
| 3 | Wishu Subekti | Zenius | Co-founder & Head of Academics | Indonesia |
| 4 | Truong Le Quynh Tuong (QT) | Classin | Director of South East Asia | SEA (China HQ) |
| 5 | Kotaro Ueda | Benesse Corporation | MD of Strategy and Global Biz Dev, | Japan, India, Indonesia, China, Taiwan (China), Korea and Thailand |
| 6 | Henry Motte-Muñoz | Edukasyon | Founder and CEO | Philipines |
| 7 | Nucky Kang | Palfish | General Manager, SEA | SEA |
| 8 | Linh Pham Giang | Hocmai | CEO | Vietnam |
| 9 | Four individuals from Google for Education | Google | Unidentified | Global and Regional |

*continues on page 65*

**Table 8.1** Interview and discussion participants (*continued*)

| | Name | Organization | Designation | Geographic focus |
|---|---|---|---|---|
| **Investors and Edtech Experts** | | | | |
| 1 | María Luján Tubio | Unicef | Regional Education Specialist, South Asia | Regional |
| 2 | Julie de Barbeyrac | Unicef | Accessible Digital Textbooks Coordinator at UNICEF-Education and Disability | Regional |
| 3 | Yaki Dayan | Neurotech Solutions | CEO & Global Edtech Expert | Global |
| 4 | Unidentified | LEK Consulting | Unidentified | Global |
| 5 | Aditya Kamath | Go-ventures | Partner | SEA |
| 6 | Sandeep Aneja | Kaizenvest | Founder & Managing Partner | Asia |
| 7 | Tu Ngo | TouchStone Partners | General Partner | Vietnam |
| 8 | Mike Michalec | Edtech Asia | Founder & Managing Director | Asia |

# 9. Annex C: Survey Description

In cooperation with the Center for Global Development, the World Bank surveyed decisionmakers in five countries in EAP. Surveys of senior government officials suggest they are not aware of—or choose not to see—the magnitude of their countries' learning deficits. A recent survey of over 900 senior government officials working on education in thirty-five low- and middle-income countries, including two Pacific Island countries, found that most policymakers underestimate the magnitude of their countries' learning deficits (Crawfurd et al., 2021). We conducted a follow-up survey, focused specifically on the EAP region, carried out jointly by CGD and the World Bank. This survey found similar gaps between policymakers' perceptions and measured literacy levels.
The follow-up survey also examined policymaker attitudes towards inclusion and accommodation of children with disabilities, as reported above. The sample for EAP included Vietnam, Laos, Indonesia, Philippines and Mongolia.

The data on inclusion is reported in detail for the first time, here. Respondents were asked to strongly agree, agree, disagree, strongly disagree, or don't know/no answer to the following questions:

> *"Children with disabilities deserve the same level of access to public schooling as children without disabilities"*

> *"In most cases, accommodations should be made so that children with disabilities can be included in regular classrooms with children who do not have disabilities."*

There were 188 respondents across the five EAP countries for this set of questions, and 412 or 413 from non-EAP countries. Interviews were conducted with senior leadership of the Ministry of Education and Ministry of Finance for each county, or their equivalents, as well as Members of Parliament. The interviews were conducted between April and July, 2022. Non-EAP respondents included officials from the following countries: Bangladesh, Democratic Republic of Congo, Ghana, Uganda, Nigeria, Pakistan and Peru.

Please see for (Crawfurd et al., n.d.) details, as well as Crawfurd et al. (2021) .Please also see the forthcoming World Bank report *"Bridging the Learning Gap: Supporting Teachers in East Asia and the Pacific"* (World Bank, n.d.).

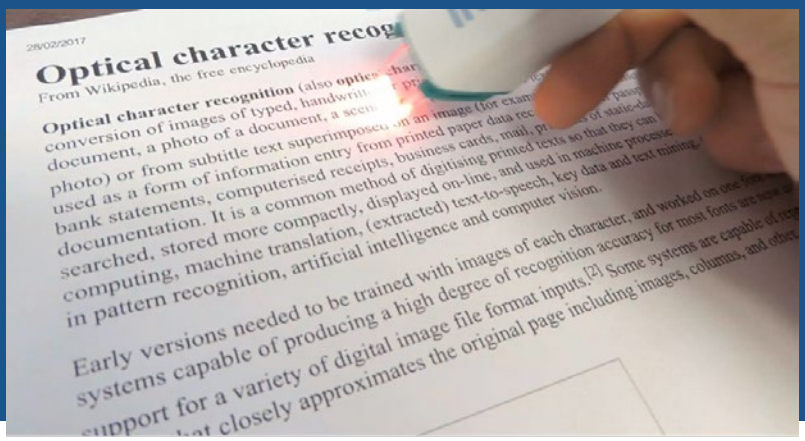
# 10. Annex D: Hardware and Software Examples

