Pre-Pilot Findings on Developing a Literacy Tablet

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ABSTRACT
We report observations on how children in a developing country respond to a *literacy tablet* that is designed to initiate and scaffold literacy learning toward self-sufficiency. This paper describes our first lessons from developing an educational system for enabling children who have no access to schooling to read with minimal outside intervention. We share lessons learned from challenges in the design process, discuss implementation considerations for deploying in remote developing areas, and discuss observations of how children use the technology. We reflect how this experience impacts ongoing work on developing countries regarding collaboration and literacy learning.

Categories and Subject Descriptors
H.5.w. User interfaces, K.3.1. computer Uses in Education, Literacy, H.5.m Information interfaces and presentation (e.g. HCI): Miscellaneous.

General Terms
Human Factors; Design

Keywords
Developing countries, literacy tablet, tablet interaction, technology implementation.

1. INTRODUCTION
Giving children access to quality education is one of the biggest challenges of our time. This problem is particularly challenging in 3rd world countries where resources may simply not be accessible or available. Unlike other developing country projects on literacy using schools and teacher intervention [13], we attempt to solve this problem by developing a scalable solution that would initiate and sustain their education outside of schools, without teacher intervention. Our experience design, nicknamed the *literacy tablet* (Figure 1) would ideally be given to children in remote villages with minimal outside intervention, if any. The tablet would guide children to master educational concepts and skills by monitoring each child's interaction over time.

We report observations and lessons learned from deploying an initial version of the device in a pre-pilot. Based on our experience, we would like to share some reflections on logistical issues, user interface considerations and collaborative teaching.

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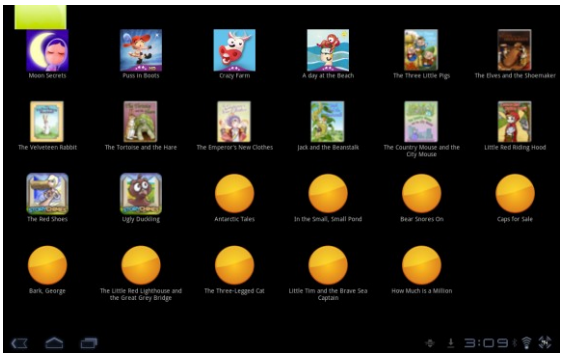

Figure 1. Picture of the screen on the literacy tablet prototype

1.1 Delivering "quality" literacy education
Prior solutions to educating the world have focused on providing access to technology, importing foreign teachers, and training local teachers [4], [12]. Technology access projects have been criticized for not developing curriculum to guide children's learning. Outreach programs have struggled with places too remote or dangerous for qualified teachers to reach. Local training programs often find that local teachers are often only slightly better educated than their charges. Attendance is sparse due to political, geographical, financial, and agricultural factors. Often villages are too remotely located or too small for the government to devote the resources to establish a school. Finally, delivering high-quality teaching is also challenging when learning materials are scarce.

1.2 Approach: Can technology help children bootstrap literacy education?
Recently, educational psychologists suggest that enough is known about cognition and literacy development to design interfaces to help children learn to read [16]. Neuroscientists have created a curriculum based on how children's brains develop reading skills by integrating the cognitive, perceptual, and linguistic processes [17]. The Hole-in-the-Wall study reported that children taught themselves to use technology with minimal teaching and adult supervision [14]. The observation that children self-organized into learning groups and collaboratively solve puzzles yields a promising potential for educational technology. Many technology advances further suggested that technology could scaffold and guide the complex path to literacy:

1. Wireless touch-screen tablets have become widely available to the public. Tablets can provide a wealth of educational resources, such as books, lectures, and educational games. Logistically, remote, rural villages in developing countries often do not have easy access to electrical power but this problem has been solvable by means of solar energy [3].
2. Touch-screen tablets provide a natural interface for interacting with digital information. There is no extra hardware needed for interacting with the touch-screen, and

users can carry them easily. Furthermore, book-sized surfaces encourage shared-visual referencing of onscreen content, prompting group communication [7]. In one instance, when young children were prompted by interactivity to enact demonstrative behaviors, they were observed to "act" like teachers [7].

