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Improving Early Reading Skills in Young Children Through an iPad App: Small-Group Instruction and Observational Learning

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Abstract

This study evaluated the effectiveness of using a researcher-developed iPad app with a 0- to 5-s constant time delay procedure to improve phonological awareness skills of young children with mild developmental delays in a small-group arrangement in a rural public elementary school in Southwest United States. The study was conducted using a multiple-probe design across three target phonemes and replicated with three young children. Results indicated all children not only improved their performance on their target phonemes but also learned some of their peers' target phonemes through observational learning. Implications for using tablet computers in a small-group arrangement are discussed.

Keywords

iPad instruction, phonological awareness, constant time delay, observation learning

Several longitudinal studies (e.g., Muter, Hulme, Snowling, & Stevenson, 2004; Savage & Carless, 2005; Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004) have examined the contribution of phonological awareness (PA) skills to reading. The results of these studies indicate that early PA skills are a good predictor of later reading achievement. Research also suggests that PA instruction is effective in improving PA and reading skills, and that gains are maintained after training (see Bus & van IJzendoorn, 1999; Ehri et al., 2001). Computer-assisted PA instruction is an effective and efficient remediation for young children who are at risk for reading difficulties, with gains in PA skills transferring to early reading skills (Lonigan, Phillips, Cantor, Anthony, & Goldstein, 2003; Macaruso, Hook, & McCabe, 2006; Macaruso & Rodman, 2011; Macaruso & Walker, 2008). Like their typically developing peers, students with disabilities benefit from computer-assisted PA intervention (Macaruso et al., 2006; Macaruso & Rodman, 2011; Macaruso & Walker, 2008).

The United States has approximately 9 million students enrolled in public schools in rural areas (Glander, 2015), and among them there is a disproportionate number of poor readers (Vernon-Feagans, Gallagher, & Kainz, 2010). Some possible reasons for a large portion of poor readers in rural schools are as follows: (a) young children in rural areas, especially those from low socioeconomic backgrounds, are less prepared for school due to the difficulties in access to high-quality preschool child care (Early et al., 2007); and (b) rural schools are in short of supports and experienced teachers who are familiar with evidence-based practices in literacy education (Provasnik et al., 2007; Reeves, 2003; Skiba et al., 2008; Vernon-Feagans et al., 2010). Computer-assisted instruction (CAI) provides students in rural settings the opportunities to access to the same high-quality education as students in other areas, which may alleviate the problems caused by the shortage of experienced teachers.

The use of the iPad as an instructional tool has increased rapidly in recent years, and the results are promising. The iPad has been used to teach various skills to students with disabilities, including promoting communication rates for students with autism spectrum disorder (ASD; Flores et al., 2012), helping English language learners (ELLs) communicate in school (Demski, 2011), increasing the academic engagement of students with language-based disabilities (Cumming, Draper, & Rodríguez, 2013), increasing and maintaining math skills for adolescents with ASD (Burton, Anderson, Prater, & Dyches, 2013), and improving early literacy skills in young children with disabilities (Chai,

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Ayres, & Vail, 2016; Chai, Vail, & Ayres, 2015). The results of these studies have shown positive outcomes and revealed high levels of teacher and student satisfaction. However, more empirical evidence is needed to support the adoption of the iPad for educational purposes.

"Touch Sound" is a researcher-developed iPad app to help young children improve early literacy skills. The app embeds a 0- to 5-s constant time delay (CTD) procedure to teach children to receptively identify initial phonemes. "Touch Sound" has been successfully used to teach PA skills to three young children with developmental delays (Chai et al., 2015). Using a multiple-probe-across-behaviors design, researchers found a functional relation between the use of "Touch Sound" and the improvement of PA skills. The participants also generalized the skills across materials and maintained the majority of skills after the intervention was completed. In addition, Chai et al. (2016) evaluated its effectiveness with young ELLs with disabilities. The study was conducted using a multiple-probe design across three target phoneme sets and replicated with three young children. All three participants not only improved performance on their target phonemes but also learned some of the incidental information (vocabulary), which was provided as the vocabulary model during the intervention.

The previously mentioned iPad studies were conducted using a one-on-one instructional arrangement. A one-on-one instructional arrangement has many benefits, but it also has some limitations. First, it is of high cost with regard to personnel and schools' fiscal resources. Currently, it is unlikely every student will get his or her own iPad. Thus, due to the limited access to technology, students who need the extra support may not get their own iPads. Second, a one-on-one instructional arrangement may deprive students of opportunities to interact with others and to learn through observing peers (Aldemire & Gursel, 2014). Research suggests that collaborative use of computers could facilitate social interactions (Fitzpatrick & Hardman, 2000; Judge, 2001).

Using small-group instructional arrangements is an effective and efficient way to teach a variety of skills to students with disabilities. Small-group instructional arrangements promote observational learning. Ledford, Lane, Elam, and Wolery (2012) reviewed 47 articles from 1990 to 2010 that employed small-group instruction for students with disabilities. In 70.2% of these studies, researchers measured participants' acquisition of observational learning, and results indicate that without additional instruction, participants mastered 63.3% of the observational learning information from other peers in the group.

Observational learning in small-group instruction has also been paired with CAI. Mechling and colleagues conducted several studies to evaluate observational learning in CAI when using SMART Board technology to teach a small group of students with disabilities to recognize letter sounds (Campbell & Mechling, 2009) and sight words (Mechling, Gast, & Krupa, 2007; Mechling, Gast, & Thompson, 2008). In their 2009 study, Campbell and Mechling used CAI with SMART Board technology and a 0- to 3-s CTD procedure to teach letter sounds to three kindergarten students with learning disabilities in a small-group format. A multiple-probe design across three letter sets replicated with three students was employed. All participants mastered their target letter sounds and also learned some of the other participants' letter sounds through observation.

