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ACCESSIBLE DIGITAL TEXTBOOKS

Creating Digital Tools to Enable Inclusive Education in Nicaragua

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Executive summary

Barriers to accessing education and achieving quality learning for children with disabilities persist in the Latin America and Caribbean region. To tackle these challenges, Nicaragua is working to enhance access to quality learning opportunities for children with disabilities. Recognizing the role technology can play in promoting inclusive education, by providing different means of presenting information,[1] Nicaragua joined the UNICEF-led Accessible Digital Textbooks initiative (ADT initiative) in 2023. This initiative integrates digital textbook content with accessibility features following the principles of Universal Design for Learning (UDL), ensuring equal access for all learners, including those with disabilities.

This report offers an overview of the research conducted during the user testing of two Accessible Digital Textbook (ADT) prototypes in Nicaragua – the Math ADT and the Knowing My World ADT. These prototypes were piloted and implemented during May and August 2023 in three schools in Managua: two regular schools and one special school. A total of 55 students, with and without disabilities, participated in the Math ADT implementation, while 58 participated in the Knowing My World ADT. The prototypes were tested and implemented by teachers in first-grade classes with the support of information and communication technology (ICT) teachers. Teachers received prior training on how to use and teach with the ADTs.

This research report delineates the good practices and challenges identified during both sets of user testing. The report is structured around four categories of lessons learned: (i) background; (ii) teachers' experiences using the ADTs; (iii) students' experiences using the ADTs; and (iv) ADT usage among students with disabilities.

Lessons learned

High-quality infrastructure, which includes a stable internet connection and well-functioning devices such as tablets and computers, was indispensable for the use of ADTs in the classroom. Effective device management practices are key to ensuring that devices and accessories are properly maintained, updated and available to be used when needed in the classroom.

Teachers reported feeling comfortable using the ADTs and recognized how useful they were for enhancing teaching in lessons. Adequate training in ADT use was important for teacher proficiency. Additionally, the presence of ICT teachers emerged as a key factor in enabling a smooth implementation process. Their expertise was instrumental in overcoming technical barriers for the use of ADTs in the classroom.

Most students expressed enjoyment in using ADTs and found them beneficial in the learning process. The appealing characteristics of ADTs were noted to significantly enhance student engagement and motivation in learning. It was observed that the interactive nature of ADTs captured students' interest effectively.

While students generally found ADTs easy to use, they often required initial guidance from teachers. Students with disabilities faced additional challenges, requiring extra assistance. Although specific conclusions based on disability types could not be generalized due to the small sample size, it was observed that students with visual disabilities encountered the most difficulty, attributed to unfamiliarity with screen readers and audio-related challenges.

Recommendations

1. **Recommendations for teachers using ADTs and other digital technologies in the classroom:**
   - Assist students in acquiring digital skills to gain familiarity with the accessories and functions of ADTs.
   - Provide concise and clear instructions when explaining ADT activities.
   - Enhance student engagement by implementing scaffolding techniques to promote interaction.
   - Implement strategies to assess students' comprehension.

2. **Recommendations for teacher training and professional development:**
   - Teachers require ongoing professional development opportunities centred on inclusion and technology.

   Recommendations for future ADT training sessions:
   - Extend the duration of the training sessions and incorporate additional hands-on activities to guarantee that teachers master all the accessibility features of ADTs.
   - Allocate teachers sufficient time to acquaint themselves with the latest version of the prototype before incorporating it into their classes.
   - Provide targeted training on strategies for using devices and related hardware (assistive technologies) effectively when using ADTs.

3. **Recommendations to technology developers to improve ADTs' functionality and capability:**
   - Aim to apply Web Content Accessibility Guidelines (WCAG) 2.2 whenever possible. These guidelines ensure that web content is perceivable, operable, understandable and robust for all learners.

Specific recommendations:
- Employ captivating themes for students and incorporate more attractive features, such as adjustable font sizes, and alternative text (alt text) for images.
- Create additional prototypes with expanded content, either building upon existing ones or exploring new subjects.
- Enlarge the button icons and position them prominently for better visibility and ease of use.

- Add corresponding alternative text (alt text), and avoid overusing emoticons, as they are not interpreted as characters by assistive devices.

