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Original
ACCESS+: Designing a Museum Application for People with Intellectual Disabilities / Soares Guedes, L., Ferrari, V., Mastrogiuseppe, M., Span &, , S., Landoni, M.. - STAMPA. - (2022), pp. 425-431. [10.1007/978-3-031-08648-9_49]

Availability:
This version is available at: 11368/3033398 since: 2022-11-07T17:43:17Z
Publisher:
Springer

Published
DOI:10.1007/978-3-031-08648-9_49
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02 November 2026

ACCESS+: Designing a Museum Application for People with Intellectual Disabilities

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Abstract. Inclusive solutions are essential to improve the user experience and overall accessibility. They contribute to the independence and participation of people with disabilities and can be designed for a wide variety of contexts. In this paper, we describe a design cycle from ideation to testing and redesign of ACCESS+, an accessible application to navigate through museum content focusing on people with Intellectual Disabilities (ID). We have focused on personalized and inclusive features so that users could tailor to their needs and preferences icons and font sizes, labels, and backgrounds. Also, users could make sense of the text by looking at symbols via Augmentative and Alternative Communication (AAC), and by listening to text-to-speech of full text with highlight, tone, and pitch configuration. Finally, users could provide different forms of feedback: ratings and comments. We conducted heuristic evaluations with an educator and a psychologist, both specialists in inclusive education, redesigning the interface and moving from a system to a user-friendly terminology. We also followed the specialists' suggestions and made the icons and text of the UI more accessible.

Keywords: Design · Accessibility · Application · Museum · Intellectual Disabilities

1 Introduction

Communication is an essential aspect of our daily lives. The majority of people rely on oral communication, although we also have nonverbal, visual, and written forms.

Technology plays an important role in daily communication by helping people express themselves, learn and access information. When designing and developing technology, accessible solutions contribute to the independence and empowerment of people with intellectual disabilities. Further, they improve the user experience and access to information about cultural heritage sites, like museums and exhibitions.

The museums are crucial for in-person cultural acquisition and learning, but are their digital versions accessible for people with intellectual disabilities? In this work, we designed an accessible application called ACCESS+ as a means to find an answer to this question. We focus on people with intellectual disabilities and the features that could help them interact with technology.

2 Related works

Accessible design can help everyone, not just those with a disability [5]. Nevertheless, existing technical solutions only partially cover the needs of users with Intellectual Disabilities (ID) [3].

Cultural heritage sites are adopting strategies to improve accessibility and participation for all. Involving people with ID in this process contributes to investigating their perceptions and obstacles to accessing knowledge.

The readability and comprehensibility of textual resources are important aspects. Mastrogiuseppe et al. [7] designed and ran a questionnaire using the easy-to-read criteria and assessed perception and physical interaction, language and symbols, content comprehension, and engagement.

Users with different reading abilities can take advantage of the museum content using multisensory experiences [9] and assistive technologies. Examples include instructive applications, tangible objects, augmented reality, and Alternative and Augmentative Communication (AAC).

In the ID community, some people take advantage of an AAC system. Sutherland et al. [11] applied a survey in New Zealand to understand the importance and need for AAC among adults with ID. The study concluded that they have a substantial need for AAC systems.

The design, development, and evaluation are not straightforward activities, and we can take advantage of a multidisciplinary framework [6]. When possible, co-design [8] activities help devise applications to support people with intellectual disabilities (ID). Also, we can benefit from improvisation [10] to deal with challenging and unpredictable situations.

3 Designing an Accessible Museum Application

The ACCESS+ application seeks to enhance access to the museum content with an accessible solution designed with people with intellectual disabilities in mind.

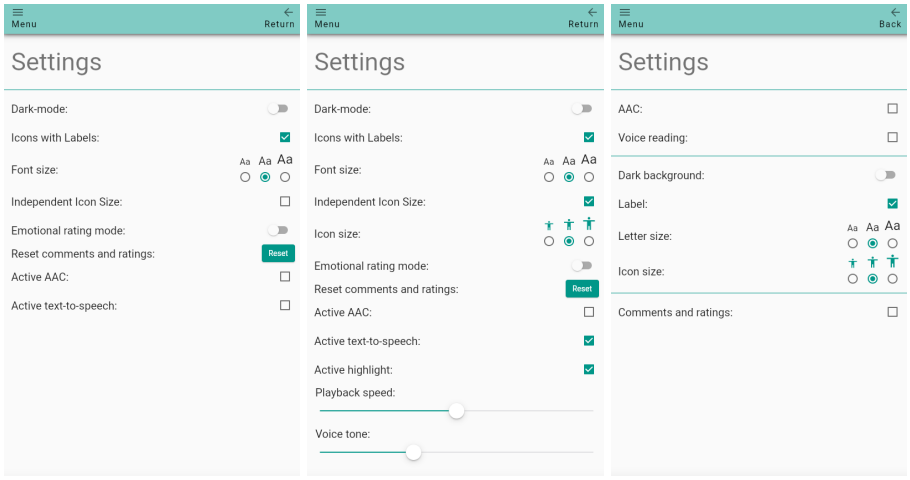
We had several meetings with experts and participants to define the application requirements. The participants belong to a special school in Trieste - Italy, where the age range is from 17 years old. We conducted online meetings and in-person research visits in the previous year to acquire empirical knowledge and develop closer contact with the participants. This long-lasting experience made us realize that several user interface elements are not intuitive for people with ID.