The purpose of the current study was to replicate and extend findings of Chai et al. (2015) and Campbell and Mechling (2009) by answering the following research questions:

> **Research Question 1:** Will young children with developmental delays learn to receptively identify initial phonemes using the iPad app "Touch Sound" in a small-group setting?
> **Research Question 2:** Will they learn their peers' target phonemes through observational learning?

Method

Participants

The participants of the current study included three young children with developmental delays. All three children attended the same half-day self-contained pre-K class 4 days per week. The classroom teacher was a certified early childhood teacher and was assisted by two paraprofessionals. The three children were recommended by their teacher to participate in the study because improving early literacy skills was a goal in each of their Individualized Education Programs (IEPs). Teacher reports, direct observations, and direct assessments were used to check inclusion criteria prior to intervention; all children had typical visual and hearing abilities and capacities to expressively imitate phonemes, to participate in a teacher-directed activity for 10 min, to take turns in group activities, to follow verbal directions, and to wait for 5 s for prompts. Before the intervention started, the researcher also tested all children using two standardized and norm-referenced assessments, *Peabody Picture Vocabulary Test-IV* (PPVT-IV; Dunn & Dunn, 2007) and *Test of Early Reading Ability-3* (TERA-3; Reid, Hresko, & Hammill, 2001), to document their general reading abilities. All three children's home language was English. All children had experiences with small-group instruction but had very limited experiences with CAI and no experience with CTD procedure.

Sarah was a Caucasian female, who was 4 years 10 months old at the beginning of the study. Sarah had a diagnosis of speech and language delays in the area of articulation. Sarah performed 2 *SD* below the mean on the *Clinical Assessment of Articulation and Phonology* (Secord & Donohue, 2002).

Her teacher and parents reported that it was difficult to understand her during connected speech. She received 30 min of intervention from the school speech–language pathologist every week. Sarah was able to write her own name, and she could name all the letters of the alphabet. Sarah scored within the normal range (Standard Score [SS] = 94, SD = −0.4) on the PPVT-IV, and she scored slightly below average (SS = 89, *SD* = −0.7) on the TERA-3. She performed "Average" on the Alphabet and Conventions subtests in the TERA-3, and "Below Average" on the Meaning subtest.

Joe was a 5-year 2-month-old Hispanic male. He exhibited speech and language delays in the area of articulation and fluency, and received 30 min of speech therapy every week. His performance on the fourth edition of the *Stuttering Severity Instrument* (SSI-4; Riley, 2008) indicated that he demonstrated severe stuttering. Joe's teacher noted that Joe was very hard to understand due to his speech disfluency, which included repetition of sounds, words, and phrases. Joe could write most of the letters in his name with no visual cues and could recognize most of the uppercase and lowercase letters of the alphabet. Joe scored within the normal range on the PPVT-IV (SS = 90, *SD* = −0.67) and below average on the TERA-3 (SS = 81, *SD* = −1.3). He performed "Average" on the Alphabet subtest, and "Below Average" on the Conventions and Meaning subtests in the TERA-3.

Dave was 4 years 5 months old. He was a Caucasian male who was eligible for special education services under the category of developmental delays in the social-emotional area. Dave had a seizure disorder, which was controlled through medication. According to his parents and teacher, he was aggressive and disruptive both at home and at school. He could follow directions, but the directions had to be repeated frequently. Dave scored below average in the adaptive and social-emotional areas in the second edition of the *Developmental Assessment for Young Children* (DAYC-2; Voress & Maddox, 2012). He received 20 min of mental health services from the school psychologist every week. Dave could not write his name independently but was able to recognize most of the letters in the alphabet. His performance on the PPVT-IV was in the "Average" range (SS = 104; *SD* = 0.27), and his performance on the TERA-3 was in the "Poor" range (SS = 79; *SD* = −1.4). He scored "Average" on the Meaning subtest in TERA-3, and "Below Average" on the Alphabet and Conventions subtests.

Settings and Materials

The study took place in a rural public elementary school in a Southwestern state. The county in which the school was located had a population density of 55 people per square mile, and the median household income was US$38,426, with 27.9% of the population in poverty (U.S. Census Bureau, 2010). The school had 533 students from pre-K to fifth grade in 2015, and 100% of them came from economically disadvantaged homes.

All intervention and probe sessions were conducted in an unoccupied, self-contained pre-K classroom next to the children's home class during the afternoon. All intervention sessions were conducted in a small-group arrangement. During the intervention sessions, an iPad was placed in the middle of a child-sized rectangular table and three children sat at the table next to each other facing the iPad so they could see all the turns easily. The researcher sat next to the children to collect data and to provide any assistance if needed. All probe sessions were conducted in a 1:1 format. The iPad was placed on the table, the child sat in front of it, and the researcher sat next to the child to collect data.

The materials used in the current study included a 16-GB iPad Air running iOS 8 and a researcher-developed iPad app "Touch Sound." The software used to develop the app were Keynote® and Audacity® 2.0.5. All pictures used in the study were downloaded from Google Image.