3. New mobile device sensing frameworks can capture usage and automatically upload the data from the field. Capturing usage data would enable the system to respond to each child's independent learning trajectory by presenting new information to scaffold the next stages of learning [2], [11].

These combined educational and technological advances prompt the research question, "How could technology bootstrap the collaborative literacy learning process?" Working with a team of educators, media researchers, literacy specialists, and technologists, we investigated if we could build an education platform to prompt self-directed literacy learning from available materials. Because of the team's academic expertise and our available content knowledge on learning, we targeted English literacy as opposed to a foreign language. We initially focused on Sierra Leone due to existing local knowledge, political contacts, and practical experience deploying technology in that nation. In this country, proficient literacy in English is needed to advance educationally beyond grade school. However, many rural children are unable to pursue formal education due to lack of access to early English education.

2. THE LITERACY TABLET

Essentially, our concept of the *literacy tablet* is a wireless touch-screen tablet that will steer a user along a personalized learning trajectory of literacy. Given that the trajectory for English literacy learning is understood, the main task was to understand how to personalize and create the content as efficiently as possible. Logistically, we wanted to understand whether we could create a learning experience from commercially available components.

The tablet hardware was selected from the commercially available tablets available in summer 2010. Sensitive to usability issues that may arise in a Saharan desert, we analyzed different hardware tablets to determine which brands could provide the best experience for novice users. Two of the five hardware brands we tested did not make the grade for functional experience. One brand did not have enough processing power or memory to provide a pleasurable experience for playing apps or movies. Another hardware brand required too long to charge (over 6 hours from a wall outlet). In field conditions, we estimated it would be impractical to charge that tablet fully in power-poor places.

Although many available tablet-based literacy apps targeted to children exist, a technologically self-contained literacy curriculum experience does not exist that can help children create the neural connections that lead to reading. Simply loading up a commercial tablet with literacy applications seemed like a good initial step. We compiled all commercially available hardware and software into prototype literacy tablets and judged their function and educational value.

2.1 Content Considerations

Our team reviewed over 100 third-party apps available in the Android and iTunes app marketplaces for appropriate examples to include. They were screened for pedagogical robustness, age appropriateness, and even for technical considerations (many apps would not run properly in a disconnected environment). Much of the currently available content for literacy development was deemed inappropriate or insufficient for proper learning; this indicates an opportunity for providing higher caliber content to parents.

We realized these children would have different cultural contexts than the apps targeted by the developed world. Art styles from African culture are very different from conventional representational styles. Cultural icons and commonplace western ideas may be out of their range of experience. We researched the teaching texts available in remote Sierra Leonean villages. We scoured the CIA Factbook[5], Peace Corp manual [1], researched Sierra Leone folklore, interviewed visiting Sierra Leoneans to assess the content we would provide. We supplemented the interactive apps with passive content (educational TV series and movies) from partner sources like PBS (ex. Between the Lions) and WGBH.

Apps were arranged, randomly, on the tablet as a 2-deep, nested collection (see Figure 1). We used plain, colored icons for the top level of app collections. The second level used plain icons for passive content, while the interactive apps retained their original icons. Children were free to rearrange these icons on their tablets and often did as a means for customization.

Many of the apps taught the ABCs or phonics through repetition and recall. We acquired Chang's thesis software [6] to see if children would be prompted to develop the same teaching behaviors as reported in the US.

Many apps were dismissed because they were educationally confusing and would not help children make the cognitive relationships needed to learn. Eventually, approximately 100 commercially available applications and educational movies were vetted by academic reading and cultural experts.

3. SIERRA LEONE PRE-PILOT

In early 2011, after 8 months creating and testing the prototypes, we were ready to observe how the target population responded to the experience in a pre-pilot. We hoped that the pre-pilot would help us answer the following questions:

1. How much human intervention would they need to learn to use the tablet?
2. How many tablets per village?
3. How to track the progress of the learners?
4. Would the tablets work in rural Sierra Leone?

Our attempts to answer these questions changed over the course of the study.

Method: One researcher, a graduate student, voluntarily traveled to his native country. The researcher took 9 tablets (3 different brands of tablets loaded with expert-approved emergent literacy apps, movies, and music from Android Marketplace and App Store. He intended to observe, facilitate, and note down usability issues for developing the literacy tablet experience. We hoped to identify which interface elements were easiest and engaging for the children.

