The *Today* and *Tomorrow* of Braille Learning

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ABSTRACT
Despite the overwhelming emergence of accessible digital technologies, Braille still plays a role in providing blind people with access to content. Nevertheless, many fail to see the benefits of nurturing Braille, particularly given the time and effort required to achieve proficiency. Our research focuses on maximizing access and motivation to learn and use Braille. We present initial insights from 5 interviews with blind people, comprising of Braille instructors and students, where we characterize the learning process and usage of Braille. Based on our findings, we have identified a set of opportunities around Braille education. Moreover, we devised scenarios, and built hardware and software solutions to motivate discovery and retention of Braille literacy.

Categories and Subject Descriptors
H.5.2 [**Information Interfaces and Presentation**]: User Interfaces.

General Terms
Design, Human Factors.

Keywords
Blind people, Braille, Learning, Games, Interactivity.

1. INTRODUCTION
Braille shows several advantages for blind people over other writing systems. First, it is flexible, making it possible to represent alphabet letters, accentuated letters, punctuation, numbers, and even musical notes. Second, the reduced number of keys required to input a chord allows a direct finger-key match, thus eliminating visual/tactile scanning. Therefore, blind users can achieve high text-entry rates using a simple 7 key chord-keyboard.

However, Braille literacy has been declining [5] mostly due to the use of electronic text and assistive software, such as screen readers. Moreover, with personal computers, blind users were nudged to use traditional QWERTY keyboards, since hardware adaptations were too expensive and cumbersome. For all these reasons, along with the big effort required to effectively read and write Braille, it has been progressively neglected. Nevertheless, Braille literacy is still the most empowering form of literacy for blind people and has shown to be the strongest predictor of higher levels of education and employment in adult life [5].

Our research goal is to provide new tools to improve Braille literacy, particularly using technology to support it rather than replace it. This is especially relevant for late blind users, who lack the motivation to learn new skills. Portugal provides an interesting case study on this point, since Braille instruction is part of blindness training public programs. Despite the initial training, few of the adventitious blind continue to use it in a daily basis, given the lack of external reinforcements and the false belief that Braille cannot be mastered after childhood. The learning process itself is long, dull, and requires expensive specialist settings. As a result, only a few are able to practice and master this system.

On the other hand, the potential of Braille has been recently explored together with mainstream devices [4] showing that the system is not confined to its traditional resources. We leverage on this idea and seek to explore new ways to support the learning of Braille making the process more appealing and available.

In this paper, we present a study to better understand how Braille knowledge is acquired, motivated and maintained. Building on the information retrieved, we present a set of scenarios using low-cost hardware and software, aimed at increasing the availability and appeal of Braille-based tools to support its learning and usage.

2. LEARNING BRAILLE TODAY
We conducted exploratory semi-structured interviews with 5 blind people (ages 26 to 53, M=37), where we asked about their daily usage of Braille and their personal experience regarding the learning process. We interviewed 3 students and 2 Braille instructors (that discussed their experiences as both teachers and students). The remainder of this section details our findings and challenges on the current state of Braille learning and usage.

Current panorama. Although participants learned Braille in various institutions, the process was similar. After an introduction to the Braille cell and dots positions with well-known artifacts (e.g. a 6-egg box), the learning sequence usually starts with reading. Yet, an overlap between reading and writing may occur.

Braille usage, even for mundane purposes, is much larger for experts than for novices. The two instructors were more aware of Braille labeling in different contexts, such as supermarket products and elevator buttons, contrasting with novice participants that over-relied on family help or memories prior to blindness. The most proficient participants also resorted to Braille in situations requiring privacy, such as creating notes as lecturing aids and labeling their artifacts for future use (ID/bank cards).

Lack of interactivity. All participants took or presently teach classes in small groups (2-4), but the interactivity among students is very limited. In advanced classes, students may take turns to write/read different parts of the text. Only occasionally, these two tasks may be interactive (e.g. one writes what the other reads).

Lack of resources. Braille classes usually confine blind learners to a Perkins Braille typewriter (or similar; or even a slate) and to paper sheets. What is a limited setting turns into the absence of resources when they leave the class. Current tools that allow the practice and production of Braille content are very expensive.

