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# Fostering Autonomy through Augmentative and Alternative Communication

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Monografia apresentada ao Curso de Bacharelado em Ciências da Computação da Universidade Federal Rural de Pernambuco, como requisito parcial para obtenção do título de Bacharel em Ciências da Computação.

Universidade Federal Rural de Pernambuco – UFRPE

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Esta Monografia foi julgada adequada para a obtenção do título de Bacharel em Ciências da Computação, sendo aprovada em sua forma final pela banca examinadora:

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Recife, 26 de fevereiro de 2021

*“If all my possessions were taken from me with one exception, I would choose to maintain the power of communication, for with it I would soon recover all the rest.”*
*(Daniel Webster)*

# Abstract

According to the World Health Organization, an estimated one billion people live with a disability. Millions of them are non-verbal and also experience motor-skill challenges. The restrictions on participation and communication caused by such disabilities often lead to discrimination and social exclusion, including the lack of access to formal education. Augmentative and Alternative Communication (AAC) is a method to afford communication for people with speech impairment. Software applications that implement AAC bring benefits of adaptability and personalization over traditional paper-based methods, but their usability needs improvement, particularly to increase user autonomy. This paper presents an interface redesign of the Livox AAC application, and a new user onboarding process based on user research to adjust the interface to user needs, contributing to user autonomy on AAC use.

**Keywords**: Augmentative and Alternative Communication, Assistive Technologies, Inclusive Education, Accessibility.

# Lista de ilustrações

# Lista de tabelas

# Lista de abreviaturas e siglas

| | |
|---|---|
| AAC | Alternative and Augmentative Communication |
| PECS | Picture Exchange Communication System |
| UNICEF | United Nations International Children's Emergency Fund |
| WYSIWYG | What You See Is What You Get |

# Sumário

# 1 Motivation and Background

Many educational studies support the idea that a big part of knowledge generation happens through interactions between students and teachers, and among peers (WEINBERGER; FISCHER, 2006). Interaction forcibly involves some communication, whether through voice, pictures, or signs, which is often challenging for people with speech disabilities, who find it hard and tiresome to express their thoughts, while their interlocutors often lose patience waiting for delayed responses. Communication challenges lead to severe barriers to children's education and integration in society.

According to a UNICEF study (MIZUNOYA; MITRA; YAMASAKI, 2016), almost 50% of children with disabilities from 15 developing countries do not go to school. Even for those who attend school, traditional teaching methods are often not suitable, especially for those who are non-verbal and have motor-skill challenges. Thus, guaranteeing attendance to formal education is not enough. It needs to be complemented by strategies and tools that facilitate communication and reduce the reciprocity gap (delay in communication caused by the time needed by the individual with a disability to process and act in a conversation).

Adaptive applications of Augmentative and Alternative Communication (AAC) (BEUKELMAN; MIRENDA, 2013) have emerged as crucial players in enabling communication for people with disabilities (BEUKELMAN; MIRENDA, 2005). A very popular method is the Picture Exchange Communication System (PECS), where the person points to physical cards in binders which represent the ideas to be communicated (such as pointing to the food they want to eat) (GANZ J., 2013). Over time, this type of system has evolved to software applications, more compact to carry, and with several added functionalities like speech synthesis and personalization of the interface (BEUKELMAN; MIRENDA, 2013).

Nevertheless, the introduction of AAC to a person with disability through software applications is not straightforward. Many users with speech impairment may also have motor or cognitive problems, such as persons with cerebral palsy and certain cases of autism (MACDONALD; LORD; ULRICH, 2013). This introduction is ideally done with the help of a speech therapist and parents' and teachers' participation. As the user's skills advance, they will develop greater autonomy.

However, many parents of children with disabilities have little to no familiarity with AAC, and for many of them, the support of therapists may not be accessible due to the low availability of those professionals and the cost of therapy. Moreover, the therapists themselves may not be skilled with communication technologies. Thus, the good

usability of the AAC application interface becomes a vital issue for its effective adoption. In many cases, to adapt applications to various disabilities, several features are introduced without considering the users' cognitive workload necessary to understand them, thus making them difficult to use.

Livox, currently within an industry-university partnership, is an AAC application that integrates artificial intelligence (use-based) with AAC to predict and highlight actions in the interface, thus reducing the communication gap. The application is used by associations of parents and supporters of people with disabilities and schools, which are given training for using the application. In 2020, the application already had 10 million phrases spoken through it, with users in 12 countries and support in 25 languages (LIVOX, 1999). However, Livox has similar problems to other AAC applications, with an interface cluttered with multiple challenging features, especially for novice users. Application analytics data as shown in Figure 1 show that this leads to a discrepancy between a significant group of advanced users who make daily use of the application and another considerable part of novice users who give up after the first months of use due to interaction difficulties. There are few intermediate users between these two groups.

