Human-Centered Design for a Sign Language Learning Application

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ABSTRACT

An animated sign language dictionary is a valuable resource for caregivers learning to communicate with residents who use sign language. This case study reports on the development of such a tool using the human-centered design methodology. Through interviews and observations with key stakeholders, we realized that our efforts could benefit a broader population that included the residents themselves. The result of this thoughtful approach is an application that is accessible across multiple platforms and features interaction modalities to accommodate the needs of various user groups.

CCS CONCEPTS

• **Human-centered computing** ⟶ **Accessibility** ⟶ Accessibility design and evaluation methods; • **Human-centered computing** ⟶ **Human computer interaction (HCI)** ⟶ **HCI design and evaluation methods** ⟶ Field studies

KEYWORDS

Human-centered design, Human-computer interaction, Accessibility, Software design

1 BACKGROUND

"If you want to go fast, go alone.
If you want to go far, go together"

~African proverb

Sign languages are a key method of communication between residents, staff and family for centers around the country that support people with a variety of physical, mental and sensory challenges. Unfortunately, educational and training opportunities often lag the need when it comes to helping new staff and families learn the basic signs that residents of such facilities rely on to communicate.

1.1 The Jack Mabley Developmental Center

The Jack Mabley Developmental Center, also called the Mabley Center, is a residential facility for Illinois citizens with multiple cognitive, physical and/or sensory challenges. It currently serves 112 residents living in seven group homes on the campus. Fifty-three percent of the residents are nonverbal and use sign language or gestures to communicate. Some residents are deaf and do not read. Others can hear but have conditions such as cerebral palsy and cannot speak. To communicate, these groups of residents rely on a modified version of American Sign Language that accommodates the various motor abilities of the residents. The Center is state-funded and receives additional support from a nonprofit organization called the Mabley Center Family Group, whose members are mainly parents and guardians of the residents living at the Center.

1.2 Need for a learning tool

To provide adequate care for residents, the Mabley Center maintains a ratio of 1:1 caregivers to residents. Most newly hired caregivers do not know sign language. During their training, caregivers receive twelve one-hour sign instruction sessions led by the administrator in charge of communication. They receive printed handouts of the signs introduced in each lesson that feature drawings of each sign. To qualify as permanent caregivers, each new hire must pass a communication exam which involves the identification and production of signs. The scoring of the exam is quite strict; passing requires that test-takers make no more than one mistake. If they do not pass, they have one additional chance to pass the exam. Most probationary caregivers find that they need to practice outside the classroom in order to pass the exam.

1.3 Deborah 1.0

Deborah 1.0 was developed by Mary Jo Davidson as a practice tool for caregivers [3]. It was a desktop application designed to help staff members at the Mabley Center learn the essential signs needed

PETRA '20, June 30-July 3, 2020, Corfu, Greece

ACM ISBN 978-1-4503-7773-7/20/06...$15.00
https://doi.org/10.1145/3389189.3398007

to communicate with residents who are deaf or have a developmental or motor disability that hinders their speech or hearing.

The application allowed users to search the database of signs by either entering the name of the sign or by choosing a handshape to filter search results. Once a sign was selected, an animation of the sign, produced by a 3D avatar, was viewable from the front, side, or top perspectives. The application also featured a quiz section where a user could test their sign recognition skills and assess their progress by viewing quiz reports. The software was written in Visual Basic and ran on Windows XP. It required a CD Rom for installation, which was distributed to administrators, caregivers and parents. Deborah 1.0 was installed on a desktop computer and accessible by the staff of the Mabley Center on the campus.

1.4 Need for an update

Deborah 1.0 was well-received; the administrators and staff members found it useful. After nearly fifteen years, the application's success and several technological advances justified a revision. Before beginning initial discussions with stakeholders, the authors identified general advances in technology that would certainly need to be addressed. First, the redesigned application needed to be accessible on multiple platforms, particularly smartphones and tablets, since usage trends indicate increased adoption of these devices [2]. Second, most devices today do not feature CD Rom drives. Therefore, the software should be accessible on a network. Finally, the ASL Project avatar has improved dramatically in appearance and is capable of producing much more realistic signing since the implementation of Deborah 1.0 (Figure 1). The redesigned application should feature the highest-fidelity animated signs.

