Accessible Digital Textbooks using Universal Design for Learning

FOR LEARNERS WITH AND WITHOUT DISABILITIES

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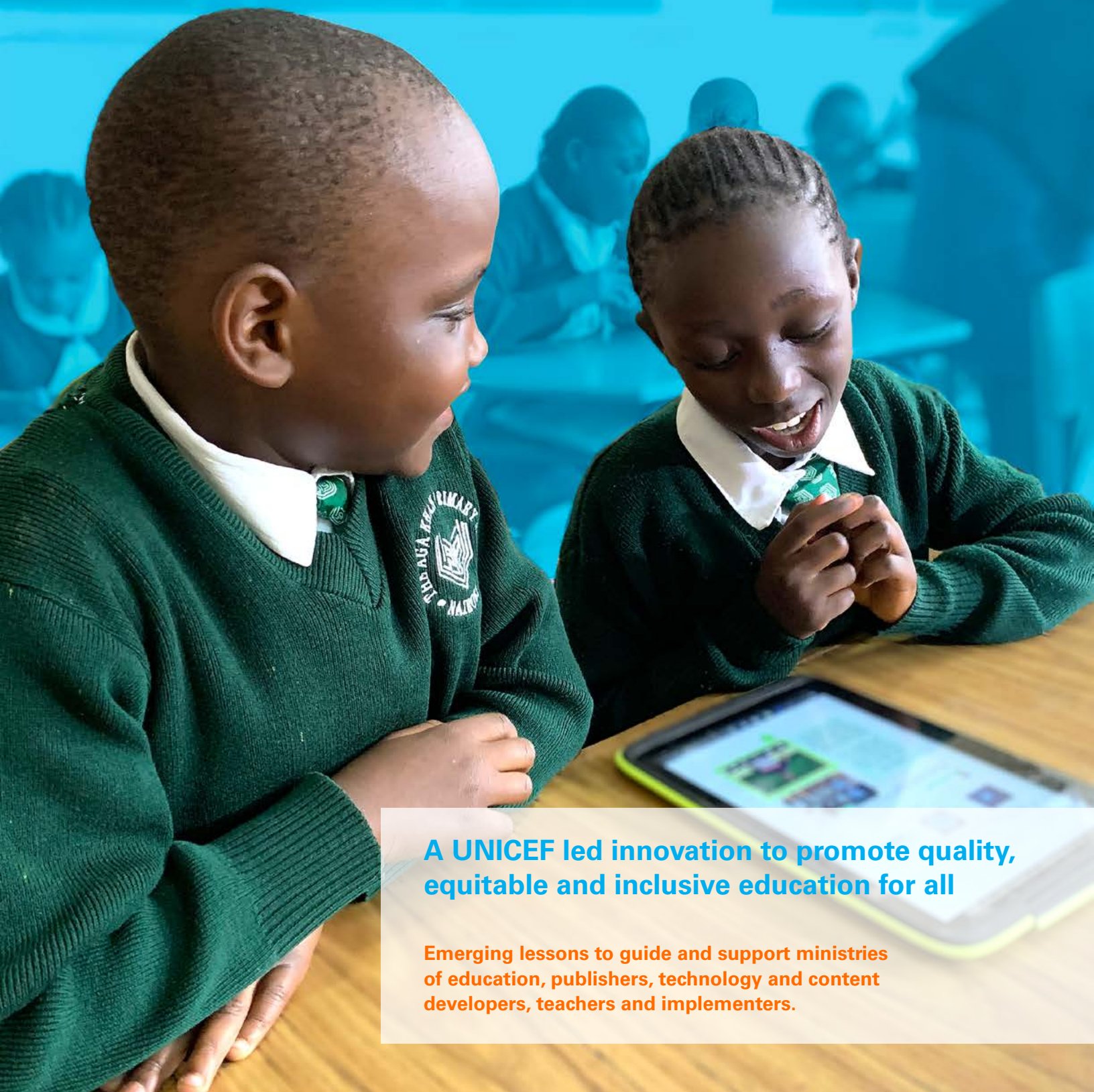
for every child



A UNICEF led innovation to promote quality, equitable and inclusive education for all

Emerging lessons to guide and support ministries of education, publishers, technology and content developers, teachers and implementers.

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Front cover: A girl and a boy who are deaf sitting in a classroom and learning from an accessible digital textbook in Aga Khan Primary School, Kenya, where UNICEF is implementing the initiative. Credits: Julie de Barbeyrac, UNICEF, 2019.

Designer HUB Collective

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Contents

Acronyms

ADT	Accessible digital textbook
ANSI	American National Standards Institute
CRC	Conventions on the Rights of the Child
CRPD	Convention on the Rights of Persons with Disabilities
EPUB	Electronic publication
ICEVI	International Council for Education of People with Visual Impairment
M&E	Monitor and evaluate
MOE	Ministry of education
NGO	Non-governmental organization
OPD	Organizations of persons with disabilities
SDG	Sustainable Development Goal
UDL	Universal Design for Learning
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
WHO	World Health Organization
WIPO	World Intellectual Property Organization

Acknowledgements

This document was developed to share emerging lessons on the design and implementation of the UNICEF Accessible Digital Textbooks for All initiative. It was prepared in a participatory manner with support, input and contributions from various partners and stakeholders.

The vision, advocacy, guidance and support for the development and implementation of this initiative come from **Rosangela Berman-Bieler** and **Gopal Mitra** of the UNICEF Disability Team. Leading the core technical team is **Julie de Barbeyrac**, who serves as this initiative's Project Coordinator.

Emerging lessons

Lessons have been generated since 2014 from initial consultations and workshops led by **Canales Foundation (Argentina), Centro para el Desarrollo de la Inteligencia (Paraguay), Down Movement (Brazil), Inter-American Institute on Disability and Inclusive Development (Uruguay), Daisy Consortium (India) and Gallaudet University (USA).**

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The initiative

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As of June 2019, the UNICEF partners for this initiative are (in alphabetical order): **Canales Foundation (Argentina), Centro para el Desarrollo de la Inteligencia (Paraguay), Daisy Consortium, Down Movement (Brazil), eKitabu, Gallaudet University, Inclusion International, Instituto Alana (Brazil), Inter-American Institute on Disability and Inclusive Development (Uruguay), International Council for Education of People with Visual Impairment (ICEVI), Itaú Social Foundation (Brazil), United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations Partnership on the Rights of Persons with Disabilities, US Fund for UNICEF, World Blind Union, World Federation of the Deaf and World Intellectual Property Organization (WIPO)/Accessible Book Consortium (ABC).**

Special appreciation goes to publishers FTD Education for their generous donation of the use of the textbook *Porta Aberta - Ciências Humanas e da Natureza, Unidade 4: Vida ao meu redor* to develop and advance the initiative's proof-of-concept by adapting and making the content of Chapter 4 accessible in both Portuguese and English.

THANK YOU FOR JOINING UNICEF IN BUILDING A MORE INCLUSIVE AND ACCESSIBLE WORLD FOR CHILDREN WITH DISABILITIES.

CHAPTER 1

Introduction

All children can learn and should be given the opportunity to reach their full academic potential. In 2016, a UNICEF analysis of 15 low- to middle-income countries revealed that among a number of socio-economic characteristics, the role of disability was the most dominant in contributing to whether children attend school or not (UNICEF, 2016). Article 24 of the Convention on the Rights of Persons with Disabilities (CRPD) states that persons with disabilities should have the right to inclusive education, at all levels, without discrimination and on the basis of equal opportunity. State parties must ensure the reasonable accommodation of the needs of children with disabilities (United Nations, 2006). To realize Article 24 of the CRPD and to achieve Sustainable Development Goal (SDG) 4 to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all by 2030, governments must meaningfully address inclusive education.

To help governments achieve these goals, the United Nations Children's Fund (UNICEF) and its partners have developed an innovative digital solution, the UNICEF Accessible Digital Textbooks for All initiative. No printed book can offer all the features needed to ensure access for everyone. Owing to barriers and misperceptions of capacity to learn, children with disabilities are among the learners most excluded from reading. Accessible digital textbooks can help address the issue of accessible learning materials, which is one of many elements needed to promote an inclusive learning environment for students with disabilities. The goal of this initiative is to increase the opportunities for children with disabilities to improve their learning outcomes by providing them with access to the curriculum in multiple mediums.

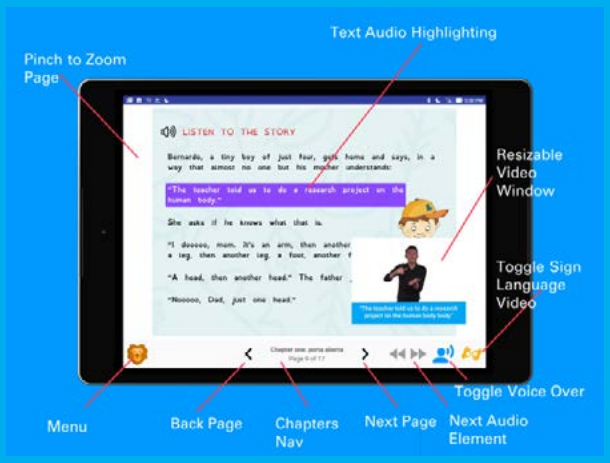
Box 1: What is an Accessible Digital Textbook?

An **accessible digital textbook** is a digital tool that gives all learners, including those with disabilities, access to information in alternative accessible formats, like narration, sign language video, interactivity, the audio description of images and other, to suit different preferences, learning styles or access needs. Through these formats, printed books which were previously inaccessible can be made accessible to learners who are blind/have low vision, those who are deaf/hard of hearing, those who have intellectual/developmental disabilities, learning disabilities, or those who prefer to access information in ways different from visual inputs.

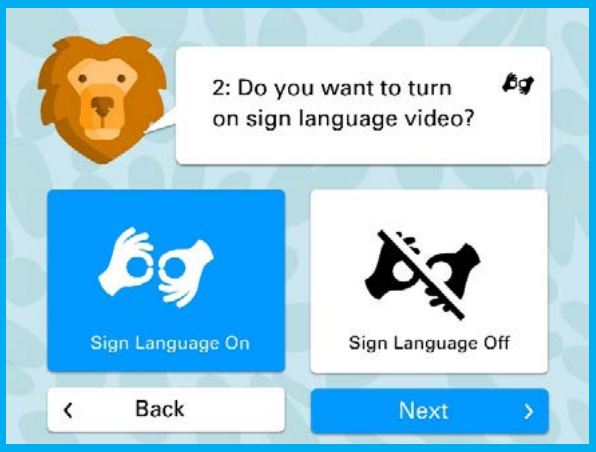
It allows children with different learning styles to access the same content, participate in the same textbook-based activities inside and outside the classroom, and have the same opportunities to achieve positive educational outcomes as their peers. Accessible digital textbooks are an adapted version of curriculum-based textbooks used in classrooms and they differ by being digital, accessible and versatile, allowing users to customize and combine diverse formats.

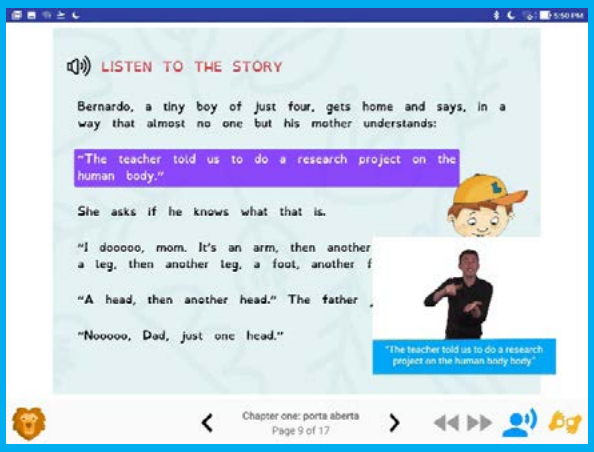
The textbook requires installation on an electronic device (tablet, computer, smartphone) or, in some cases, it can be downloaded from a source and installed using an internet connection. Once installed, the learner can use the textbook offline on the device.

EXAMPLES OF AN ACCESSIBLE DIGITAL TEXTBOOK USING UNIVERSAL DESIGN FOR LEARNING (UDL) PRINCIPLES WITH VARIOUS TECHNOLOGICAL FEATURES THAT GIVE ALL INDIVIDUALS EQUAL OPPORTUNITIES TO LEARN.



The opening menu allows for all learners to benefit from the accessibility technologies offered.





According to their needs, the learners can dynamically customize how they wish to learn throughout the experience.

UNICEF (2018) adapted from *Porta Aberta - Ciências Humanas e da Natureza*, Coleção Porta Aberta, 1st edition © Mônica Jakievicius, Denise Mendes, Margarete Artacho de Ayra Mendes, Roberto Giansanti, FTD, São Paulo, 2014.

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Beyond the goal of improving immediate access to textbooks, the UNICEF Accessible Digital Textbooks initiative follows Universal Design for Learning (UDL) principles (*see section 2.3 and Booklet 11 in the series on inclusive education*) and builds flexibility and versatility into the design of textbooks. UDL provides opportunities for all children, with or without disabilities, to learn according to their individual preferences. Following these principles enables a customized teaching and learning experience for all, while helping persons with disabilities to realize their potential and allow them to contribute more fully to their communities/societies.

This initiative also supports textbook content adaptation and the digital technology needed for authoring and reading accessible books that follow UDL principles. The aim is to influence the textbook and learning materials market towards accessible digital formats and languages, including sign languages. Governments, particularly ministries of education (MOEs), and publishers that provide textbooks and learning materials in traditional hard copies should also provide them in accessible digital formats. At the same time, the initiative aims to support commercial publishers with the tools needed to meet this demand.

By bringing together writers, publishers, teachers, organizations of persons with disabilities (OPD), technology developers, MOE representatives and other stakeholders, the initiative ensures the development of the standards and guidelines needed to produce textbooks and learning materials in accessible digital formats and languages. To make the materials accessible to a wide range of students, including those with disabilities, textbooks and learning materials must combine, at a minimum, accessible features like narration, sign language, interactivity and the audio description of images.

While the early stages of the initiative focus on materials specific to the foundational years of education, including preschool and the early grades of primary school, the goal is for all learning materials to be made available in accessible digital formats. This initiative is based in the educational system, established by implementing MOEs as part of education for all policies and implemented through procurement or other processes. This guarantees sustainability, product quality and the regulated provision of accessible digital textbooks for students with different learning styles. Publishers are key stakeholders in the production and distribution of accessible digital textbooks. Using the CRPD as a framework, this initiative aims to extend educational opportunities to all children, including those with disabilities currently out of school and those on the move, by serving as motivation to re-engage with formal education.

