Teaching Math to Deaf/Hard-of-Hearing (DHH) Children Using Mobile Games: Outcomes with Student and Teacher Perspectives

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ABSTRACT

Leveraging the use of mobile devices for education, such as instructional games, is an area of increasing interest for targeted subpopulations of students including those who are deaf/hard-of-hearing (DHH). This paper outlines the perspectives of Deaf Education teachers and DHH children who participated in the GeePerS*Math project. Interviews and surveys provide data from the primary implementation of the technology in an ecologically valid setting. Findings included similar results from both teachers and students with regard to attitudes and transfer of skills within the game to those in traditional curriculum. Unintended outcomes, such as gaining orienteering skills and peer-tutoring, were also noted. The results helped to inform the designers of educational technology with ways to relate with classroom instructors and children when creating advanced mobile applications.

KEYWORDS

Deaf Education, Design Research, Educational Technology, Mobile Games

INTRODUCTION

The interest in leveraging mobile technology for education has been increasing in number and complexity in traditional education, military, and corporate contexts for at least the past decade (e.g., Klopfer, Squire, & Jenkins, 2002; Naismith et. al, 2004). Specifically, leveraging portable smart devices such as phones and tablets for K-12 environments has been of keen interest for instructional technologists and learning scientists (Shelton et. al, 2010). Designers of educational technologies must therefore be cognizant of the students’ needs as part of their development process.

The iterative design utilized in this project draws from literature in design research. According to Collins et al. (2004), Anderson & Shattuck (2012) and Palalas et al. (2015), design research methods are well-suited to contextually-based, real-world messy settings in projects that require iterative
evaluation and revision during the project design lifecycle. Gibbons (2014) specifically addresses the existence of a multitude of variables in design research and the need to define, describe, and record “the research situation, for each new iteration, as much detail as possible, in the spirit of keeping a lab notebook” (p. 109). One component of design research involves creating a detailed profile of the population and environment in which the design experiment is to be conducted. In this instance, the design research team involved the teachers and students early in the design process of all instructional gameplay components, as well as during post-gameplay. This involvement increased the effectiveness in the way the educational tools were built and facilitated the creation of opportunities for successful implementations within the classroom. Specifically, the students provided valuable insight with regard to the design of the educational games. The students provided direction as to how the design could assist their classmates in achieving the educational goals of the exercise.

The GeePerS*Math game was implemented in a state-level network of schools for the Deaf and Blind. Several elementary schools and several classrooms in each school participated. Communication methods of the students included both ASL and oral methods. The children who participated were in 4th, 5th, and 6th grades. Students were surveyed regarding design elements after playing the games. This research followed the IDLF framework as proposed by Bannan-Ritland (2003), in that data was extracted through a design research method as implemented through educational activity. Through the first phase of the iterative design and development process, the following key questions guided this research:

1. How do teachers and students describe the impact on student attitudes as a result of playing the GeePerS*Math game?
2. How do teachers and students describe the impact on student knowledge (mathematics concepts, nature of mathematics, and nature of mathematics) as a result of playing the GeePerS*Math game?

This article offers a rich description of the initial implementation aimed at designing, developing and evaluating a global positioning GPS mobile game to help students who are deaf and hard of hearing (DHH) 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 article presents the results of the implementation of the project in several schools with DHH students. Further, it describes ongoing design work based on the student and teacher evaluation of the mobile game to address the future requirements of educational technology in this particular area of study.

ANALYZING THE GAP

Performance indicators over the last four decades describe a consistent and significant gap in the mathematics achievement of DHH students. While the 2013 National Assessment of Educational Progress reports 74% of 8th grade and 83% of 4th grade U.S. students at or above the “basic level” in mathematics, the most recent achievement data on DHH students show ~20% of 4th and 8th graders scoring above a “basic” level of understanding in problem solving and above a “below basic” level in procedures or computation (NAEP, 2013). These percentages indicate an overwhelming majority of DHH students are performing below their grade level with at least half graduating from high school at a 5th/6th grade level in mathematics (Traxler, 2000). These statistics are supported by Blackorby & Knokey (2006) in a study showing that 30–52% of students with hearing loss score below the 30th percentile for mathematics calculation and by Noorian, Maleki, & Abolhassani (2013) confirm DHH
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