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# Using an iPad® App to Improve Sight Word Reading Fluency for At-Risk First Graders

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**Abstract**

We used a multiple baseline across word lists design nested within a multiple baseline across participants design to examine the effects of instruction delivered using an iPad® app on sight word fluency and oral reading fluency of six first graders identified as at risk for reading failure. In Study 1, three students participated in teacher-directed iPad® instruction to learn sight words. In Study 2, three other students participated in self-mediated iPad® instruction. We measured sight word fluency and oral reading fluency in both studies; In addition, we measured academic engagement in Study 2. Results showed increases in sight word fluency during the iPad® instruction, but limited gains were seen in oral reading fluency. The three participants in Study 2 consistently achieved high levels of engagement during the iPad® instruction compared with engagement during independent reading time. The benefits of using technology in the classroom and directions for future research are discussed.

**Keywords**

sight word fluency, iPad® instruction, computer-assisted instruction, academic engagement

Reading proficiency is arguably the most important academic skill needed for school success. Students who fail to acquire basic reading skills in primary grades fall further behind their peers in intermediate and later grades. Despite national efforts to improve academic outcomes for all students, a recent national report in reading (National Center for Education Statistics, 2011) shows that 51% of African American, 49% of Hispanic, and 53% of Native American fourth-grade students were reading below basic levels. Included in this diverse group are students who speak a primary language other than English, commonly referred to as English Language Learners (ELLs). Although the need for early identification, systematic, and intensive intervention for struggling readers has been established (Lane, Menzies, Munton, Von Duering, & English, 2005), early interventions for at-risk students are underrepresented in the literature. For the purpose of this study, the term *at risk* was used to describe students from culturally and linguistically diverse groups performing below grade level on measures of early reading skills.

Sight words, also referred to as high-frequency words, constitute a sizable portion of the text students encounter in reading. Many of these words do not conform to phonetic rules. Instruction in sight words not only can result in a corresponding increase in reading fluency and comprehension (Fuchs, Fuchs, Hosp, & Jenkins, 2001) but also can improve students' confidence levels and reduce their frustration with reading (Bliss, Skinner, & Adams, 2006). Efforts to identify effective sight word reading interventions for at-risk students have included peer tutoring interventions (e.g., Kourea, Cartledge, & Musti-Rao, 2007), incremental rehearsal (e.g., Joseph, Eveleigh, Konrad, Neef, & Volpe, 2012), and constant time delay (e.g., Rohena, Jitendra, & Browder, 2002). Recent studies have also documented the positive effects of computer-assisted instruction (CAI) on the acquisition of word reading skills of struggling readers and students with disabilities (Coleman-Martin, Heller, Cihak, & Irvine, 2005; Cullen, Keesey, Alber-Morgan, & Wheaton, 2013).

An advantage of using CAI is the ability to individualize instruction for each student. Hilton-Prillhart, Hopkins, Skinner, and McCane-Bowling (2011) used a computer-based sight word reading intervention with three students in which each sight word was displayed on a PowerPoint® presentation slide on the computer. The students were

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prompted to read the word before they could hear a recording of the word, listen to the word, and repeat the word before a new word was displayed. All three students met or exceeded the goal of 85% accuracy on word reading. The researchers contended that repeating the word after listening to the word promoted accurate responding in students. Mechling, Gast, and Krupa (2007) used SMART Board® technology to teach target grocery sight words (e.g., salsa, pretzels, bagels) to a group of students with moderate disabilities, and found it to be an effective medium to teach the sight words in a small-group format. Presenting information via an interactive medium with the use of sounds, video, and animation can be effective in engaging the learner and in turn increase attention, time on task, and academic engagement (AE) time (Haydon, Hawkins, & Denune, 2012; Neely, Rispoli, Camargo, Davis, & Boles, 2013; Thoermer & Williams, 2012).

Although there is increased attention to the use of technology for literacy instruction (Beschorner & Hutchison, 2013; McClanahan, Williams, Kennedy, & Tate, 2012; Northrop & Killeen, 2013), an area that can benefit from further inquiry and empirical validation is the use of education-based applications (a.k.a. apps) available for use on mobile devices. Findings from a content analysis of the education category of iTunes® App store call out to academia to develop a research agenda that investigates touchscreen technology and apps as "a key ally in supporting children's learning" (Shuler, 2012, p. 6). The principles of instructional design, namely, *contiguity, repetition*, and *feedback and reinforcement* (Gagne & Briggs, 1979, in Wang & Sleeman, 1994), are embedded into the structure of these apps. When translated into classroom practice, students using apps are required to make observable responses immediately following the presentation of the stimulus (i.e., contiguity). The apps provide students with multiple opportunities to practice the skill (i.e., repetition), and have the capability to provide immediate feedback and reinforcement. Specifically, research examining the effectiveness of engaging with these iPad® apps over more traditional methods of instruction is warranted.

In this article, we present two studies designed to evaluate the effects of using an iPad® educational app on first graders' sight word acquisition and fluency. In Study 1, three students received teacher-directed iPad® instruction targeting five sight words each week. The dependent measures included sight word reading fluency and oral reading fluency. In Study 2, three other students were trained to engage in self-mediated iPad® instruction targeting five different sight words each day. Sight word reading fluency, oral reading fluency, and AE time served as the dependent measures in the second study. In Study 1, we asked, "What are the effects of teacher-directed iPad® instruction on the sight word fluency and oral reading fluency of first graders and ELLs at risk for reading failure?" In Study 2, we asked, "What are the effects of self-mediated iPad instruction on sight word fluency and oral reading fluency of first graders and ELLs at risk for reading failure?" and "To what extent did the self-mediated iPad® instruction affect students' academic engagement in comparison with their engagement during independent reading time?"

## Study 1

### Method

*Participants.* Three students (2 male, 1 female; all ELLs), Kayla, Bob, and Larry, ranging in age from 6 years 4 months to 6 years 10 months participated in the study. The students were nominated by the teacher to participate in the study due to their scores of "at risk" or "some risk" levels on Winter benchmark assessments of the Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency measure (DORF; Good & Kaminski, 2007). Kayla was referred for special education evaluation and was identified with a specific learning disability toward the end of the study. Bob did not have an identified disability; and Larry was diagnosed with speech and language impairment prior to the study. Both Kayla and Larry received speech therapy services twice a week for 30 min per session. Speech goals for both students included speaking in complete sentences and answering "wh" questions. Both Kayla and Larry worked on articulation exercises with the speech therapist. In addition, Kayla and Bob received 35 min of small-group instruction each day as part of the school's response to intervention (RtI) initiative in the area of language arts. The special education teacher and the reading specialist collaborated on providing RtI instruction, with a focus on early literacy skills (e.g., letter sounds, phoneme segmentation, blending, reading consonant–vowel–constant words, and reading sight words).