1.1 PURPOSE AND AUDIENCE

The purpose of this document is to:

1. Provide information and share emerging lessons on how to develop accessible digital textbooks to meet the needs of different learners;

2. Explain why textbooks must be accessible in digital formats for use by all styles of learners; and

3. Provide an overview of the work conducted to date by UNICEF and its partners.

This document provides a synthesized compilation of the guidelines developed for this initiative by different experts in the field of disability and inclusive education. It uses a phased approach to help the reader understand the steps necessary to develop and produce accessible digital textbooks.

The initiative uses UDL principles to demonstrate how accessible features in digital textbooks can support education outcomes for all students. The approach used by this initiative allows students to build upon their inherent learning styles instead of being restricted to using learning materials that may act as unnecessarily challenging barriers. This document intentionally focuses on learning styles versus the alternative disability-specific approach. One of the findings in the process of creating digital accessible textbooks is that adaptations and features developed for this initiative benefit more than one disability group and even children without disabilities. Whenever possible, this document focuses on joint interventions and features that address different learning needs and preferences.

This document is designed for a broad audience of diverse stakeholders engaged in the development or use of accessible digital textbooks, including: (1) policymakers (such as representatives of MOEs); (2) publishers; (3) technology developers; (4) UNICEF staff and implementing partners; (5) the donor community; (6) non-governmental organizations (NGOs), particularly those working in inclusive education; (7) OPD; (8) teachers and administrators; and (9) users and families. Given the diverse range of stakeholders, these emerging lessons attempt to provide a general summary appropriate to the different parties while avoiding overly-specific technical issues only relevant to one group. The annexes provide additional information for the benefit of specific stakeholders.

THIS DOCUMENT EXPLORES THE INTERSECTION OF TECHNOLOGY AND CONTENT ADAPTATION TO HELP IMPROVE LEARNING OUTCOMES OF STUDENTS WITH AND WITHOUT DISABILITIES.

1.2 UNICEF'S WORK IN ACCESSIBLE DIGITAL TEXTBOOKS

Since 2014 and building on existing progress enabled by the Marrakesh Treaty to Facilitate Access to Published Works for Persons Who Are Blind, Visually Impaired, or Otherwise Print Disabled *(see Annex A)*, UNICEF has been conducting wide-ranging consultations on accessible digital textbooks, involving education and technology experts, software developers, publishers and OPD, among others. UNICEF has established solid partnerships around this initiative to advocate for and create the basis for advancing the development of accessible digital textbooks. Efforts have included:

1. Work on content adaptation.

A scoping exercise and several consultations took place with key stakeholders to create the basis for the initiative's implementation within countries' educational systems. As a result, UNICEF began to identify funding and technical partners to build the foundations for the initiative. Four regional workshops were held, in Argentina, Brazil, Paraguay and Uruguay, to create and develop guidelines to produce accessible textbook adaptations. Each workshop focused on a specific type of function (hearing, sight, intellectual/developmental acuity and learning) as well as mother-tongue and second-language access. Inclusive education specialists, technologists, OPD members, MOEs and learners with disabilities participated in this activity with the support of UNICEF Headquarters, regional offices and the respective country offices. While the initiative initially focused on how students with specific disabilities learn, it has evolved to include a UDL approach that addresses how learners perceive and communicate information differently.

The four workshops generated initial guidelines on the basic aspects to consider when teachers are designing or adapting textbooks for students with different learning needs. They also helped to create the first accessible textbook prototype, developed in Brazil.[1] Subsequently, three global technical meetings were held to review the first draft of the guidelines and advise experts on ways to produce, pilot and implement accessible digital textbooks in low- and middle-income countries. Feedback from all the consultations has been incorporated in a second accessible textbook prototype that currently serves as the basis for the guidelines now being tested and validated.

Content adaptation

Content adaptation of a textbook is the practice of modifying the traditional ways that text and exercises are presented so they are accessible to persons with different types of disabilities and learning styles.

1 Key partners in these consultations included Canales Foundation (Argentina); the Inter-American Institute on Disability and Inclusive Development (Uruguay); Down Movement (Brazil); and Centro para el Desarrollo de la Inteligencia (Paraguay). The following four draft guidelines were developed: (1) in Argentina: draft guidelines for the development of accessible educational materials for learners who are deaf or hard of hearing; (2) in Uruguay: draft guidelines for the development of accessible educational materials for learners who are blind or have low vision; (3) in Brazil: draft guidelines for the development of accessible educational materials for learners who have an intellectual or developmental disability and those who have learning disabilities; (4) in Paraguay: draft guidelines for the development of accessible educational materials in the mother tongue/a second language.

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2. Work on technology development.

UNICEF is working with several partners in the technology/accessibility community to extend the accessibility of existing publishing standards to a broader population. In line with UDL principles, this innovation will allow authors, content creators and publishers to develop and enhance their own accessible digital textbooks but, more importantly, it will allow parents, teachers and students to choose, combine and synchronize different features, such as narration, sign language, interactivity and the audio descriptions of images, into customized textbooks for a specific user.

As a result of UNICEF and its partners' influence and leadership under this initiative, the shift from disability-specific learning towards UDL is increasingly being considered by technical partners, governments and donors involved in the use of technology for learning in Kenya and Brazil, for example. This model is currently undergoing validation and testing by MOEs in several piloting countries, including Kenya, Nicaragua, Paraguay, Rwanda, Uganda and Uruguay. The initial lessons show that a user-centred experience that follows UDL principles combined with an understanding of learning styles in the content adaptation process can assist learning outcomes in all learners and is more inclusive for learners with disabilities in a wider range of contexts.

1.3 THEORY OF CHANGE

As a basic human right, education forms the foundation of individual, social and economic development. Some existing educational systems, however, are failing too many children around the world, especially learners with disabilities.

Although there is a severe lack of data, available evidence from a few countries shows that, without exception, children with disabilities are more likely to be excluded from school than their peers without disabilities. Even when they join school, children and adolescents with disabilities are less likely to complete primary or secondary education, and the inequality grows as the level of education advances (UNICEF, 2016).

The goal is that all learners with disabilities have equal access to quality learning through accessible and affordable digital textbooks in all contexts.

This theory of change is based on the following assumptions: (1) MOEs committed to implementing the CRPD, SDGs, and policies and practices maintain their support of inclusive education; (2) publishing companies continue to see the benefit of producing accessible digital textbooks, and new copyright laws permit and facilitate their production; (3) teachers, learners and their families are willing to use new technologies and inclusive teaching methods; (4) the cost of tablets, smartphones and other mobile reading devices continues to decrease, allowing widespread affordability and availability; and (5) in the long term, the cost of producing textbooks in accessible formats is minimal in relation to the overall cost of producing and printing traditional textbooks.

This project's theory of change proposes that:

- ✓ If committed MOEs and key stakeholders partner and invest in making accessible digital textbooks available for children with disabilities…
- ✓ If governments and families invest in assistive technology (hardware, software, computer, tablets, smartphones) …
- ✓ If standards and guidelines are jointly developed, adopted and used by all stakeholders involved in the book chain ecosystem…
- ✓ If the book chain ecosystem has the capacity to produce and distribute accessible digital textbooks to children with disabilities…
- ✓ If the communities, teachers, parents and caregivers value education for children with disabilities…
- ✓ If children with disabilities, teachers, parents and caregivers are committed, trained and have access to technology…

…then quality textbooks in digital format will be accessible, available and affordable for learners with disabilities in development and humanitarian contexts.

FIGURE 1

Theory of Change of the Accessible Digital Textbooks Initiative

Source: UNICEF, Disability Section, Programme Division, 2019.

1.4 PROMOTING SUSTAINABLE CHANGE

The five systematic changes required to sustain the initiative's implementation nationally include:

1. Systems have the capacity to produce accessible digital textbooks.

MOEs are committed to administering the initiative, producing and procuring quality accessible digital textbooks and implementing policies and practices that are supportive of inclusive education. They also commit to defining, reviewing and approving content based on the curricula; initiating and approving the procurement process (including specifications for the print runs and digital-text versions); and ensuring publishers develop the content of the textbooks according to the specifications by providing publishers adequate tools and training opportunities.

2. Publishers and authors are committed to creating and producing quality accessible digital textbooks.

By referring to the emerging lessons and standards developed by UNICEF and its partners, publishers will coordinate and produce born-accessible digital textbooks with adaptations in the compatible e-book file format EPUB 3.

3. Technology is available, affordable and accessible.

Once the open-source reader and authoring tools are developed and available on a global repository platform and adhere to UDL principles, locally trained technologists can produce accessible digital textbooks and maintain quality control and usability, thus allowing widespread affordability (assuming the cost of tablets and smartphones continues to decrease).

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4. Teachers and service providers are trained and supported to adapt the content of accessible digital textbooks.

When policies from the MOE are aligned to the Convention on the Rights of the Child (CRC), CRPD, SDGs and Marrakesh Treaty, and the budget is allocated to make textbooks accessible, there is a greater chance the initiative will be followed. This ensures teachers and service providers can make accessible digital textbooks and learning materials available for learners with disabilities.

5. Teachers, children and users, including families, are trained and prepared to use the accessible digital textbooks.

In an inclusive educational setting, when families, children and teachers are willing to use new technologies and are adequately trained and supported, participants will see how learning with accessible digital textbooks complements quality teaching.

The design of new textbooks should incorporate accessible content, like narration, sign language video, interactivity, and the audio description of images from the outset, rather than retrofitting them later at additional cost. Textbook developers can incorporate more interactive content than possible in print media, thus promoting further innovation and ways of learning. These materials can also be updated much more quickly in digital format than in traditional print media. It is vital that MOEs commit to improving ongoing evidence and research, data, policy attention and resources to address the significant structural and social barriers learners with disabilities currently face in accessing inclusive and equitable quality education.

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CHAPTER 2

Why accessible digital textbooks are needed

Understanding the educational situation of students with disabilities helps provide context and background on why accessible digital textbooks are needed. This section also provides information on the international policies and frameworks that mandate inclusive education and access to information for individuals with disabilities, and a summary of UDL principles, which serve as the foundation for accessible digital textbooks.

2.1 GLOBAL SITUATION OF CHILDREN WITH DISABILITIES

Though the exact number remains unknown and more recent data are not available, an estimated 93 to 150 million children under 18 years of age worldwide have disabilities (WHO, 2011). Children with disabilities remain one of the most marginalized and excluded groups and face multiple barriers and challenges related to accessing education. As stated by UNICEF (2013):

> Discrimination arises not because of the intrinsic nature of children's disability, but rather, as a consequence of lack of understanding and knowledge of its causes and implications, fear of difference, fear of contagion or contamination, or negative religious or cultural views of disability. It is further compounded by poverty, social isolation, humanitarian emergencies, lack of services and support, and a hostile and inaccessible environment. Too often, children with disabilities are defined and judged by what they lack rather than what they have. Their exclusion and invisibility serve to render them uniquely vulnerable, denying them respect for their dignity, their individuality, even their right to life itself.

Specifically, children with disabilities face some of the following challenges (UNICEF, 2013):

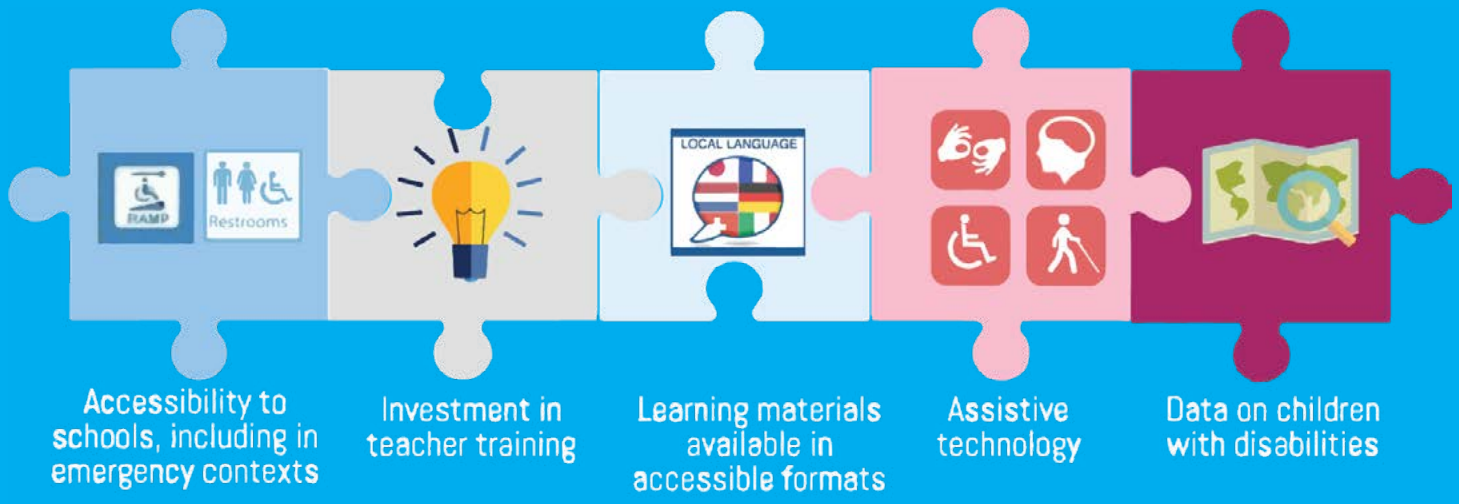
- Girls with disabilities often suffer double discrimination facing not only the stigma, prejudice and inequities encountered by many persons with disabilities, but also exclusion because of gender discrimination.
- Many children with disabilities continue to spend much of or all their lives in institutions, nursing homes, group homes or other residential institutions.
- Consistent evidence emerges from research that children with disabilities are more likely to experience physical and sexual violence and neglect than non-disabled children.

In addition, lack of access to quality education continues to be one of the largest challenges for children with disabilities. In accessible education facilities, inflexible curricula, the lack of assistive devices, inaccessible learning materials and teachers who are not yet prepared to support diverse learning needs in the classroom can all serve as barriers to the education of students with disabilities (Hayes, Turnbull and Moran, 2018). The lack of these essential components can result in students not enrolling in schools, dropping out or remaining in school but not achieving their full academic potential. Accessible digital textbooks can help address the issue of accessible learning materials, which is one of many elements needed to promote an inclusive environment for students with disabilities.

To achieve inclusive education for all, the following components are needed (*see* ***Figure 2***):

FIGURE 2

Five essential components to achieve inclusive education



Credits: UNICEF, Disability Section, 2017.

2.2 EDUCATION OF CHILDREN WITH DISABILITIES

Learners with disabilities face multiple barriers and challenges related to accessing education. A UNESCO analysis of data from 49 countries suggests that children with disabilities are more likely to be out of school, drop out of school and have fewer years of education, and are less likely to complete primary or secondary education and possess basic literacy skills (UNESCO, 2018). Parents and teachers often see no point in educating a child with a disability and, as a result, a disproportionate number of children with disabilities are believed to be out of school. If a learner with a disability is enrolled in school, teachers are likely unprepared to effectively educate him/her or other learners with different learning styles. In addition, learners with disabilities lack the materials, accommodations and devices that are needed to allow them to reach their full academic potential. For example:

- Only 1–2 per cent of students who are deaf in low- and middle-income countries have access to education in sign language, resulting in high percentages of illiteracy rates (World Federation of the Deaf, 2017).