In partnership with the Natural History Museum of Trieste, also located in Italy, we designed ACCESS+. We developed the current content of the application in two different languages (English and Italian). However, we present only the English version here to keep it consistent with the paper language. For research purposes, the application content was limited to the topics the participants were learning and could further appreciate in guided visits. The application in its first version includes already several features that could help people with ID during their interactions.

When designing the ACCESS+, we aimed for a simple, consistent, and customizable design [3][5]. We used conventional mobile application designs (e.g., top bar, burger menu icon, left side menu list) to structure the content. We wanted the application to be similar and consistent to what the users might have already seen/used or may see/use in the future. Regarding fonts, spacing, colors, and dimensions, we referenced the WCAG 2.1 and other W3C/WAI guidelines [1].

We developed ACCESS+ using an open-source UI software development kit called Flutter [4]. This choice allowed us to develop a cross-platform application, in particular, we wanted to be able to deploy for Android, iOS, and the web. Moreover, the application design is responsive so that we can easily use it on mobile, tabled, and desktops. All those technical decisions have been made in order to have a coherent design among different platforms and screen sizes.

We implemented a variety of customizations to allow participants to adapt the interface to their needs (Figures 1a, 1b, 1c).



(a) First prototype (b) Full menu (1a) (c) Redesigned page

Fig. 1: ACCESS+ Settings page before and after Redesign.

- **Light and Dark modes**. Both modalities have a high contrast between background and text and background and accent color. We limited the range of colors to three (background, text, and accent) for simplicity matters. Except for the emotional rating icons coloring (we will explain the reason below).
- **Three size options**. It is possible to enlarge or reduce the size of the text and icons (together or independently) according to the user's needs. However, we predefined the dimensions to avoid the content overflowing and becoming confusing to the user.
- **Icons labelling**. To support the understanding of standard icons (e.g., arrows, menu button, play button, etc.), we decided to add a textual label so that, even if the users do not recognize the icons, they have a textual alternative to understanding them. Nonetheless, the setting is optional so that users that can not read or find the addition of labels more confusing than helpful can hide the labels.
- **Different feedback options**. The user can give feedback by written comment, rating, or both.
- **Different rating scales**. The user can set the preferred rate scale. Either the Likert-scale Star Assessment (Fig. 3b) or the Emotional Assessment (Fig. 3a). We decided to emphasize negative, neutral, and positive emotions by coloring the icons red, yellow, and green since the differences between the three icons might not be recognisable by some users.
- **Textual content and AAC**. The application allows users to access content in textual form or its AAC representation (Fig. 2). AAC (mainly used by non-hearing and non-speaking users) allows people with ID to make sense of the text by looking at pictograms. Each word is carefully adapted and converted to a symbol. ACCESS+ leverages the Aragonese Center of Augmentative and Alternative Communication (ARASAAC) AAC API [2]. ARASAAC offers graphic and material resources adapted to facilitate communication and cognitive accessibility. Its API allows us to find the best AAC representation (pictograms) for each word/concept in the application content.
- **Text-to-speech**. ACCESS+ also implements text-to-speech. This feature works differently depending on the selected content format (textual or AAC). When the content is textual, the user can listen to the text by pressing the Play button that switches to a Stop button during the reading. The user can also activate the highlight functionality that highlights the currently read word, and this should allow users to follow along more easily (Fig. 3c). When the content is in AAC, the user can press the Play button under each pictogram to activate the text-to-speech (Fig. 2). In both cases, it is possible to set the tonality of the voice and the playback speed (Fig. 1b).

4 Heuristic Evaluation and Redesign

We asked two special education experts to analyze the first prototype and give feedback about possible improvements. One of them is an educator, and the other