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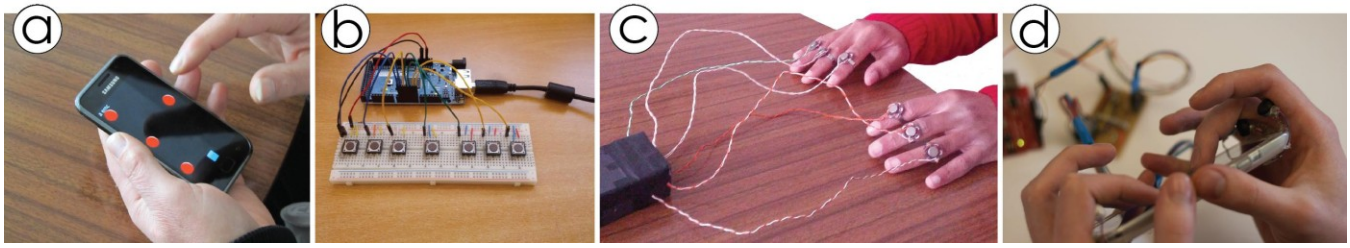

Figure 1. Novel hardware and software tools for alternative Braille-based applications (a) BrailleType, a text-input application for touchscreen devices [3]. (b) A low cost Braille-input device (c) UbiBraille [1], a Braille-reading vibrotactile prototype; (d) HoliBraille [2], a vibrotactile multi-point feedback prototype to improve Braille input.

Moreover, Braille resources (e.g. books) are promptly rejected, as reasonable performances require higher proficiency levels.

Lack of perceived purpose. Late Braille learners typically have lower proficiency levels and do not understand the purpose of improving it. In particular, they feel that audio-based technologies suffice to provide textual feedback and that the big effort required to be proficient in Braille is not advantageous. In contrast, the proficient ones were very positive about the advantages that such knowledge provides in their daily lives.

Lack of motivators. Lack of perceived purpose results in low motivation levels. This contributes to little learning effectiveness and to the abandonment of Braille after class completion. Both instructors acknowledged the lack of use of external motivators; yet, one of them introduced a simple game with cards and proverbs that seemed to improve largely the students' motivation. Even those reluctant to learn Braille, expressed excitement to participate and whilst they were unaware of the fact, they were practicing and enhancing their Braille reading skills.

3. LEARNING BRAILLE TOMORROW

Braille is commonly associated with its printed representation, notwithstanding it is much more than that; it is a system and an alphabet with enormous potential. Moreover, not so long ago, it was difficult and/or expensive to produce and have access to Braille content. Current digital technologies enable the creation, consumption and even conversion from other text-based content into Braille notation, leading to a much wider set of resources. Further, while still relevant in its traditional usage, it can be reinvented for mainstream or **novel technologies**, and through them, to novel scenarios. For example, recent projects have explored touchscreens as Braille chord keyboards [4].

Traditional Braille devices are heavily stereotyped. Fig. 1 presents our work on pushing Braille input to **mainstream devices** (a) as well as augmenting it with **Braile ouput** (d); (b) shows a **low-cost** Braille keyboard, that can be easily assembled to be used outside the classroom; (c) presents a method for vibrotactile Braille reading showing that the system is not restricted to the fingertip.

By deploying and adapting the Braille alphabet to new devices and technologies, other possibilities emerge. Particularly, given the **communication** and storage capabilities of current mobile gadgets, Braille can be used more interactively. Revisiting the Braille learning process, these capabilities enable **interactivity** between instructors and students and new scenarios for **collaboration/competition** between students.

Deploying Braille in low cost or mainstream devices enables new applications in which users can learn in new ways, explicitly or implicitly. Games can provide motivation and even allow users to learn without noticing. We are currently developing 3 applications to be deployed in a blind training institution: **BrailleHero**, a game to foster self-learning where, similarly to the popular game GuitarHero, the user has to input Braille chords to keep the music going (Braille input and output); **Horse Racing,** game where users are provided with stimulus (audio or vibration) representing characters, words or questions and have to correctly answer, as fast as possible (repeat the stimulus or answer a question); **Word Whispering,** a collaborative game where a word is transmitted from one user to the next (vibrotactile feedback and one Braille input method) expecting that it reaches the last user as the word it was initially inputted. The developed scenarios also support the traditional instructor-student and student-student dictation settings. One other advantage comes with the feedback retrieved by the applications, which can then be used to parameterize the learning tools, tailoring the learning process to each individual.

4. CONCLUSIONS

We characterized the Braille learning process, highlighting existing limitations and opportunities that arise from current technologies. We presented a set of scenarios, together with hardware and software tools, that aim to foster Braille availability and the motivation to learn. One limitation with our approach comes with the absence of focus on traditional fingertip reading, which is the hardest skill to acquire. However, it promotes knowledge of the Braille system, a fundamental first step to motivate people to improve their fingertip reading skills as well.

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