- Fewer than 10 per cent of children who are blind have access to formal education (International Council for Education of People with Visual Impairment [ICEVI], 2006).

- In many low- and middle-income countries, only 5–15 per cent of people who require assistive devices and technologies have access to them (World Health Organization [WHO], 2019).

- Many low- and middle-income countries do not recognize learning disabilities and, as a result, do not provide any classroom support (Hayes et al., 2018).

- Students with intellectual disabilities are often denied an education based on misperceptions concerning their ability to learn; when they are educated, they tend to be educated in segregated classrooms and are not provided equitable learning opportunities (Inclusion International, 2018).

The lack of quality education often results in students with disabilities remaining illiterate. Basic literacy and numeracy can transform the lives of all children and makes economic sense. For example, every year a child spends in school, his/her earnings increase by 10 per cent (Global Education First Initiative, 2015). Likewise, for children with disabilities, the return on investment in education is three times higher than for children without disabilities (Lamichhane, 2015). But even this figure underestimates the economic impact of additional schooling for children with disabilities. When children with disabilities attend school, they become more independent and earn more as adults, thus reducing the amount of time family members spend caring for them. In turn, family members can earn more money working.

Education also reduces the need for welfare costs and current and future dependence (UNICEF, 2012). Evidence shows that when children without disabilities are educated in inclusive settings, they have improved reading and math outcomes (Cosier, Causton-Theoharis and Theoharis, 2013). Students without disabilities who are educated in an inclusive education classroom are also more accepting of diversity and express a sense of belonging to their school culture (Shogren et al., 2015). In addition, students with and without disabilities educated in inclusive classrooms are more likely to establish friendships with each other as opposed to when students are educated in segregated classrooms (Bunch and Valeo, 2004; Abt Associates and Instituto Alana, 2016).

It is important to note that access to education does not mean access to quality inclusive education. For inclusion to be meaningful, students with disabilities must have access to the national curriculum and learning materials on an equitable basis as their peers without disabilities.[2] This includes basic literacy and numeracy learning materials as well as materials that promote the other key elements of the national curriculum. For many students with disabilities,

2 While recognizing the importance of establishing an inclusive national curriculum that is accessible to persons with disabilities, the Accessible Digital Textbooks initiative focuses on the development of accessible digital textbooks. Accessible digital textbooks are one of many elements that build the national curriculum. This focus should not be perceived as UNICEF not valuing the other elements of the curriculum, such as instructional content, assessments and extra-curricular activities, but aims instead to highlight in a dedicated document the need for accessible leaning materials.

accessing information requires materials or textbooks to be placed in a specialized format (e.g., Braille, large print or digital text). Frequently, the content of these materials also needs adaptation to address the individual learning styles of different students with disabilities (National Center on Accessible Educational Materials, 2018). Technology is often an effective intermediary to help make access to information possible. *(See Annex A for frameworks that support inclusive education and the development of accessible materials and formats.)*

2.3 UNIVERSAL DESIGN FOR LEARNING

Universal Design for Learning is an educational framework recognizing that all children learn differently and benefit from differentiated learning techniques in the classroom. Essentially, UDL uses practices, space, and materials that engage all of the learning strengths mentioned above. UDL seeks to accommodate individual learning differences and styles by developing and making use of flexible learning environments. Such approaches particularly accommodate children with different types of disabilities and facilitate their inclusion in the classroom.

Moving away from the 'one-size-fits-all' approach to learning improves learning outcomes for all children, including those with and without disabilities, and improves students' motivation to learn. UDL follows three core principles, as showed in Figure 3: Universal Design for Learning:

1. Provide multiple means of representation.

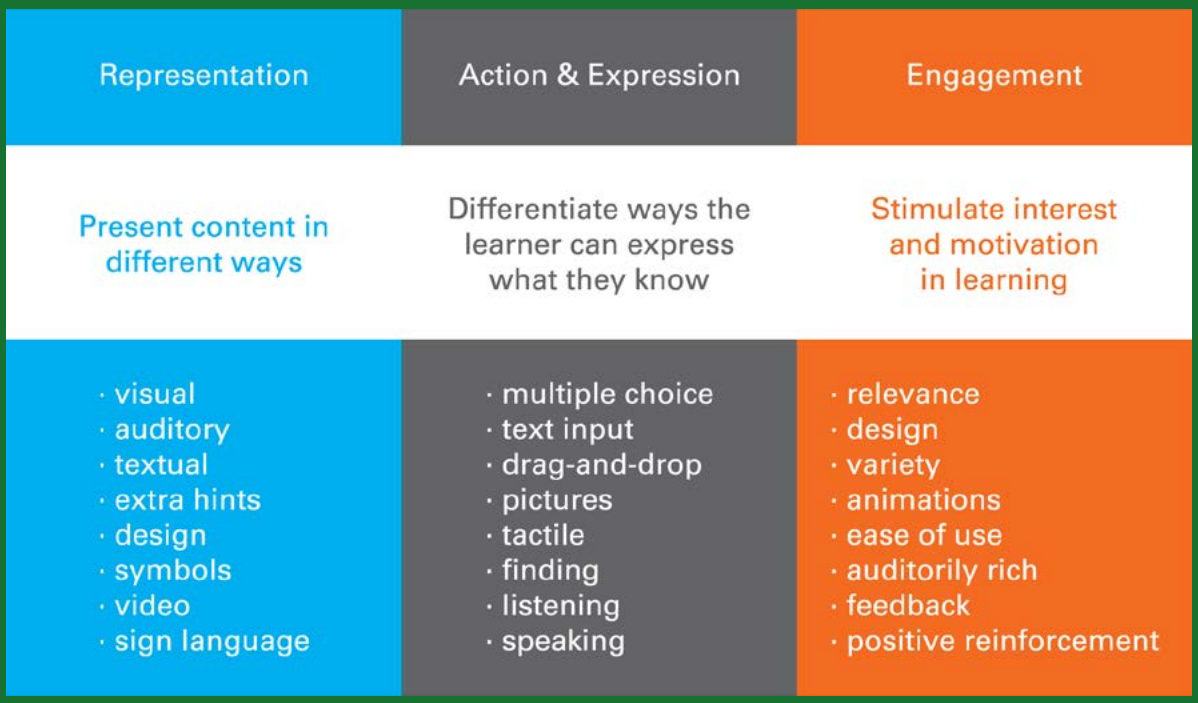
This signifies that children perceive and comprehend information differently. For example, some children learn better by having access to visual aids while other children may require auditory reinforcement. Multiple means of representation allow for students to learn using different options for perception, language and symbols, and comprehension. This would include, for instance, providing videos with captioning or audio transcriptions, allowing learners who are deaf and/or have language processing disorders to access the information provided in videos.

2. Provide multiple means of action and expression

Students express learned information in different ways. As stated by the National Center on Universal Design for Learning, "It should also be recognized that action and expression require a great deal of strategy, practice, and organization, and this is another area in which learners can differ. In reality, there is not one means of action and expression that will be optimal for all learners; providing options for action and expression is essential" (CAST, 2018).

FIGURE 3

Universal Design for Learning



Credits: UNICEF, Disability Section, 2018.

3. Provide multiple means of engagement.

Learners are motivated and engaged in learning in different ways. This principle encourages students to explore individual interests or learning methods. For some, this might be watching instructional videos, while for others, this might be doing interactive exercises to demonstrate knowledge. Developing textbooks that allow multiple means of engagement supports the learning of all children.

Research has found that using UDL in the classroom improves all students' progress in the areas of literacy, math and science (Rao, Ok and Bryant, 2014). For UDL to be most effective, it requires accessible spaces, accessible teaching techniques and accessible materials (Rose et al., 2012). Achieving any of these three components continues to be a challenge for many low- and middle-income countries.

UNICEF and its partners are committed to addressing all three challenges to promote equitable learning opportunities for learners with disabilities. This document is a first but important step to help educational systems move towards providing more accessible learning materials. For more information on UDL, see UNICEF's Booklet 11 on UDL.

Box 2: Different learning styles

Accessible digital textbooks can help address the issue of accessible learning materials, which is one of many elements needed to promote an inclusive learning environment for students with disabilities. The 'one-size-fits-all' approach to education fails to recognize the various learning styles that benefit different learners, including those with disabilities. As a result, teaching methods tend to address only one or two learning styles, often leaving the other students frustrated, less engaged and less motivated to learn. Providing differentiated learning, and/or providing instruction and materials that meet different learning styles, can help improve learning outcomes. There are, at least, four learning styles (VARK, 2019), although students often prefer a mix of two or more *(see Figure 4)*:

- **Visual**: Learners prefer information presented visually, such as maps, charts and sign language.
- **Auditory/aural**: Learners prefer to receive information that is heard or spoken, such as lectures, audiobooks, music and group discussions.
- **Reading/writing**: Learners prefer to read books or e-readers and write information in essays or written assignments.
- **Kinesthetic/tactile**: Learners prefer to obtain information through experience and practice, such as simulations and interactive games.

Different learning styles addressed in accessible digital textbooks

Students are more motivated to learn when presented information in a way that builds on their strengths and responds to their individual learning styles. Because they often have limitations in one or more areas of functioning, students with disabilities are at a particular disadvantage when instruction and materials are presented in only one format. For example, learners who are blind or have low vision tend to be auditory or kinesthetic/tactile learners (Zebehazy and Lawson, 2017). Learners who are deaf or hard of hearing tend to benefit from visual strategies and a rich visual and tactile environment (Luckner, Bowen and Carter, 2001). However, it is important to stress that many factors influence students' compensatory skills, and learners with intellectual disabilities, developmental disabilities and/or various learning challenges will have a mix of visual, auditory and kinesthetics/tactile learning styles.

FIGURE 4

Source: Adapted from VARK website, 2019.

CHAPTER 3

How to produce accessible content and technology for textbooks

As discussed in this document, textbooks are a key tool for introducing and providing content for learners. As countries look to provide digital textbooks in the classroom, they must make textbooks fully accessible to all students. Learning materials are accessible if they are:

1. Written in a way that provides **accessible content**: The content has been adapted to answer the learning needs of different types of learners, including adapting the exercises to allow learners to understand the instructions and be able to answer them.

2. **Technologically accessible**: The technology is the tool that, if accessible, allows learners to access the textbooks' content. Therefore, interaction occurs between both the content and the technology.

For example, a learner who is deaf benefits from having a sign language video in his/her mother tongue alongside the written content in the textbook. In this case, the 'accessible content' is the sign language narration and the accessible technology is the capability of viewing a video inside the digital textbook.

This section provides the requisite framework for accessible digital textbooks; an overview of the technological functions and how to adapt content when developing accessible digital textbooks; and key information on how to develop textbooks with accessible content that takes advantage of technology to promote learning.

3.1 REQUISITE FRAMEWORK FOR ACCESSIBLE DIGITAL TEXTBOOKS

Accessible digital textbooks can be a valuable tool to promote learning for all children, especially for those with additional learning needs. However, it is important to consider the framework and environment needed for accessible digital textbooks to make the most impact. The following points highlight the framework in which accessible digital textbooks should ideally operate.

- **Accessible digital textbooks are a supplement, not a replacement, to the role of the teacher in the classroom.** The role of the teacher as the primary means of instruction is essential even when learners have accessible digital textbooks. Teachers should be educated to recognize different learning styles and to modify the accessible digital textbook appropriately and individually (fit-for-user). Many teachers may require education and support on the technology to best use the different features within an accessible digital textbook. (*See Annex B for additional practical suggestions for adapting content.*)

- **Accessible digital textbooks are one of many components within an effective and inclusive educational system.** Access to quality learning materials does not negate the need to provide access to Braille materials for students who are blind, access to qualified instructors fluent in local sign language for students who are deaf, nor the need to adapt curriculum and content for all students, including those with intellectual disabilities. An effective and inclusive educational system with appropriate policies, classroom supports and accommodations is needed for accessible digital textbooks to be most effective.

- **Accessible digital textbooks should be used as part of a broader framework that provides inclusive education.** The use of digital textbooks should adhere to the standards set forth in the CRPD. Thus, accessible digital textbooks should not be used to reinforce segregation, nor should access to accessible digital textbooks serve as justification for not providing inclusive education to children with disabilities.

- **Government and other key stakeholder commitments are essential for accessible digital textbooks to be effective.** All digital textbooks can and should be made accessible, thus eliminating the procurement of non-accessible digital textbooks. However, for this to take effect, governments and other stakeholders must commit to the development and procurement of accessible digital textbooks. Likewise, governments must have the means or plans for students to access digital textbooks on affordable tablets or other technology and ensure that the books are distributed and used by the children at a district or local level.

3.2 DEVELOPING ACCESSIBLE CONTENT

Too often, when learning materials are designed, they only take into consideration a narrow proportion of the student population: those students who can access material without any limitations. This demands that content be retrofitted to ensure access, which requires a teacher to have a skill set that is generally not available in the schools of most low- and middle-income countries. Thus, all learning materials should be born accessible. In other words, using the concept and practices of UDL, all learning materials should be designed and developed in a way that is inherently accessible to all students.

General principles:

- **Provide clear objectives and summaries.** Learning objectives should be clearly stated at the beginning of each chapter. Summaries of key points at the end of the chapter should be used to reinforce learning.

- **Use clear and user-friendly language.** Simple and clear language should be used throughout the document. Technical language should be avoided as much as possible and, when used, the materials should provide a glossary of terms with images. Acronyms should also be avoided whenever possible.

- **Use consistent language throughout the text.** To help avoid confusion, consistent nouns should be used to describe objects. For example, the words 'room' and 'classroom' should not be used interchangeably. One variation of the word should be chosen and used consistently throughout the text.

- **Repeat content in a different way.** Without becoming redundant or dull, new concepts should be repeated several times. For example, the concept should be stated, information should be given on how to learn the concept, a conclusion should be provided, and then the concept should be restated. Graphics and images will reinforce the new learning concepts.

- **Use graphics, videos and diagrams with accompanying text.** Developing image-rich content, videos and interactive tools will help to teach content and test knowledge. Graphics alone should not be used to demonstrate a point, and all additional videos, images and interactive activities should be accompanied by text. Text accompanying graphics and images should: (1) consider the context and age group targeted; (2) be accurate and objective; (3) be succinct using as few words as possible; (4) not be redundant by providing the same information in the surrounding text; (5) use language appropriate for the age level; and (6) provide details that will support learning and exercises.

