Using SMART Board Technology to Teach Young Students with Disabilities and Limited Group Learning Experience to Read Environmental Text

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Abstract: A multiple probe design across behaviors was used to evaluate the effectiveness of a SMART Board used in conjunction with teacher delivered constant time delay (CTD) to teach environmental text to three young students with disabilities and minimal group learning experience during small group direct instruction. Observational learning, instructive feedback, and generalization were also assessed. Initially, reinforcement was presented to the group via the SMART Board, but was modified to a token economy to address challenging behavior and non-responding in some students. Results suggest that using a SMART Board and CTD was effective for one participant when group reinforcement was used and effective for all participants when an individualized token economy was added to sessions. Teachers should be cautious when using group reinforcement strategies with young students who may not have extended learning histories with small group instruction and reinforcement other than token economies. Suggestions for future research and implications for practice are provided.

A number of evidence-based and recommended practices exist for teaching young children with disabilities, including naturalistic teaching strategies, embedded instruction, and peer-mediated learning (Odom & Wolery, 2003; Sandall, Hemmeter, Smith, & McLean, 2005). In addition, the use of response prompting procedures (e.g., system of least prompts, progressive time delay, simultaneous prompting, constant time delay) for implementing individualized instruction in small groups is an evidence-based practice for use in early childhood settings (Ledford, Lane, Elam, & Wolery, 2012; Wolery & Hemmeter, 2011). Preschool teachers often work with students who have limited to no experience in a classroom setting, including students who are transferring from Part C to Part B services under the Individuals with Disabilities Education Act (IDEA, 2004). Interaction with adults and peers in the context of a preschool classroom should function to prepare children for successful experiences in elementary and secondary education. Teaching students in small groups may prepare young children with disabilities for these future environments, as well as increase the likelihood students receive direct instruction in less restrictive settings (Wolery, Ault, & Doyle, 1992). Although adequate evidence exists for the use of prompting procedures in small groups (Ledford et al., 2012), fewer studies exist for teaching younger students, and no studies report including participants without a previous history of small group instruction.

Technology

In addition to the use of individualized evidence-based practices, the use of technology in early childhood classrooms is a recommended practice for all young children, including those with disabilities (Sandall et al., 2005; National Association for the Education of Young Children [NAEYC] & the Fred Rogers Institute [FRI], 2012). Computer-assisted instruction, which combines technology with instructional strategies, provides teachers options for incorporating technology into the classroom. For example, multiple studies suc-
cessfully combined software programs, such as Microsoft® PowerPoint, with computer presented response prompting (e.g., CTD) to teach sight word reading to children with disabilities (Coleman, Hurley, & Cihak, 2012; Yaw et al., 2011). Another option is using interactive whiteboards, such as a SMART Board, during instruction. A SMART Board is an interactive projector screen that allows users to manipulate images and activities using touch screen technologies (SMART Board Technologies, 2013). SMART Boards also allow for a larger display of stimuli (compared to other materials, e.g., flash cards, tablets, computer monitor) that is visibly accessible to multiple students (Mechling, Gast, & Thompson, 2009), and the inclusion of preferred text (e.g., Great Work!) or pictures with animation and audio (e.g., thumbs up with applause sounds; Campbell & Mechling, 2009) to promote appropriate attending and responding.

Research Support for SMART Boards

The U.S. Department of Education (2010) reported that many teachers in public school settings have an increased availability of interactive whiteboards (e.g., SMART Boards) in their classrooms. As these technologies become more widely accepted by school districts, peer-reviewed research related to the efficacy of using these technologies in conjunction with evidence-based practices should be established prior to their adoption. However, research studies examining these technologies are scarce, especially for young students with disabilities and students with limited exposure to group instruction (Campbell & Mechling, 2009; Mechling et al., 2007, 2009; Yakubova & Taber-Doughty, 2013). Only one study used SMART Boards in conjunction with evidence-based practices to provide instruction to young students with disabilities (Campbell & Mechling, 2009). In the study, the instructor presented response prompts (i.e., constant time delay) to teach a group of three elementary-aged participants with learning disabilities to label letters; however, all participants had previous experience with “large and small group instruction and computer-assisted instruction using a desktop computer and 1 to 1 instruction” (p. 49). Research with interactive white boards has primarily consisted of adolescents and adults with intellectual disabilities who have learning histories with small group instruction (Mechling et al., 2007, 2009; Yakubova & Taber-Doughty, 2013). Mechling et al. (2009) compared SMART Boards and flashcards paired with response prompting procedures to teach sight words to a group of adolescents with intellectual disability; SMART Boards led to increased acquisition over traditional flashcard instruction. In addition, participants and teachers reported a preference for technology-based instruction rather than traditional flashcards.

While there is a growing body of research for using SMART Boards with older students and students with a history of group instruction, the NAEYC (2003, 2005), along with Odom and Wolery (2003) and the Division of Early Childhood (DEC; Sandall et al., 2005), highlight the importance of differentiating instruction for young children in early childhood programs beyond using an adapted curriculum and procedures designed for older students. Older students may have several characteristics differentiating them from young children with disabilities (McLean, Wolery, & Bailey, 2004), including (a) increased experience with learning academic skills, (b) a learning history with varied response prompting strategies, (c) engaging in and receiving reinforcement during small group activities, and (d) accessing technology.