ELLs are classified as beginner, intermediate, or advanced based on the results of the State's English as a Second Language (ESL) Achievement Test. Both Kayla and Bob scored at the "advanced" level and received English language instruction from a certified ESL teacher. Larry did not receive a test result due to incomplete testing. Students' demographic information is shown in the upper panel of Table 1. All three students scored below benchmark on the district-administered sight word test, which was an untimed test consisting of 100 sight words. The beginning-, mid-, and end-of-year benchmarks were 25, 50, and 100 words, respectively. On the mid-year assessment conducted in January, Kayla, Bob, and Larry scored 7, 2, and 38, respectively. See Table 2 for assessment results.

*Setting.* The study took place in a first-grade classroom of an elementary school in the Northeast of the United States. The school is considered a suburban school with urban

**Table 1.** Student Demographic Information.

| Student | Age | Gender | Race | English proficiency | Disability | Related services |
|---|---|---|---|---|---|---|
| | | | Study 1 | | | |
| Kayla | 6 years 4 months | Female | Hispanic | Advanced | SLD | Speech (2 × 30 min/week)<br>RtI (5 × 35 min/week) |
| Bob | 6 years 10 months | Male | Hispanic | Advanced | None | RtI (5 × 35 min/week) |
| Larry | 6 years 10 months | Male | Hispanic | Testing incomplete | SLI | Speech (2 × 30 min/week)<br>OT (1 × 30 min/week) |
| | | | Study 2 | | | |
| Tammy | 7 years 9 months | Female | African American | Native English speaker | None | RtI (5 × 35 min/week) |
| Matt | 6 years 3 months | Male | Hispanic | Proficient | SLI | Speech (2 × 30 min/week) |
| Jack | 6 years 9 months | Male | Hispanic | Proficient | None | None |

*Note.* SLD = specific learning disability; RtI = response to intervention (small-group pull-out instruction); SLI = speech and language impairment; OT = occupational therapy.

school characteristics. The total school population was 881 students in Grades K-8, with about 75% of students eligible for free or reduced lunch program. There were 27 children in the first-grade classroom (85% Hispanic, 15% African American). The study took place three times a week during reading period (9:30–10:10 a.m.) for 10 min each session. Study participants sat at two tables designated for iPad® instruction. The other students in the class were scattered around the room, either on the carpet during independent and partner reading time or at other tables in the classroom during small-group instruction with an adult. All procedures were completed in accordance with the University's Institution Review Board with prior approval obtained from school district administration.

*Interventionist.* The interventionist for this study was the first-grade teacher, Ms. B, a 27-year-old Caucasian with 5 years of teaching experience. Ms. B holds a teaching degree in childhood education with certifications in ESL and special education. Ms. B volunteered to participate in the study due to her interest in using mobile technology in the classroom.

*Independent variable.* The educational app used in this study was *The Sight Words: Kids Learn App* for iPad®, developed by Teacher Created Materials Publishing. The app included 300 sight words from Fry's list (Fry & Kress, 2006). The free version of the app included only 25 sight words, with provision to buy more words with in-app purchases (e.g., 1–100 for US$4.99; 1–300 for US$8.99). This app was selected due to its simple user interface with easy-to-follow activities, providing students with a multimodal approach to learning. Specifically, students had the opportunity to read a word, listen to the word by tapping on the word, write (copy) the word, record the word in their own voice, and replay to hear the word. The app also included activities at the end of five words to reinforce the skills disguised in a game format (e.g., Tic-tac-toe).

*Dependent variables and data collection.* There were two dependent variables. The primary dependent variable was the sight word reading fluency (for proximal measure) and the secondary dependent variable was oral reading fluency (for distal measure). The first and third authors served as data collectors and examiners throughout the study. All assessments for this study took place at a table located at the end of the hallway where students were pulled out one at a time for weekly testing at the end of the week (i.e., Friday).

*Sight word reading fluency*. The primary dependent variable was the number of sight words read correctly in 1 min, expressed as correct words per minute (CWPM) on weekly word reading probes. There were three lists of 30 words each, created using the first 90 words in the *Sight Words: Kids Learn App*. Of these 90 words, 74 (i.e., 82%) were a direct match to the list of 100 sight words in the school district-administered test. The researchers created four alternate versions of each of the three lists (i.e., A, B, C, D) to be presented in a counterbalanced format, such that no two versions were administered consecutively. The words from each list were printed on one letter-sized paper on two columns with 15 words in each column. Lists with the least number of words read correctly during baseline probes were selected for each student. Kayla and Bob were probed on Lists 1 and 2, and Larry was probed on Lists 2 and 3. During an assessment, the examiner pointed to each word and asked the student to read the word. Words read correctly or self-corrected within 3 s were marked as "correct." If the student read the word incorrectly or did not read the word within 3 s, the examiner marked the word as "incorrect" and moved to the next word. At the end of 1 min, the examiner stopped the assessment and started the probe for the next list.