Screening and Phoneme Selection

Target phonemes were selected through student screenings and teacher input. The researcher developed a pool of possible stimuli (21 initial phonemes). During screening sessions, each participant was assessed individually using 5 in. × 8 in. index cards. Four pictures of objects were printed on each of the index cards: one picture of an object beginning with a potential target phoneme in the top middle and three pictures at the bottom (including one object starting with the same initial phoneme as the one on top and two distractors). Each student completed six screening sessions (one per day), with 21 trials per session. Each trial consisted of a general attentional cue (i.e., "Child name, look!"), a task direction (e.g., This is pear. Point to the picture that starts with the same sound as pear. Duck, paw, apple.), and a 5-s response interval.

A correct response was recorded if the child correctly pointed to the picture of the object that began with the same initial phoneme as the given object within 5 s of the task direction. Correct responses resulted in the delivery of verbal praise (e.g., Good job!). An incorrect response was recorded if the child provided no response or pointed to an incorrect picture within 5 s of the task direction. Incorrect responses were ignored. After the screening sessions, a list of phonemes the children had not mastered was generated. The researcher discussed the list with the classroom teacher and speech therapist. Finally, three target phonemes were selected for each child (see Table 1). Because each child's target phonemes would serve as the observational learning information for the other two participants, the selected target phonemes had to meet the following criteria: (a) the child made no more than one correct response over the six screening sessions, and (b) the two observational learners made no more than two correct responses over the six sessions.

Table 1. Target Phonemes for Instruction.

Participants	Target phonemes	Observational learning
Sarah	/d/, /b/, /m/	/l/, /θ/, /v/, /h/, /p/, /f/
Joe	/l/, /θ/, /v/	/d/, /b/, /m/, /h/, /p/, /f/
Dave	/h/, /p/, /f/	/d/, /b/, /m/, /l/, /θ/, /v/

Dependent Variables and Response Definitions

The target behavior was defined as the child touching the picture of an object that began with the same initial phoneme as the given object within 5 s after the app delivered the task direction. Two dependent variables were measured: (a) percentage of unprompted receptive identification of target initial phonemes and (b) percentage of unprompted receptive identification of peers' target initial phonemes. During the "Touch Sound" intervention sessions, children's responses were recorded as (a) unprompted correct: child touched the correct picture within 5 s after the app delivered the task direction, (b) unprompted incorrect: child touched an incorrect picture within 5 s after the task direction, (c) prompted correct: child touched the correct picture within 5 s after the app delivered the prompt, (d) prompted incorrect: child touched an incorrect picture within 5 s after the prompt, or (e) no response: child failed to touch any picture within 5 s after the prompt. The following three responses were recorded during probe conditions for target initial phonemes and observational learning information: (a) unprompted correct, (b) unprompted incorrect, or (c) no response (child did not touch any picture within 5 s after the task direction).

Experimental Design and General Procedures

The current study employed a multiple-probe design (Gast & Ledford, 2010) across three phonemes and replicated across three young children to examine the effectiveness of using a researcher-developed iPad app "Touch Sound" in a small-group arrangement to improve PA skills. The experimental conditions include (a) target initial phoneme probe condition, (b) observational learning (nontarget initial phoneme) probe condition, and (c) "Touch Sound" intervention condition. Sessions were conducted once a day for 3 to 4 times per week when at least two of the three children were present. When a child was absent, the researcher responded to the trials of the absent child. All sessions occurred in the afternoon around 1:00 p.m. due to scheduling needs of the classroom teacher. Each intervention session lasted approximately 13 min. The probe condition was conducted prior to the intervention condition and immediately after the group reached criterion to move to the next phonemes.

Data were collected and graphed after each session. The decision to move to the next phase or condition was made based on group performance. The criterion to move from 0 s delay sessions to 5 s delay sessions was when each child achieved 100% prompted corrects in at least one session. The criterion to move to the next phoneme was at least two children reached 100% unprompted corrects across three consecutive sessions.

Probe Procedures

Target initial phonemes. Probe sessions were delivered through the iPad app "Touch Sound." Each probe session on target phonemes consisted of nine trials, three trials for each target phoneme. Probe sessions were conducted for a minimum of three sessions or until data were stable.

During the probe sessions, the researcher placed the iPad on the table in front of the child; presented a general attentional cue, "Child name, let's start to work"; and loaded the app. "Touch Sound" delivered a welcome message and a specific attentional cue, "Touch the smiling face to start." Following the specific attentional response from the child, "Touch Sound" introduced the task, provided an example, and then advanced to the first screen. The first screen contained a picture of an object at the top starting with the initial target phoneme and three pictures of choices on the bottom. The app then provided the task direction (e.g., "This is *kite*. Please touch the word that starts with the same sound as *kite*. Bus, pencil, camera."). The child had 5 s to respond before the next trial was presented. No feedback was given after probe trials. The purpose for this was to control threats to internal validity that may be caused by repeated testing. At the end of each probe session, "Touch Sound" delivered a general verbal praise, "You've done a great job!" The researcher recorded the child's responses on a data sheet.

Observational learning. Because "Touch Sound" instruction was delivered in a small-group setting, every child's target phonemes also served as observational learning information for other children. The observational learning probe condition was conducted to examine whether young children could acquire their peers' target initial phonemes through observation. The procedures were identical to those in the target initial phoneme probe condition. Each probe session on observational learning consisted of 18 trials, three trials per phoneme. Children were individually assessed on the observational learning information in one session after each of the four target initial phoneme probe conditions.