Figure 1: The ASL Project avatar in 2006 vs. 2020.

2 HUMAN-CENTERED DESIGN

The approach to redesigning Deborah 1.0 followed the human-centered design methodology [8]. We planned to collaborate with stakeholders continuously as we designed and developed the application, periodically sharing progress, and iteratively incorporating changes guided by their feedback.

Initial discussions with administrators revealed several important insights. As the authors had suspected, most of the staff reported that they no longer have access to computers with CD Rom drives at home. In fact, many did not use desktop or even laptop computers, opting instead for smartphones and tablets. The administrators had been maintaining the original software on a desktop computer for caregivers. However, it received little use in recent years. While there is a strict policy forbidding cell phone usage by caregivers while on duty, the administrators agreed that the redesigned application would be most useful if it was accessible on mobile devices so that caregivers could learn and study while away from work.

The administrators wanted the new software to closely align with their sign instruction curriculum. They asked that the quiz feature be maintained so that caregivers could use it to prepare for their mandatory exam.

In addition to administrators, we included in our initial discussions some staff members and parents of residents. While caregivers were assumed to be the primary users of the revised system, some parents indicated that this tool might be useful for the residents as well. Additionally, a charity, which had supported the development and dissemination of the original software expressed interest in participating.

We asked caregivers for a critique of the original software and for a "wish list" of features for the new version. We learned that fewer than ten percent owned desktop or laptop computers, but they all owned smartphones. We also learned that they did not use all of the features in Deborah 1.0. Particularly, the innovative sign lookup and quiz features were almost never used. The single feature that the caregivers consistently wanted was a dictionary where they could type or select a word and see the avatar produce it from the front, side, or overhead views.

We began animating the requested signs so that we could start sharing an initial prototype with stakeholders as soon as possible. When several samples were ready for evaluation, we met with the stakeholders to share our progress and asked for their opinion about the accuracy and naturalness of the animation. All said the animations were fine. The sign language instructor brought to our attention that the original software contained several animations that were incorrect. We asked him to demonstrate the signs that were in error, which we captured on video. He also mentioned that the vocabulary had expanded since the original version. So, we recorded videos of his signing the additional vocabulary as well.

In a follow-up email, the president of the parents' organization expressed strong concerns about the direction of the project. The parents wanted there to be direct benefits to the residents as well as the caregivers. They felt that the residents were being ignored in the design process. We addressed their frustration over the course of several subsequent phone calls. Together, we decided that the new application would serve the hearing residents who live together in group homes with deaf residents, but do not have access to sign language learning resources. The president of the parents' group recalled how one hearing resident learned sign language by watching a fellow deaf resident interact with a caregiver. To the parents, it was of utmost importance that "If you live in a

community, you need to be able to *communicate* with members of that community."

This conversation revealed a crucial insight. Until this point, our focus had been on caregivers as the primary users. Now we realized that there were two user groups of equal priority: the caregivers and the hearing residents.

Although the hearing residents had the same goal of learning signs as the caregivers, we discovered that the requirements for the application interface were quite different. First, due to the very low average reading level, the interface would need to be highly visual and would need to rely on as little text as possible. Second, residents do not have access to the internet and typically do not have cell phones or tablets, in contrast to the caregivers, who have cell phones and access to the Internet at any time that they are away from campus. The important insights that shaped the redesign are summarized in the table below. We shared this summary with the stakeholders and they agreed that these four findings were essential.

Table 1: Insights from stakeholders.