*Oral reading fluency*. We administered the oral reading fluency progress monitoring probes from DORF (Good &

**Table 2.** Assessment Results for All Participants Across Both Studies.

| | | CWPM | | | District sight word test score | | | DORF Benchmark Scores | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | January G: 20 | | May G: 40 | |
| Student | Tests | Baseline *M* (range) | iPad® condition *M* (range) | Maintenance | September G: 25 | January G: 50 | May G: 100 | CWPM | Status | CWPM | Status |
| | | | | | Study 1 | | | | | | |
| Kayla | List 1 | 4.8 (3–6) | 18.4 (10–24) | 21.1 | 1 | 7 | 27 | 2 | At risk | 7 | At risk |
| | List 2 | 1.3 (0–2) | 6.0 (5–7) | 3.0 | | | | | | | |
| | DORF-PM | 4.7 (1–6) | 6.8 (3–12) | 8.0 | | | | | | | |
| Bob | List 1 | 1.6 (0–4) | 13.9 (7–24) | 17.0 | 0 | 2 | 50 | 0 | At risk | 9 | |
| | List 2 | 1.0 (0–4) | 9.0 (7–12) | 4.0 | | | | | | | At risk |
| | DORF-PM | 1.8 (1–3) | 6.5 (4–10) | 9.0 | | | | | | | |
| Larry | List 2 | 7.6 (4–10) | 20.5 (17–24) | 29.0 | 14 | 38 | 84 | 10 | Some risk | 18 | At risk |
| | List 3 | 8.5 (6–10) | 16.9 (15–20) | 21.0 | | | | | | | |
| | DORF-PM | 8.1 (3–12) | 11.5 (7–15) | 22.0 | | | | | | | |
| | | | | | Study 2 | | | | | | |
| Tammy | List 2 | 7.2 (4–10) | 22.0 (15–35) | 25.3 | 14 | 57 | 96 | 9 | Some risk | 21 | Some risk |
| | List 3 | 8.4 (3–13) | 27.2 (23–31) | 25.0 | | | | | | | |
| | DORF-PM | 13.8 (11–16) | 16.0 (7–30) | 24.0 | | | | | | | |
| Matt | List 3 | 9.0 (7–11) | 31.9 (21–44) | 45.4 | 22 | 40 | 95 | 8 | Some risk | 20 | Some risk |
| | List 4 | 6.2 (2–10) | 23.3 (19–32) | 24.5 | | | | | | | |
| | DORF-PM | 9.0 (7–14) | 18.3 (12–30) | 26.0 | | | | | | | |
| Jack | List 4 | 15.4 (5–20) | 49.4 (27–72) | 48.8 | 15 | 55 | 96 | 10 | Some risk | 55 | Low risk |
| | List 5 | 13.0 (5–22) | 37.6 (25–53) | 30.0 | | | | | | | |
| | DORF-PM | 21.2 (11–31) | 38.5 (35–42) | 65.0 | | | | | | | |

*Note.* CWPM = correct words per minute; DORF = Dynamic Indicators of Basic Early Literacy Skills oral reading fluency; G = benchmark goal; DORF-PM = Dynamic Indicators of Basic Early Literacy Skills oral reading fluency progress monitoring probes (Good & Kaminski, 2007).

Kaminski, 2007) periodically, by following its administration guidelines, as a distal measure. That is, we wanted to evaluate if an increase in sight word reading fluency resulted in any collateral increase in oral reading fluency in connected text. This measure was expressed as CWPM.

*Research design and data analysis*. We used a multiple baseline across behaviors (word lists) nested within a multiple baseline across participants design (Harris & Graham, 1985). This design required the time-lagged application of the independent variable to one of the behaviors for the first participant, while maintaining baseline conditions for other behaviors and participants to control for threats to internal validity. When the first participant achieved a steady state for the first behavior, the independent variable was applied to the next behavior, and the first behavior for the next participant. The same procedure was applied to the remaining behaviors and participants. Nesting the multiple baselines across word lists within a multiple baseline across participants design allowed for demonstrating an additional level of baseline logic (i.e., prediction, verification, replication). The design controlled for possible cross exposure of words across other instructional settings (e.g., general education classroom, RtI, special education classroom), showing true responding to the independent variable.

We used the visual analysis method (Kazdin, 2011) and the conservative dual-criterion (CDC) method to increase the objectivity of interpreting the data (Swoboda, Kratochwill, & Levin, 2010). In the CDC method, the level and trend lines are drawn 0.25 standard deviations in the direction of predicted intervention effect. A particular number of data points in intervention above both criterion lines are needed to conclude a reliable treatment effect.

*Procedures*. The experimental conditions consisted of baseline, teacher-directed iPad® instruction, and maintenance. A pre-baseline survey was administered to determine each participant's skill in using an iPad® prior to the baseline condition.

*Pre-baseline survey and training*. At the beginning of the study, a researcher assessed the students' knowledge and skills on using an iPad®. The students were asked whether they owned an iPad® or a similar tablet device at home. They were also asked to demonstrate the following skills: (a) power "ON" the iPad®, (b) select a specific app, (c) enlarge a page, (d) turn to the next page, (e) write a word on the iPad®, (f) record a word after being shown how to record and replay, and (g) power "OFF" the iPad®. If a student failed to complete one or more of these steps, the researcher explicitly modeled the skill and gave the student multiple opportunities to practice with feedback until the student was able to complete these steps independently.

*Baseline*. During baseline, the students engaged in reading group with no change to their routines. On a typical day, students rotated through three activities, including independent reading time (IRT), partner reading, and small-group

reading directed by either the teacher, assistant teacher, student teacher, or assistant principal. During IRT and partner reading, students collected their respective reading bins and found a place on the carpet. Each reading bin included four to six books that matched each student's reading level. The students were expected to read quietly during IRT or read with their partner during the partner reading time. During small-group reading sessions, an adult facilitated a reading activity for the group to read a story together and to engage in a discussion to enhance comprehension of the text. Occasionally, the classroom teacher (Ms. B) used her personal iPad® to reinforce phonemic awareness skills and letter-sound correspondence skills with the students in her group; however, the *Sight Words: Kids Learn App* was not used during the baseline condition. There was no explicit and systematic instruction in sight words provided during baseline condition.

*Teacher-directed iPad® instruction*. Ms. B and researchers developed a script to serve as a guide for the teacher to use during the intervention sessions. The teacher first reviewed the rules (i.e., "Be gentle with iPad®," "Go only to *Sight Words app*," and "Listen to your teacher and follow instructions") and explained the correct use of iPad® with each student. Then, the teacher started the timer for 10 min and led the student through a series of steps. The teacher targeted five words for each instructional session, and prompted the student to listen to the word, say the word, write the word, say the word, record the word, listen to the recorded word, repeat the word, and then move to the next word. The cycle was repeated three times for all five words. If the student failed to complete one of the steps in the cycle, the teacher redirected the student to complete the step along with immediate feedback and error correction as needed. The student was then allowed to play a game by completing the activity present at the end of the instruction. Each student worked on the same set of words for three instructional sessions over a 1-week period. A new set of words was introduced the following week, with the previous five words serving as review words. The teacher-directed iPad® condition was implemented for 13 weeks with Kayla, Bob, and Larry participating in a total of 33, 23, and 17 instructional sessions, respectively.