Intervention Procedures

A researcher-developed iPad app "Touch Sound," which has an embedded 0- to 5-s CTD procedure, was used to teach each child to receptively identify three initial phonemes in a small-group setting (see Figure 1). Each

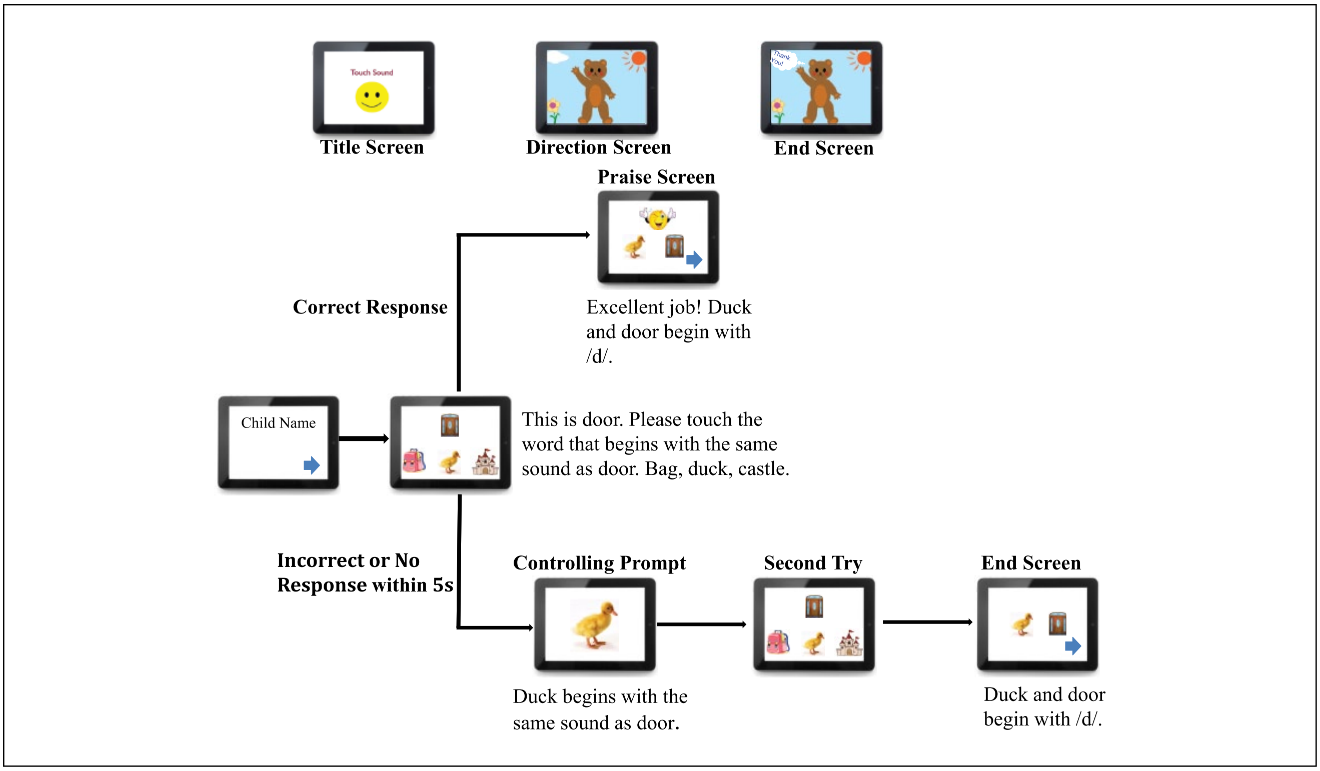

Figure 1. Touch Sound major screenshots.

instructional session consisted of 15 trials, five trials for each target phoneme. To avoid a situation where children only learn to match pictures, different vocabulary examples and pictures were used in each trial; three similar lessons were developed for all children's first, second, and third target phonemes, respectively. During each session, every child got an opportunity to respond before the other children received a second turn.

At the beginning of each instructional session, the researcher reminded the children that they could only touch the iPad screen when they saw their name on it. Then the researcher gave the group a general attentional cue, "Let's start to work," and launched the app. "Touch Sound" delivered a welcome message, and a specific attentional cue, "Please touch the smiling face to start." Following the attentional response (i.e., one child touched the smiling face), "Touch Sound" explained the task and presented an example. One child's name was shown in the middle of the screen to indicate it was his or her turn to respond. The researcher asked, "Whose turn?" and the child responded "My turn" and touched the arrow to start his or her trial.

The instruction for each target initial phoneme started with 0 s delay sessions. The first screen of each trial contained four pictures of different objects: One picture of an object that started with the target initial phoneme was placed in the middle of the top row, and three pictures of choices were placed at the bottom. "Touch Sound" delivered the task direction, "This is *door*. Please touch the word that begins with the same sound as *door*. Bag, duck, castle." The app immediately advanced to the prompt screen, in the middle of which only the picture of the correct response was presented, and delivered the controlling prompt, "Duck begins with the same sound as door." Then the child had 5 s to respond. Prompted corrects led to the praise screen on which the two pictures of objects starting with the same target initial phonemes and a picture of balloons or fireworks were shown. "Touch Sound" then delivered descriptive verbal praise (e.g., Excellent job! Duck and door begin with /d/.). Prompted incorrect or no response led to the end screen on which only the two pictures of objects that started with the same target initial phonemes were presented and "Touch Sound" provided corrective feedback (e.g., Duck and door begin with /d/.).