Examples and technical descriptions in this annex are drawn from: Altai Consulting. Information and Communication Technologies (ICTs) and Inclusive Education. Lyon: Humanity & Inclusion, 2021. Licence: Attribution—NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) and Creative Commons.

***Photo:*** A computer with Braille keyboard by Elizabeth Woolner

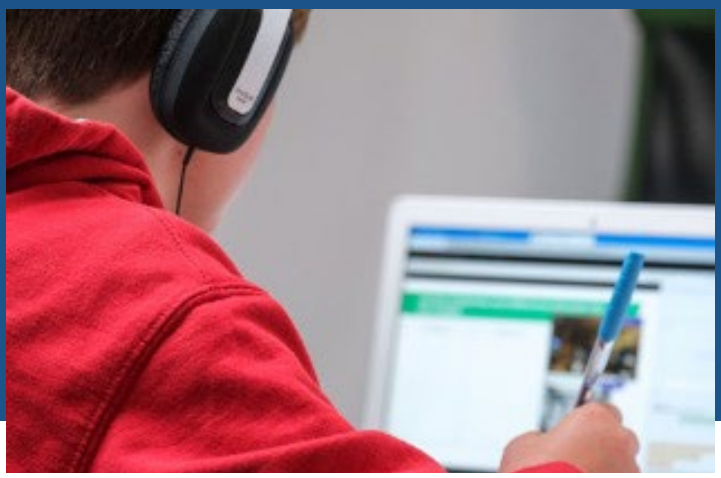
**Computers.** Enabling hardware that can be used in various educational settings which include but are not limited to: teaching, exam marking, and home-work. For learners who are visually impaired, the computer will need to be equipped with a large screen and tailored display content (for example, large fonts) or combined with additional solutions such as a magnifying glass or a magnification software. The computers will also need to be equipped with audio feedback. For blind students, the use of a computer will need to be combined with an accessible screen reader and/or Braille feedback. The cost of a computer ranges from EUR 200 to EUR 2,000 and requires power supply and additional assistive software and/or hardware for improved accessibility.

***Photo:*** 2 OCR Reading Machine. Screen capture from a video by Vassia Atanassova




**Optical Character Recognition (OCR) Reading Machine.** The OCR reading machine is a hardware device that converts paper materials (whether printed typed or handwritten paper materials) into texts and provide a read out when combined with headphones. Compared to computers and screen reader, the OCR reading machine can be particularly convenient for learners with low computer skills and learners that prefer paper/printed materials instead of screens. The OCR reading machine battery needs to be recharged and requires headphones for readouts. The cost of an OCR reading machine ranges from EUR 2,500 to EUR 3,500.

***Photo:*** 3 Screen reader connected to headphones by Compare Fibre



**Screen reader.** A software that can help learners with different degrees of visual difficulties to access digital texts displayed on a computer or a smartphone and offer voice-over to assist the learner in navigating a computer or a smartphone. The software is fairly easy to download and install. The cost of a screen reader app ranges from

free (i.e. NVDA on Windows) to more expensive apps (i.e. Jaws which may cost from EUR 1,500).

***Photo:*** 4 Teacher using a microphone to transmit audio directly to learners with hearing aids. Generated with Midjourney

**Frequency Modulation (FM) Systems.** A hardware that offers wireless audio for learners with hearing difficulties. An example of the learning setting would be the teacher who will be equipped with a microphone and the learner will be equipped with a receiver. The FM system transmits a radio signal to the receiver creating a more audible environment and keeps the voice at a constant level even when the teacher is moving around the classroom. The FM system is particularly useful for students who are enrolled in mainstream schools. The tool uses a battery that needs to be recharged. The cost of FM systems is at least EUR 1,000.

***Photo:*** Generated with Adobe Firefly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