- Integrate audio narration and accessibility features specifically designed for students with visual disabilities who are not familiar with assistive technologies, such as screen readers, magnifiers, etc.

- Enhance the narration quality in the case of audio narration.

- Ensure the contrast ratio of text and images is sufficient for readability.

- Increase the size of images and texts when they do not meet the minimum legibility standards.

- Optimize the order and presentation of images.

- Make the ADTs easier to find on digital devices.

- Develop and validate content so that it adapts seamlessly to different screen types, including computers, tablets and smartphones.

- Explore the development of an offline version compatible with mobile phones and other screen types.

Contents

Acronyms and abbreviations

ADTs	Accessible Digital Textbooks
CRPD	Convention on the Rights of Persons with Disabilities
FGD	focus group discussion
ICT	information and communication technology
MINED	Nicaragua's Ministry of Education
UDL	Universal Design for Learning
UNAN	National Autonomous University of Nicaragua
UNICEF	United Nation Children's Fund
UNICEF INNOCENTI	UNICEF Innocenti – Global Office of Research and Foresight
UNICEF LACRO	UNICEF Latin America and the Caribbean Regional Office

Glossary of terms

The terms used in this report are aligned with those presented and used in the UNICEF Inclusive Education Booklets and the World Health Organization's International Classification of Functioning, Disability and Health (WHO ICF-CY).

1. Introduction

In the Latin America and Caribbean region, more than 19 million children have a disability, and this represents 10 per cent of children aged 0–17 years.[2] An estimated 7 out of 10 children and teenagers with disabilities in the region remain out of school.[3] Within this context, Nicaragua, through its regulatory framework and other efforts, is continuously working to improve access to quality education for all children.[4] For example, it ratified the Convention on the Rights of Persons with Disabilities (CRPD) in 2007, and also has a regulatory framework that emphasizes free access to education for all students and ensures access to the general education system for students with disabilities.[5]

Inclusive education means providing access and quality learning for all children, alongside reducing or eliminating barriers to learning and participation.[6] Digital technology plays a crucial role in supporting inclusion by offering different ways of presenting information and facilitating engagement for children with disabilities, through general and assistive technologies.[7] Nicaragua's Ministry of Education (MINED), in collaboration with UNICEF, has launched initiatives to promote inclusive education. One such initiative is the Strengthening of Institutional Capacities for the Successful Inclusion of Children with Disabilities in the Educational System, focusing on accessible infrastructure, teacher training, digital technology, inclusive educational materials and a communication strategy fostering social change.[8]

As part of this project, the UNICEF-led Accessible Digital Textbooks initiative (ADT initiative) aims to apply Universal Design for Learning (UDL) principles to ensure equal access to learning materials for learners with disabilities and diverse learning preferences. In Nicaragua, MINED, in collaboration with the National Autonomous University of Nicaragua (UNAN-Managua), the Zamora Terán Foundation and UNICEF Innocenti – Global Office of Research and Foresight, tested the first two Accessible Digital Textbook (ADT) prototypes in May and August 2023. The prototypes were based on the Math ADT and the Knowing My World ADT (*see Box 1*) for first- and second-grade levels.

This report provides an overview of the research conducted during the user testing of the ADT prototypes in Nicaragua. It outlines good practices and the challenges encountered, as well as offering recommendations to strengthen the implementation of the ADT initiative. This research, co-developed by UNICEF Innocenti, UNICEF Nicaragua, MINED and UNAN-Managua, is part of a regional effort coordinated by the UNICEF Latin America and the Caribbean Regional Office (UNICEF LACRO).