Overcoming the barrier of the learning curve of the novice user requires persistence and tutoring from experienced professionals. Figure 1, from Livox analytics, shows that users have difficulty adapting to alternative communication. Only 2.1% of the users speak more than 300 sentences on average per day with Livox (which is the average number of sentences spoken by a person without speech impairment).

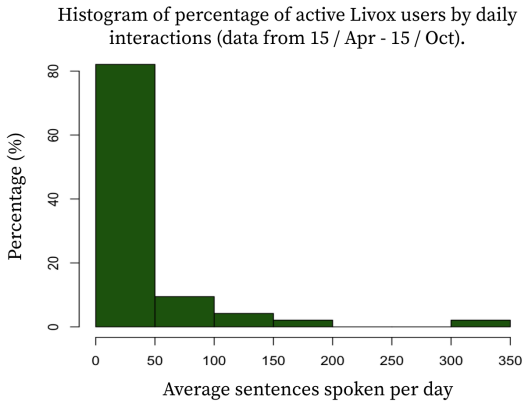


Figura 1 – Speaking average using Livox

Another problem with AAC applications is that they only work satisfactorily on tablets or touchscreen computers, which are, generally, more expensive than smartphones. Prohibitive access to technology prevents larger-scale usage and limits the social contribution of applications.

Considering the needs to: (i) reach a larger part of the population; and (ii) reduce

the barriers of AAC acceptance to promote user autonomy for individuals with speech impairment and their carers, we propose an interface redesign of Livox. To guide this redesign, we investigate through qualitative field research with therapists and parents the difficulties faced when using the current version of Livox in order to improve the user flow and experience.

# 2 Related Works

The alternative communication process using cards can be done traditionally through the Picture Exchange Communication System (PECS). It consists of using physical cards, that are exchanged among a person with disability and a therapist, containing a person's actions and desires, such as food or a request for action. However, this traditional system has the disadvantage of not being dynamic, since it is a printed format, making it necessary to forecast all possible actions and situations when the cards are designed and purchased. Users might have to carry around heavy binders and not be able to create new actions quickly. To communicate through PECS, the communication partner (typically the parent, teacher, or therapist) acts as a mediator, providing communication cards according to the situation.

Several AAC software applications, such as AraBoard (BALDASSARRI et al., ), Proloquo2Go (PROLOQUO2GO, 2018) and Livox seek to implement PECS in a modern and dynamic way, being weightless, easily updated, and extended. On the other hand, they replicate the functionality of PECS without particular concerns with usability or with the diversity of user profiles. Thus, these applications are more likely to be adopted by individuals skilled in the traditional system, or those who have the support of therapists trained by the pedagogical team of the applications.

As learning to use these applications is not simple, tutorials are provided depicting the meaning of each interface element, but they fail to encourage or explain the overall use of the application in communication or the introduction of the alternative communication process. For example, the Proloquo2Go manual present instructions to explain how the cards can be edited. However, several steps are necessary for common and simple actions, and the amount of glyphs requires much explanation in the manual. Proloquo2Go is the most downloaded alternative communication application for the iOS operating system (PROLOQUO2GO, 2018), showing that it is still one of the best solutions available despite the lack of usability.

The current version of Livox presents similar problems. When activating the application, the user is directed to the home screen (Figure 2), which presents a general user profile and several icons, with little explanation of what can be done with the application. If the person has previous training and knowledge, they may guess that the buttons next to the user's name are for: editing user settings; editing communication boards; opening a yes/no board; and finally using a virtual keyboard (from left to right in Figure 2). It is also unclear to a novice users that the application will open the user's initial board when the user name is pressed.

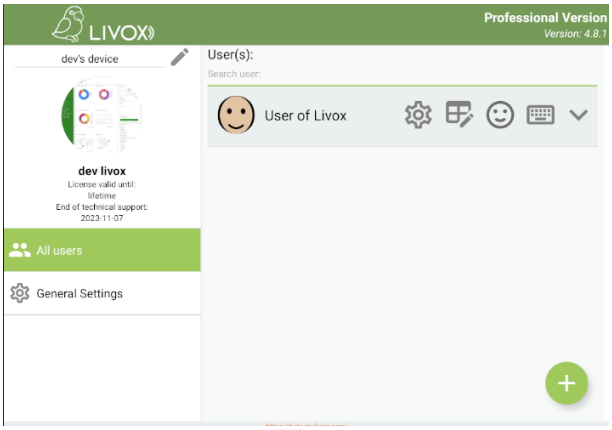


Figura 2 – Home screen after Livox activation

The lack of explanation on what to do next may make users resort to manuals and that extra step might lead to abandon the application since it is hard to read and understand. Thus autonomous use is hard to achieve, placing a barrier for the families, but also for children's communication outside their home, as at school. Our redesign attempts to improve usability thus fostering autonomy on a scale that provides better use autonomy without training.