During 5 s delay sessions, the child was given 5 s to respond after the task direction before the controlling prompt was shown. Unprompted corrects resulted in the praise screen. Unprompted incorrect resulted in the prompt screen. Following the prompt screen, the child had a second chance to respond, and then the child was led to the end screen no matter what his or her response was.

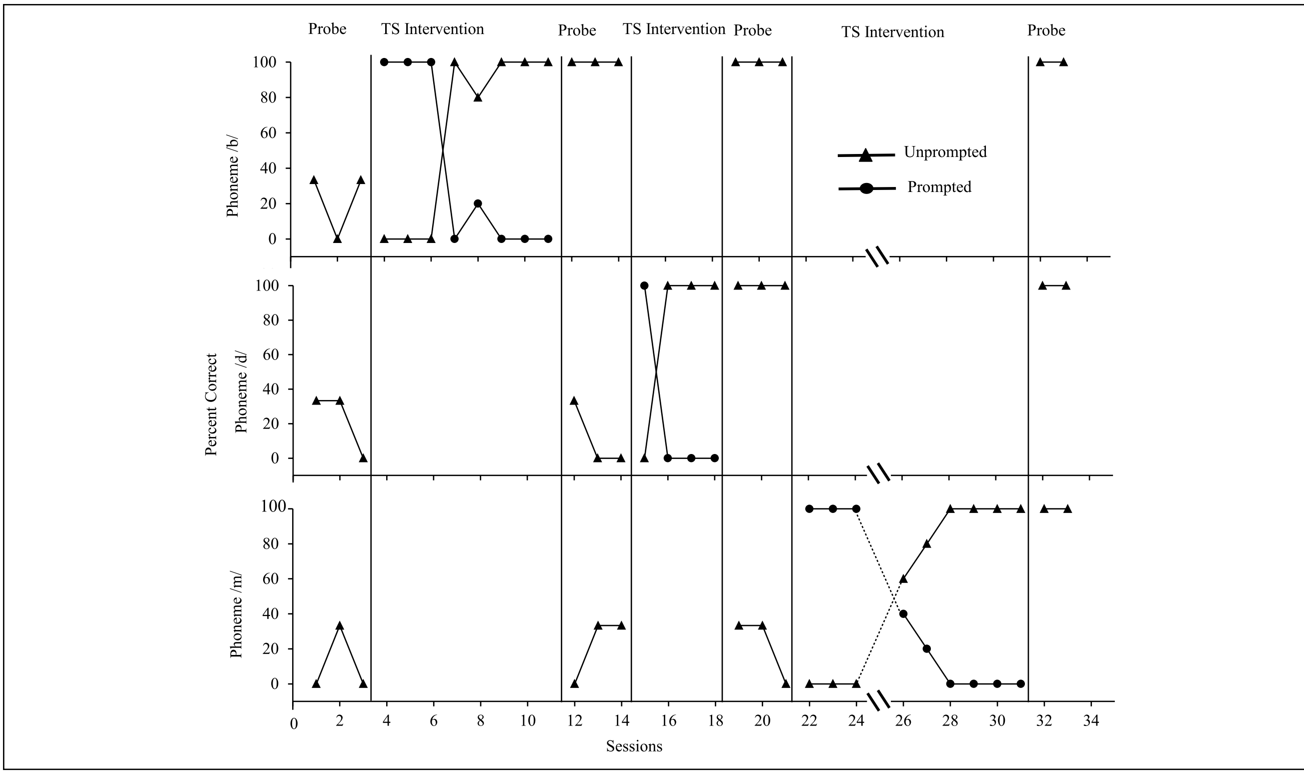

Figure 2. Percentage of unprompted correct responses for Sarah.
Note. TS = Touch Sound.

Results

Interobserver Agreement (IOA) and Procedural Fidelity

IOA and procedural fidelity data were collected simultaneously at least once a week and at least once during each experimental condition by trained independent observers. Data were collected for at least 25% of all sessions for all children and conditions. IOA was calculated using the point-by-point method by dividing the number of agreements by the sum of the number of agreements plus disagreements and multiplying by 100 (Cooper, Heron, & Heward, 2007). For all sessions in which IOA was recorded, the percentage of agreement was 100% for all three children.

Procedural fidelity data were collected on researcher behaviors and operation of the iPad app. Procedural fidelity data were measured using a checklist and calculated by dividing the number of correct behaviors by the total number of expected behaviors and multiplying by 100 (Ayres & Gast, 2010). Researcher behaviors observed were as follows: (a) delivering general attentional cue, (b) launching "Touch Sound," (c) prompting "Whose turn?" and (d) no prompting provided by the researcher throughout the session. "Touch Sound" functions collected included the following: (a) delivering specific attentional cue, (b) displaying the name of the child who would respond, (c) delivering task direction, (d) giving the appropriate delay interval to respond, (e) delivering controlling prompt, (f) delivering reinforcement for unprompted corrects, (g) delivering corrective feedback, and (h) providing general praise for completion. The mean procedural fidelity ranged from 77% to 100% across probe and intervention sessions with a mean of 93.67% for researcher behaviors and a 100% of "Touch Sound" functions. The mean procedural fidelity data for researcher behaviors were 100%, 100%, and 81% for Sarah, Joe, and Dave, respectively. The reason for low procedural fidelity data on researcher behaviors for Dave was that the researcher needed to redirect him during the intervention sessions as he exhibited disruptive behaviors.

