Iterative Technology-based Design with Deaf/Hard of Hearing Populations: Working with Teachers to Build a Better Educational Game

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Abstract: Leveraging the use of mobile devices for educational games has been an area of increasing interest for targeted subpopulations of students, such as those who are deaf/hard of hearing. This poster outlines the involvement of Deaf Education teachers in directing the design and development of a mobile game for their students, and the ways their participation reinforced the goals of the educational objectives as embedded in unique gaming experiences.

Objectives
With this paper, we offer a rich description of one project aimed at building a global positioning GPS mobile game to help students who are deaf and hard of hearing (D/HH) learn mathematics. By working with Deaf Education teachers in an iterative design and development cycle, critical aspects of instructional design were identified and monitored as manifested in the prototype technology. Researchers created a prototype mathematics game for mobile devices equipped with GPS technology called GeePerS*Math: The Logic Machine Rescue. This paper presents the results of the initial design and implementation decisions of creating the GPS game with specific requirements for the student D/HH population. It is part of a larger project investigating GPS-enabled mobile learning games with D/HH students.

Theoretical Perspective
Successful communication and language proficiency are critical to learning and classroom performance, however D/HH students struggle with English, its vocabulary and structure, in both oral and written modes (Barham & Bishop, 1991; Kelly & Mousely, 1989). Particularly in mathematics, the frequent use of conditionals, comparisons, negation, and inferences, as well as multiple meaning words often impede the D/HH student from understanding mathematical concepts and problems (Kelly, Lang, Mousely, & Davis; 2003; Kidd & Lamb, 1993; Kidd, Madsen, & Lamb, 1993). In addition, signing these concepts (whether in ASL or an English-based sign system) without awareness or knowledge of mathematics may lead to a mis-representation of the concepts/problems causing further misunderstanding (Ansell & Pagliaro, 2001).

Increases in achievement among hearing students can be associated with instructional approaches that engage them in challenging mathematics problems as recommended by the National Council of Teachers of Mathematics (NCTM, 2000). However, studies show that mathematics instruction within Deaf Education relies heavily on traditional practices of rote learning and procedural understanding with little emphasis on higher order thinking skills and true problem solving (Kelly, Lang, & Pagliaro, 2003; Pagliaro, 1998; Pagliaro & Kritzer, 2005).

Methods
Project GeePerS*Math is being implemented in schools for children who are deaf and hard of hearing as well as those who are being mainstreamed in the regular public school system in order for project developers to better understand the needs and challenges of implementation in each type of school. One project school (oral) has 420 children from K-grade 6, with 40 children who are deaf or hard of hearing in inclusive settings within the school. The second school (ASL) serves approximately 50 children, all of whom are deaf or hard of hearing. To add meaning to data collected and analyzed quantitatively, a multiple-case qualitative research study design will be followed throughout the development of this project.

Small focus groups were held with participating teachers in the fall of 2010 and spring of 2011 to engage teachers in the development and evaluation of the gaming technology. Questions focused on the development of the gaming technology, as the project staff needed to understand the context in which the children learned, their level of sophistication, their attention spans, and how they might perceive the games. In the fall, teachers were asked questions that elicited the types of mathematics problems their children would need
to practice in the gaming technology, the types of games and characters necessary to engage children (cartoons, realistic), the game setup, and how the games should proceed

Findings
The focus group responses were categorized by type of question and frequency of response. The comments were used in the design process of the first game prototype (see Table 1).

Table 1: Examples of Most Mentioned Design Considerations by teachers of students of D/HH

<table>
<thead>
<tr>
<th>Design Consideration</th>
<th>Game Implementation</th>
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<tbody>
<tr>
<td>1. Use a superhero</td>
<td>Welcome to the X-Fraction Hero Training Program. There are five stages to your training. In each part you must do a task key to progressing the narrative to get an item and ruin the plans of evil Dr. Ickles and his monsters.</td>
</tr>
<tr>
<td>2. Make the mathematics fun; not just mathematics problems</td>
<td>The storyline of the game centers on superhero training. The child using the game is designated as a superhero in training. In the story, Dr. Ickles has stolen the logic machine from the research lab and the trainee (the child playing the game) must solve a number of challenges (and mathematics problems) in order to progress through the game and rescue the logic machine.</td>
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<tr>
<td>3. Make the mathematics problems straightforward</td>
<td>The river is 26 feet wide. The blue rope is 12 feet long. If you tie the blue and red ropes together, how much more of the red rope do you need to be able to get across the river? A: 14; B: 2; C: 12; D: 10</td>
</tr>
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Significance
Using teachers to help create an iterative design for the production of a mobile game to learn mathematics is challenging due to scheduling, curriculum integration, training, and other resource constraints. In order to integrate audience participation in the design and development of games, we involved the teachers of students who are D/HH. This involvement facilitated communications about enjoyable elements infused and aligned with relevant mathematics standards. An exciting aspect of this project is its potential contribution to knowledge in the field as described in the previous section, but perhaps especially related to practice. By using the strategies and technology to be developed, it is expected that more D/HH children will successfully achieve mathematics milestones, and in turn, improve their chances to reach competency in mathematics.

References

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