*Maintenance*. Maintenance of sight word reading fluency was measured 3 weeks after the iPad® instruction ended, consistent with probe procedures followed during baseline and intervention conditions.

*Interscorer agreement.* A second observer (the third author), trained by the primary data collector (first author), sat 3 ft from the primary data collector and independently scored the weekly word reading probes to obtain interscorer agreement on 46% (7 of 15) of the probes for Kayla, and 40% (6 of 15) of the probes for Bob and Larry across word lists. The interscorer agreement was determined by using an item-by-item comparison, and was calculated by dividing the number of agreements between the two observers by the total number of agreements and disagreements multiplied by 100. There was a mean agreement of 100% for Kayla and 99.8% (range = 96.7%–100%) for both Bob and Larry.

*Procedural fidelity.* Intervention procedural fidelity was assessed using a checklist describing the steps involved in each instructional session. Based on the checklist, the third author scored whether or not the teacher prompted the student through the following steps: (a) press the speaker icon, listen to the word, and say the word; (b) write the word and say the word; and (c) record the word and say the word before moving to next word; as well as whether or not the teacher provided immediate error correction or positive feedback. Procedural fidelity was 100% as observed on 37% of the iPad® sessions (15 of 41 sessions) across participants.

*Intervention acceptability.* Ms. B completed an adapted version of the Teacher Post-Intervention Acceptability and Importance of Effects Survey (Lane & Beebe-Frankenberger, 2004) at the end of the study for both Studies 1 and 2. The survey comprised 10 close-ended questions scored on a Likert-type scale from 1 (strongly disagree) to 5 (strongly agree), and two open-ended questions soliciting the teacher's opinion on the intervention and suggestions for future use. Parents were solicited to complete a parent version of the survey with six close-ended and two open-ended questions addressing their views on the iPad® instruction. The researchers interviewed the students about using an iPad® for learning and whether they would like to use the iPad® for future learning.

## Results

*Sight word fluency.* Figure 1 presents participants' sight word reading fluency data with both baseline level and trend criterion lines. All three participants showed low to moderate levels of performance during baseline condition, with a mean baseline score of 4.8 (List 1) and 1.3 (List 2) CWPM for Kayla, 1.6 (List 1) and 1.0 (List 2) for Bob, and 7.6 (List 2) and 8.0 (List 3) for Larry. The introduction of the teacher-directed iPad® condition resulted in an increase in level for sight word fluency with no overlapping data with the baseline condition on all word lists for all participants. The CDC method requires a minimum of five intervention data points to evaluate treatment effects. This was possible for only the first target list for each participant. The intervention data for Kayla and Bob on List 1, and Larry on List 2 are clearly above both level and trend lines suggesting a reliable treatment effect. The results are inconclusive

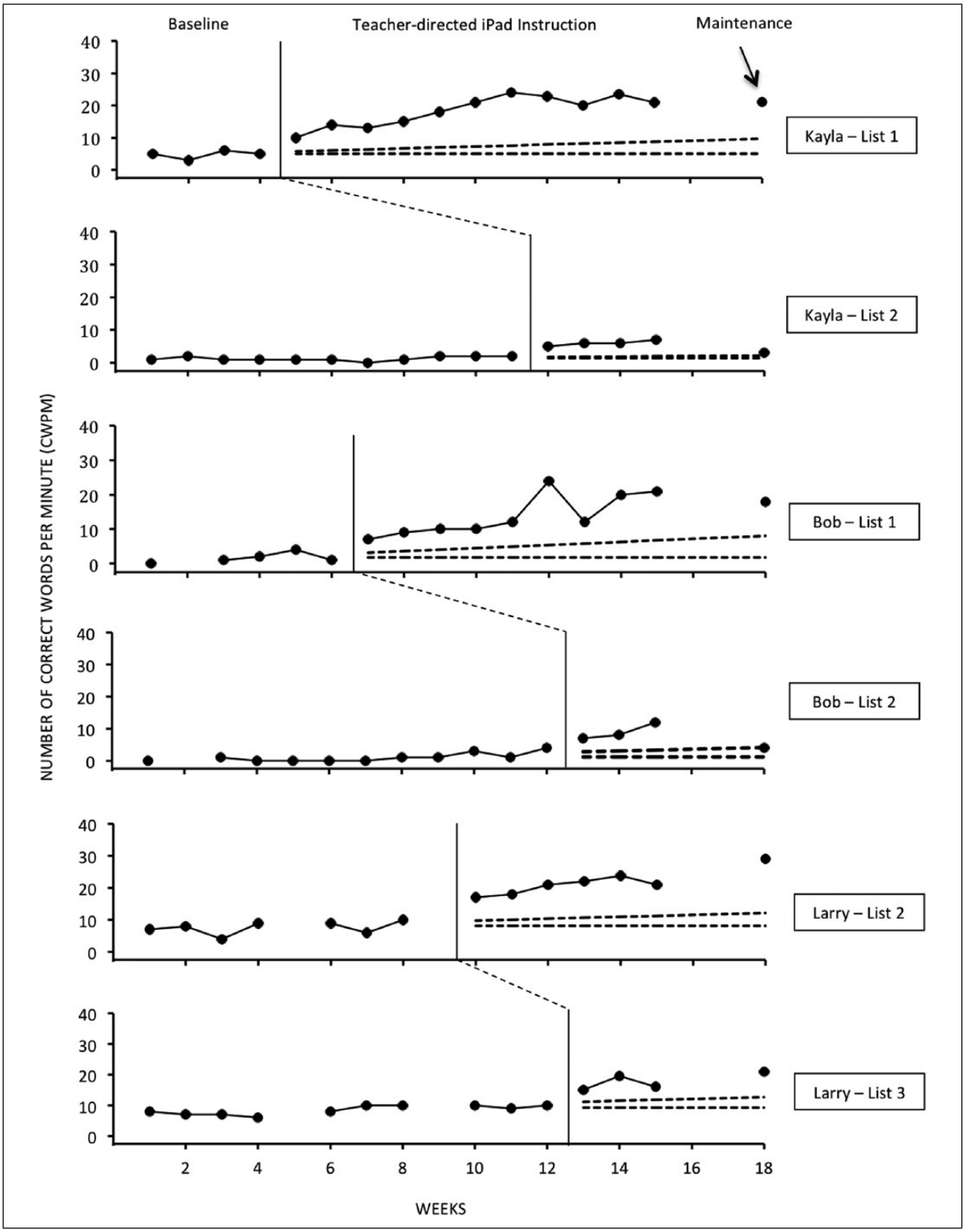


**Figure 1.** Sight word fluency for Study 1 participants (Kayla, Bob, and Larry) during baseline, teacher-directed iPad® instruction, and maintenance.

for the second set of lists due to insufficient data points.