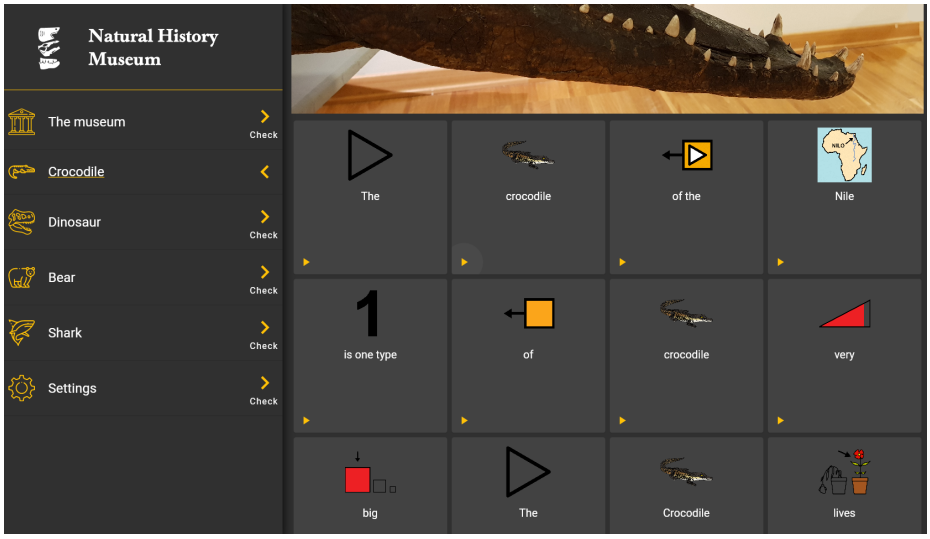
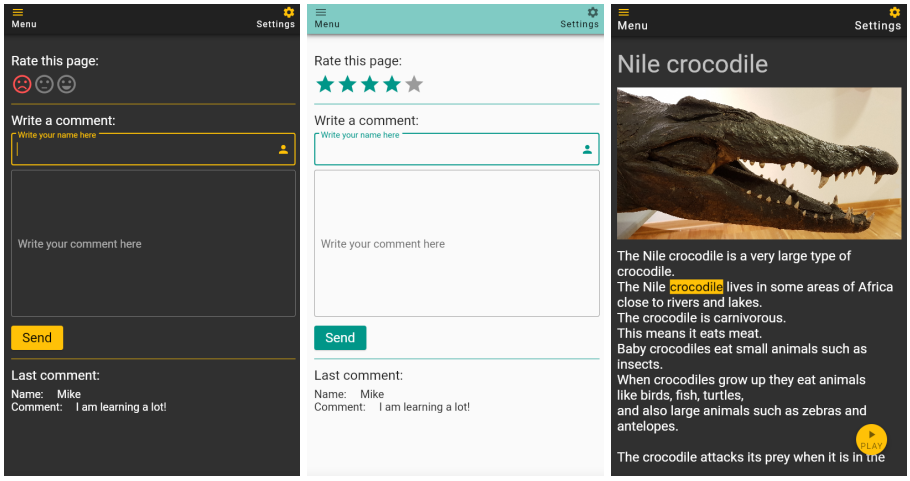


Fig. 2: AAC feature with Dark Mode and Landscape tablet orientation.



(a) Emotional Assessment (b) Likert-scale Assessment (c) Text-to-speech feature

Fig. 3: ACCESS+ rating modes, comment section and text-to-speech feature highlighting text.

is a psychologist with long-term experience working with people with intellectual disabilities. Unfortunately, due to the COVID-19 pandemic, we could not proceed to an in-person co-design session and evaluation while designing and developing this app.

One of the experts noticed that the text in easy-to-read language had incorrect line wraps. The line's wraps play an essential role in pacing text and making it easy to understand. Regrettably, viewing on a small device such as a smartphone makes it difficult to structure the sentences precisely, and the experts have already had this problem on other occasions. We made some improvements on this aspect.

Another feedback was related to the evaluation and comment elements. Experts mentioned that it would be interesting to understand if the different rating formats and comment sections will be intuitive to grasp or disruptive.

The next consideration was relative to how intuitive the icons could be. The start and stop AAC icons seem intuitive from the experts' perspective, but it requires future investigation.

The experts described the settings page layout as problematic. We redesigned the page organization to be more straightforward. For example, the setting to change the icon size was hidden in the first prototype (Fig. 1a). This information not readily available would have forced users to take an extra step to be able to enlarge or reduce the icons' size independently from the font size. After the redesign, the setting is immediately available (Fig. 1c).

We redesigned and changed the terms used in the interface from being system-oriented to user-friendly. For example: instead of "Active AAC" we used just "AAC"; "Dark-mode" was changed to "Dark background"; we changed the "Return" button to "Back"; and "Icons with Labels" was modified to simply "Labels".

5 Conclusions

We developed an accessible application to browse museum content focusing on people with ID. The application's features can benefit all users, including those with limited or emerging reading skills, such as the illiterate and children. We will require further investigation with additional involvement of participants and co-design sessions to improve the interface.

Further, we learned a lot during this process, mostly about how to fruitfully collaborate with people with ID. Still, once more, we realized how technology used in museums is far from being widely accessible.

Finally, we plan an extensive evaluation session with users and a new design cycle as future works. Some suggestions for extra features include: providing additional descriptions of items on display; implementing the possibility for visitors to record themself expressing their opinion on the visit; integrating an augmented reality functionality; adding a button to change the orientation of the screen; providing a setting to hide the side menu to increase focus on main content; making sure all buttons have labels and are intuitive to select; and enabling visitors to make drawings inspired by the exhibition, in a sort of atelier modality.

Acknowledgements We would like to thank SNSF, USI and its UROP Internship program for funding this research.

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