- **Use broad font.** When writing a document, broad fonts should be used (such as Ariel, Helvetica or Universal) rather than narrower fonts.

- **Use a uniform heading structure.** Headings should not appear in only different font sizes or formats as these may be changed by the user. A consistent heading structure is needed for navigation both visually by individuals who may quickly scan text as well as by eReaders or assistive technologies.

- **Provide hyperlinks.** Providing hyperlinks facilitates navigation and access to additional information when the internet is available. Links to websites should have: (1) descriptive link text that does not rely on the context from the surrounding text; (2) minimum text in the link; and (3) underlined text with a colour that stands out from the surrounding text.

- **Distinguish between sequential and unordered lists.** For sequential lists, numbers that are tabbed should be used to show the different sequential order. For non-sequential lists, bullet points should be used.

- **Separate numbers.** Numbers should be written using points, parentheses and commas as separators to avoid screen readers converting the numbers incorrectly.

- **Provide an overview if content uses text and graphics.** Flow charts or decision trees can be beneficial for students with learning disabilities, but graphics alone can be challenging for blind or low-vision students. Ideally, both text and graphics should be present to allow students with different learning styles access and for use as reinforcers.

- **Provide a glossary.** Key words or new terminology should be defined and placed in a glossary. This glossary should be linked to specific words so students can quickly access content. Ideally, these words should be provided aurally, in sign language and phonetically. Images and symbols should be included to help describe new words as much as possible.

- **Provide meaning for icons.** Icons should include a clear explanation of their meaning and appear in the glossary. Often, exercises in textbooks are not accessible to all students. For example, an exercise that asks a student to draw a line between an element and a colour cannot be done by a blind child, or an activity that has many steps can be difficult for a child with short-term memory difficulty. When adapting the content, teachers and publishers need to consider offering alternative exercises or creating exercises that are accessible for all.

Adapted exercises:

- **Provide extra hints.** Providing additional information and descriptions gives context to content. For example, furnishing more details when describing images will help learners answer the exercise questions; when adapting exercises, adding the details of the image description should also be considered.

- **Provide a consistent layout.** The layout of all exercises needs to be consistent. For example, all questions should be on one side of the screen and all possible answers on the other side.

- Give step-by-step instructions. When possible, exercises should be broken into single steps and should present a single piece of supporting material, such as a single question and the corresponding required answer. This contributes to preventing students from being overwhelmed by both information and interactive choices.

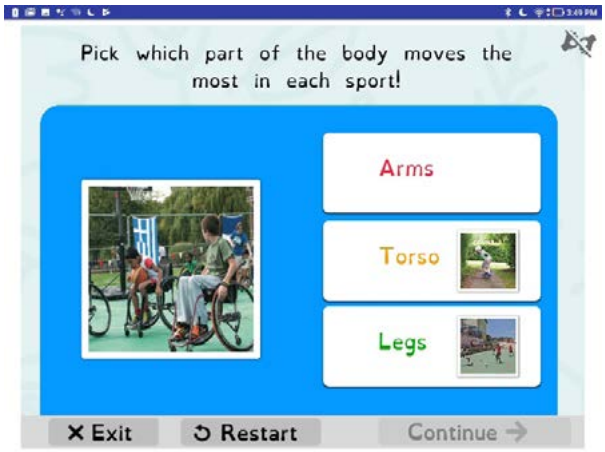
- **Give context for activities.** When possible, context for an activity should be provided by linking to the textbook concepts both before and after the activity and by showing images that support the purpose of the activity.

- **Use a variety of exercises.** Students should be able to demonstrate their understanding of content in different ways. For example, only allowing students to conduct sorting activities may exclude many students who are blind or have low vision, while listening activities may exclude students who are deaf or hard of hearing. Diverse options are ideal and allow different styles of learners to participate. Examples of activities that are best suited to adaptation for accessibility include:

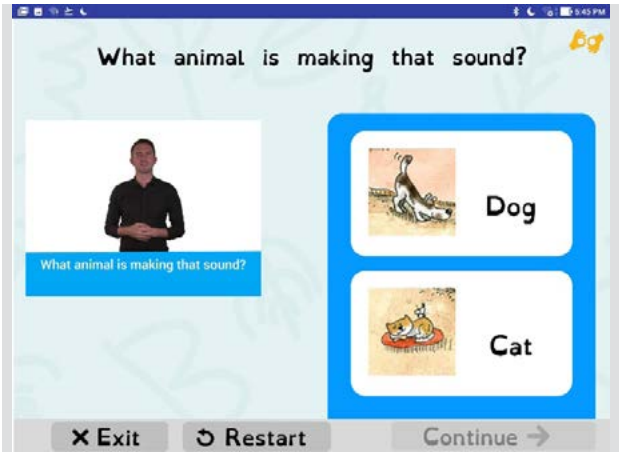
    - ***True or false:*** deciding if the statement is true of false (no other answer is possible)

    - ***Short answer:*** brief prompting that demands a written answer

    - ***Matching activities:*** pairing each of a set of stems (e.g., definitions) with one of the choices provided in the question

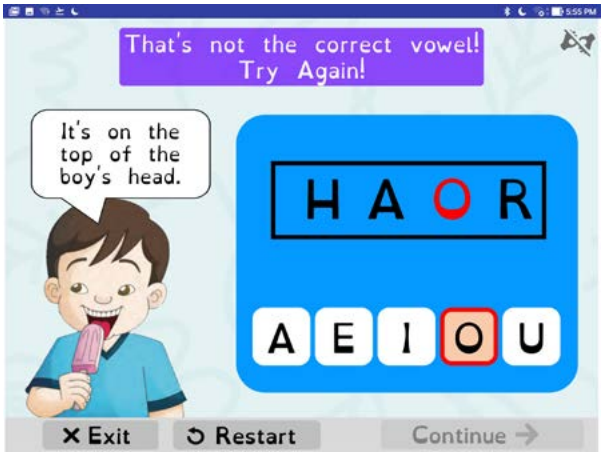


    - ***Listening activities:*** identifying a sound and matching it with an element in the image



- ***Sorting activities:*** putting each element or image into proposed (or selected) categories

- ***Spelling activities:*** completing the word by choosing between proposed letters



- ***Memory activities:*** finding a pair of images among the different proposed images

3.3 DEVELOPING ACCESSIBLE TECHNOLOGY

A textbook developed following a UDL approach, in accordance with and building upon open technical standards, will provide features that may increase the efficacy of the underlying material for more people in a wider range of learning situations. Accessible formats are versatile by definition, and users can customize and combine such features as audio narration, highlighted text, sign language video, font type and size, background contrast, line spacing, illustrations, animations and other features to suit different access needs or preferences. These format-specific features can be combined with device- or operating-system-specific features, like text-to-speech, magnification, interaction controls, etc., to create a highly flexible and optimized learning experience for the user. No assumptions are made regarding the needs of a specific type of disability; instead the user can choose the best way to learn. It enhances utilization and learning for all children and, because of the flexible features, may facilitate the learning experience.

All the functions available in the digital authoring and reading tool are independent but synchronized. Therefore, the user can create a profile with his/her preferences, and the personalized settings are automatically installed when content is uploaded in the software. This facilitates learning, especially in a situation when a tablet or other digital support is shared by students in the classroom. The following are examples of features that should be included as part of accessible technologies:

- **A title for activities to facilitate navigation.** Though not compulsory, a title page introducing the core activity (i.e., naming the sorting activity) with a description helps learners understand the division between text and interactive activities and, therefore, alerts them that a digital interaction experience may begin.

- **Synchronized sign language videos.** Access to videos with local sign language, preferably with narration provided by a deaf teacher, is important. Videos should have subtitles based on sign language interpretation and not the text. A sign language teacher or narrator who is fluent or a native deaf signer should be dressed in either black or white, depending on the colour of their skin, for contrast between their hands and clothing. The person should also avoid wearing too much jewellery and should wear long sleeves. The background should be black, blue or green.

- **Text highlighting.** Highlighting the text (sentence or paragraph) helps to indicate or emphasize the text. It should be synchronized with the audio track.

- **Interactivity capability.** Interactivity for exercises should be provided if the activity is not accessible to all learning styles.

- **Additional text or features for complex concepts.** Additional explanations or examples using technology features (through sign language video, symbols, simple text or video, conceptual maps, timelines, etc.) should be provided if the text is complex.

- **Multiple labelling techniques (for example, using colours or symbols).** Consistent coding should be used for informing and highlighting important words/concepts/titles to attract the user's attention. Coding also helps users navigate within

the textbook. For example, different colours should be used to distinguish between titles and exercises.

- **Audio description.** Audio recordings of all text should be in human voices and local languages and accents. Male and female voices should be used intermittently to create a gender balance.
- **Multiple sounds.** Navigation, identification and confirmation should have distinct tones or sounds (i.e., different tones or sounds when answers are provided correctly or incorrectly). Clear quality sounds that are well-known to users of that culture should be provided.
- **Illustrations and symbols to differentiate and discriminate content and activities.** Illustrations and photos should be used that facilitate browsing and support understanding words/concepts/titles.

User requirement matrix

User requirements were developed to specify the different types of technology needed to make digital textbooks accessible and to enhance users' learning experience in a manner equitable for all *(see Annex C for the full user requirement matrix developed as part of this process)*. While the features required to accommodate a specific type of user are listed under one disability area in the user requirement matrix, often several functions serve equally for different types of disabilities. Thus, producing adaptations of textbooks with a multidisciplinary technical team *(see Chapter 4)* is necessary to avoid duplication and to be cost effective. The matrix shows functionalities per disability that can be incorporated into accessible digital textbooks.

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3.4 ECOSYSTEMS FOR PRODUCING ACCESSIBLE DIGITAL TEXTBOOKS

Ensuring that students with disabilities have the required accessibility tools and quality accessible digital textbooks is a unique challenge. Leveraging the existing textbook ecosystem is likely to achieve better outcomes in the short term than seeking to create a new independent ecosystem. To ensure sustainability, existing textbook procurement mechanisms should be expanded to include accessible digital textbooks following the mainstream curriculum. This requires policymakers, mainly the MOE, to raise the awareness of publishers by implementing policy measures that incentivize them and to build publishers' capacity to produce and publish born-accessible digital textbooks.

The publisher, whether a government, a single independent publisher who has won a tender or several competing publishers, is an essential and central player. Publishers must follow the curriculum requirements provided by the MOE and create the content of the learning materials to ensure that it is approved, validated and/or adopted by the MOE. Also, publishers oversee the production of accessible content with authors/teachers, the printing processes and, occasionally, distribution. Publishers must collaborate on accessible digital textbooks with technologists and designers to produce and incorporate accessible functions and formats. When publishers do not have the in-house capacity to provide the accessible content because of a lack of resources or knowledge, they can outsource the services to experts usually provided by local OPD, government agencies or specialized companies. ***Figure 5*** shows the possible roles of stakeholders in the development of accessible digital textbooks.

A strong relationship needs to be formed between the users, teachers and publishers to make sure the tools meet the needs well. Feedback, maintained by communication channels, will inform the publishers about users' needs and the usability and quality of the accessible digital textbooks. Prior to using the accessible digital textbooks in the classroom, teachers will be trained by the MOE with the support of UNICEF and local OPD.

UNICEF will address the right of learners with disabilities to learning opportunities through inclusive, quality education and accessible information.

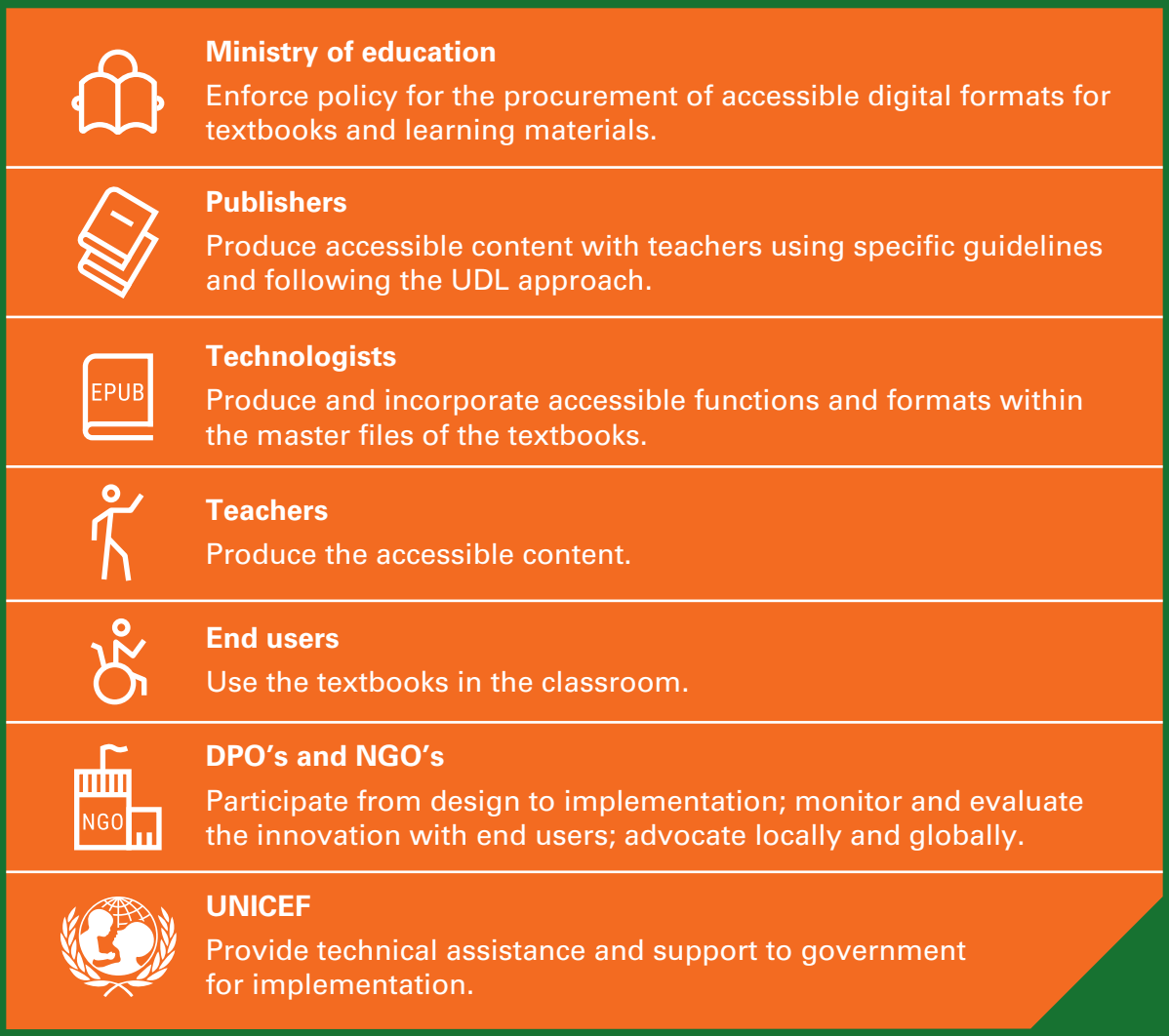
UNICEF's convening role in the development of accessible digital textbooks includes:

1. Partnerships and engagement: UNICEF partners with key stakeholders and donors in the private and public sectors at the country and global levels to develop and implement the Accessible Digital Textbooks for All initiative. Our partnerships seek to increase the adoption of accessible digital textbooks in the global book chain and boost funding while building trust, motivation and skills to make informed decisions and take appropriate actions towards implementing the initiative at a country level. UNICEF also aims to engage children with disabilities, communities, teachers, parents and caregivers in the whole process.

