Low-Cost Technologies to Teach Beginner Braille to Children

Sara Azari (EECS 4080)
Practices in Enabling Technologies (PiET) Lab, Lassonde School of Engineering, York University

Introduction

- At present, there are very few interactive technologies available to help children with visual impairments to learn Braille. Teaching is typically done by trained teachers using a variety of teaching techniques and evaluation instruments.
- Treasure Box Braille (TBB) is an interactive device that provides an innovative approach to supporting the development of functional knowledge of Braille in children with visual impairments. The project espouses a low-cost DIY approach. TBB falls under the ENAMEL (ENAbling MEdia for Literacy) project.
- This project concerns making the TBB accessible to anyone who wants to make Braille learning a better experience, and on improving the TBB user interface.
- The objective of this research is to investigate and test the usability of the Treasure Box Braille and its associated set of teaching materials.

Background

A literature search revealed 92 publications that were relevant to the topic of technologies that support Braille education.

- Electronic Braille Tutor (Kumar, 2007)
  Audio feedback was provided on Braille letters that were written using the customized slate and stylus for an easier use
- Electronic Braille Blocks (Jafri, 2014)
  RFID-enabled blocks with embossed Braille labels, teaching through games, auditory feedback
- Braille Tutor (Joshi and Samasgikar, 2016)
  Uses 8 solenoid-based buttons to represent a Braille cell
- Braille Play (Milne et al, 2014)
  A 3x2 grid on smartphone, and when a letter is presented in Braille, pressing/touching the "raised" dot of the current letter will cause a vibration (Vbraille + Ubraille)

The Treasure Box Braille Prototype

TBB consists of:

- a 3D printed box
- a low-cost single-board computer (Raspberry Pi 2 B)
- a specialty refreshable Braille cell (Metec, Germany)
- an audio speaker and 4 buttons for user input
- open source software

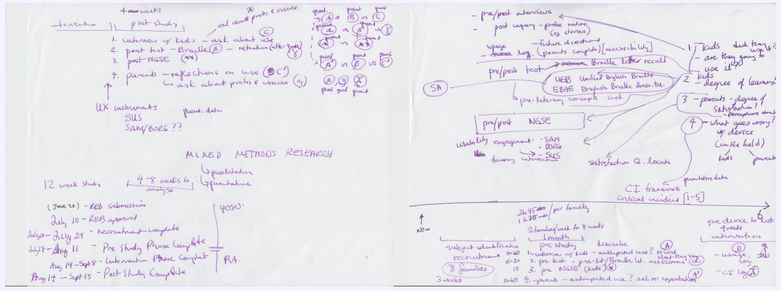
The Authoring App

- TBB presents interactive scenario to draw the interest of the child towards learning Braille characters through story telling.
- There are various scenarios developed in the current version of TBB software.
- For any user who likes to create stories, they may use the authoring application (fully compatible with screen readers). There is also a software simulator.

Method

- We employed an iterative, user-centered design (UCD) process (Norman, 2013).
- We performed a series of pilot tests at the lab (Pilot A, B, C), starting with testing the first prototype of the TBB with our tester, Runa Patel, one of the ENAMEL team members, who is representative of target users and knows Braille fluently.
- Following this, we employed a four week probe (field testing).
- Field testing protocol is shown below; at-home setting with families that have a child with a visual impairment using a pre/post methodology.
- Will employ standardized measures of usability, empowerment, satisfaction, and motivation. We also evaluate impact on the child's knowledge of Braille, and generate design feedback.
- Prior to starting the field study, we submitted the protocol to York's Research Ethics Board (HPRC). This protocol requires consent by proxy since it involves vulnerable minors.
- To support the DIY aspects, a set of instructables were prepared.

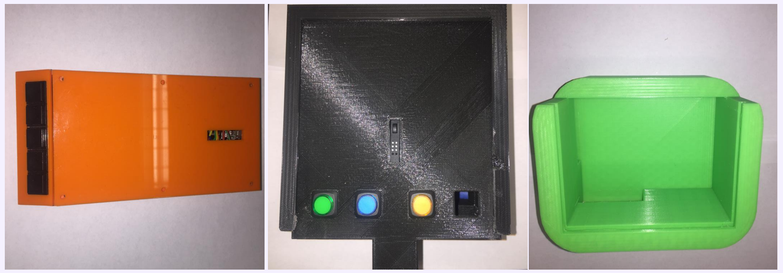
Stage	Weeks	What	Instrument/Technique
Participant Recruitment	1-3		Purposive Sampling
Pre-Probe A	4-5	Interview with Child Participant (A) Interview with Parent/Guardian (A')	***Semi-Structured Interview (SSI) Questions (pre)*** SSI for Children, SSI for Parents/Guardians ***Demo/Training Session***
Pre- Probe B	4-5	Pre-Intervention Assessment of Child Test children's Braille knowledge	***Quantitative Instruments:*** UEB/EBAE Braille Letter Recall Modified NGSE
Technology Probe	6-7	Families use TBB device at home (2 weeks, 10 occasions)	***Qualitative/Quantitative Instruments:*** Use Diary/Critical Incident reporting UX instruments SAM/BORG/SUS Field Observations Data from TBB (score, time use)
Post- Probe C	1-4	Interview with Child Participant (C) Interview with Parent/Guardian (C')	***Semi-Structured Interview Questions (post)*** SSI for Children, SSI for Parents/Guardians Debriefing Session
Post-Probe D	5-9	Post-Intervention Assessment of Child	UEB/EBAE Braille Letter Recall Modified NGSE UX instruments SAM/BORG/SUS



Brainstorming for study protocol development

Results and Conclusion

- The results of pilot tests A, B, and C, were used to adjust TBB.
- We built various versions of the TBB prototype, modifying the 3D model, software, and the interface.



Prototypes 1, 2 and 3

Current Challenges and Future Work

One of the most challenging aspects of the study design was coming up with a scheme to measure the improvements, if any, using the TBB would have made in the level of Braille literacy knowledge of the users. That being said, we studied various pre-literacy preparation and tests, and collected the characteristics and pre-learning knowledge possessed by the participants prior to the study that we like to make sure the participants are able to perform.

Once the field study is completed, future work will be to make use of the study results to derive the next version of the TBB system. As well, future work will include evaluation of the instructables.

References

Baljko, M. (2008). *The Aesthetics of Emergence: Co-constructed Interactions*. in TOCHI.

Jafri, R. (2014). *Electronic Braille Blocks: A Tangible Interface Based Application for Teaching Braille Letter Recognition to Very Young Blind Children*. in Computers Helping People with Special Needs.

Joshi, A., Samasgikar, A. (2016). *Braille Tutor: A Gift to the Blind*. in Advances in Signal Processing and Intelligent Recognition Systems.

Kumar, S. (2007) *Talking Braille: A new tool to teach blind children*.

McCal, S., McLinden, M., Douglas, G. (2100). *A review of the literature into effective practice in teaching literacy through Braille*. in RNIB Knowledge and Research Hub.

Milne, L. R., Bennett, C. L., Azenkot, S., Ladner, R. E. (2014). *BraillePlay: Educational Smartphone Games for Blind Children*. in ACM ASSETS.

Norman, D. (2013). *The Design of Everyday Things*.

Wheeler, J. (2016*). Literacy and Assistive Technology Instruction for Children with Visual Impairments and Multiple Disabilities*. presented at the 2016 General Assembly Papers.

Acknowledgement

I would like to express my gratitude to Professor Melanie Baljko as my supervisor, and the PiET lab, York University, for providing resources to conduct the ENAMEL/TBB project.