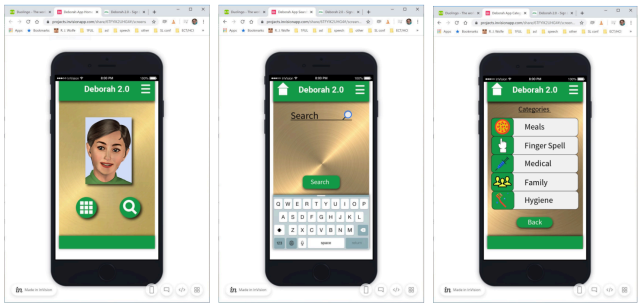
User groups	Quiz Feature	Interface	Device	Internet
Caregivers	No	text-based	Mobile only	Yes
Residents	No	visual	Desktop only	No

The first finding delighted the developers on the team because they would not need to implement a new quiz feature. Even though the administrators' initial assumption was that the quiz feature was highly desirable, subsequent interviews with caregivers revealed that this feature was rarely used. To accommodate the second finding, the designers discussed how to address the conflicting user needs for the interface. Caregivers should be able to search using text for a sign and residents should be able to browse visually recognizable graphical options. We decided to create two methods to select a sign: one that is purely text-based and one that uses icons and text. For the latter approach, we organized the words into logical categories that mirrored the structure of the curricular materials used by the sign language instructor. Each category is accompanied by an icon depicting the types of words in that category.

The third finding indicated that the users would access the software from a variety of devices. For this reason, we planned to use Bootstrap [7] in the prototyping process because it has features to accommodate most smartphone, tablet, and desktop screen ratios. It implements responsive web design, which allows the same content to fit multiple formats [5].

3 BUILDING THE PROTOTYPE

We created a high-fidelity prototype that simulated the application's functionality using InVision [4] and shared the link with stakeholders (Figure 2). The interface had two initial options: a search screen, which allows the user to enter text (Figure 3) and browse screen (Figure 4)which allows the user to make a selection based on both textual and visual elements. The prototype was interactive, allowing stakeholders to select and view a limited set of signs. This allowed us to validate the application's basic usability.



Figures 2, 3, and 4: The initial prototype.

3.1 Initial feedback on the prototype

All of the stakeholders liked the overall look-and-feel. There were only a few suggestions made about the prototype. Since there were only two initial choices, browse and search, the hamburger menu was deemed unnecessary. For the search screen, we decided to replace the textbox with a dropdown menu. Since there were only 225 words in the dictionary, a dropdown list was a reasonable option that would enable users to see only the available words listed alphabetically and avoid typing a word that is not available. Generally, choosing from a set is preferable to having to recall key words [6]. This change also obviates the need for keyboard input, simplifying the interaction while maintaining efficacy. On the browse screen, the icons' dark green background interfered slightly with the visibility of some of the icons. We addressed this issue by changing the background color to white.

3.2 Application Development

After the revised prototype received approval from the stakeholders, we created a web app by adding the backend functionality. The choice of implementing a web app instead of a native app has two substantial advantages for the developers. First, software updates to the app happen at the central server. Users always have the most current version. Second, the app will work on all devices with a modern browser as long as a connection to the Internet is available. We built the implementation using HTML, JavaScript, Bootstrap [7], CSS, and ASP.net [1].

To accommodate computers without an internet connection, we were confronted with two alternatives. Either we could install a web server on a desktop computer and use a browser to access the local server or we could rewrite the application using a desktop technology. We decided on the latter because it would be a simpler implementation and would be easier for residents to access. Since the screens were already defined, creating the desktop application in C# took less than a day of developer time. The web app and the desktop app were rolled out on May 9, 2019. The web app can be accessed at http://deborah2.net and the desktop version is available by contacting grants@aslproject.com.

3.3 Feedback on the Application

Staff members and residents' families liked the accessibility of Deborah 2.0, because, "I can look up words on my phone." Server logs indicate that people have been viewing videos steadily since the rollout in May 2019. In February 2020, the last month where complete statistics are available, the number of videos viewed per day averaged 49, which indicates substantial acceptance, given that the number of current staff is slightly more than 100.

For privacy and security reasons, there are no quantitative details kept on the residence usage of the desktop version of Deborah 2.0 (Figure 5). However, staffers report that several of the residents have become interested in Deborah 2.0 and have spent a considerable amount of time using the computer.