2. Evidence and use: To intensify the production of accessible digital textbooks using UDL principles, UNICEF is working with key stakeholders to pilot the initiative in five countries and to validate the guidelines and standards that will eventually be adopted and used by all stakeholders involved in the book chain.

FIGURE 5

Roles of stakeholders in developing accessible digital textbooks



Credits: UNICEF, Disability Section, 2018.

3. Innovations: UNICEF supports the development of quality accessible digital textbooks, including applying UDL principles to the latest accessible publishing technology to increase the books' demand and supply.

4. Knowledge sharing: Accessible to all key stakeholders, UNICEF's global portal on the Accessible Digital Textbooks initiative encourages MOEs, donors and publishers to commit to making accessible digital textbooks available to learners with disabilities. It allows sharing knowledge, products and models with other countries, including facilitating south-south cooperation.

5. Advocacy: UNICEF is negotiating and advocating for the inclusion of all accessible adaptations of textbooks and learning materials from the curriculum, covered by copyright agreements to ensure access for all, as part of the accessible digital textbooks initiative with implementing countries.

6. Policy: UNICEF supports the development of policies to ensure accessible digital textbooks and learning tools are available nationally to guarantee that learners with disabilities are using these textbooks and that learning outcomes are measured.

7. **Capacity development:** UNICEF supports training to improve the capacity of publishers, authors, curriculum developers, teachers, learners, parents and caregivers as well as other stakeholders to produce and use accessible digital textbooks using UDL principles.

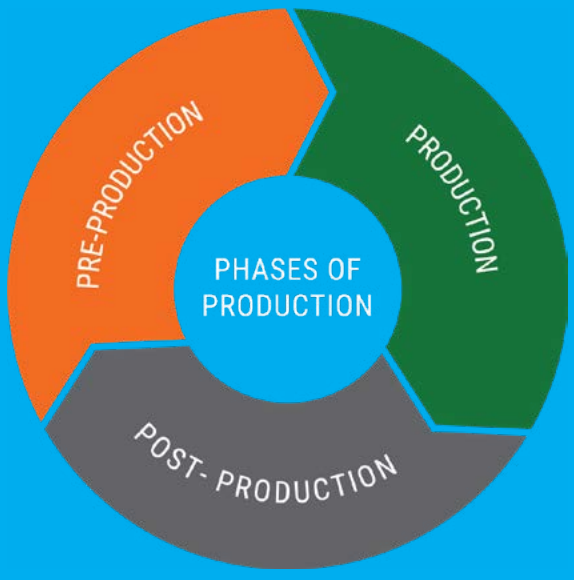
CHAPTER 4

Methodology to pilot the Accessible Digital Textbooks initiative at the country level

UNICEF and its partners have developed steps to produce, test and validate the piloting of the accessible digital textbooks at the county level. The textbooks must be managed under the educational system and produced jointly with a multidisciplinary technical team, collaborating with teachers, experts, technologists, publishers, authors and, as always, users with disabilities and OPD. To help countries produce materials, UNICEF and its partners propose a three-phased, step-by-step method: (1) pre-production; (2) production; and (3) post-production. This chapter offers an overview and guidance on how to administer the phases to reach the goal of developing accessible digital textbooks. ***Figure 6*** shows the production phases of accessible digital textbooks.

FIGURE 6

Phases of production



Source: UNICEF, Disability Section, 2018.

4.1 PRE-PRODUCTION PHASE

The pre-production phase includes initial implementation steps to build local capacity in a country. All stages are needed, but the sequencing of the following actions is optional:

1. **Understand the needs of the country in terms of accessibility to learning materials and inclusive education**: Identifying the country preparation and configuration prior to testing the initiative can be done through the Country Readiness Questionnaire (Annex G). This questionnaire seeks to help the country gather information that will support the implementation of accessible digital textbooks. It is divided into three areas that explore a macro analysis of the ecosystem, the production of accessible digital textbooks and in-school factors. The analysis is concluded with the list of identified gaps and the solutions to mitigate.

2. Identify key stakeholders and establish a mechanism such as a steering committee. Identifying and mapping which OPD, NGOs, UNICEF representatives, donors and MOE representatives should be engaged throughout the process is key. A mechanism such as a steering committee should be formed to move the initiative forward in the country and an initial meeting held to explain the purpose, benefits and challenges of the initiative as well as to define roles and responsibilities/accountabilities. Key publishers and local academia should also be engaged in this early process if feasible. In addition, local users, such as students with and without disabilities, teachers and parents of children with and without disabilities should be identified and engaged. The steering committee should also include OPD members that represent different categories of disabilities. In addition, it is important to identify local providers/technologists who can convert the master copies of the textbook into an accessible format such as DAISY/EPUB 3.

3. Begin planning and coordinating the pilot. An initial step is to bring together key stakeholders involved in designing and procuring accessible digital textbooks. The available technical and financial resources within the country and how to leverage and use them must be discussed. Discussions should also include how to access technology/devices for students (e.g., tablets, computers, mobile phones) if they are not already available. Understanding the capacity of a multidisciplinary country team, led by the MOE with support from the UNICEF country office, to develop an accessible digital textbook should include a conceptual and technological needs assessment to better determine what gaps and opportunities exist in the country. The methodology and technical gaps to be filled (training, workshops, capacity-building, support, discussions, etc.) must be defined using the country's education sector plans, if available.

4. Establish a core technical team from members of the agreed coordinating mechanism)such as the steering committee). Recruiting local professionals and specialized teachers to serve on a multidisciplinary technical team is critical. This core team needs to encompass persons with disabilities with diverse experiences, including expertise related to children, teaching/learning, pedagogy and learning styles. Different types of teachers (e.g., general education teachers, special education teachers, linguistic experts, and learning and assessment experts, where available) should be engaged in this technical team. This team should work together with OPD to provide support and advocacy initiatives for persons with disabilities. The team should also include the technology developers to understand the capacity and limitation of the current technology. This technical team could be charged with adapting the content of the textbooks, produce the accessible formats, and be part of the validation process.

The multidisciplinary team should be trained on the topics and materials to be adapted; be neutral regarding the content; respect the script and the experts' opinions; work together with disability communities; and have open dialogue and exchange. It is recommended that each member of the team agree on the schedule, budget, needs, expected results, and intermediate and final product deliverables, as well as on the quality, specifications and content. The primary roles and functions of the multidisciplinary team are to:

- Plan the project's stages, activities and timelines;
- Organize operational, technical and financial resources;
- Convene the technical production team;
- Lead and execute the project until the final product is achieved;
- Make sure the materials produced are properly validated by the local disability community and users;
- Articulate actions for the technical/production team;
- Communicate the progress with the steering committee; and
- Guarantee the product's implementation as public policy.

5. Agree on the UDL principles. Each member of the multidisciplinary team should acknowledge the guidelines and, when necessary, be trained on the premises of the UDL principles to facilitate the comprehension of the fundamentals: from disability-specific to inclusive/universal design principles.

6. Define and analyse the technology ecosystem. The team should examine and understand the production infrastructure within publishers and governing bodies, to determine if they have the capacity to produce accessible digital textbooks and to establish if the existing EPUB technology infrastructure is prepared to handle the depth of requirements for universal textbooks.

Recommended composition of the core technical team:

- MOE representatives
- Team coordinator
- Multidisciplinary technical experts/teachers per category of disability
- Technology specialists
- Linguists
- A DAISY/EPUB 3 technology specialist
- Learning and assessment specialists
- Publishers and authors
- Users with disabilities
- Audiovisual producer, designer, sound engineer and editing experts

7. Select textbooks from the curriculum. Though it would be ideal for all textbooks within the curriculum to be accessible to learners with disabilities, it may be best while initiating the first phases of the project to select a few textbooks and provide those in an accessible digital format in order to test them within the classroom setting.

8. Select pilot schools. Before scaling the project nationally, piloting the initiative in at least five schools is recommended. Inclusive schools, if they exist in the country, should be selected as part of the pilot initiative only if the teacher is fluent in sign language to guide and respond to the students' needs. If the country has yet to establish a fully inclusive educational system or is in the process of doing so, it is recommended to include schools with a varied student population, including students with different types of disabilities.

9. Organize an inception workshop. A workshop with the core technical team is recommended to review how to produce content for accessible digital textbooks and to agree on what adaptations should be made for the selected textbook following UDL principles. Participants should also start creating the accessible activities together to understand UDL and how UDL concepts relate to technology. If needed, external experts should be involved to educate the core team about inclusive education and UDL and how these principles can be integrated into accessible digital textbooks.

10. Validate the process. Before entering in the production phase, the process should be validated by the MOE and stakeholders, as well as by representatives of the disability groups.

4.2 PRODUCTION PHASE

The production phase includes developing and adapting the prototype. In most cases, publishers do not have the original files of materials in accessible formats. Therefore, the first step is to transform the materials delivered by the publisher into a format that can be adapted and sent back to the publisher for distribution, e.g., in EPUB 3 format.

Public policies can encourage publishers to make their books born accessible. Throughout this phase, it is important to negotiate with and offer training to publishers to generate a cultural change and promote the use of UDL as a fundamental part of accessible digital textbooks.

Producing adaptations in different media is extensive and delicate work because it requires expertise, resources, quality content and knowledge at all stages (*see Annexes D, E and F for more technical guidance*). The recommended step-by-step approach is as follows:

1. **Develop a storyboard.** A collaborative meeting with the multidisciplinary team should be held to adapt the textbook content. The book should be analysed to define, chapter by chapter, what accommodations are needed. For example, agreement is needed on where to add a video with sign language next to an exercise, or where to add interactivity for an exercise.

2. Establish technical needs. Once all accommodations have been detailed in a flow chart for the entire book, the technical resources outlined to produce the accommodations should be defined. For example, to produce the sign language videos, the team should define the length of each video, the narrators' scripts, the quality of the images, the translation of the texts, the production company/consultants, the editors, etc.

3. Identify the technical teams producing each accommodation. This step entails identifying who will coordinate, create, produce and manage the content for each accommodation.

4. Start production. The different accommodations/media for the textbook should be produced, such as filming the sign language videos, recording the narration and audio descriptions, etc. Every step of production should be coordinated by an expert and developed by the members of the technical team following production guidance or international standards.

5. Validate the content. Before the post-production phase, all content materials should be validated by publishers, teachers, OPD and persons with disabilities.

4.3 POST-PRODUCTION PHASE

This phase includes creating the 'production master files', as well as 'translating' these files into the different accessible formats. It also includes defining the conditions for quality control and final production of the materials. The recommended steps are the following:

1. Edit the accessible content. The publisher participates in the organization and design of the material and in putting together the final pieces (illustrations, text, videos, audio, etc.). The publisher will then deliver the final product to the coordinator. Content editing and adaptation at this stage should be performed by and with professionals who have specific knowledge in the fields of special education, in pedagogy and/or in the specific field of study covered by the material. Technical knowledge related to accessibility is part of the process; curriculum content analysis must also be considered, as well as the competencies targeted by each adaptation. In some cases, local or regional academics and teachers/experts can be involved; in other cases, international experts can be referred by partners or UNICEF for support.

2. Design the accessible features. The different productions should be compiled and sent to a web designer/technical expert to design the textbook, including the different media/adaptations in the EPUB 3 document. Support from UNICEF Headquarters and/or south-south cooperation with previous implementing countries that have developed this capacity should be determined.

3. Proof the final features. All content should be edited and checked for accuracy.

4. Produce a master file. The digital source file will be adapted as necessary to create what is called the 'production EPUB 3 master file', or the basis from which textbooks will be produced in the various accessible formats. This text file will be linearized and ordered according to pedagogy and following the guidance criteria. The various graphic elements will also be identified and adapted before being transferred to the publisher.

5. Agree upon textbook design with experts and users. This very important step in the post-production phase determines if the requirements of the accessible digital textbooks have been met. The validation should be performed by textbook users (students, parents and teachers) in various contexts (for different disabilities, in diverse schools and environments, etc.).

6. Test and validate. Multiple testing sessions should be planned with different groups of users using standardized methodology. The methodology and the final version of the accessible digital textbook should be validated with MOEs, publishers, technologists, OPD, teachers and users.[3] In some cases where resources and technical expertise are limited, regional or international experts and/or partners can be involved with the support of UNICEF.

7. Distribute and maintain the digital textbook in the devices. Depending on the local distribution channel, the accessible digital textbook will be distributed to schools and users. MOEs, publishers, and users must have a means of communicating to track challenges and validate quality control. This implies, for example, having a

3 UNICEF is validating the pilot process of this initiative in several countries, which will be evaluated by external stakeholders. The findings from this process will be integrated into future editions of this document.

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person in the field with the expertise to maintain the technology who can communicate with the MOE, publishers or partners on challenges for users. Another communication channel can be through a messaging app where the teachers can inform the publishers, partners and MOE about the challenges for the students or themselves.

8. Create a user guide. For the user to understand how to use the tool (textbook), the step-by-step process should be documented and the open-source document shared with the users, partners, stakeholders, publishers, etc. A tutorial embedded into the textbook is recommended, as are accessible webinars or training materials.

9. Document the process. Keeping track of the necessary steps, challenges, gaps, learnings, results and outcomes is recommended, not only for reporting reasons, but also to share with the community and stakeholders involved in the innovation. The progress will inform future countries when they implement the initiative.

Conclusion

The **emerging lessons** in this document are intended to guide and support MOEs, publishers, technology and content developers, teachers and implementers in the piloting of the Accessible Digital Textbooks for All initiative. This document reflects the innovative progress made so far by UNICEF and its partners to make accessible digital textbooks that allow children with disabilities to learn using combined accessible features like narration, sign language, interactivity, simplified language, audio description of images, and other functions to access the same content and participate in the same textbook-based activities inside and outside the classroomas their peers.

UNICEF is currently piloting the Accessible Digital Textbooks for All Initiative in Kenya, Nicaragua, Paraguay, Rwanda, Uganda and Uruguay. The findings from those pilots will strengthen this evolving area of work and feed into the lessons learned to inform future implementing countries, building on knowledge sharing and south-south cooperation.