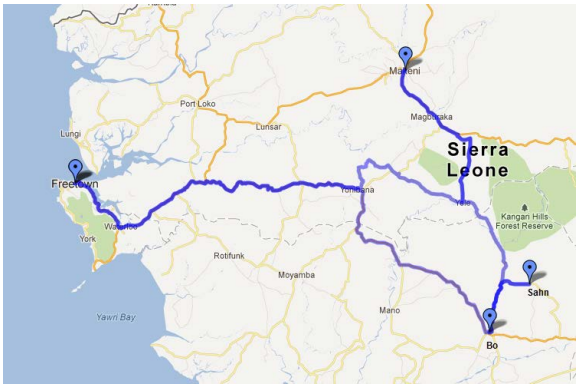

Figure 2. Pre-pilot map of 4 remote rural villages near Freetown, Makeni, Bo, and Sahn Malen.

The researcher visited four rural villages outside of Freetown, Makeni, Bo, and Sahn in Sierra Leone over the course of two weeks. He traveled over 450 miles between remote villages, staying 2 days in each village (Figure 2). Travel took at least one day due to infrastructure, and one visit was cancelled due to washed-out roads. The researcher had recruited groups from the local population using word of mouth by calling his contacts in each area. In each town, approximately 8 to 20 children, approximately 80% male, ages 2-15 voluntarily came to play with the prototypes. Approximately 60 children saw the tablets in total, for a single sitting lasting a few hours. The children gathered on porches and living rooms in private homes. After giving them the tablets, he walked around the room documenting the experience with cameras and interviewing or giving advice to the children.

At each village, the children had little to no schooling although there were schools in the larger nearby village. Most of the children did not attend school, and attended irregularly if they did. None of them knew how to read, although some of the older ones had heard of reading and the ABCs. None of the children owned any electronic devices, but some had seen mobile phones from visits to the bigger cities.

3.1 Pre-Pilot Observations

The local reaction to the idea of a *literacy tablet* was overwhelmingly positive and eager from the communities. It was hard for the researcher to keep track of the number of children because he would start with 8 children and then more would show up when they heard there was something to play with. In Sahn, 20 unschooled children (ages 4-15) from 2 neighboring villages walked for 6 miles to see the prototypes. At one site, 2 English speaking Peace Corp volunteers helped introduce the tablet software. The children soon learned how to "read" the stories on the tablet exhaustively.

Children were also extensive in learning the buttons on the tablet. They had no problems figuring out how to independently turn on iPads due to the lone power button on top and single home key on front. Xooms have a hidden power button in an unexpected place at the back of the tablet. Vizios, with obvious buttons but many of them, were moderately easy to power on. Due to the form factor of the hardware buttons, users experienced similar ease in navigating through the tablets.

Because only one click was needed, children were able to open apps without help. Children figured out how to quit apps quickly after. The iPad home button was the easiest to learn, while the Android back button took a slightly longer time to figure out. They would quickly exit apps that had multiple steps before they game play. Apps that began with instructions or selection buttons were likely to be exited quickly. Apps that contained a lot of audio instructions were also ignored, since the children did not yet speak English.

Gestural control in apps seemed the easiest to use. Alphabet Car and Fruit Ninja were favorites. Alphabet Car is a gesturally controlled driving game where the tilt of the screen controls which side of the road the user's car is on. Users can steer the car over a letter to create a word. Fruit Ninja requires that users swipe their finger across different flying fruit while avoiding bombs.

Unlocking the Xoom tablet was difficult. Children eventually guessed the unlocking gesture by reasoning that they needed to "turn" the lock. The lock metaphor was cumbersome in comparison to the slide arrow on the iPad. In reality, all they had to do was drag their finger past a certain distance. The wider drag distance required to unlock the Vizio made them the hardest to unlock. The whole idea of "locking" a tablet to prevent theft was a strange idea to the children.