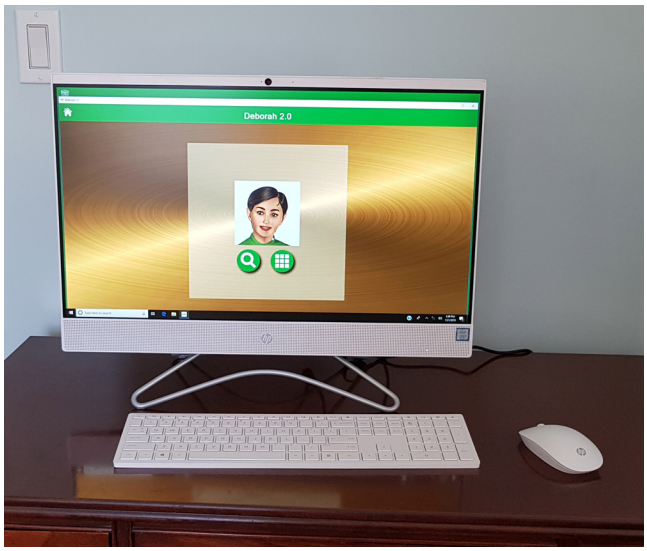


Figure 5: The desktop application.

4 REFLECTION

Applying human-centered design enabled our team to develop a useful application that meets the needs of two distinct populations. Their specific needs might not have been discovered had we not diligently fostered open communication and iterative design.

Developing software solutions to meet the expectations of multiple stakeholders is not without its challenges. Each is motivated by different priorities and power dynamics. The administrators wanted an efficient and effective way for their staff to learn signs so that they could be better prepared for the mandatory test. Staff members wanted a tool that helped them study on their phones in a simple and direct way. Residents wanted to better communicate with their community members. And parents wanted to advocate for their children.

By taking small steps and communicating with stakeholders during development, we unearthed unanticipated physical, cognitive, and technological constraints. We found that some users typically used smartphones, while others preferred or were restricted to desktop computers. Some users had limited motor or cognitive abilities. Some did not have internet access. If not detected early, these constraints might have presented major issues. But since we could address them as they arose, the stakeholders were able to collaborate on solutions. The iterative design also improved efficiency because stakeholders approved design and implementation decisions as they happened.

Perhaps equally significant were the insights related to power dynamics. The parents, particularly, had felt disenfranchised in the past. Their default posture was to push back when they feel unheard. Indeed, this was the case when parents felt ignored because initial discussions centered around the caregivers and how to make them better at their jobs. The key insight was when we realized that there was an entirely different group that we had not considered. Additionally, when stakeholders are kept in the loop, they are more likely to feel a sense of ownership, to contribute to the design, and to help promote the solution.

For developers to embrace human-centered design, they must listen. All stakeholders should be heard and have the opportunity to contribute. This means that developers must be open to new ideas and willing to embrace solutions advocated by others. Unfortunately, the more contributors to the project, the slower the design process. But the outcome is well worth it, as development is guided by well-articulated design goals.

For this project, we had the luxury of a flexible deadline for the final deliverable. We had the opportunity to come to a consensus through patient discussion and without pressuring anyone. Had we imposed a strict deadline, we might have sped through the planning phase and missed critical insights. We would have developed a solution that would have been useful only to a subset of the potential population and inaccessible to an important and significant portion of the community.

5 FUTURE DIRECTIONS

Deborah 2.0 has been in use on the campus of the Jack Mabley Developmental Center for nearly a year. Other than analytics in the monthly server logs and informal feedback, we have not collected detailed usage data. In the coming months, we hope to conduct a formal usability and acceptability evaluation that will provide valuable insight to guide future revisions. Once further validation has been conducted, we plan to distribute Deborah 2.0 more widely.

ACKNOWLEDGMENTS

This project would not have been successful without the essential insights of Barbara Achino, President of the Mabley Center Family Group. We deeply appreciate the guidance of the staff and administration of the Jack Mabley Developmental Center, in particular Steven Caudillo, and Melissa Shaw, who were wonderfully supportive of our efforts. A special thanks to Mary Ellen DeLeonardis and her late husband Nicholas who inspired this project from its inception. This work was supported in part by DePaul University, The American Sign Language Project, NFP, and Bowling Green State University.

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