Initial experiences show tremendous potential for expansion to address a major learning barrier, as well as to improve the quality of learning for all children, improve the quality of teaching, address stigma and discrimination, and generate new local service providers capable of producing universally designed digital learning materials, which are the future of learning and an absolute imperative to ensure inclusive and equitable learning for all.

Glossary

Accessibility	Persons with disabilities accessing, on an equal basis with others, the physical environment, transportation, information and communication, including information and communications technologies and systems, and other facilities and services open or provided to the public, both in urban and in rural areas (United Nations, 2006).
Accessible digital textbook	A digital tool that allows all learners, including those with disabilities, to access information in alternative accessible formats, letting children with different learning styles to access the same content, participate in the same textbook-based activities inside and outside the classroom, and have the same opportunities to achieve positive educational outcomes as their peers. Accessible digital textbooks are an adapted version of the curriculum-based textbooks used in classrooms. They differ by being digital, accessible and versatile, allowing users to customize and combine diverse features like narration, sign language, interactivity, the audio description of images and other functions, to suit different preferences, learning styles or access needs. The textbook requires installation on an electronic device (tablet, computer, smartphone) or, in some case, it can be downloaded from a source and installed using an internet connection. Once installed, the learner can use the textbook offline on the device.
Accessible formats	Information available to people with different types of disabilities, including displays of text in Braille; tactile communication; large print; accessible multimedia; written content; audio materials; plain language, human-reader and augmentative and alternative modes, means and formats of communication, including accessible information and communication technology (United Nations, 2006).

Disability	Long-term impairments that affect the functioning of a person and that in interaction with attitudinal and environmental barriers hinder the person's full and effective participation in society on an equal basis with others (United Nations, 2006).
EPUB	An e-book file format that uses the '.epub' file extension; the term is short for 'electronic publication' and is sometimes styled 'ePub'. The format is supported by many e-readers, and compatible software is available for most smartphones, tablets and computers. It is a technical standard published by the International Digital Publishing Forum, and became an official standard of that organization in September 2007, superseding the older Open eBook standard (source: <www.w3.org/publishing/groups/epub3-cg>).
Inclusion	A process that aims to ensure that the most vulnerable people are taken into account equally and that they participate in and benefit from development and humanitarian programmes.
Inclusive education	An approach that ensures that barriers to participation and learning are removed and that teaching methodologies and curricula are accessible and appropriate for students with disabilities. All individuals are welcomed and supported to make progress and their individual requirements are addressed (INEE, 2010).
Organizations of persons with disabilities (OPD), also known as Disabled People's Organizations	Organizations of persons with disabilities and/or their representatives, including self-help groups, federations, networks and associations of parents of children with disabilities. An organization is considered an OPD if a majority of its board and members are persons with disabilities (PWDA, 2018).

Persons with disabilities (children, adolescents and adults)	Persons who have long-term physical, mental, intellectual or sensory impairments that in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others (United Nations, 2006).
Universal design	The design of products, environments, programmes and services usable by all people, to the greatest extent possible, without the need for adaptation or specialized design; this does not exclude assistive devices for particular groups of persons with disabilities where needed (United Nations, 2006).
Universal Design for Learning	An educational framework recognizing that all children learn differently and benefit from differentiated learning techniques in the classroom, using practices, space and materials that engage all the learning strengths. It seeks to accommodate individual learning differences and styles by developing and making use of flexible learning environments. Such approaches particularly accommodate children with different types of disabilities and facilitate their inclusion in the classroom.

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ANNEX A: INCLUSIVE EDUCATION POLICIES AND FRAMEWORKS

Several international policies and frameworks exist that support the development of accessible materials and textbooks to assist in the education of children with disabilities. These policies and frameworks include:

- **Salamanca Framework for Action on Special Needs Education.** Adopted in 1994, the framework promotes the education of children with disabilities and recommends that curricula content be adapted to the needs of children with disabilities and accommodate child-centred pedagogy (see <www.unesco.org/education/pdf/SALAMA_E.PDF> for more information).

- **United Nations Convention on the Rights of Persons with Disabilities (CRPD).** Adopted in 2006, Article 24 of the CRPD recognizes the right of persons with disabilities to education. Also, it states that persons with disabilities must receive the support required within the general educational system to facilitate their effective education, and that individualized support measures must provide maximized academic and social development. This includes access to alternative scripts and to augmentative and alternative modes, means and formats of communication, as well as facilitating the learning of sign language (see <www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities.html>, and refer to the CRPD Committee 'General comment No. 4 on the right to inclusive education', available at <http://tbinternet.ohchr.org/_layouts/treatybodyexternal/Download.aspx?symbolno=CRPD/C/GC/4&Lang=en>, for more information on how Article 24 can be applied by governments).

- **Marrakesh Treaty to Facilitate Access to Published Works for Persons Who Are Blind, Visually Impaired, or Otherwise Print Disabled.** The Treaty introduces a "standard set of limitations and exceptions to copyright rules in order to permit reproduction, distribution and making available of published works" in accessible formats for persons who are blind or have low vision or are otherwise print disabled (World Intellectual Property Organization [WIPO], 2017). The Treaty was signed in Marrakesh on 27 June 2013 and came into force on 30 September 2016. It creates significant opportunities for the production and exchange of accessible reading materials. The legal framework promoted by this Treaty will allow agencies producing accessible materials in different countries to share and exchange their files, which will expand the availability of materials and encourage greater and better use of existing resources (see <www.wipo.int/treaties/en/ip/marrakesh> for more information).

- **Sustainable Development Goals (SDGs).** Goal 4 on quality education works to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" by 2030. This objective includes several targets and indicators that also promote the education of children with disabilities. ***Figure A.1*** shows how accessible infrastructure and adapted learning materials are critical indicators within this SDG (see <https://sustainabledevelopment.un.org/?menu=1300> for more information).

FIGURE A.1

SDG 4: Inclusive and equitable quality education for all

Source: Developed by UNICEF, Disability Section, 2017.

As recommended in the above international legal instruments and policy frameworks, the Accessible Digital Textbooks initiative offers an innovative solution for students with disabilities to overcome some of the barriers to accessing inclusive and quality education.

ANNEX B: ADDITIONAL CLASSROOM/CONTENT MODIFICATIONS FOR LEARNERS WITH DISABILITIES

Classroom/content modification for students who are blind or have low vision

Blind or low-vision students tend to be auditory and/or tactile learners who benefit from methods and instructional approaches that support these styles of learning. Accessing information through traditional print materials without modifications or adaptations can be challenging for many students with low vision and relatively impossible for students who are blind. For blind students, accessing text signifies obtaining materials in Braille. Other students with vision-related challenges may benefit from accessing audiobooks as well as having text in large print (i.e., font size of 18 points or larger). In addition to gaining access to these adapted materials, suggestions on how classroom instruction can be modified to include blind or low-vision students include:

- Allowing students to provide written descriptions instead of visual representations. For example, instead of drawing a picture, allowing the students to provide a written description with a Braille reader to the teacher;
- Reducing the need to copy information. For example, if the teacher provides information on the chalkboard and asks students to write down the problem, providing the information either in Braille or electronically to students who are blind so they can work on the problem;
- Allowing students to use manipulatives (physical objects used as teaching tools) to demonstrate their understanding of a topic;
- Permitting exams to be taken orally and students to respond to test questions verbally;
- Only speaking when facing the student(s); and
- Describing any pictures in a book in as much detail as possible.

Classroom/content modification for students who are deaf or hard of hearing

Deaf students are usually visual learners who benefit from accommodations that promote instruction in sign language and build on visual and interactive strengths. Students who are deaf or hard of hearing should have access to instruction that uses bilingual education, which educates students in both the local, indigenous sign language and the national written language. This includes providing visual learning methods to promote literacy and learning. Also, it is important that sign language be encouraged to increase social interaction and meaningful engagement with peers. In addition to gaining access to bilingual education, suggestions on how classroom instruction can be modified to include deaf or hard-of-hearing students include:

- Placing the classroom seating in a 'U' shape so that all students can see the teacher and the chalkboard clearly;
- Ensuring the students' attention before providing directions or new content;

- Giving instructions in a way that is as brief and simple as possible, and when repeating instructions, repeating exactly what was said without paraphrasing;
- Making movement, especially hand and body movement, purposeful;
- Repeating other students' comments and questions, especially when they are sitting behind the student; and
- Allowing extra time to provide oral responses.

Classroom/content modification for students with intellectual or developmental disabilities

Students with intellectual and developmental disabilities are capable of learning and being engaged in academic content. People with intellectual disabilities often learn best using a multimodal approach and, thus, learn best using a mix of features designed for visual, auditory, tactile and activity-based instruction. Students with disabilities should have access to an age-appropriate curriculum that is adapted to their individual needs. Learning should be strength-based, building on the individuals' strengths and interests and not only focused on addressing their specific learning challenges. As all children are different, there is no 'one-size-fits-all' approach to classroom adaptations but, instead, approaches should be individualized on the specific child's strengths and learning needs. Suggestions on how classroom instruction can be modified to include students who have intellectual or developmental disabilities include:

- For students with writing challenges, omitting or reducing exercises that require copying information;
- Accepting other forms of reports, such as drawings, oral reports, etc. For example, instead of a written report about their family, students who have challenges writing can draw pictures and add a few descriptive words for each member of their family;
- Permitting exams to be taken orally and students to respond to test questions verbally;
- Providing audiotapes or information in simplified text; and
- Simplifying tests, homework or activities. For example, if the classroom has a spelling test and a student is struggling with spelling, introducing a few spelling words at a time to gradually build upon the student's strengths.

Classroom/content modification for students with learning disabilities

Different types of learning disabilities can affect students' ability to process information in different ways. Learning disabilities can include auditory processing disorders, dyscalculia, dysgraphia, dyslexia, language processing disorders, non-verbal learning disabilities and visual perceptual and visual motor deficits. Each of these types of learning disabilities often present diverse learning strengths as well as different types of support needs. Given that learning disabilities

vary and that each student even with the same learning disability diagnosis may have distinctive needs and learning styles, accommodations and modifications must be individualized. For example, some students with learning disabilities may benefit from having access to audiobooks while others may need to see written descriptions of content. Allowing for a multidisciplinary and multimodal approach to instruction can help support a student with a variety of learning needs. It is also important to note that the type of support may change as a student either learns or masters new content.

Additional support that might benefit students with learning disabilities include:

- Permitting exams to be taken orally and students to respond to test questions verbally;
- Allowing the use of assistive technology devices (spelling and grammar checkers) for essay exams;
- Allowing the use of a calculator for exams;
- Having students take notes using coloured markers to highlight important information;
- For students with reading challenges, finding other ways than reading out loud for them to participate in group discussions (e.g., role-playing, describing information or providing an oral summary of the content); and
- Providing audiotapes or information in simplified text.

ANNEX C: USER REQUIREMENT MATRIX

Features/ disability	Blind or low vision	Deaf or hard of hearing	Intellectual and developmental isabilities	Learning disabilities	Motor disabilities
Mandatory requirements					
On/off function All multimedia objects should include an ON/OFF option (for sounds, audio, moving objects, video, etc.)	✓	✓	✓	✓	✓
Portrait orientation The screen orientation of the book must be available in both portrait and landscape format. When selected in the menu, the preferred screen orientation should always remain the same to avoid confusion and disorientation.	✓	✓	✓	✓	✓

Features/ disability	Blind or low vision	Deaf or hard of hearing	Intellectual and developmental disabilities	Learning disabilities	Motor disabilities
Subtitles All audio recordings must be converted into text and videos must have subtitles in local language and subtitles for the deaf and hard of hearing (both ON/ OFF selectable).		✓	✓	✓	
Highlighting The text block must be highlighted when the user browses with a mouse or finger and when the narration reads the text.	✓		✓	✓	
Media or visual support The software must allow pictures, images, graphics and videos to be inserted.	✓ (for low vision)	✓	✓	✓	✓

Features/ disability	Blind or low vision	Deaf or hard of hearing	Intellectual and developmental disabilities	Learning disabilities	Motor disabilities
Narration (text to speech) A narration of all the text in the book must be available, including headings, page numbers, titles and references. The text must be synchronized with the narration. Ideally, the recording should be made using human voices, with local accent and vocabulary.	✓		✓	✓	✓
Vibration feedback Vibration feedback must be available to acknowledge a user command for an operation, such as to acknowledge an answer or to confirm that a key has been pressed on the screen, or for feedback prompting the end of an action.	✓	✓	✓	✓	✓

Features/ disability	Blind or low vision	Deaf or hard of hearing	Intellectual and developmental disabilities	Learning disabilities	Motor disabilities
Audible feedback Audible feedback must be available to acknowledge a user command for an operation, such as to acknowledge an answer or to confirm that a key has been pressed on the screen, or for feedback prompting the end of an action.	✓		✓	✓	✓
Audio description Audio descriptions must be available for the user to access descriptions when required, such as for videos, images, pictures or graphs. **Narration**. Ideally, the recording should be made using human voices, with local accent and vocabulary.	✓		✓	✓	✓

Features/ disability	Blind or low vision	Deaf or hard of hearing	Intellectual and developmental disabilities	Learning disabilities	Motor disabilities
Drag and touch functions The user should be able to drag a finger around the interface and hear the content on the screen (with or without vibration). The user should also be able to point/click without dragging.	✓ (point/click only)	✓ (for hard of hearing)	✓	✓	✓
Adjustable positioning of the video The user should be able to position the video where desired on the screen.		✓ (for sign language video)	✓	✓	✓
Adjustable video size Three sizes of the window—small, medium, large—should be available in the settings.		✓ (for sign language video)	✓	✓	✓

Features/ disability	Blind or low vision	Deaf or hard of hearing	Intellectual and developmental disabilities	Learning disabilities	Motor disabilities
Subtitles for deaf and hard of hearing All audio materials must be accompanied by transcript and video materials must be accompanied by subtitles for the deaf and hard of hearing.		✓			
Synchronization					
Synchronized video with a sign language teacher/narrator who is fluent or a native deaf signer A video of a local sign language teacher/narrator must be included next to the corresponding text, word, image or paragraph; the sign language interpreter should be fluent or a native deaf signer who signs the content of the text or the activities in local sign language, with voice-over and subtitles (with visible/non-visible options).		✓			

Features/ disability	Blind or low vision	Deaf or hard of hearing	Intellectual and developmental disabilities	Learning disabilities	Motor disabilities
Synchronized video A video synchronized with the text, the image, the exercise or the graph must be available next to the corresponding reference. The size and positioning of the window on the screen should be adjustable. Subtitles in the local language should be part of the video (so they move along with the video).		✓	✓	✓	✓
Synchronized narration The narration must be synchronized with the text for the headings, page numbers, titles and references. The audio description should be synchronized with headings, page numbers, the table of contents, the glossary, images, videos, graphs, exercises and references.	✓		✓	✓	✓