Maintenance data indicate that Kayla and Bob were able to maintain more words on List 1 in comparison with List 2. Larry was the only student who scored higher on the maintenance probe than during weekly probes completed during the iPad® condition, with 29 and 21 CWPM on Lists 2 and 3, respectively. The top panel in Table 2 shows each participant's mean and range of sight word fluency across conditions.

*Oral reading fluency.* As shown in the top panel of Table 2, the DORF progress monitoring data for all three participants indicate minimal increase from baseline to the end of the study. The mean scores on the DORF data show an increase of 2.1, 4.7, 3.4 CWPM from baseline to intervention for Kayla, Bob, and Larry, respectively. The DORF benchmark assessments also showed limited improvement for all participants.

*Intervention acceptability.* Ms. B agreed that the iPad® intervention targeted important skills, was suitable to classroom culture, and produced positive effects. She strongly agreed that that she would continue to use the iPad® intervention as needed, citing the success of students in mastering the words, uninterrupted student time on task, and the ability to individualize to student needs as positive attributes of the intervention. Ms. B listed the inability to modify word lists within the application, student's loss of interest toward the end of the study, and the learning of sight words in isolation as aspects she disliked about the intervention.

All students agreed that the iPad® intervention gave them skills to perform better at school and at home. Kayla and Larry expressed positive feelings with regard to participating in the group, spending time with the teacher, and using the iPad®. Bob indicated his dislike for the iPad® and working in the group but was pleased to have additional time with the teacher. All three students wished to continue the iPad® intervention beyond the study's conclusion. One parent returned a completed survey. The parent found the iPad® intervention to be generally effective in supporting reading instruction and noted improvement over time, stating "I see my son is more sure when he is reading than [in the] beginning."

## Study 2

### Method

*Participants and setting.* The participants were three different students (2 male, 1 female), Tammy, Matt, and Jack, in Ms. B's first-grade classroom. The participants ranged in age from 6 years 3 months to 7 years 3 months ($M_{age}$ = 6 years 9 months). Like the participants in Study 1, these students scored below benchmark on the district-administered sight word test or scored at the "at risk" or "some risk" level on the DORF Winter benchmark assessments (Good & Kaminski, 2007), and were nominated by their classroom teacher to participate in the study. The lower panel of Table 1 lists these participants' demographic information, with their benchmark assessment results presented in Table 2. Matt had a diagnosed speech or language impairment and received speech therapy services two times a week for 30 min in a small-group setting. In addition to articulation exercises, the speech therapist worked with Matt on speaking in full sentences and answering "wh" questions. Tammy and Jack did not have a disability classification; however, Tammy was receiving small-group literacy instruction every day for 35 min as part of the school's RtI initiative, as described in Study 1. The setting was identical to that in Study 1, with Ms. B present in the classroom during the iPad® intervention.

*Independent variable.* Each participant was provided with an individualized zip-folder containing materials required for the self-mediated instruction. The zip-folder included one iPad® loaded with the *Sight Words: Kids Learn App*, one laminated sheet on rules and instructional cues, and one log sheet to be completed by the student after each session. The log sheet included three columns: words, date completed, and teacher signature. The first column included the list of words targeted for each session. Once the student completed the 10-min session with the target words, he or she was required to write the date, and have it attested by the teacher or a researcher. The log served as a record for the student's attendance and completion of words.

*Dependent variables and data collection.* The dependent variables in Study 2 included sight word fluency, oral reading fluency, and AE.

*Sight word fluency*. Measurement of sight word fluency was similar to Study 1. During baseline condition, students were probed on five lists of 30 words each created using Fry's sight word list. However, only two lists that represented the least number of correct words read during baseline were targeted for intervention. Probe data were reported on Lists 2 and 3 for Tammy, Lists 3 and 4 for Matt, and Lists 4 and 5 for Jack.

*Oral reading fluency*. Similarly to Study 1, the DORF progress monitoring probes served as the distal measure of the intervention effects in this study.

*Academic engagement*. We measured AE during typical IRT (i.e., IRT) and self-mediated iPad® time, each lasting 10 min. AE during IRT was defined as the student looking at a book and turning pages of a book. AE during the self-mediated iPad® condition was defined as the student working through the steps outlined in the self-mediated instruction, operationalized as tapping the word on the

iPad®, listening to the word, recording the word, saying the word, writing the word, and playing the games on the *Sight Words* app. Engagement data were recorded using a momentary time sampling method in 10-s intervals, and reported as the percentage of observed intervals in which the student was actively engaged. Observers used a MotivAider™, an electronic timing device, to signal the start of intervals during observation sessions. The first author trained the third author in direct observation recording techniques and practiced collecting data to establish at least 80% or higher reliability scores prior to actual data collection. Data on AE were collected for all students after Tammy entered the iPad® condition.

*Research design and procedures.* The research design, pre-baseline survey of students' iPad® skills, the baseline condition, and maintenance probe were identical to Study 1. The only variation was in the delivery and format of the iPad® instruction, where students were taught to engage with the iPad® independently.

*Self-mediated iPad® instruction*. During this condition, a researcher first reviewed the rules (same as Study 1) and explained the correct use of iPad® with each student. The researcher then started the timer for 10 min and facilitated the students through the response requirements and steps in the instructional cycle that were similar to Study 1. In contrast to Study 1 where students were presented with the same five words for 1 week, students in Study 2 were presented with five different words each session. After completing the instructional cycle three times, the students were allowed to play a game by completing the activity present at the end of the instruction. Beginning the second session, the students reviewed the previous day's words before playing the game. A researcher sat closely with each student for the first two sessions to ensure that the student completed each instructional step correctly. After the initial two training sessions, the students were required to raise their hand and ask for help from the teacher or researcher as needed. Students typically raised their hand if they completed their instructional cycle and wanted to know what to do next. In one instance, a student raised her hand when her iPad® was not responding and she needed help with the device. At the end of 10 min, the students were prompted to complete their logs, place all materials back in their zip-folders, and return the folders to a predetermined location in the classroom. Completing the logs required the students to get their session initialed by the teacher or researcher, at which time they received general feedback about their session (e.g., "You did a nice job learning words today"). The self-mediated iPad® condition was implemented for 12 weeks with Tammy, Matt, and Jack participating in a total of 30, 27, and 21 instructional sessions, respectively.