Box 1: Nicaragua's Accessible Digital Textbookss

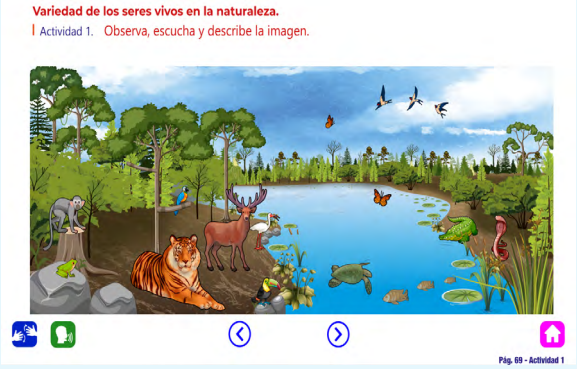
ADTs are a digitalized adaptation of curriculum-based textbooks and storybooks, designed in alignment with Universal Design for Learning (UDL) principles, which give all learners, including those with disabilities, access to information in alternative accessible formats. The main accessibility features of ADTs include audio narration (text-to-speech), sign language videos, interactivity and audio description of images.

Math ADT

Engaging first-grade interactive book featuring a diverse range of accessible activities designed to facilitate the learning of numbers 1 to 10.

Knowing My World ADT

An interactive second-grade book offering insights into the animal and plant kingdoms, explaining their characteristics and environments through engaging content



2. Research questions and methodology

2.1 Research questions

The user testing of the Math and Knowing My World ADT prototypes addressed the following research questions:

- What are the challenges and best practices undertaken by students and teachers utilizing the ADTs in the classroom?
- How do teachers use the prototypes in their teaching practice to engage with students with disabilities and diverse learning preferences?
- How can pedagogical practices and teacher support be enhanced with ADTs?

2.2 Methodology

A mixed-methods approach was developed to assess the ADTs' user testing. It incorporated structured classroom observations, teacher interviews and focus group discussions (FGDs) with children with and without disabilities. The data collection instruments were collaboratively developed, adapted and validated by UNICEF Nicaragua, UNICEF LACRO, UNICEF Innocenti, MINED and UNAN-Managua. The research protocol and instruments received ethical approval from the Ethics Review Board of the Health Media Lab Independent Review Board.

The research was carried out through the following three phases:

1. **Phase 1 – Pre-user testing**: Initial data collection assessed teachers' and students' familiarity with technology. Teachers received a two-day training programme dedicated to learning how to use and integrate ADTs into lesson plans. For this phase, the methods used were a pre- and post-training teacher survey, as well as a pre-implementation student FGD.

2. **Phase 2 – User testing:** User testing of the Math ADT took place in May 2023, and the Knowing My World ADT in August 2023. Testing included at least two sessions lasting 40–50 minutes each. Classroom observations captured pedagogical practices and interactions between students and teachers while using the ADTs.

3. **Phase 3 – Post-user testing:** The final phase gathered insights from students and teachers regarding their experiences using the ADTs. Post-user testing FGDs with students and semi-structured interviews with teachers explored perceptions of using the ADTs in classrooms and gathered recommendations to improve the ADT tool for further implementation and scale-up.

Sample and ADT prototype testing procedures

The user testing took place in three public schools situated in Managua, including one special school and two regular schools with inclusive practices. The selection of the two regular schools was based on their inclusive education practices, catering to students with disabilities or those requiring general educational support. All three schools were equipped with information communication technology (ICT) teachers and classrooms, which facilitated the user testing. A total of 55 students participated in the user testing for the Math ADT, with 15 of them having disabilities. Similarly, 58 students took part in the user testing for the Knowing My World ADT, with 14 having disabilities. Among the students with disabilities were children with autism, and intellectual, visual and hearing disabilities. Annexes 1 and 2 provide a detailed breakdown of participants that were involved in the user testing for both ADTs.

While a special school was included in the user testing, it is essential to recognize that the number of students with disabilities within this sample is limited. Consequently, any conclusions drawn based on specific types of disabilities should be approached with caution and not generalized.

The ADT user testing in Nicaragua aimed to identify the challenges, benefits and areas for improvement of the Math ADT and the Knowing My World ADT. The findings are framed around key lessons learned, organized thematically across four main areas: (i) background; (ii) teachers' experience using the ADTs; (iii) students' experience using the ADTs; and (iv) ADT usage among students with disabilities.

3. Lessons learned

3.1 Background

ADT teacher training was essential to facilitate effective and appropriate use of this tool. Teachers reported that the training programme provided them with knowledge on the use of the ADT prototypes and their main accessibility features. Teachers in the post-training survey reported increased confidence in using the prototypes. While recognizing the advantages of the training and its usefulness, teachers suggested extending its duration and dedicating more time to a deep dive into the specifics of the prototypes and their uses.