Features/ disability	Blind or low vision	Deaf or hard of hearing	Intellectual and developmental disabilities	Learning disabilities	Motor disabilities
Synchronized video and audio narration The narration and sign language video, if both are enabled, should synchronize by paragraph by waiting for the longest media element to finish playing before continuing.	✓	✓	✓	✓	✓
Menu All functions must be provided in a menu from which the user can choose preferences and create a profile that stores this information. The menu should have an optional sound, vibrations, sign language video and voice feedback.	✓	✓	✓	✓	✓

Features/ disability	Blind or low vision	Deaf or hard of hearing	Intellectual and developmental disabilities	Learning disabilities	Motor disabilities
Navigation The document navigation must be facilitated with tagging. The text must be tagged with the structure of the book, including headings, page numbers, the table of contents, the glossary, images, videos, graphs, exercises and references.	✓	✓	✓	✓	✓
Glossary The textbook must have a glossary with options to access the definitions: text, icon/symbol, audio, narration of the word, phonetic spelling and sign language video.	✓	✓	✓	✓	✓

Features/ disability	Blind or low vision	Deaf or hard of hearing	Intellectual and developmental disabilities	Learning disabilities	Motor disabilities
Text adjustment Adaptable fonts (upper/lower case), changeable colours, background contrast, line spacing, space between words and a simple uncluttered layout with zoom functions are all attributes that must be available to make the content more usable.	✓ (for low vision)		✓	✓	✓
Preferred requirements					
Standard size of interactive items All interactive buttons, images or icons should be at least 9 mm by 9 mm. All touch targets should be surrounded by an inactive space in a contrasting colour.	✓ (for low vision)	✓	✓	✓	✓

Features/ disability	Blind or low vision	Deaf or hard of hearing	Intellectual and developmental disabilities	Learning disabilities	Motor disabilities
Speed control of interactive features The user should be able to adjust the speed of all interactive features, such as videos and screen elements.	✓	✓	✓	✓	✓
Electronic memory The software should be able to store such information as preferences, layout and answers to exercises, and to mark where the student last opened the book.	✓	✓	✓	✓	✓

Features/ disability	Blind or low vision	Deaf or hard of hearing	Intellectual and developmental disabilities	Learning disabilities	Motor disabilities
Future enhancements					
Interactive support The software should allow interactive inputs.	✓	✓	✓	✓	✓
Voice recognition The software should allow voice recognition that converts spoken words into typed text.	✓		✓	✓	✓

ANNEX D: RECOMMENDATIONS FOR PRODUCING ADAPTATIONS FOR USERS WHO ARE DEAF OR HARD OF HEARING

Rationale

Sign languages are the natural languages of people who are deaf. They are languages with grammars independent of spoken languages. They are considered natural languages because: (1) they develop naturally over time among a community of users; (2) they are acquired through the ordinary course of language acquisition by children exposed to them; and (3) they are grammatically organized according to principles found in all other human languages but exhibit independent patterns of organization that make each language unique. **Approximately 95 per cent** of children who are deaf and hard of hearing are born to hearing parents (Mitchell and Karchmer, 2004), who often do not know any sign language. For parents of children who are deaf that already know a sign language, their deaf child can acquire language naturally with sign language. Unless parents learn a sign language and encourage their children who are deaf and hard of hearing to acquire the sign language, their children will likely face language deprivation syndrome. Sign language is the most natural way for children who are deaf and hard of hearing to acquire language. Thereafter, they can use that first language to learn other languages. The local language, for example Spanish in the case of Spanish-speaking countries, is learned as a second language.

Importance of sign language

- Children who are deaf and hard of hearing should have access to the national curriculum without the need for additional modifications or simplifications to text based solely on deafness.[4] No information should be simplified, and no version in simplified language will target the deaf student population.
- If a word does not exist in the sign language in question, the best way of expressing the concept should be assessed. Recommendations for this process include:
    - Creating a glossary with the main concept and introducing provisional signs;

4 For children who are deaf or hard of hearing with additional disabilities, such as an intellectual disability or learning disabilities, text may need to be adapted to address the educational needs based upon the additional disabilities.

THE MULTIDISCIPLINARY TEAM SHOULD INCLUDE DEAF MEMBERS AND, IDEALLY, EVERYONE ON THE TEAM SHOULD KNOW HOW TO SIGN.

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- Asking recognized schools for the deaf or national associations of deaf people affiliated with the World Federation of the Deaf if there is an existing sign; and
- Creating a consultative committee to intervene in the decision-making process.

Linguistic translation process

This process takes place during the pre-filming training period and includes teaching deaf narrators and practices. The team starts by reading the text, discussing the general meaning and translating each paragraph or sense unit into the local sign language. The team members reach linguistic agreements and a recorded draft is created. Deaf narrators carry out practices based on these agreements. The number of meetings varies according to the narrators' prior experience in conducting such materials, the complexity of the issues and texts, and their length. It is necessary to consider this process when calculating the total time needed to prepare the material as decisions about these adjustments can take longer than expected, affecting budgets.

The following should be noted during this process:

Mutually exclusive elements are involved in using sign language and creating truly accessible material. In this respect, the following guidelines should be respected to ensure that the resulting material is high quality:

- No artificial signed systems, such as Signing Exact English, should be used, such that sign language grammar is respected. Neither of the two languages (the spoken language and the sign language of each country) may be subject to distortion or manipulation. That is, no tenses, conjunctions, signs or compound words that do not exist in sign language should be invented.[5] Attempts to sign each word of a spoken language result in the linguistic characteristics of sign languages not being respected and being transformed into hybrids that are unconducive to the access of information and unintelligible for deaf people, and that ignore the status of sign language.

- The contents must not be simplified but must instead be translated.

- Explanations or examples can be included if the complexity of the text or concepts requires them.

- Fingerspelling should be used with caution. Fingerspelling is often the bridge between sign languages and learning written languages and is frequently used to spell a new written word that is being introduced. However, as spelling is not an integral part of sign language, it should not be used regularly as a way of communication. If necessary, the sign names of the characters should be used rather than the spelling of the names.

- Under no circumstances should new signs be invented. When no sign is known for a particular word, the following strategies are recommended:

    - Using written boards
    - Explaining the concept
    - Providing examples.

5 Artificially developed systems like Signed English, Signed Spanish, etc., have none of the three characteristics of natural sign language: they have been developed in large part not through regular use by a community, but by committee; they tend to be taught rather than acquired; and their grammatical organization derives purely from another language. Thus, although people using a 'signed' language are moving their hands, they are not using a sign language. For these reasons, the signed portion of their utterances does not have the grammatical, morphological, phonological or lexical structure of a sign language. In fact, because sign languages have a different structure from spoken languages, it would be impossible to speak full sentences and sign complete sentences simultaneously. The end result would be signed sentences that are mostly incomprehensible, often contradictory to the intended meaning and largely incomplete.

To verify whether an existing sign exists, the team should consult one or more local, recognized deaf associations, keeping in mind that sign languages change with generations and evolve with time, like any spoken language.

Introducing a glossary

To build on prior knowledge, developing a glossary that contextualizes the topics and introduces concepts and signs unknown to the students can be beneficial. The vocabulary of particular fields (e.g., vertebrates and invertebrates, the solar system, the plant kingdom) can be presented in a glossary and developed in-depth in a video. However, no manual can replace a teacher and it should not attempt to do so.

Any extra material added to a video must be aligned with both the guidelines and the flexibility of the publisher, and will be subject to funding.

Practices based on agreements and linguistics consensus

Since children are the target audience, special attention should be given to the configuration of the signs and the signing speed. The students' language level should also be taken into account, so that the information is presented in an age-appropriate manner. The language must be natural and clear, without expansion or exaggeration of the signs. This can be achieved by ensuring that the narrator or reader knows the subject being addressed and is interested in the content. Similarly, it is important to pay attention to the use of space.

The phase when the team reaches agreement and consensus concerning the sign language and linguistic content is known as the internal validation stage. The deaf team will propose, understand and agree with the script and content to be signed.

To carry out correct language work, the following aspects must be agreed upon:

- Dialogues
- Descriptions
- Metaphors
- Double meanings
- Use of space
- Specific signs
- Fingerspelling
- Use of images and illustrations
- Boards with text
- Written or video explanations
- References to the written text
- Glossaries
- Activities to be carried out beforehand
- Examples

Producing sign language videos

Using a deaf-centred production team that has responsibility for ensuring compliance with the necessary requirements is key.

Skills and general requirements

The team should be comprised of people who bring together the following competencies:

- Fluency in sign language and native knowledge of the local sign language, recognized by the deaf community as role models and references in the areas of education, leadership and the knowledge of sign language;
- Fluency in written language with training and experience in general linguistics, language teaching (e.g., Spanish), translation and interpretation, preferably with prior experience of working with the deaf community;
- Knowledge of the deaf culture and the deaf community;
- A propensity to interact periodically with members of the deaf community;
- The ability and experience to translate written materials into sign language and vice versa, preferably with knowledge of audiovisual production, design and editing; and
- The skills to control, validate and follow up on the final result, with training and experience in social projects, social science research and/or linguistics, and preferably with prior experience of working with the deaf community.

The narrator will be responsible for transmitting the message in sign language in the video and presenting the content clearly. This team member will also participate in the validation and linguistic adaptation of the material. The narrator must be deaf or hard of hearing, be fluent in the local sign language and have experience in teaching in sign language, as well as be fluent in reading and writing the local language. If these competencies are not available, priority should be given to the deaf person's fluency in sign language with the assistance of another person who is not as fluent in sign language but knows both languages.

It is highly recommended that the narrator be a deaf person, which will ensure that the content is not just transmitted in a linguistically effective way, but that it reflects a way of understanding the world and important visual behaviours. This is especially important in places that have no associations for the deaf or groups of deaf adults who can serve as linguistic role models. The team should include another deaf person who can provide live feedback to the narrator during performance, which is often called 'sign language coaching'. The project manager should ideally be deaf, and the narrator/production team should have a say in who is selected for the interpreter role.

The interpreter should be approved by the multidisciplinary team's deaf members as his/her role is to facilitate teamwork.

Technical recommendations

Camera format

- The person behind the camera should know sign language.
- A digital camera should be used because of its superior usability, quality and edition.
- The camera should have sufficient storage to record 60 minutes of video.
- The camera should be able to film in high definition. The exact quality to be used is decided in post-production but, for editing purposes, filming of the highest quality is crucial.
- The camera should preferably allow the aperture and exposure time to be configured manually.
- The camera should preferably have an optical zoom that also allows manual focus.
- The camera should preferably allow white balance to be set automatically or manually.

Sound (optional)

- Sound should be handled by a sound support person in the production team.
- The voice-over recording should be in WAV format, which provides the best audio quality.
- The recording should take place in a recording studio or in a controlled environment that is acoustically desirable and isolated to reduce background noise.
- The microphone should be a high-sensitivity digital microphone, preferably unidirectional.
- The voice-over person should have closed or semi-open headphones.
- A microphone stand should be used to make the work easier and to help avoid vibrations.
- Editing software, such as Audacity, should be used.

Clothing

- In consideration of low-vision deaf individuals, wearing solid clothing that contrasts with the skin tone of the narrator (or of the person providing the voice-over) is recommended: either dark colours (e.g., black, brown, navy blue, dark green) or light colours (e.g., off-white or peach). The clothing should also have no stripes or patterns (e.g., polka dots) and no low V-neck or scooped neckline. Long sleeves are preferred, ending exactly at the wrists.

- Hair style, jewellery and clothing should not obscure the face and hands, although this requirement can be adjusted to reflect sensitivity to various cultural contexts.

Lighting

- When filming, special attention must be paid to the shadows from the screen or from the presenter, which should be kept to a minimum.
- The light should be sufficient to generate contrast between the screen and the narrator.
- Making the most of natural light is recommended, while paying attention to the shadows that may appear.
- There are two methods to using artificial light:
    - **Three-point lighting**: A main light is positioned about 45 degrees to the right or left of the subject and 45 degrees downward, pointing to where the face and torso are located. A filler light is placed behind and opposite the main light, at the height of the camera, and a rear light is positioned slightly above the subject, shining back to the screen.
    - **Flat lighting**: Two lights are positioned behind the camera, in opposite directions, to cover the entire surface and eliminate shadows.

Studio and equipment

- Film studio
- Recording studio
- 1 digital professional camera
- 1 tripod
- 1 professional microphone
- 1 set of professional semi-open headphones
- 1 microphone stand
- 1 audio recording studio or other adequate location
- 1 computer
- Audio software
- Editing software
- Video compression software
- Screen or chroma, green or blue colour
- Map of the studio showing the necessary distances between the camera, the presenter, the reflectors, the screen, etc.

Recording and filming

- The camera should be at eye level so the narrator is directly signing to the person who is watching the video.
- The signs should not be cut off by the camera; the narrator signing upwards, downwards and to the sides must be visible.
- The camera should not be moved; it should remain in the same position.
- An indication of the space the signer can use must be provided.
- The correct position of the narrator should be marked on the floor.
- If possible, it is best to disable automatic focusing as it reduces the filming quality, and to use manual focusing on the face. Either a manual zoom should be used or the camera should be placed at the correct distance.
- Minimum space (less than 2 metres) should exist between the screen, the narrator and the camera.
- The narrator must be natural and should not look towards the assistant or stop signing in the camera. Sign language coaching should be included in the process, led by a deaf person fluent in signing.

As the specialist may not be present during filming, it is essential that the narrator practise the material thoroughly and fully respect the script. The translation team should focus on a conceptually accurate translation into sign language, not on a word-for-word translation. It is preferable to record small sections at a time to facilitate the editing and keep it natural.

Selected tasks

- Make sure that the studio is clean and available.
- Make sure that the camera is charged or can be plugged in during filming.
- Check that the lights are working and that the necessary cables are available.
- Convene the technical coordinator, the linguistic adviser, the cameraperson and the narrator .
- Arrive at the studio one hour before filming starts to prepare the equipment.
- Film short test clips before starting the real shoot.

Post-production

Voice-over for those who are hard of hearing

- The video should have voice-over, which can be turned on and off.
- The voice should accompany the sign language, not the text.
- The duration of each film block should be calculated and used to time the voice recording, which should last about the same amount of time as the sign language block.
- In literary texts, the voice-over should accompany the written text.
- In storytelling, the voice-over should accompany the deaf narrator.
- The team should identify persons to voice the text or story.
- The reader and the sound engineer should develop a detailed timeline.
- Each reader should practise reading at the speed of the sign language narration.