# 3 The LIVOX application

LIVOX is an Android application that translates the traditional concept of communication boards to a mobile (tablet) environment, which was used in this study as the researchers are involved in the industry-academia partnership. An example board is shown in Figure 3 with pictograms that enable the user to communicate their desires.


Figura 3 – Board with communication cards

The interface can be customized to adjust to needs related to user interaction, considering other cognitive, visual, and motor disabilities beyond speech impairment. Some examples include: number of board columns and rows (adjusting the size of images); click interval (avoiding involuntary touches for users with repetitive movements); scanning of items with user selection by touching on any part of the screen; the IntelliTouch functionality, which analyses several aspects of imprecise user touch on screen to guess the desired interaction; and the possibility of keeping the relative position of items on the screen (particularly important for users with Autism).

Besides daily general communication, Livox can be particularly useful in educational settings. Cards can be customized with words, images, and sentences and be used from simple literacy activities (e.g., letter identification) to storytelling. Contents from schoolbooks can also be adapted to Livox, creating accessible material for children with disabilities and contributing to their inclusion and autonomy at school.

# 4 Results From User Research

In order to try to improve user autonomy in Livox, we followed a user centered design approach (BARBOSA; SILVA, 2010). To better understand the users' difficulties and needs, we performed a qualitative field research with therapists and parents (given the difficulties in doing such research with children with speech impairments). Semi-structured interviews were undertaken with two professional therapists responsible for training and teaching more than 100 families in AAC and using Livox. The therapists were asked questions to help us understand how the application could be improved for novice teachers and parents to start using Livox without the constant need for professional support. One of the therapists owns a Psychology clinic where she works with more than 100 users of Livox (4 out of the top 10 Livox users were her patients). She also has experience with Livox as a parent, having herself two children with autism. The second interviewee is also a speech therapist and has been working with Livox since its conception in 2013. She gave more than 50 courses in institutions and schools about alternative communication, being an expert in the area.

In order to complement the interviews' findings with the views of parents and teachers, we sent an online questionnaire to the 200 top Livox users of October 2020 according to authentication data. These users are the most engaged with the application, speaking more than 300 sentences a day. The questionnaire focused on daily communication with the children using Livox, including difficulties with the interface, favorite functionalities, suggestions for improvements, and children's main interests in terms of the content of the communication.

# 5 User Research

## 5.1 Results from interviews

The main finding from the interviews with the two speech therapists related to Livox's ”visual pollution”:, i.e. the opinion that there is too much information, from the start, on Livox interface and even on the boards themselves. According to the therapists interviewed, as they start using Livox with a child with disabilities, they first remove all communication cards shown by default. The reason is that, although these cards have the benefit of covering a large area of everyday life, many of them will not be used in the beginning, causing too great a cognitive load for the children learning to communicate through Livox. In the area of Human-Computer Interaction (HCI), cognitive load is studied as the amount of mental processing needed to use an artifact, which is known to affect the ability to find content and complete tasks: the higher the cognitive load, the harder to interact with the interface (WHITENTON, 2013). This impacts the efficacy and efficiency of the novice user's communication, which can lead to early dropout, as identified in Livox's reports (Section 1).

It was consensual between the therapists interviewed that a good way to introduce a child to alternative communication is with two cards only (Yes and No), since these two options account for most alternative communication by novice users. As the child gets used to answering yes and no through the application, communication can be incrementally enriched with their topics of interest, such as a toy with which they like to play. This allows transferring interest from a favorite object or activity to the use of the application.

After the child has gained proficiency in communicating about their favorite objects or themes, topics related to essential life activities can be introduced (such as the food category). Users with autism, for example, use Livox a lot to ask their carer for food. According to the therapists, they most frequently communicate about food and about what they like to play. Again, the therapists highlight the importance of the minimalist interface, as children with autism can become frustrated with too many options in the application when they are looking for this one card that represents their favorite toy. Then, a third stage of communication consists of adding emotions to the boards so the child can communicate how they feel.