*Interscorer agreement.* Similar to Study 1, a second observer independently scored the weekly sight word fluency probes on 26% (4 of 15) of the sessions for Tammy and Matt, and 33% (5 of 15) of the sessions for Jack across the word lists. There was a mean agreement of 98.7% (range = 94%–100%) for Tammy, 100% for Matt, and 99.4% (range = 95%–100%) for Jack. Interscorer agreement data for the AE were measured using an interval-by-interval comparison and were collected on 19% of observational sessions across students and conditions, with a mean agreement of 99% (range = 93%–100%).

*Procedural fidelity.* Using a checklist, an observer scored whether or not each student independently completed the following steps: (a) press the speaker icon, listen to the word, and say the word; (b) write the word and say the word; (c) record the word and listen to the word; and (d) say the word before moving to next word. The procedural fidelity data were collected on 26% (7 of 27), 21% (4 of 19), and 25% (4 of 16) iPad® sessions for Tammy, Matt, and Jack with a mean fidelity of 98.6%, 99.2%, and 98.8%, respectively.

*Intervention acceptability.* Ms. B completed one survey for both studies. A parent version of the survey was sent to all parents. Similar to Study 1, the researchers interviewed the students to solicit their opinions about using an iPad® in the classroom for learning and whether or not they would like to use the iPad® for future learning.

## Results

*Sight word fluency.* Figure 2 presents Study 2 participants' sight word fluency data with both baseline level and trend lines. Both Tammy and Matt showed stable levels of responding during baseline condition, followed by a slight increase in trends and levels in both word lists during the self-mediated iPad® condition. Jack's baseline data on both word lists indicate a slight upward slope over the course of the baseline condition; however, there was a steep ascending trend for his intervention data. The mean increase in sight word fluency across participants ranged from 14.8 CWPM for Tammy's List 2 words to 34.0 CWPM for Jack's List 4 words (see lower panel of Table 2). All three students scored above both lines indicating a reliable treatment effect for Tammy on List 2, Matt on List 3, and Jack on List 4. Due to insufficient data points for the second set of word lists, the treatment effect based on the CDC method is inconclusive.

Tammy and Jack were able to maintain their newly acquired sight words 3 weeks after the iPad® instruction ended. Matt scored highest on the maintenance probe on List 3 (i.e., 45.4 CWPM) in comparison with his performance during intervention with a mean score of 31.9

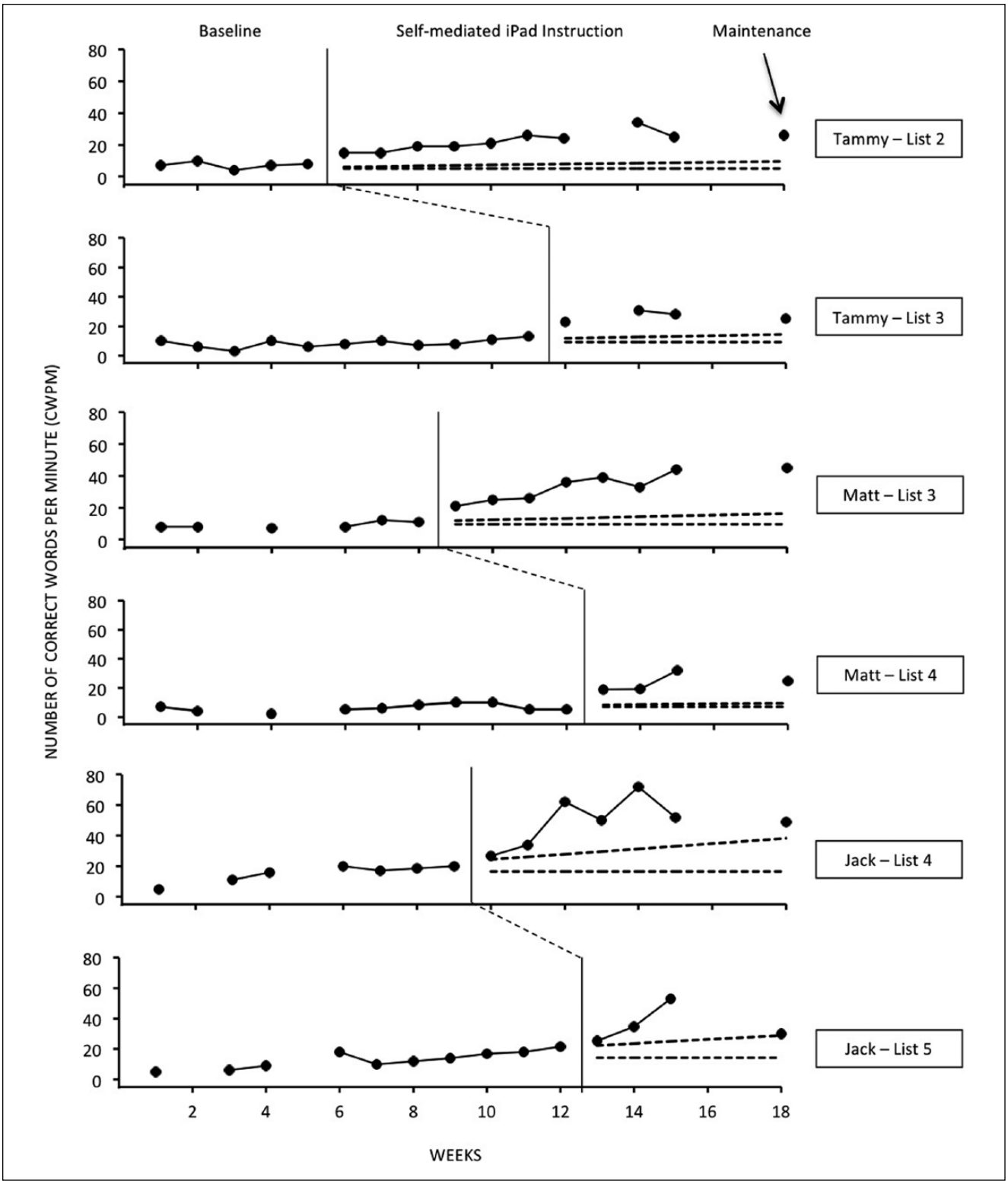


**Figure 2.** Sight word fluency for Study 2 participants (Tammy, Matt, and Jack) during baseline, self-mediated iPad® instruction, and maintenance.