Socially, the children were very group-oriented in their interactions. When one child found an app interesting, they would call out and gather crowds around them. Age and gender contributed much to the dynamic. Boys were most aggressive, physically hitting and yanking away the tablets from girls when they saw something interesting. At one point, older children found a popular Sierra Leone song and all others in the room stopped and gathered around to listen. A few young children (2-4 year olds) were initially afraid to touch, and were guided by others. When parents were present, they tended to guide the interaction, instead of allowing the children to investigate freely.

4. PRE-PILOT FINDINGS

Our pre-pilot helped us answer the following questions:

1) How much human intervention needed?

Very little instruction is needed to use the technology. Apparently, it typically took 30 minutes for the first child to turn on the tablet. Then that child would teach everyone.

2) How to track the progress of the learners?

We also realized that a custom application would be necessary to allow us track and scaffold reading progression and technological literacy. To make the experience enjoyable, apps that use gestural control, with minimal steps to gameplay action were desired. Apps would also have to be tested for independence from wireless networks.

3) How many tablets are needed?

We realized that we would need to provide one tablet per child per site. This would help the younger children and girls to keep their tablets. We would follow the One Laptop Per Child (OLPC) model of enlisting cultural support from the elders and adults in the community, to help the children feel ownership for the tablets [15]. We reasoned that the more freedom children had to play with the devices, the more quickly they would learn from them [14].

4) Would the tablets work?

Unfortunately, the Wi-Fi connectivity required by many children's book apps rendered them inoperable. Although the power needs of 9 tablets were moderate, charging the tablets took time away from play. It was clear that a custom charging solution would be needed in even more remote places where power was not as readily available.

4.1 First Observations of Literacy Teaching

One of the included apps in the pre-pilot was a TinkRBook (a tinkerable storybook) [6]. We were able to see how children reacted to a storybook reading experience, even though the other book applications were not working due to disconnected wifi problems. Consistent with children in the US [8], they were fascinated by the ability to change the duck color and touch the words. When literate adults guided the children in reading the words, the children quickly repeated the phrases in a sing-song manner. It seemed they were eager to learn from the adults about text, even though they could not read.

Through questioning, the researcher found that children could easily connect the association between the word 'duck' and the onscreen picture of the duck. However, they had difficulty transferring the onscreen concepts and into the real world. For example, the word "mud" is well known, but the children had to be prompted before recognizing that the word "mud" on the screen could also refer to the mud on the ground.

Another observation was the strength of one child's memory. When the researcher circled back to the first town (Freetown) a week later, he observed that one of the children, a 4-year old boy, had particularly good recall of the content. When this child took hold of the tablet again, he immediately began teaching his friends using choral reading. He would point to a word and say the word correctly, and then his peers would echo this "teacher." Whether he understood all the words is debatable, but his memory (after only one exposure by the adult) and initiative to retell the written story was inspiring. He was a quick learner [9], and we wondered if his peers would respond similarly if provided with more exposure to the tablet [10].

5. DISCUSSION AND NEXT STEPS

Based on our pre-pilot findings, the need for customized software was apparent. In order to understand the children's progress and interests, we would have to track and scaffold the children's interaction with content. The next version of the literacy tablet aims to refine 3 basic components: a) customized literacy trajectory content, b) affordances to aid technological literacy and c) more robust methods to analyze a user's literacy progression.

5.1 Literacy bootstrapping is possible

In regards to literacy learning, our videos clearly show that the children were connecting the words to the images and sounds correctly. They understood the existence of a connection between the elements and words within the storybook. They were independently taking the steps toward reading, and they were teaching each other.

Again, these children had never been exposed to school before, so it was impressive to see evidence of self-organized peer teaching with minimal exposure to technology and demonstration by adults. This particular finding from the pre-pilot spurred hope that initiating and sustaining literacy education through these tablets may be possible.

5.2 Children share to teach each other

The most surprising result of the deployment was the observation of peer teaching among the community. In particular, children were eager to learn more about the tablet and content in order to share with each other. Our observations reaffirm earlier reports of this behavior, but demonstrated how powerfully new knowledge spread through audible, tactile and kinesthetic channels. Once a child learned how to operate one facet of learning, their wisdom was shared enthusiastically. We were also very impressed with how quickly parents learned from their children and wonder at the potential of education spread with children in the role of teachers to their communities in these remote areas.

6. ACKNOWLEDGEMENTS

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