PRF RESEARCH GRANT INFORMATION FORM

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Title of Project
Comparing the effectiveness of two app-based number lines in teaching price comparison for students with autism

Will the research study involve the use of vertebrate animals, human subjects, or rDNA/biohazards?  
X Yes  
No

(If yes, indicate reference numbers below. This is a required field – if no approval has been obtained, indicate ‘pending’ in approval number line)

PACUC [Animals] approval number  
IRB [Humans] approval number  
IBC [r-DNA, bio-hazards] approval number

Do you currently have a PRF Grant  
X yes  
no

If yes, expiration date  
Sponsor Program No.  

Not required, however, if you know the name of the Ph.D. graduate student you will be supporting:

Name of Student  
Pei-Lin Weng

Student ID #  
00233-29870

Graduate Index  
3.87  
(Based on  
107  
accumulative hours completed)

Project Director Signature  
Emily C. Bouck  
Date  
1/16/13

Endorsed:

Dean or Delegate Signature  
/  
Date
Abstract

Price comparison is one of the functional mathematics skills required for increasing independence in community living. Yet, little literature exists on how to teach this skill and what adaptations to use within in grocery stores, especially for students with autism. A number line is a commonly employed tool for teaching price comparison. However, its lack of visual cues as adaptations might not be sufficient for students with autism who have not yet mastered symbolic numerical comparison (i.e., Arabic number comparison) skills. The purpose of this study is to compare the effectiveness of two types of app-based number lines (i.e., number lines with and without non-symbolic numerical representation [i.e., an array of dots]) presented on mobile devices to teach price comparison in grocery stores. A single-subject, alternating treatment design study will be employed across three-to-five secondary students with autism. Visual analysis and two effect size indices, such as percentage of non-overlapping data and standard mean difference, will be conducted to compare the effectiveness of the two types of app-based number lines.
Proposed Study Narrative

Brief Introduction

Statement of the problem. Price comparison (i.e., determining the lowest-priced product) is a functional mathematics skill involved in purchasing processes that promotes independent living for students with disabilities, including students with autism (Browder, Spooner, & Trela, 2011; Cihak & Grim, 2008). Price comparison is a chained-step task, meaning it consists of multiple steps (i.e., identifying prices, comparing prices, selecting lower-priced items; Storey & Miner, 2011). Of the steps that compose price comparison, comparing the magnitude of numbers (i.e., prices) is the most critical – and often most challenging – step (Weng & Bouck, in preparation).

Despite the value of price comparison for all individuals, let alone for students with disabilities, only one published study exists on how to effectively teach students with disabilities price comparison (Sandknop, Schuster, Wolery, & Cross, 1992). In that study, Sandknop et al. (1992) found number lines to be successful in teaching price comparison to students with disabilities. Although number lines have a long history being employed in general and special education (Browder et al., 2011; Earnest, 1985; Mosley, 2001), the literature on using number lines to teach numerical comparison for students with autism is still scarce. Recent work by Weng and Bouck (in preparation) investigated teaching students with autism price comparison skills and found number lines were effective. However, students who struggled with comparing numbers struggled with price comparison even with use of the number line.

Although a number line can act as a scaffold for students with disabilities who struggle with comparing numbers to select the lowest priced item and hence be more independence, a traditional number line may be insufficient. Traditional number lines consist of only symbolic
numbers (Mosley, 2001). Researchers need to explore appropriate adaptations to the traditional number line for students with autism.

**Rationale of the study.** This proposed study will investigate the effectiveness of an adaptation (i.e., additional visual cues on a number line) on helping students with autism learn and independently employ the critical steps of price comparison. Students with autism usually benefit from visual cues as adaptations, although research does not exist for these students with regards to visual cues on a number line (Quill, 1997). However, visual non-symbolic numerical representations (e.g., an arrays of dots) are often used to scaffold students’ understanding of symbolic numbers (Mosely, 2001). As a result, adding non-symbolic numerical representations to traditional number lines may facilitate the processing of symbolic numerical representations by students with autism (Reeve & Humberstone, 2012).