CWPM (range = 21–44), and maintained his words on List 4 at 24.5 CWPM.

*Oral reading fluency.* Similar to the pattern noticed in Study 1, increases in sight word fluency did not result in a

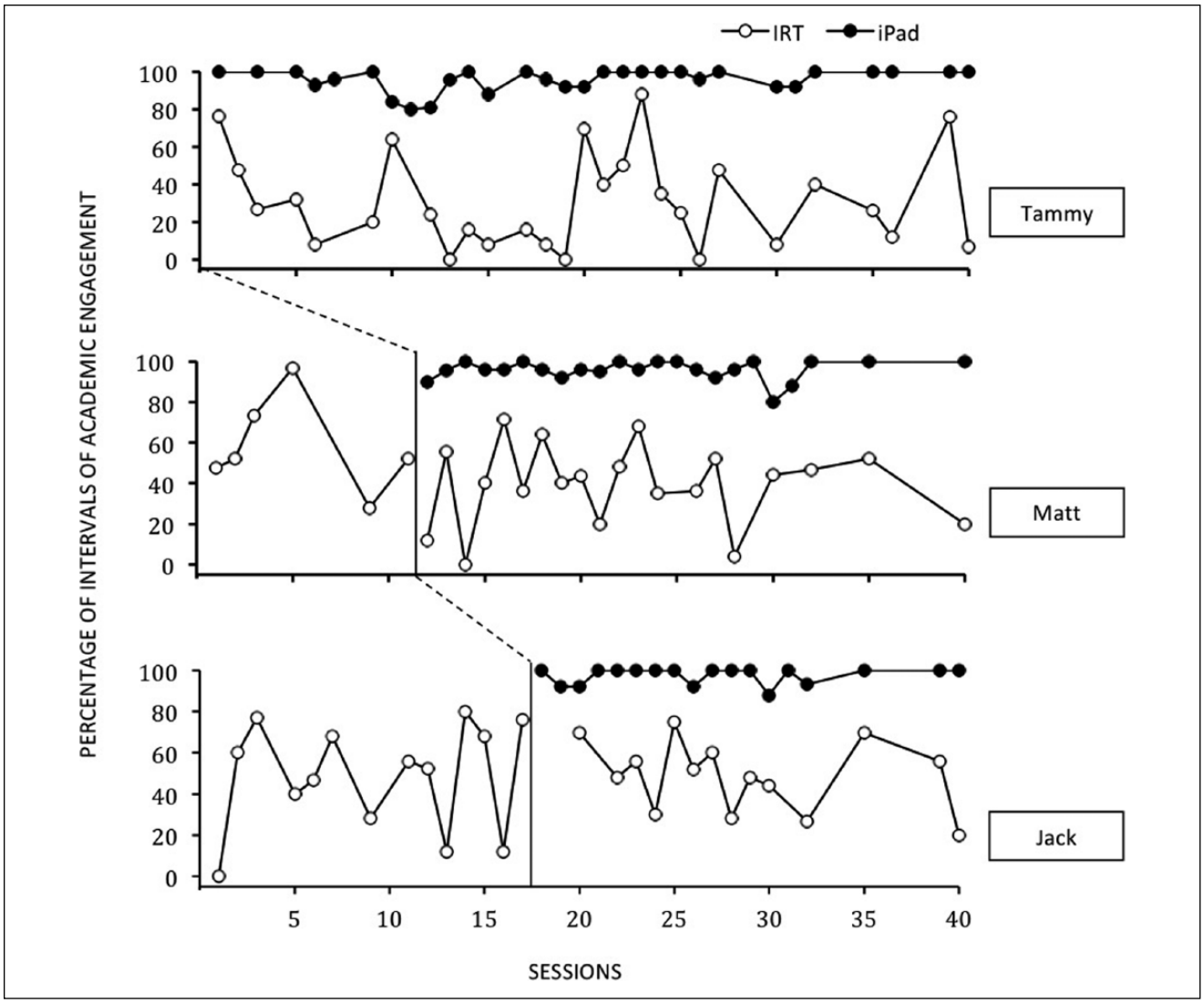


**Figure 3.** Academic engagement for Study 2 participants during IRT and self-mediated iPad® intervention (iPad).
*Note.* IRT = independent reading time.

dramatic increase in DORF progress monitoring probes for Tammy and Matt. Jack was the only student who reached and exceeded the end-of-year benchmark score of 40 CWPM by scoring 55 CWPM on the Spring DORF benchmark assessment.

*Academic engagement.* The data in Figure 3 provide a clear indication of levels of AE during IRT and self-mediated iPad® condition. Except one data point for Matt where he showed high level of AE during baseline condition, AE was consistently higher during the iPad® condition in comparison with IRT for all three students. The AE data during IRT show variability for all students from one day to another, with the mean percent during the intervention phase being 31.1% (range 0%–88%) for Tammy, 39.4% (range 0%–71.4%) for Matt, and 48.8% (range 20%–75%) for Jack. In contrast, the AE data during the iPad® condition show consistently stable states of behavior with minimal variability; specifically, the mean percentage of AE for Tammy, Matt, and Jack was 95.9% (range 80%–100%), 95.9% (range 80%–100%), and 97.6% (range 88%–100%), respectively.

*Intervention acceptability.* Ms. B's responses to the intervention acceptability survey pertain to both studies and are reported in Study 1. We did not receive any parent surveys for Study 2. All three participants in Study 2 unanimously expressed that they enjoyed participating in the intervention. Matt specifically cited the iPad® app's "games" and "writing the words" components as positives. All three

students liked using the iPad® and being a part of the group. They all felt that they learned important skills. Jack stated that he "learned words he couldn't sound out" and that "it was more fun than reading on the carpet."