Target Phonemes Acquisition

The "Touch Sound" intervention was introduced in a staggered manner when the children reached criterion on previous target phonemes. Each child's performance remained at a stable or decelerating trend before the introduction of the intervention; performance improved after the intervention was introduced. Direct intrasubject and intersubject replications were obtained. Figures 2 to 4 present data on the mean percentage of unprompted corrects of each child across three target phonemes under target initial phoneme probe and intervention conditions. The group reached the criterion in eight, four, and 10 sessions for each of their target phonemes, respectively.

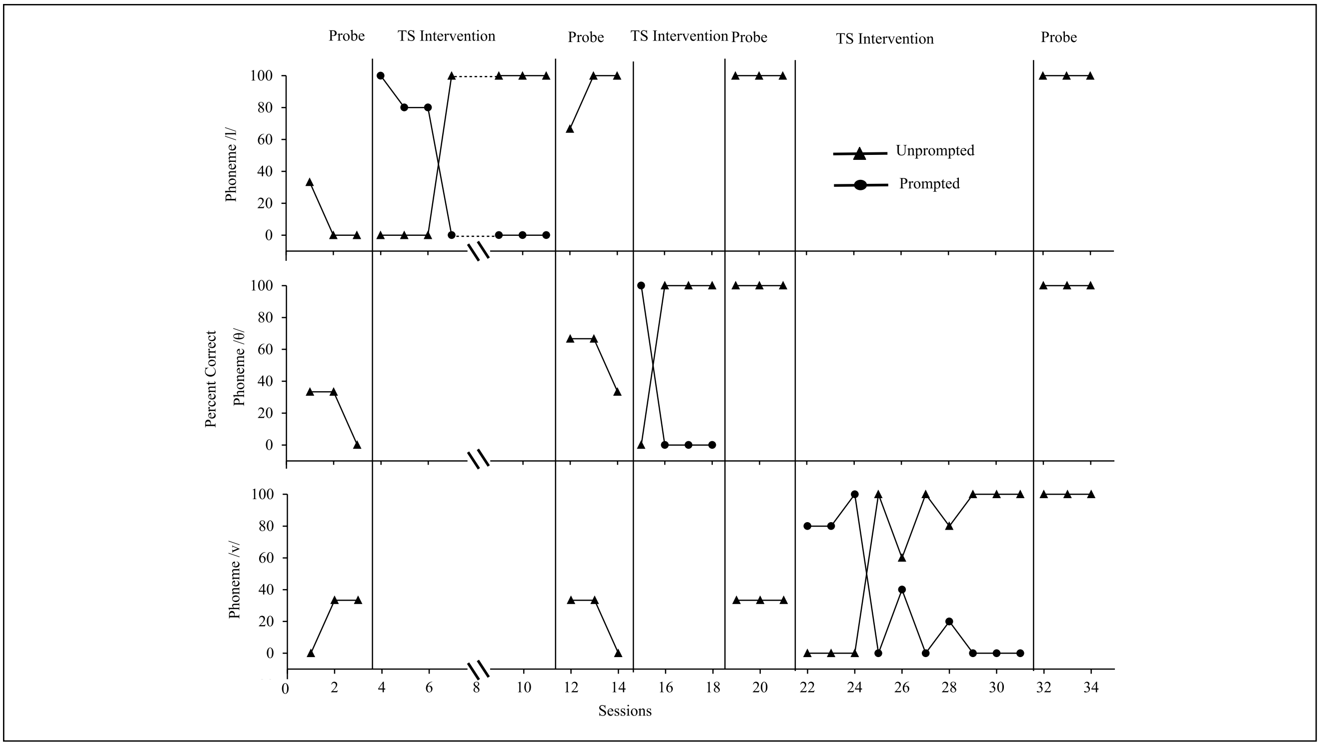

Figure 3. Percentage of unprompted correct responses for Joe.
Note. TS = Touch Sound.