The learning experience with the prototypes heavily relied on strong connectivity and the availability of high-quality technological devices. While only one major issue related to connectivity was reported, poor connectivity impacted on the loading of video and audio in some classrooms. Moreover, issues relating to sound, including poor quality and a lack of speakers, affected all students and was particularly a barrier for students with visual difficulties.

ICT classrooms facilitated the effective implementation of prototypes. While all participating schools had ICT classrooms, a remodelling project in one school meant that the testing was conducted in the library instead. As some schools may not have dedicated ICT classrooms, the findings suggest that any space offering access to digital devices, the necessary accessories and a reliable internet connection can serve as a viable alternative for the use of ADTs.

3.2 Teachers' experiences using the ADTs

Data gathered in both sets of user testing enabled the prevailing conditions that influence teachers' use of ADTs to be identified, as well as teachers' role in the implementation process and their recommendations to enhance the overall effectiveness of the ADT prototypes.

3.2.1 Pre-testing

Teachers' prior experience with technology for special education purposes enhanced their proficiency in using and teaching with the ADT prototypes. Before the user testing, nearly all teachers reported feeling comfortable using various digital devices, such as smartphones, tablets and computers. Most teachers regularly incorporated these devices into their lessons, with computers being the most used, followed by smartphones and tablets. Teachers at the special schools reported receiving ample training in utilizing technology for special education purposes. However, only about half of the surveyed teachers had undergone formal training in technology for learning within the last three years.

Prior teaching experiences with students with disabilities and training on special education equipped teachers with useful learning methodologies to attend to diverse access needs and learning preferences. While the ADT training sessions proved to be beneficial in enhancing teachers' understanding of UDL, a significant number of teachers, particularly those specializing in special education, already possessed training in and hands-on experience of teaching students with disabilities. Their prior experience not only fortified their knowledge but also empowered them with a broader spectrum of effective methodologies tailored to meeting diverse needs and learning preferences.

QUOTE

"In previous years, I attended students with inclusivity. I can say that the experience was very nice, and I consider a great achievement obtained with each of them, in different school years. Currently, I am satisfied to have under my attention a student with Down Syndrome."

Pre-teacher training survey from a regular school

3.2.2 In-classroom implementation

In general, teachers demonstrated being able to use the ADT prototypes effectively, conducting classes and actively engaging learners with these tools. Differences between individual teachers became apparent during user testing, particularly in the case of the Math ADT. The teachers who worked with students with autism demonstrated a higher level of proficiency in using the ADTs than their counterparts working with students with visual and hearing disabilities. Furthermore, the findings indicated a positive trend in proficiency as teachers became more familiar with the ADT prototypes over successive sessions. Only a few teachers faced challenges when presenting the ADT prototypes to the class, indicating a generally smooth integration of these tools into their teaching. Overall, the teachers consistently adopted a student-centred approach, prioritizing the diverse needs of their learners. Most teachers effectively communicated how to use the ADTs to students, by providing clear explanations and employing examples that enhanced students' understanding and application of the tool.

Most teachers expressed satisfaction with the ADT prototypes and demonstrated a commitment to their continued use. Teachers highlighted the user-friendly nature of the prototypes and acknowledged the potential impact ADTs could have on student motivation and engagement, attributing this to their appealing characteristics, such as colourful images and videos. Furthermore, teachers noted that the use of this tool helped students with learning how to use new technologies. In addition to being viewed as a user-friendly resource, teachers recognized that ADTs were valuable instruments for integrating technology into classrooms and addressing diversity.

QUOTE

"The prototype is very useful; it is a tool that appeals to students, and it also helps them to be updated in the use of technology."