In addition to evaluating the effectiveness of an adapted number line to facilitate price comparison skill learning, this proposed study will employ a mobile device to present number lines (i.e., app-based number lines). Although paper is the most common media to present number lines, mobile devices provide different advantages as an instructional assistive technology (Cannella-Malone, Wheaton, Wu, Tullis, & Park, 2012). For one, mobile devices allow for easier and more age- or situation-appropriate use in community-based settings, which is the ultimate goal of learning functional skills, such as price comparison. In sum, the purpose of this study is to investigate the effectiveness of two types of app-based number lines delivered via mobile device to teach price comparison for students with autism.

**Specific Research Hypotheses or Questions**

The results of this study will provide empirical evidence on the effectiveness of using an adapted number line – specifically adding additional visual cues (e.g., arrays of dots) – in
teaching price comparison skills to students with autism. Specific research questions include: (a) Are number lines effective in teaching price comparison? (b) Which type of number lines yields a greater effect (i.e., percentage of selecting lower priced items)? (c) Which type of number lines yield greater acquisition rate (i.e., percentage of completing steps of price comparison, and the number of sessions to master all steps) in a grocery store? and (d) How do students and teachers perceive the use of two types of number lines on a mobile device during price comparison tasks?

Methodology/Research Design

A single subject experimental design – specifically an alternating treatment design (ATD) study across participants – will be employed to investigate the use of two types of numbers lines among students with autism during price comparison tasks. Single subject experimental design is an experimental methodology commonly used to investigate functional relationships between independent and dependent variables, especially for low-incidence populations, such as students with autism (Horner, Carr, Halle, McGee, Odom, & Wolery, 2005). ATD is selected because it allows researchers to compare the effects of two interventions by rapidly alternating instruction on two equivalent target behaviors (Barlow, Nock, & Hersen, 2009).

Participants. Three-to-five seventh-to-twelfth grade students with autism will be recruited. All recruited students need to meet the following criteria: (a) enrolled in middle or high school; (b) diagnosed with autism based on state criteria or diagnostic instruments; (c) identified with mild or moderate intellectual disability; (d) demonstrated one-to-one correspondence from 0-20; (e) not yet mastered price comparison skills; (f) visual and hearing functioning within normal ranges prior to or after correction; and (g) IEP goals related to functional mathematics and community-based activities – specifically involving trips to grocery
stores. The special education teachers of participating students will also be recruited for social validity purposes.

**Research Procedures.** The ATD used in this study consists of a baseline phase, a training phase, an intervention phase, and a generalization phase. This study will take place in three types of settings: special education classrooms, local grocery stores, and shopping malls. Baseline and intervention sessions will be conducted in local grocery stores, while training sessions will be completed in the special education classrooms of the target students. Generalization sessions will occur in local shopping malls. Grocery stores and shopping malls represent where students typically partake in the community-based instructions and apply price comparison skills in authentic situations.

The baseline phase will consist of five sessions and each session will involve five trials of selecting lower priced items in grocery stores. During each trial, two different priced choices will be given. Students will be given verbal directions to select the lower priced grocery item from the given choices per trial. Responses will be counted as correct if a student select a lower priced item and place it in the cart within 20 seconds per trial. The responses will be considered incorrect if students did not pick up a lower priced item and place it in the cart, or did not respond within 20 seconds. No additional instructions will be given.

Prior to intervention, researchers will teach students how to use the two app-based number lines, including how to select the marker and eraser function modes on the apps. On the number line without additional visual cues, students will need to use their fingers to circle two target numbers on the number line presented on the mobile device under the marker mode and use fingers to erase the circles after finished tasks under the eraser mode. On the other number line with additional visual cues, students operate the number line the same way; the only
difference is that the dots (i.e., visual cues) associated with the magnitudes of the numbers will appear on top of the circled numbers and dots will disappear when circles are erased. Students are required to independently operate the two apps before moving into intervention.

The intervention phase will consist of a minimum of 10 sessions – at least 5 sessions per condition. The two conditions will randomly alternate, with no more than two consecutive sessions with the same condition. Each session consists of five trials of selecting lower priced items in grocery stores. Similar to baseline, responses will be counted as correct if a student completes a step of a price comparison task within 20 seconds. The responses will be considered incorrect if students do not complete each step or did not respond within 20 seconds. When students fail to respond within 20 seconds, the researchers will also employ most-to-least prompting procedures to teach students correct steps (Wolery, Ault, & Doyle, 1992).