The therapists agreed that alternative communication, at first, consists of asking for objects without the construction of a full sentence. For example, when asking for a ball, the child will only press ”ball”without constructing the phrase. This is similar to the

typical language learning process, as a child with typical development takes around five years to develop speech fully. For a child who is starting to express themselves, it is essential to recognize visual, sound and sensory characteristics (for example, learning that a cat has soft fur and meows). Then, communication evolves to the use of core-words (the 50 to 200 most common words in children's vocabulary), so that they are able to create sentences in formal language, for instance, including the use of pronouns and verbs.

When asked about the general user experience with novice users, the therapists argued that most parents use Livox for one person only, so the user selection screen (Figure 2) should be skipped. The card creation screen (Figure 4) was said to have a counter-intuitive flow, making it hard to teach the parents.

The experts argued that most barriers to user autonomy in Livox derive from screens that do not clearly indicate the next step in each flow and usually parents making mistakes like just giving the boards for their child to use. Since the boards contain many cards, their child often becomes frustrated. The parents also do not know how to navigate the application for configuring the adequate settings for their child's disabilities, requiring constant assistance to be able to configure the communication boards and other settings.

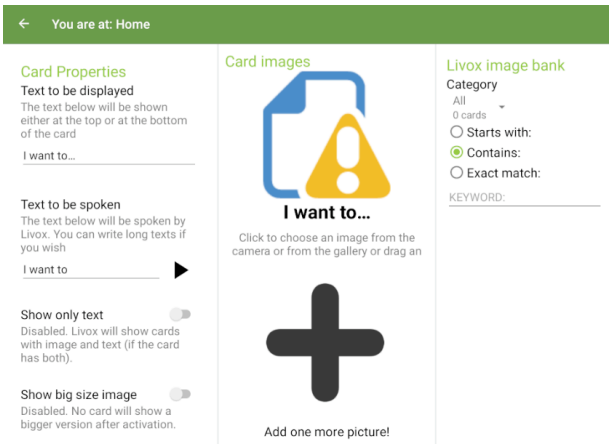


Figura 4 – Current edit interface

## 5.2 Results from questionnaires

We obtained 17 responses to the survey sent to parents who use Livox with their children. Their children were aged 10-11 years on average (71%). About half of those children (47%) have Autism, and 41% have cerebral palsy, 6% have Down Symdrome and the other 6% have no other disability than verbal.

Livox is used by the respondents mainly for spontaneous communication (70%); answers to questions (70%); and teaching content (59%); and mostly at home (64%)

and school (52%). This shows that the children most engaged with Livox have reached enough autonomy to use the tool with different people (parents, teachers), in family and educational settings.

Figure 5 shows the most used Livox functionalities, highlighting natural conversation and yes/no questions, which are indeed essential to daily life, with the potential of reducing the communication gap. This confirms the therapists' views on starting communication through Livox with yes/no cards only and slowly evolving through main topics of interest.

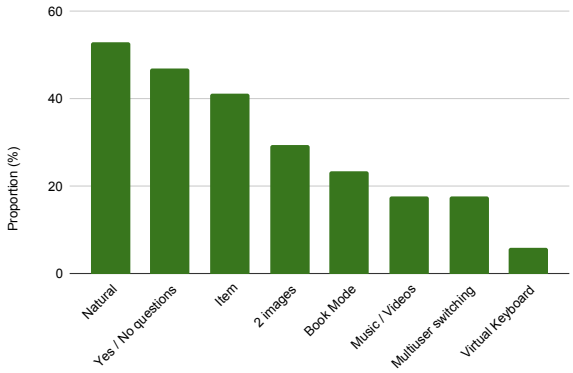


Figura 5 – Main Livox functionalities used by participants

We also asked the users to evaluate certain aspects of Livox on a score from 1 to 5. Ease of use scored 3.5, indicating that usability is not a strong positive aspect even among very frequent users. Related to that, the attractiveness of Livox scored 3.7, reinforcing dissatisfaction with the interface. As for potentially solving communication problems, the score obtained was 3.6. This can be strongly correlated to the poor usability of the interface but can also be due to the lack of key functionalities or vocabulary. In this sense, in line with the therapists' opinions on how word cards should be added, we asked about children's main topics of interest. Music and video, cartoons, and food are the most appealing categories for the children (Figure 6). The interest in food vocabulary confirms the therapists' account of the importance of this category.