Post-training teacher survey from a regular school

ICT teachers played a crucial role as essential support for teachers in how to use the prototypes and integrate them into their lessons. They were present during all piloting sessions, and their assistance in navigating the prototypes provided significant benefits. Throughout the entire implementation process, ICT teachers provided valuable support, focusing particularly on helping teachers to understand how to effectively use the prototypes and on addressing any technological issues that arose. While, in most cases, their role was supportive, there was one instance where a teacher encountered substantial challenges in explaining and using the prototype, as she did not know how to use some of its functions. In this specific situation, the ICT teacher assumed a more

prominent role, guiding and explaining in a more direct manner to overcome the challenges faced by the teacher. This highlights the flexibility and adaptability of ICT teachers in responding to varying needs and challenges during the integration of these prototypes.

3.3 Students' experience using the ADTs

The findings in this section shed light on the conditions influencing the interaction between students and the ADT prototypes, along with the challenges and benefits that students encountered during their use of the prototypes.

3.3.1 Pre-testing

Students' general familiarity with technology helped them adapt to specific accessories and recognize the similarities between the prototypes and other platforms. However, students have not attained full proficiency in all aspects of digital technology, and still faced challenges using some accessories or features. Students frequently use technological devices for entertainment, such as calling friends or family, playing games, using social media, watching videos on platforms like YouTube and listening to music. For educational purposes, students engage with digital devices at school, and in some cases may use computers and tablets once a week in the ICT classroom. Despite this, students reported encountering challenges, including rapid battery depletion, difficulties managing accessories (keyboards, typing on tablets), and smartphone usability issues attributed to small font size and images.

Teachers and parents helped students navigate specific challenges while using technological devices. Students reported receiving assistance from teachers at school on how to use technological devices for both educational purposes and entertainment, mirroring the kind of assistance provided by family members at home.

3.3.2 In-classroom implementation

Most students found the ADT prototypes interesting, enjoyable and easy to use. They recognized that the ADTs were an engaging learning tool. Overall, students demonstrated focus, interest and motivation while using the prototypes, with only a few showing signs of disengagement. However, differences emerged between students with and without disabilities in terms of ease of use. Students with disabilities often required teacher assistance to access and use the prototype, while those without disabilities navigated it autonomously, albeit occasionally seeking guidance from teachers. Students without disabilities generally found the prototypes easy to use and navigate, once they had received instructions from their teachers. Nonetheless, it is worth noting that some students reported challenges with specific activities in the Knowing My World ADT.

QUOTE

> "All the students liked the illustrations, the colours, the interactive activities, the texts, the sounds and audios. The girls with hearing disabilities expressed that they liked the videos with sign languages. The children liked that the book was used on technological equipment, in this case tablets and laptops."
>
> *FGD response from a special school*

While most students without disabilities found the ADT prototypes easy to navigate, some still required assistance with specific accessories and features. Peer-to-peer assistance proved useful in these instances. The most common challenges included issues with page navigation, as well as using the mouse and keyboard. In these instances, students frequently supported each other in clarifying device usage or activity-related questions. Overall, with the guidance and assistance of both teachers and peers, students effectively overcame these obstacles.

QUOTE

"Students were engaged and curious about the Accessible Digital Textbook and supported each other spontaneously when using the platform."

Classroom observation from a regular school

3.4 ADT usage among students with disabilities

Findings from the user testing revealed differences between the experiences of students with disabilities and those without disabilities. This section further explores the experience of students with disabilities, identifying the factors that shape their use of the ADT prototypes, while analysing variations in experience based on the type of disability.

Students with disabilities actively engaged with the ADT prototypes. They actively participated in class by raising their hands and making comments. The format of responses from students with disabilities varied, and included using sign language, oral communication and pointing at images in the prototype.

QUOTE

"The students were attentive, focused and showed a lot of interest in using the prototype."

Classroom observation from a special school

Students with disabilities exhibited a lower level of autonomy when using the prototypes in comparison with those without disabilities. Nearly all students with disabilities, except one student with autism, required individual assistance to use and navigate the prototypes. In contrast, only a few students without disabilities needed individual assistance. Despite this reliance on assistance, students with disabilities generally managed to complete their activities successfully.

Among students with disabilities, those with visual disabilities encountered the most challenges when handling the prototypes because of their lack of familiarity with screen readers. Additionally, not all students had access to headphones, and for those who did, using them restricted their ability to follow general instructions, necessitating more individualized assistance. Despite these challenges, students were able to complete their activities, and there was a noticeable improvement from the second to the third session.

