

# Challenges in the Design of a Mobile Application to Support Literacy for Students with Deafness in Mexico

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In this contribution, we describe the challenges faced in the design of a mobile application to support literacy for students with deafness in Mexico. First, we present a brief background regarding literacy for deaf people. Then, we discuss accessibility and interface design issues. We present a first version of a low-fidelity prototype of an application to support vocabulary learning for people with deafness, which relied on documented guidelines and suggestions focused on users with deafness. We aim to improve this prototype and to design a mobile version including the participation of users with deafness. Lastly, we discuss some challenges and ideas associated with the design of this application.

CCS • Human-centered computing • Accessibility • Accessibility technologies

**Additional Keywords and Phrases:** People with deafness, accessibility, HCI4D, literacy of deaf people

## 1 INTRODUCTION

According to the World Health Organization, over 5% of the world's population - 432 million adults and 34 million children - has hearing loss, and it is estimated that this number will grow [13]. In Mexico and Latin America, the deaf population faces severe social and academic exclusion due to critical aspects, such as late diagnosis, poor exposure to sign language, lack of academic opportunities, and differences in communication between people with and without hearing. A significant number of people with deafness in developing countries learn sign language late in their infancy, or in their teenage years, therefore compromising their linguistic development [5].

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The main issue for people with deafness is not the access to sound, but the access to written language. Most adults with deafness achieve a reading and writing comprehension comparable to that of a 4th-grade elementary school child [5-6][12]. It is very complex to master a language that is not heard. Additionally, written language has no syntactic relationship with sign language, which makes its acquisition more difficult. For a hearing person, it is easy to establish a relationship between written and spoken symbols; this association is very difficult for a deaf person. Furthermore, unlike hearing people, for a deaf person reading and writing are not parallel systems to the language they master. A deaf person must be able to read independently to learn, communicate ideas, and organize information. Hearing students have two main channels for acquiring information, visual and auditory while deaf students only have the visual channel. This means that a hearing student can take notes during class without looking at the teacher, while deaf students often must divide their attention between the teacher and the interpreter. This issue causes an important loss of information during classes [7]. According to [4] only a low percentage of deaf people can finish secondary education, and even fewer, manage to access higher education. A lot of important decisions regarding deaf people's education depend on their family and their economic condition. Some studies report a high incidence of hearing parents with deaf children [1]; which makes it difficult to educate them in early childhood in the written language and basic concepts. The lack of access to written language makes it difficult for deaf users to access digital contents, and for that reason it is important to further study their specific context and needs.

### **1.1 Accessibility and interface design issues**

The interface design for people with deafness is one of the most understudied topics in HCI and accessibility. Their user profile is not fully understood, and it is poorly documented. It is usually assumed that because they can perceive contents visually, people with deafness understand what they read. However, as explained before, this is not necessarily the case. The lack of reading and writing skills compromises the use of devices, applications and contents in general. On the other hand, it is difficult to gather requirements for the design of interfaces accessible to them, mainly due to the difference in communication modalities. There are very few specific design principles for interface design accessible to deaf users; evaluating proposals is also an issue due to the difficulty doing user testing to improve the design. In most cases, the intervention of a sign language interpreter is necessary.

The Web Content Accessibility Guidelines (WCAG) include principles and techniques to make contents accessible to people with different perception issues. WCAG states that contents must be not only perceivable but also operable and understandable. Some of the WCAG that are related to the design for users with deafness are: use of captions, use of sign language, consideration of sensory characteristics, avoid unusual words, write texts that must not require a user's reading ability more advanced than the lower secondary education level. Regarding the visual design, [3] suggest the use of icons for common actions such as mail, save, exit, search, etc., to facilitate deaf users, the recognition of those elements in the interface, since they are common across different pages and systems. They also suggest favoring several pages with few texts instead of one page with a long text.

WCAG principles and recommendations for visual design for deaf users were considered in the interface design of a low-fidelity prototype of an application to promote vocabulary learning in deaf students [8]. The application is a work in progress, and its main purpose was presented in [10]; it aims to present different texts, highlighting the keywords that are relevant to the reading comprehension according to the text's lexical analysis.

The keywords are to be illustrated with videos in Mexican sign language and are accompanied by supporting images. The current design of the low-fidelity prototype considered WCAG 2.1 principles, and the recommendations in [3]. Some of the design decisions were use of icons and images to accompany the text of the options; texts with few words per page; and, signed alphabet as an alternative to the regular keyboard. Figure 1 illustrates the design of two interfaces for this application.



Figure 1: A low-fidelity prototype of Códice [8]

The prototype presented here was designed by relying entirely on the literature review. While documental background is important, the design of these interfaces could be enriched greatly by including deaf participants in the design process. Our aim is to design a second version of the prototype for the web and to design a mobile version, this time including deaf participants in the design process. Understanding the needs of the final users is critical in applications such as these since it deals with the literacy of deaf people which is one of the main barriers in their access to information and education, which are basic human rights.

User-centered design methodologies promote the involvement of the user in every step of the design and development of a product. More than ever, it is necessary to include deaf users in the design process and observe their preferences and choices to make design decisions, considering their proactive suggestions. In this regard, we consider participatory design as a convenient approach to building interfaces by getting this type of user involved directly in the interfaces aimed for them. There are several purposes for doing participatory design: probing participants, immersing them in the domain of interest, getting a better understanding of their experience, or generating ideas or concepts for future designs [11]. The approach has produced successful results co-designing with older adults [14] and children [9] without ICT background [2]. More than asking potential users to give their input on a functional or non-functional design, they would become co-designers. Participatory design can be practiced throughout the design process (Figure 2).

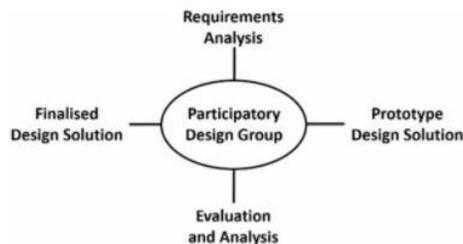


Figure 2: Participatory design interaction within the design process [15]

We consider that this approach would facilitate the workflow amongst deaf and hearing people by reducing the need for direct communication mediated by an interpreter and increasing the hands-on interaction on the interface itself. The techniques for participatory design, such as collages, mockups, drawings, and pictures, amongst others, could be adapted for achieving specific goals. Moreover, participatory design techniques can be carried out both onsite and online. On the other hand, recruiting deaf participants and finding an interpreter is not an easy task, at least in developing countries and under the situation of the global pandemic. In our case, we invited participants and their interpreter through a local civil association. We found out that they were more than willing to participate in projects such as this, not only because they are aware of the importance of improving their reading and writing skills, but also because they want to be heard. Even though we won't be able to meet in person while the covid related restrictions last, we have already conducted some preliminary virtual meetings with deaf students and their interpreter. While these first meetings suggest that we can succeed conducting virtual participatory design techniques, the limitations of this modality in the context of our group of participants are yet to be discovered.

By exploring the possibilities of participatory design techniques, we could gather significant insights on the behavior and preferences of deaf users, while maintaining a low budget since these techniques mainly use paper and pencil or free collaborative online tools, making it ideal for working in low resource settings.

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