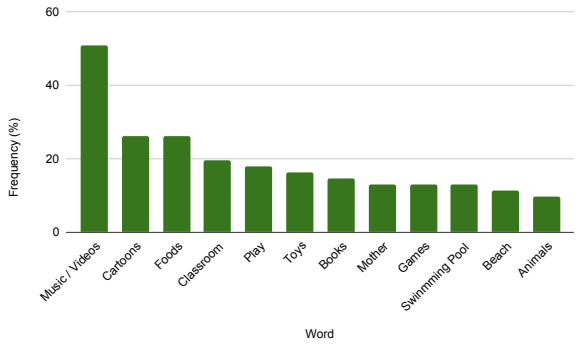


Figura 6 – Frequency of the words mentioned in the question about children's topics of interests

# 6 Mobile Interface Redesign

User research showed that the most used features should be prioritized in the interface to maximize efficiency and efficacy in communication. Based on the therapists' feedback on how the users do not know how to adjust the settings for each disability, in the user setup screen (Figure 7), a questionnaire for parents and teachers was designed to allow pre-configuring the best parameters for a new user based on their informed abilities, thus addressing the excessive cognitive load caused by too many interface elements. For example, depending on the child's visual abilities, cards can be bigger with higher contrast; and Intellitouch is enabled if the parent informs that the child presents repetitive movements or other motor difficulties.


Figura 7 – New user creation screen

The questionnaire also asks about the user's experience with alternative communication, and depending on this information, the application presents a step by step tutorial introducing AAC to novice users, while advanced users will not see this tutorial and have core-words boards unlocked by default. These design choices are aligned with the usability heuristic of flexibility and efficiency of use (NIELSEN; MOLICH, 1990)(NIELSEN, 1994), personalizing the interface to the needs of users with different levels of expertise.

The mobile application home screen was redesigned with a tutorial for novice users. The five steps, that were built with the experts' feedback, guide the parent in creating a new board from scratch and then sophisticating communication gradually: (i) A guide on introducing communication with Yes/No questions; (ii) Adding cards with the child's topics of interest, which make them more eager to use the application in order to request something; (iii) Adding feelings and requests, like feeling pain or going to sleep; (iv) Adding cards with pronouns and articles to better emulate the formal grammar;

(v) Adding core-words, meaning completing the board with all 50 words that are most common in the user's language.

For assisting the parents on creating new content that better adapts to their child's life, the edit screen, where the user can change the content of the communication boards (Figure 8) was redesigned with the concept of "What You See Is What You Get"(WYSIWYG), allowing the user to see the result of a specific card without leaving the screen. This change was due to the due to the need for a more intuitive flow reported in the interviews (the previous design is shown in Figure 4. The new interface allows the user to see the overview of the final result while editing, also making it a faster process, aligned with the heuristics of flexibility and efficiency of use (NIELSEN; MOLICH, 1990)(NIELSEN, 1994).

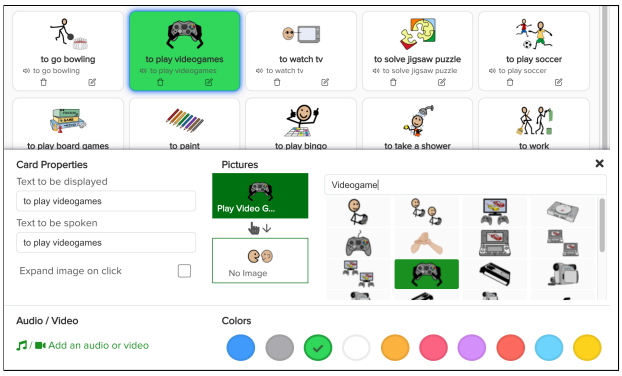


Figura 8 – Redesigned editing interface

For the parent who has the need of changing the application default settings, this menu was redesigned to group options in categories and make the possible changes clearer by providing an instant preview of the configuration changes. Setting controls were changed from sliders to steppers on fine-tuning configurations to help people with motor problems to use them more precisely. This redesign aims to reduce clutter and provides better accessibility, addressing the heuristics of error prevention, minimalist design, and match between system and real-world (NIELSEN; MOLICH, 1990)(NIELSEN, 1994).

# 7 Final Remarks

Livox is a popular AAC application with great potential for contributing to the effective inclusion of children with speech impairments, at school and in society, by providing means for their communication. However, user research indicates that novice users' learning curve is steep, leading to early dropout and a high level of need for professional support. Aiming at improving user autonomy (considering children with disabilities, their parents, and teachers) and improving learnability, we propose a redesign of Livox interface based on user needs collected from interviews with therapists and questionnaires for parents and teachers. As future work, the prototype needs to be tested by Livox users to evaluate usability and learnability, expected benefits in communication, and increase in user autonomy.

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