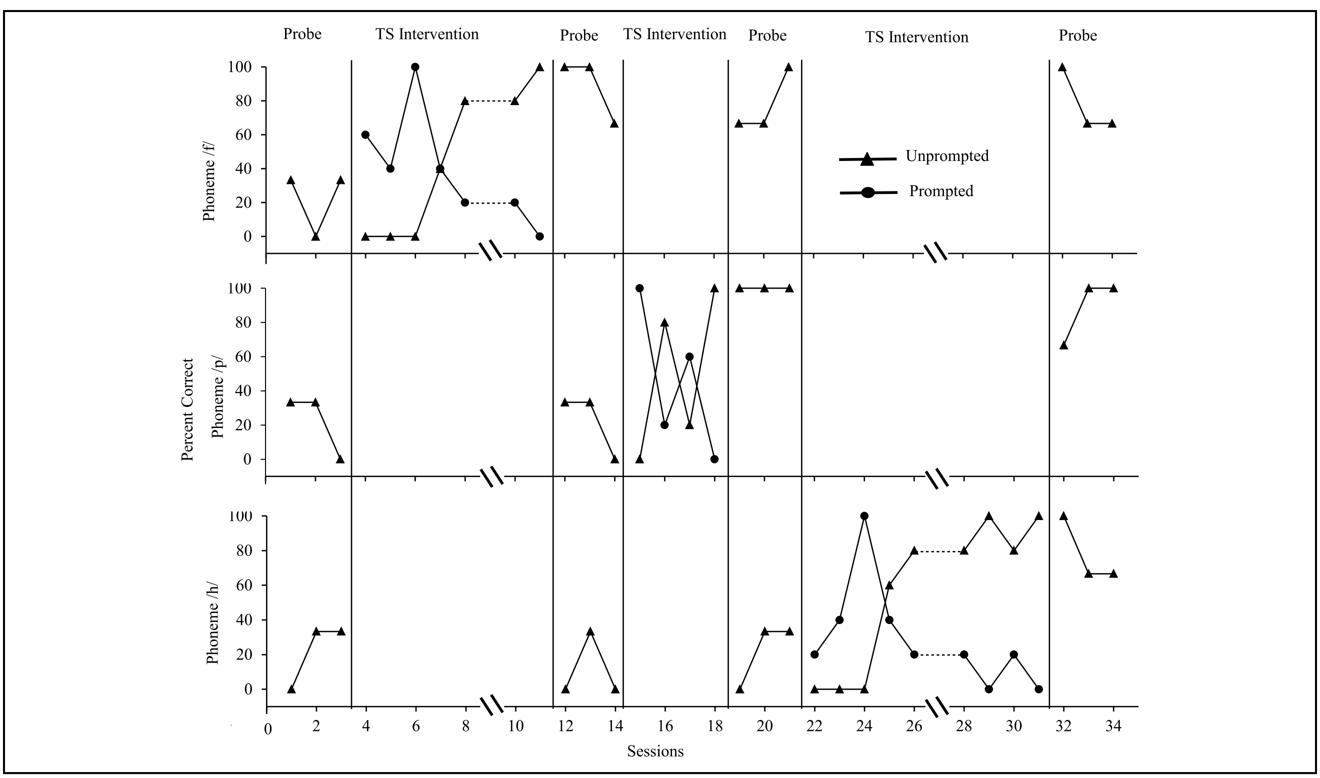

Figure 4. Percentage of unprompted correct responses for Dave.
Note. TS = Touch Sound.

Sarah. Sarah's performance on her target phonemes during probe and intervention conditions is displayed in Figure 2. Before intervention, Sarah demonstrated an average of unprompted correct responses of 22.22%, 16.67%, and 18.52% for phonemes /d/, /b/, and /m/, respectively. Visual analysis revealed an immediate change in level after receiving "Touch Sound" intervention, and she reached 100% of unprompted corrects for three consecutive sessions on all three phonemes. Sarah left school 1 week earlier than the end of the school year, so she only participated in two probe sessions after the group reached criterion on their third phonemes. Her performance during both sessions was 100% unprompted corrects on all three target phonemes.

Joe. Preintervention data revealed an average of unprompted corrects of 11.11%, 38.89%, and 25.92% for untaught phonemes /l/, /θ/, and /v/, respectively. Joe's data, shown in Figure 3, demonstrate a positive change in level with the introduction of the intervention. For all three of his target initial phonemes, Joe reached 100% unprompted corrects for three consecutive sessions after the intervention. His performance remained at 100% accuracy on all three target phonemes during the three probe sessions conducted after the intervention was completed.

Dave. Dave's performance is depicted in Figure 4. Probe data before intervention indicate an average of unprompted correct responses of 22.22%, 22.22%, and 18.52% for phonemes /f/, /p/, and /h/, respectively. After the intervention was implemented, Dave demonstrated a change in level in all three target initial phonemes. However, Dave's performance was not consistent in that he exhibited some noncompliant behaviors like disrupting other children and refusing to follow directions during the intervention. The noncompliant behaviors were blocked, ignored, or redirected. The researcher discussed the situation with Dave's teacher, and his teacher suggested if he behaved well during intervention, he could get an extra treat when he came back to class. Dave reached 100% accuracy on all three of his target phonemes after receiving the small-group "Touch Sound" intervention, but he never reached the criterion for three consecutive sessions. In the three probe sessions conducted right after the intervention was completed, he remained at an average of 77.78%, 88.89%, and 77.78% of accuracy for /f/, /p/, and /h/, respectively.

Observational Learning

Tables 2 through 4 summarize the percentage of unprompted corrects of the receptive identification of other children's target initial phonemes learned through observation. The results suggest all three children learned some of their peers' target phonemes after the intervention was completed. Sarah and Joe performed at an average of 88.89% of accuracy (range = 66.67%–100%) during the final observational learning probe condition and Dave performed at an average of 72.22% of accuracy (range = 33.33%–100%).

Table 2. Sarah's Percentage of Unprompted Corrects for Observational Learning Information.

Phoneme	Probe 1	Probe 2	Probe 3	Probe 4
/f/	33.33	100[a]	100[a]	100[a]
/l/	33.33	66.67[a]	66.67[a]	66.67[a]
/θ/	33.33	33.33	100[a]	66.67[a]
/p/	33.33	33.33	100[a]	100[a]
/h/	33.33	0	66.67	100[a]
/v/	0	33.33	0	100[a]

[a]Data were collected after intervention.

Social Validity

Upon completion of the study, social validity data were collected using a researcher-developed questionnaire. The questionnaire included five open-ended questions pertaining to the classroom teacher's perception on the goal, procedures, outcomes of the study, and possible use of "Touch Sound" in the classroom. The teacher reported that learning PA skills was an age-appropriate and important goal for pre-K students. The participants in the study, especially those with speech and language impairments, benefited from the instruction delivered via "Touch Sound," as it provided a lot of verbal models. The use of a small-group instructional arrangement also helped young children learn to take turns and follow directions. The teacher believed "Touch Sound" could be easily used in some individualized or small-group targeted instruction. Some informal interviews of the children were conducted throughout the study. Sarah and Joe always expressed how they liked to work on "Touch Sound" because they were good at it, but Dave gave inconsistent answers, and he said he was bored in some sessions.