Finally, generalization phase will consist of six sessions using similar procedures as intervention phase. Each session will consist of five trials of selecting lower priced items in shopping malls. The order of two conditions will be counterbalanced throughout the six sessions.

**Planned Analysis and Interpretation**

In this study, results will be interpreted via visual analysis and effect-size computations of baseline phases and two types of intervention conditions (i.e., app-based number lines with and without additional visual cues). Visual analysis involves visually inspecting and comparing trends between two conditions (Barlow et al., 2009). In addition, two effect-size indexes (i.e., percentage of non-overlapping data and standard mean differences) will be computed (Scruggs & Mastropieri, 1998; Olive & Smith, 2005). Finally, social validity interviews from students and their special education teachers will be compiled to solicit feedback regarding the use of an app-based number line to teach price comparison.
References


Timeline

Spring 2013
- Obtain IRB approval

Summer 2013
- Prepare materials needed for the study, including the iOS apps to present two types of number lines employed in alternating treatment sessions, training materials, data collection sheets, interview questionnaires.
- Finalize participating students and teachers whose students are recruited

Fall 2013
- Conduct pre- and post-interview with recruited students and teachers
- Start data collection

Spring 2014
- Complete data collection
- Analyze data
- Write manuscripts for publications
- Submit a proposal to a conference for dissemination

Summer 2014
- Submit manuscripts to peer-reviewed journals for publication
Funding Rationale

Funding will provide an opportunity for a graduate research assistant (GRA) to develop and conduct this single subject experimental design study in conjunction with the faculty member. This study requires a great deal of time to prepare materials and collect and analyze extensive individual data across multiple schools and community settings. Without PRF funding to free a GRA from other obligations, it will be difficult to carry out data collection in a reliable and constant manner. The GRA will be assisting the researcher in all aspects of the study. The role and duties of the GRA include: developing instructional materials (e.g., an mobile application) for community-based activities for multiple students, collecting data multiple times a week across settings, and training an interrater for reliability. The researcher and this GRA will work collaboratively to analyze data and write manuscripts for journals and proposals for conferences. The researcher will mentor and support the GRA in strengthening her research and writing skills
Previous Support

Is this proposal an application for a 2nd year of an existing PRF award? No.

If this is not a 2nd year extension, have you ever had a year-long PRF before, and, if so, when was your most recent award?

Yes, the most recent PRF awarded to Emily Bouck was the 2011-2012 academic year. The PRF supported a doctoral student to collect data relative to her dissertation. To date, one paper from the project is currently under review (revise and resubmit), and another paper is currently in preparation. Both the student and Bouck are listed as authors on both publications.
Strategic Value

This research aligns with COE strategic directions including: collaborate with P-12 schools and teachers to create outstanding learning experiences and develop engagement activities that are substantially beneficial to all parties. This research will take place at our local schools with secondary students with autism and their teachers. These students and teachers will experience evidence-based strategies to teach functional mathematics skills in community settings with a goal to increase students’ independence post school. Collaborating with secondary students and local teachers provides us first-hand and practical perspectives, which can minimize the gap between research and practice.

This PRF is consistent with the faculty member’s research interest – technology to support mathematics education, including functional skills – for students with disabilities. The faculty member is currently leading data collection in a related research project to create a comprehensive collaborative research agenda. This PRF also provides an opportunity to foster a continuing line of research laid out for the targeted graduate student assistant. The targeted graduate student previously completed a related project (Weng & Bouck, in preparation), which will be submitted to a peer-reviewed publication within the next month.

Multiple external funding sources could be sought for the premise of this study. For example, the program, the Technology and Media Services for Individuals with Disabilities—Stepping-up Technology Implementation, funded by the Office of Special Education and Rehabilitative Services, provides funding opportunities for research on the use of technology for children with disabilities. Another grant opportunity is through one of the Institute of Education Sciences programs on Autism Spectrum Disorders (ASD) (CFDA Number: 84.324A). The program provides funding for research focusing on student with ASD.