QUOTE

"In the third session, a student with visual disabilities autonomously navigated and interacted with the prototype."

Classroom observation from a special school

The individualized assistance provided by teachers to students with disabilities limited their opportunities to interact with their peers. It was noteworthy that students with visual and hearing disabilities demonstrated the highest level of interaction among themselves, compared with students with other disabilities. This reduced interaction was attributed to the significant individual assistance provided by teachers.

Some students with disabilities exhibited better performance with either a computer or tablet. No specific patterns were identified throughout the user testing, but individual characteristics and prior expertise played an important role. For instance, one student with Down syndrome preferred using the computer as it allowed for greater dexterity, while another student with intellectual disabilities switched from the computer to a tablet, resulting in improved performance.

QUOTE

"One of the students used the mouse instead of the laptop touch pad, as it was easier for him to use."

Classroom observation from a special school

4. Conclusions and recommendations

The findings from both sets of user testing showcase the importance of the ADT tool and its potential to enhance student motivation and to foster positive and inclusive teaching in the classroom. Overall, the user testing revealed that ADTs can effectively support teachers in their lessons for all students, including those with and without disabilities. Students demonstrated increased engagement and proficiency with the ADTs after initial sessions, which was noted by teachers, who also recognized the tool's positive impact on student motivation.

ICT teachers played a crucial role in supporting teachers, ensuring comprehensive understanding and effective use of the ADT prototypes among all students. Specifically, students with disabilities were observed using accessible features of the ADTs, adapting their use to suit their individual needs and learning preferences. Teachers provided additional support to ensure that these students comprehended instructions and actively participated in lessons.

It is essential to stress that technology serves as a means to achieve educational goals. Continuous assessment and enhancement of ADTs are vital, aiming to promote student autonomy and minimize learning barriers.

The following recommendations are framed to inform tangible actions in the following areas: (i) ADTs and digital learning use in the classroom; (ii) teacher training and professional development; and (iii) features and functionality of the ADTs.

1. Recommendations for teachers using ADTs and other digital technologies in the classroom

- **Assist students in acquiring digital skills to gain familiarity with the accessories and functions of ADTs.** Before introducing ADTs, confirm that students possess a reasonable understanding of how to operate digital devices and their accessories. If not, offer clear instructions and guidance, addressing any difficulties students may encounter. This proactive approach prevents students from encountering prototype challenges as a result of general difficulties in using digital devices.

- **Provide concise and clear instructions when explaining ADT activities.** To optimize students' utilization of this tool, verify their comprehension of all ADT functions. When delivering instructions, offer examples and confirm students' understanding. Allow time for independent exploration of the tool and help as needed. This approach ensures effective engagement with and mastery of ADT functions.

- **Enhance student engagement by implementing scaffolding techniques to promote interaction.** Create heterogeneous groups strategically, encouraging students to engage and support each other, maximizing the benefits of ADTs. This grouping approach proves advantageous not only for students with disabilities but for all students.

- **Implement strategies to assess students' comprehension.** To enrich children's learning, it is crucial for teachers not only to guide students through activities but also to employ techniques that verify their understanding. This includes incorporating complementary activities that assess fundamental concepts related to the topics covered within the ADTs.

2. Recommendations for teacher training and professional development

- **Teachers require ongoing professional development opportunities centred on inclusion and technology.** This training should equip them with the necessary knowledge and skills in teaching methodologies to address diverse needs and foster inclusion in mainstream classes through the effective use of technology. It's essential that the training provided is continuous and incorporates a practical component to ensure hands-on application of the skills acquired.

In addition, teachers provided valuable feedback and recommendations for future ADT training sessions:

- **Extend the duration of the training sessions and incorporate additional hands-on activities to guarantee that teachers master all the accessibility features of ADTs.** While teachers recognized the adequacy of the training, they proposed extending the duration to facilitate a more comprehensive exploration of the content, accessibility functions and instructions for use of ADTs.

- **Allocate teachers sufficient time to acquaint themselves with the latest version of the prototype before incorporating it into their classes.** This approach will enhance teachers' confidence in utilizing ADTs, ensuring that they are well prepared to provide effective assistance to students encountering difficulties or questions.