## General Discussion

Despite the increased attention to the use of mobile technology in the classroom, the literature on the use of educational apps for literacy purposes is currently only narrative or descriptive in nature (e.g., McClanahan et al., 2012; Thoermer & Williams, 2012). The purpose of the two studies presented in this article was to examine the effects of using literacy-based apps on the sight word fluency and oral reading fluency (Study 1 and Study 2), as well as AE (Study 2) of at-risk first graders. Results from both studies indicated that the 10 min of teacher-directed iPad® instruction in Study 1 and self-mediated iPad® instruction in Study 2 resulted in increases in sight word fluency as evidenced by weekly probes. The staggered introduction of participants to the iPad® condition and the corresponding increase in levels of responding replicated across two word lists and three participants in each study indicate a functional relationship between the iPad® instruction and sight word fluency. Using the CDC method in conjunction with visual analysis, we are able to conclude that a systematic change with reliable treatment effect has occurred from the baseline to the iPad® intervention condition. In the case of participants in Study 2, AE data reveal higher levels of engagement with the iPad® in comparison with their engagement during IRT. Furthermore, the classroom teacher, students, and one parent expressed positive opinions about the intervention.

Sight word fluency data in both studies clearly indicated that all participants improved their sight word reading fluency after receiving either the teacher-directed (Study 1) or the self-mediated (Study 2) iPad® instruction. Results from both studies also suggest that iPad® instruction with the *Sight Words: Kids Learn App* was effective and feasible regardless of instructional format (teacher-directed vs. self-mediated). It should be noted that the instruction delivered via the iPad® was a supplement to instruction provided in the classroom beginning mid-first grade. It is likely that we would have seen stronger gains if the iPad® instruction was employed in the spring of kindergarten year or beginning of first grade.

One benefit of CAI is its potential to provide explicit instruction, embedded feedback, and multiple repetitions to allow for independent practice (Cheung & Slavin, 2012). With high procedural fidelity scores, it is likely that the pre-baseline survey and training as well as close monitoring during the first two iPad® instructional sessions ensured that the Study 2 participants had the essential skills to engage in the self-mediated iPad® instruction with minimal adult support or prompting. It is important to note that in both studies, students were required to respond to the stimulus words as presented on the iPad® during instruction but were required to read the words on paper during the weekly probes. The positive results may have indicated students' ability to generalize learned words from the iPad® to words presented in print.

Despite the gains in sight word fluency seen across all students, five of the six students continued to perform below grade level in oral reading fluency at the end of the study. This finding is not surprising. First, the oral reading fluency was a distal measure in both studies. Although the participants' increased sight word knowledge may have reduced decoding difficulty in passage reading, the degree to which the targeted sight words were present in these passages was not examined in these studies. Second, in both studies, the participants practiced targeted sight words in isolation. Although sight word recognition and decoding is an essential component of being a fluent reader, achieving oral reading fluency requires explicit fluency instruction to support students in reading text with speed, accuracy, and proper expression (National Institute of Child Health and Human Development, 2000). Of the five ELL participants in these studies, two students (i.e., Kayla and Bob) scored at the "advanced" level requiring ESL services. ELLs have fewer experiences with print materials in English reducing their exposure to specific vocabulary learning and often need instructional practices that support both oral and written language skills with multiple opportunities to read high-frequency words (Helman & Burns, 2008). Both Kayla and Bob increased their DORF scores the least, indicating that more intensive reading instruction in conjunction with efforts to increase the scope and sophistication of their oral language proficiency may be needed. Such an approach requires instruction where new words are embedded in meaningful contexts with multiple opportunities to use and practice the words (Martin-Chang, Levy, & O'Neil, 2007).

AE data presented in Study 2 support previous studies (Haydon et al., 2012; Neely et al., 2013) on the effects of iPad® instruction on student engagement. Researchers have documented a positive correlation between AE and academic performance (Greenwood, 1991); therefore, it is essential that practitioners choose interventions that maximize student's engagement with the learning activity. All three students in Study 2 displayed stable and high levels of AE when participating in the self-mediated iPad® instruction, as compared with engagement during IRT. Although IRT has merit in promoting reading behavior among children, it may be counterintuitive to assign IRT to students who struggle with the reading activity. Students who lack skills to decode the texts are likely to perceive IRT as difficult and therefore are less likely to engage in the reading activity independently. With the growing population of students needing Tier II or supplemental instruction and the

limited teacher resources, mobile technology has the potential to provide students with an individualized learning experience that maximizes engagement and promotes academic learning.

## Limitations and Directions for Future Research

Although the current findings suggest that the iPad® intervention was effective and acceptable, there are some methodological limitations. First, the DORF was a distal measure, and not a direct measure of sight word generalization. Despite the slight increases in DORF scores, there is no sufficient evidence to suggest a functional relationship between the iPad® instruction and DORF scores. Constructing sentences or passages with the target words and assessing student's fluency on these target words in connected text might have been a more accurate measure of generalization (cf. Kourea et al., 2007).

A second limitation concerns data collection. Due to the end of the school year, each participant only received iPad® instruction on two word lists with limited data points for the second word list. As a result, treatment effects cannot be determined using the CDC method. Future research is warranted to attend to the potential time constraints with intervention implementation. Third, although Ms. B used her personal iPad® occasionally to allow her students to practice phonemic awareness skills and letter-sound correspondence skills, we did not examine the potential novelty of using iPad® as a tool to deliver instruction. Systematically examining and/or controlling for novelty effects should be important considerations in the future.

Finally, as mentioned by Ms. B, there was no provision in the app to customize the word lists for students. Word lists with the most number of unknown words for each student were targeted for instruction, still requiring students to practice some of the words they had already mastered. In the future, researchers can explore the development of apps with the capacity to create individualized word lists for students and examine the differential and combined effects of apps and incremental rehearsal technique (Joseph et al., 2012) in teaching sight words.

## Conclusion

Adoption of educational apps using touchscreen technology has increasingly become common in today's K-12 classrooms. The availability of numerous educational apps on iPad® allows classroom teachers to supplement their instruction and in turn motivate children to be active and engaged learners. With built-in components of effective instruction (e.g., model-lead-test, scaffolding, performance feedback, repetition, reinforcement, attention to individual learning rates), educational apps show great promise in supporting the needs of at-risk students and help achieve higher academic learning and engagement in the classroom. Teachers should be encouraged to use these technologies in the classroom to target skill development across a variety of subject areas.

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