Recording

- Sign language narration and voice-over are separate tasks that should be carried out by separate individuals.
- The voice-over reader must agree to the use of his/her voice.
- The voice-over must follow the signing, not vice versa.
- During the recording, the production team should make sure that the reading of the text, the pronunciation, the intonation and the timing are adequate.
- The production team should include interpreters who can interpret the voice-over for assessment by the deaf members of the team.
- The sound engineer should edit the voices and send the files to the production team, who should check them before sending them to the editor.

Subtitles

- Subtitles on videos should be obligatory, unless the text and the signing are present at all times (preferably the videos can be watched with or without subtitles).
- The subtitles should be offered in a number of colour options to accommodate individual needs. If only one choice is possible, subtitles should be in black and large font.

ANNEX E: RECOMMENDATIONS FOR PRODUCING ADAPTATIONS FOR USERS WHO ARE BLIND OR HAVE LOW VISION

Note: This annex does not take into account deaf-blind and low-vision deaf individuals, who require other adaptations.

- Avoid using texts as images.
- Separate complex tables with groups of cells into a greater number of tables to simplify reading.
- Write numbers using points and commas as separators, to avoid the screen reader or synthetic voice converter incorrectly reading numbers (e.g., '1 482', which the automatic conversion will voice as 'one, four hundred and eighty-two', instead of as 'one thousand, four hundred and eighty-two').
- Adopt text sources that are compatible with the digital medium. Using American National Standards Institute (ANSI) sources creates serious conversion problems, because the references are lost and all the formulae must be rewritten. Use sources compatible with UTF-8 (dominant multi-byte encodings for the World Wide Web), which is the standard for digital books.
- When icons are used, include a clear explanation of their meaning.
- Avoid images in the middle of a phrase (e.g., to substitute for Greek characters).
- Avoid using colour in the text to indicate grammatical issues; describe these issues using written comments.
- When using InDesign software to create books, mark the structure of reading flow using InDesign's XML marking tool. This will ensure that when the text is exported (whether directly in InDesign or as a PDF generated from it), the natural text flow will not be lost and all the text blocks and images will remain in the right order.

Recommendations for producing audio description (audiobooks)

Human narration is ideal for recording the audio description, voice-over and narration. The narrator must use a local accent and vocabulary, be clear and have previous experience in voice recording. Following these suggested steps will produce quality audio-description content:

1. Identify the required accessibility resources and adaptations. The multidisciplinary team must meet to map out or make an outline of the digital textbook, estimate the timeline to produce the accommodations, determine the responsibilities, and decide on the production location;
2. Establish criteria for images, pictures, colours, fonts, page layout, etc.;
3. Prepare a glossary. To build on prior knowledge, a glossary helps to explain topics or key words and to introduce concepts, icons, signs, phonetics and simple language; and
4. Make the recording.

Recommendations for voice-over post-production

- The video should have voice-over, which can be turned on and off.
- The voice should accompany the sign language, not the text.
- The duration of each film block should be calculated and used to time the voice recording, which should last about the same amount of time as the sign language block.
- In literary texts, the voice-over should accompany the written text.
- In storytelling, the voice-over should accompany the narrator.
- The team should identify persons to voice the text or story.
- The reader and the sound engineer should develop a detailed timeline.
- Each reader should practise reading at the speed of the sign language narration.

Recording

- The reader must agree to the use of his/her voice.
- During the recording, an assistant should make sure that the reading of the text, the pronunciation, the intonation and the timing are adequate.
- The sound engineer should edit the voices and send the files to the coordinator, who should check them before sending them to the editor.

Subtitles for those who have low vision

- Subtitles on videos should be optional (preferably the videos can be watched with or without subtitles).
- Subtitles should be in black and large font.

ANNEX F: RECOMMENDATIONS FOR PRODUCING ADAPTATIONS FOR USERS WITH INTELLECTUAL AND/OR DEVELOPMENTAL DISABILITY

Design

- Use bold and italic type with moderation, especially in Serif fonts.
- Use fonts sized between 14 and 18.
- Use short sentences and avoid word-breaking at the end of the line. As a general rule, each sentence should have between 50 and 65 characters.
- Use 1.5 spacing between the lines.
- Use left alignment, which facilitates the vertical organization of the beginning of the text from left to right.
- Use texts with black letters on a white background.
- Put the text in a box to assure contrast if it is necessary to use an image as background.
- The spacing between numbers should follow the same rule as letters (it can be too narrow in mathematical calculations, for example).
- When using icons and symbols, represent something real that is considered to be universally understood, and provide images or texts that reference the place and use of the represented objects.
- Use contrast to differentiate chosen elements from others, by changing colours, enhancing words and images, or using different sizes or font types.
- Use alignment to allow a logical sequence of texts and images.
- Use arrows or circles to connect related elements.

Organization

- Use text and images to instruct students on how to handle the book and to show how it is organized (e.g., show units, chapters, modules, etc.).
- Start chapters with a resource that reflects their content.
- Provide a partial table of content, preferably on each new chapter page.
- Organize the content using advanced organizing elements, such as conceptual maps, comparative boards, graphics, checklists, infographics and other features that contribute to the systematization of the concepts and processes presented in the book.
- Insert glossaries on the pages where the main words appear throughout the book and not only at the end. The glossaries should include short texts and images.
- Use colours as a book guideline.

- Maintain and repeat the logic applied to the book structure as this helps the organization and comprehension of the material since this repetition validates the purpose and promotes the understanding of the book's contents.

Exercises

- Avoid more than one question in each query.
- Use one task for each query.
- Put questions into context.

Extra hints/resources

- Allow interactivity and digital content resources.
- Use simple language.
- Produce information in different media.
- Use resources to enhance text comprehension, such as new words, highlighting complex expressions and showing semantic origins whenever possible.
- Contextualize the content using resources, such as timelines, images in a logical sequence and captions, songs and book tips, along with the resources previously described.
- Use resources for concept experimentation, such as simulations, manipulation exercises and physical experimentation of concepts.
- Apply queries and specific questions to survey prior knowledge about the theme of the chapter. These questionnaires can be placed anywhere in the chapter.
- Propose resources for learner expression, such as oral presentations, videos and different types of texts, drawings and art.
- Use repertoire-broadening resources, such as animations, videos, documentaries, specialists' opinions boxes, movies and books, advice boxes, tables and other resources, that can increase knowledge on themes presented by the book.
- Offer an audio link or music related to the text (offline and online).
- Use software that provides a number of symbols representing objects, activities and feelings as a resource of symbol standardization (e.g., picture communication symbols).

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ANNEX G: COUNTRY PREPARATION AND CONFIGURATION: {COUNTRY}

This questionnaire seeks to help you gather information that will support the implementation of accessible digital textbooks within your country. It is divided into three areas that explore a macro analysis of the ecosystem, the production of accessible digital textbooks and in-school factors.

Countries interested in adopting accessible digital textbooks will need to explore a set of questions and identify points of responsibility for production and implementation.

In addition, a technical review should be undertaken to ensure that the necessary technology and infrastructure are in place to produce accessible digital textbooks.

1. Macro analysis of the ecosystem

1	Is your country a signatory to the United Nations Convention on the Rights of Persons with Disabilities (CRPD)?	The CRPD details the rights of all children to an education. Specific obligations in education are identified in Article 24.	o Yes o No o No information available
2	Has your country ratified the WIPO Marrakesh Treaty?	The WIPO-administered Marrakesh Treaty makes the production and international transfer of accessible books for visually impaired persons and persons with print disabilities. It does this by establishing a set of limitations and exceptions to traditional copyright law.	o Yes o No o No information available
3	Does your Ministry of Education have an inclusion policy that stipulates making accommodations of need?	Clear policy on the right to an inclusive education, identifying accommodations of needs that should be made, is crucial to ensure that distribution of accessible digital textbooks is undertaken to reach all schools.	o Yes o No o No information available Please attach or provide a link.

4	Who is responsible for the production of accessible textbooks in your country and who else is involved in the process?	There may be a single coordinator (agency, MOE) who oversees production or there may be a range of actors producing textbooks formally or informally.	List the stakeholders and the areas they participate in:
5	Is there a formal requirement for accessible textbooks in policy or law within the country?	A legal or policy framework for accessible textbooks is a significant part of encouraging publishers to create accessible books from the outset.	Indicate the details of the policy or law and link to where it is available:
6	How many inclusive schools have been identified in the country?	Inclusive schools will need to be supported and may lack the specialist knowledge required. Links between specialist providers and inclusive schools may help to bridge these gaps.	Indicate the number and types of schools, including the age range:
7	What political leadership exists to ensure the full inclusion of learners with a disability in the education system?	Without such leadership, limitations and compromises will be made to include pupils. Leadership is also essential in releasing the resources necessary to accommodate needs.	Indicate the details of the political leadership, if any:

8	How many special schools exist, and for which needs?	It may be necessary to distinguish between schools that are supervised by the MOE and centres supervised by the Ministry of Health and Special Affairs.	Indicate the number and types of schools, including the age range:
9	Do schools have a formal process for identifying learners' needs and making accommodations?	Schools will be responsible for ensuring that accessible digital textbooks are in the hands of learners. Policy at the entire school level seeks to ensure that a process for internal distribution of textbooks with appropriate support is understood by all stakeholders.	o Yes o No o No information available Please provide a brief description, link or attachment.
10	How are need accommodations coordinated in your country and resources allocated (in special schools and inclusive schools)?	Accommodations for disabilities may be funded at the school level, district or nationally. There may be no funding at all. Understanding how any accommodations will be met will be important in seeking to provide accessible textbooks and the technology upon which they are used.	Indicate how the need accommodations are coordinated:
11	Does a business case exist to produce accessible digital textbooks locally?	Some countries or publishers have an established economic case, detailing both the demand and educational benefits of accessible textbooks.	o Yes o No o No information available Please provide a brief description, link or attachment.

12	How are accessible textbooks procured in your setting? Who is responsible for the provision of textbooks for learners with a disability?	Procurement of learning materials is managed differently in different settings. In some countries it is managed centrally, in others regionally, while in others, all responsibility rests with the school. This may be related to the underlying independence of schools and their budgets.	Indicate how accessible textbooks are procured and who is responsible:
13	What are the prevailing attitudes towards education for children with a disability in your country?	The provision of accessible textbooks to all pupils with a disability is based upon a rights-based model. In countries, there is often pity or sympathy for those with disabilities, but unless reflected in rights, such attitudes are unlikely to lead to full social and educational inclusion.	Indicate the prevailing attitudes:
14	How aware are stakeholders of technology and digital content to meet the needs of those with a disability?	Much of the technology used by people every day (phones, tablets, computers) has a range of built-in features that help those with a disability. Many stakeholders are not aware of these features, so they are not used in the classroom or in wider daily life.	Indicate how aware stakeholders are:

15	Are there examples of accessible digital content available and used in schools in the country?	There may be examples of accessible resources in the country, websites, ATM's, TV subtitles etc. Many people may not be aware of these and their use. Examples of use of such accessible content and technology can be useful in encouraging uptake of accessible textbooks.	o Yes o No o No information available Please provide a brief description, link or attachment.
16	Is accessibility a requirement for public procurement of technology and textbooks?	It is important that the technology introduced in schools and to learners has been designed to support access for all. Failure to do so when procuring leads to the need to make accommodations at a later stage, which is both expensive and technically challenging.	o Yes o No o No information available Please provide a brief description, link or attachment.
17	Is the impact of accessible textbooks monitored and evaluated for learners' progression? Is there a methodology developed to evaluate the impact?	The use of accessible textbooks should be evaluated for impact. Feedback from this evaluation is essential to inform future delivery.	o Yes o No o No information available Please provide a brief description, link or attachment.
18	Are gaps in provision and availability of accessible textbooks identified and potential solutions recommended?	The evaluation should clearly identify gaps and weaknesses in the production and implementation model of accessible digital textbooks, creating development questions to mitigate.	o Yes o No o No information available Please provide a brief description, link or attachment.

2. Production of accessible digital textbooks

19	Is there a clearly communicated policy and process by which schools and learners can download and use the accessible textbooks?	The criteria for access to accessible textbooks and alternative formats need to be clearly stated with simple instructions to understand the process for installing textbooks onto devices for use. This may be done manually or directly from the cloud. If delivered through a website or repository, the interface itself will need to be accessible to support the needs of learners with a disability.	o Yes o No o No information available Please provide a brief description, link or attachment.
20	Do learners have access to the technology they need to engage with the textbooks?	Learners with a disability will need to have access to the technology they require to read and interact with the accessible textbooks.	o Yes o No o No information available Please provide a brief description, link or attachment. If yes, please specify: o Tablet o Computer o Other o Personal device o Shared device
21	Are clear workflows established with publishers for the preparation and review, testing and validation of accessible textbooks?	A clear process by which accessible textbooks are developed is important in seeking to ensure that all books are produced to a common standard. A review of the output should be part of that process to reduce errors.	o Yes o No o No information available Please provide a brief description, link or attachment.
22	What incentives to produce accessible textbooks are offered to publishers?	Incentives may include weighting for procurement, grants, publicity and legal requirements.	Indicate the incentives if any:

23	Do publishers receive guidance, standards, training and technical support on production of accessible textbooks and alternative formats?	Publishers may need support to understand the requirements for accessible publishing, from design to distribution. They also need clear guidance from any ministry on the requirements and standards to be met.	o Guidance o Standards o Training o Technical support Please provide a brief description, link or attachment of guidance, standards, etc.

3. Use in schools

24	Are schools aware of all options for accessible textbooks? How can they get the information? Is there an entity/ person responsible for information and coordination?	Schools may not be aware of all the ways in which text can be presented to learners. If they are unaware, it is unlikely that the option will be offered, and the format will not be supported.	Schools aware: o Yes o No Information: Responsible:
25	Do learners, parents and caregivers receive training and guidance on the technology they need to access the books?	Learners will need to be introduced to any application they are using to access the textbooks. On-demand training using video and audio files is effective to reinforce any training from a professional.	o Yes o No o No information available Please provide details on frequency and who does the training.

26	Do teachers receive the training they need to support learners using alternative formats adequately?	All teachers working with children with a disability should undertake training in the use of alternative formats and their benefits. This should help them to develop a positive attitude towards the resources and understand how to use them effectively in the classroom.	o Yes o No o No information available Please provide details on frequency and who does the training.
27	In schools, is a process of remediation available for textbooks that contain accessibility errors?	If errors arise in the production of the accessible textbooks, a feedback loop a feedback loop to the publisher who can correct the error and upload an updated version is needed.	o Yes o No o No information available If yes, please describe the mechanism:
28	Is technical support available to schools for the technology used by learners to access the textbooks?	Maintaining the platforms and devices used in schools is essential to establish uninterrupted access to the books. Technical support should incorporate a loan device if return-to-base repair is necessary.	o Yes o No o No information available

Gaps identified in previous table

Question number	Gap	Solution to mitigate

Completed by

Name	Position	Date

Stakeholders consulted

Name	Organization	Position	Date