- **Provide targeted training on strategies for using devices and related hardware effectively when using ADTs.** This training should give teachers a broader understanding of how different tools and techniques can be adapted to meet diverse student needs, ensuring that they are equipped with various approaches to support students who face challenges using assistive technologies available at school premises, as well as any that students may bring to school.

3. Recommendations to technology developers to improve ADTs' features and functionality

Teachers and students provided feedback regarding the content, features and functionality of the ADTs, which should be taken into consideration for the development of new books, and for the further implementation and scale-up of the ADT initiative.

- **Aim to apply Web Content Accessibility Guidelines (WCAG) 2.2 whenever possible**. These guidelines ensure that web content is **perceivable, operable, understandable and robust** for all learners. Each guideline within WCAG includes testable success criteria, and meeting these criteria determines compliance with WCAG. Prioritize meeting the success criteria starting from the least complex (Level A) to the most complex (Level AAA).

Specific recommendations

- **Employ captivating themes for students and incorporate more attractive features, such as adjustable font sizes, and alternative text (alt text) for images.** Recognizing that motivation is pivotal for the learning process, the inclusion of engaging topics, such as animals and nature (as observed in Nicaragua's case), is recommended.

- **Create additional prototypes with expanded content, either building upon existing ones or exploring new subjects.** Participants recommended designing an ADT focused on literature.

- **Enhance button icons for clarity and usability.** Enlarge the button icons and position them more prominently for better visibility and ease of use.

- **Add corresponding alternative text (alt text), and avoid overusing emoticons**, as they are not interpreted as characters by assistive devices.

- **Integrate audio narration and accessibility features specifically designed for students with visual disabilities who are not familiar with assistive technologies, such as screen readers, magnifiers, etc.**, to facilitate easier access and navigation within the ADTs. This will cater to the needs of students with visual disabilities without necessitating familiarity with screen reader usage.

- **Enhance the narration quality in the case of audio narration** for improved comprehension.

- **Ensure the contrast ratio of text and images is sufficient for readability.**

- **Increase the size of images and texts when they do not meet the minimum legibility standards** to ensure accessibility for all students.

- **Optimize the order and presentation of images** to present content in a clearer and more organized manner.

- **Make the ADTs easier to find on digital devices**, perhaps by assigning a distinctive icon. This will help teachers and students access them quickly.

- **Develop and validate content so that it adapts seamlessly to different screen types, including computers, tablets and smartphones.** This flexibility enables students to select the device they are most familiar with and thereby enhances their use of the ADT.

- **Explore the development of an offline version compatible with mobile phones and other screen types**, allowing students to access the content without the need for connectivity and across a broader range of devices.

Annex 1

Table 1: **Summary of participants by type of instruments**

PROTOTYPE	PRE- AND POST-TRAINING SURVEYS	FGD	CLASSROOM OBSERVATIONS	SEMI-STRUCTURED INTERVIEWS
Math ADT	**11 teachers**	**23 participants** 6–10 participants per FGD	**55 participants** 14 observation sessions	**6 teachers**
Knowing my World ADT		**24 participants** 8–10 participants per FGD	**58 participants** 14 observation sessions	**9 teachers**

Annex 2

Table 2: **Summary of participating students – Accessible Digital Textbook user testing**

PROTOTYPE	SCHOOL TYPE	PARTICIPANTS	GENDER
Math ADT	**Regular school**	17 students without disabilities	12 boys 5 girls
	Special school	2 students with hearing disabilities 2 students with visual disabilities 6 students with intellectual disabilities 4 students with autism	5 girls 9 boys
	Regular school	3 students without disabilities 1 student with an intellectual disability	17 boys 7 girls

PROTOTYPE	SCHOOL TYPE	PARTICIPANTS	GENDER
Knowing My World ADT	**Regular school**	22 students without disabilities	12 boys 5 girls
	Special school	2 students with hearing disabilities 2 students with visual disabilities 6 students with intellectual disabilities 4 students with autism	5 girls 9 boys
	Regular school	22 students without disabilities	15 boys 7 girls

Note: All participating students were in first or second grade, aged between 6 and 11 years old.

Endnotes

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