Discussion

A multiple-probe design across three target phonemes replicated with three participants was used to determine the effects of using a researcher-developed iPad app "Touch Sound" in a small-group instructional arrangement to teach young children with developmental delays to receptively identify initial phonemes. The intervention produced immediate changes in participants' receptive identification of target initial phonemes. The results support and extend the existing literature on computer-assisted PA training for young children with disabilities, use of iPad as an instructional tool, and observational learning in small-group CAI instruction.

In Campbell and Mechling's (2009) study, they employed SMART Board technology to deliver instruction. The current study used an iPad to deliver instruction, which has a

Table 3. Joe's Percentage of Unprompted Corrects for Observational Learning Information.

Phoneme	Probe 1	Probe 2	Probe 3	Probe 4
/b/	0	66.67[a]	66.67[a]	100[a]
/f/	0	100[a]	100[a]	100[a]
/d/	0	33.33	66.67[a]	66.67[a]
/p/	0	33.33	100[a]	66.67[a]
/h/	33.33	66.67	66.67	100[a]
/m/	33.33	33.33	33.33	100[a]

[a]Data were collected after intervention.

Table 4. Dave's Percentage of Unprompted Corrects for Observational Learning Information.

Phoneme	Probe 1	Probe 2	Probe 3	Probe 4
/b/	33.33	0[a]	33.33[a]	33.33[a]
/l/	33.33	100[a]	66.67[a]	100[a]
/d/	33.33	33.33	66.67[a]	66.67[a]
/θ/	0	66.67	66.67[a]	66.67[a]
/m/	33.33	0	33.33	66.67[a]
/v/	0	33.33	33.33	100[a]

[a]Data were collected after intervention.

very small screen. Although the small screen limits the number of students in the small group, at the same time it would not disrupt other students in the classroom. Compared with previous studies that used tablet computers to teach students with disabilities (e.g., Chai et al., 2015; Cumming, Draper, & Rodríguez, 2013; Flores et al., 2012), this study is the first one that used iPad in a small-group setting to teach several students all at once. All children in the current study not only improved performance on their own target phonemes but also learned a portion of other children's target phonemes through observation.

Study Limitations

Although the results of the study are positive, there are some issues to be discussed. First, the internal validity of the study may be weakened due to the fact the researcher had no control over what happened in the classroom. The classroom teacher was informed not to teach these phonemes, but it was impossible to eliminate all the possible learning opportunities. Two of the children also received weekly speech therapy during the intervention. Although the researcher asked their speech therapist for her input when selecting the target phonemes, there was no collaboration between the researcher and the speech therapist. This may explain why Joe improved his performance on the second phoneme, /θ/, from an average of 22.22% of accuracy to an average of 55.56% of accuracy before the intervention on the second phoneme was provided; it may also explain why each child made progress on some of his or her observational learning information before he or she received the intervention (i.e., Sarah and Joe improved their performance on /h/, and Dave made progress on /θ/).

Second, because of the end of the school year, it was not possible to collect maintenance data for their third target phonemes or generalization data. Lack of maintenance data for the third phonemes is not as problematic because both Sarah and Joe remained at 100% of accuracy after 3 weeks of intervention on their first phonemes and after 2 weeks of intervention on their second phonemes. Dave maintained at an average of 77.78% and 88.89% for his first and second phonemes. However, lack of generalization data made it impossible to evaluate how the intervention impacted children's reading performance, for example, identifying the phonemes in a story or using these phonemes in conversation.

Recommendations for Future Research

There are several directions for future research that may come as a result of the current study. Small groups may not be the best instructional arrangement for everyone. In the current study, Sarah and Joe made more progress compared with Dave. Dave's noncompliant behaviors from time to time affected his performance. Future studies should consider which prerequisite skills are necessary to participate in small-group activities, so researchers could teach those skills to children like Dave ahead of time.

During the intervention, the researcher made several anecdotal observations about the social–verbal interactions between the children. For example, Sarah reminded Dave when it was his turn, or told him to touch the correct answer. This is an important fact to note, and further research should be conducted to evaluate how children's social–verbal interactions affect learning.

Implications for Rural Special Education

Reading is a critical skill to learning. Early PA skills predict children's future reading abilities (Schatschneider et al., 2004). Young children with disabilities tend to have lower PA skills compared with their typically developing peers (Conners, Rosenquist, Sligh, Atwell, & Kiser, 2006). Teachers should provide up-to-date evidence-based instruction to help those children catch up. However, the shortage of qualified special educators in literacy education in rural areas makes it a significant challenge.

While tablet computers are becoming a more widely used instructional tool in today's classroom, there are minimal guidelines as to how to appropriately use them to facilitate teaching and learning. This study evaluated the use of a researcher-developed iPad app "Touch Sound" in a small-group setting to teach young children early literacy skills. The positive results may give classroom teachers ideas of how to use it in their daily activities. Now, "Touch Sound" is available to the public at the Apple App store for no cost. Teachers could just download "Touch Sound" on a few iPads and place them in a center, and students can go there to practice their PA skills either individually or in small groups with minimal adult supervision and support. Using apps like "Touch Sound" that incorporate evidence-based practices could provide those young children in rural areas the same learning opportunities to have access to high-quality instruction as young children in urban areas. Currently, it is not possible for each student to get his or her own tablet computer in most public school classrooms, especially in rural settings, where resources are limited, so a small-group instructional arrangement may help to overcome the difficulties associated with limited access to technology.

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