SMART Boards and Instructive Feedback

In addition to combining technology and evidence-based practices, limited information is available using efficacious instructional strategies like instructive feedback with young children during small group instruction. Instructive feedback refers to the addition of information within the consequent event of a learning trial (e.g., “You are right Johnny, that letter is B; and ball starts with B”; Werts, Hoffman, & Darcy, 2011). Additionally, instructive feedback does not significantly increase the length of instruction and allows opportunities for observational learning from peers (acquiring a group mates’ instructive feedback information; Wolery et al., 1992). There is a long-standing history in the literature of researchers demonstrating the utility of instructive feedback.
for teaching a range of discrete skills such as sight words, coin values, shapes, and numerals (Werts, Wolery, Holcombe, & Gast, 1995). In a recent study, Reichow and Wolery (2011) compared instruction with and without instructive feedback when teaching preschoolers with autism spectrum disorders to read sight words or label pictures of objects. Results indicated that including instructive feedback during instruction was more efficient and led to increased acquisition of target and non-target information compared to instruction lacking instructive feedback. When using instructive feedback, researchers primarily do so without the inclusion of technology-based instruction. Only one identified study evaluated the effects of instructive feedback presented on a SMART Board. Campbell and Mechling (2009) assessed receptive letter sound identification presented as instructive feedback via SMART Board technology with an instructor presented prompt and found that all children demonstrated gains from baseline. No studies have assessed the presentation of instructive feedback information solely via SMART Board technology without an instructor presented cue or prompt.

Research Questions

While the use of technology is a recommended practice for teachers of young children (Sandall et al., 2005), additional research is needed using a SMART Board as a medium for presenting information (target information and instructive feedback information) and reinforcement (positive text statements, pictures, audio) with young children with disabilities since young children, especially those without group instruction experiences, may differ from older students (NAEYC & FRI, 2012). The purpose of this study was to evaluate the effectiveness of teacher delivered CTD instruction, with reinforcement, target stimuli, exemplars of target stimuli, and instructive feedback presented via a SMART Board, to teach young students with disabilities and limited experience with group learning to (a) read environmental text taught directly to the student and (b) to the student’s group mates as observational information. In addition, this study assessed reading of Dolch words which were not directly taught but were presented via the SMART Board as instructive feedback to (c) target students and (d) their group mates as observational instructive feedback information. Finally, we assessed whether each student generalized reading of (e) their environmental text and (f) observational information to natural stimuli.

Method

Participants

Three students with disabilities, all male, were recruited for this study. Each student was enrolled in a public primary school program (K-2 with preschool special education) in the southeastern United States. Two students were eligible for special education services under the category of Significant Developmental Delay (SDD), and one student was diagnosed with autism spectrum disorder (ASD); all students had a secondary eligibility of speech-language impairment. Inclusion was based on the following criteria: (a) diagnosed disability or special education eligibility, (b) previously passed a hearing and vision screening, (c) IEP goals related to sight word acquisition or student demonstrated prerequisite reading skills (i.e., expressively identify letters and letter sounds) along with parent expressing desire for student to begin reading instruction, (d) sat and attended to an activity at least 15 min. with minimal redirection, (e) imitated a verbal model of target words, (f) waited at least 3 s for a prompt, and (g) no history with small group direct instruction. Student records and teacher interviews were used to assess inclusion criteria and prerequisite skills.

Students had limited to no experience with sight word instruction and those with a history of sight word instruction experienced minimal success. All students had experience with SMART Board technology and small group activities. However, small group activities focused on increasing recreation or leisure activities, with some opportunities for incidental learning. Some typical SMART Board activities were shared storybook readings, watching educational videos, playing interactive games (e.g., www.Starfall.com), and coloring. Students had no experience with instructive feedback.

Barry, 4 years, 6 months, had a special education eligibility of SDD and received full-day
services for delays in social-emotional development and communication in a self-contained preschool classroom. He displayed relative strengths with academic tasks, such as expressive identification of letters, letter sounds, and numerals. While Barry did not have a previous history with explicit sight word instruction, he could read 10 sight words, consisting primarily of pre-primer Dolch words (e.g., and, jump, look, me). According to his teacher, Barry likely acquired these words incidentally while playing educational computer games. During free play, Barry often engaged in perseverative, isolate play, but, on occasion, would observe peers’ play while he remained on the periphery of activities. Barry used verbal communication in a non-functional manner, often imitating phrases and questions asked by teachers and paraprofessionals, and typically did not request preferred items and activities. Barry displayed characteristics indicative of ASD (e.g., restricted interests, delays in socialization and communication), but had not been formally evaluated at the time of the study. Identified reinforcers included Spongebob Squarepants videos, letter magnets, computer games, and iPad games.

Alan, 5 years, 3 months of age, had a special education eligibility of SDD and received full-day services for delays in social-emotional development in the same classroom as Barry. He did not have experience with sight word instruction, nor did he have any sight words entering the study, but he could expressively identify numerals 1–10 and label all letters and many letter sounds. Alan displayed ASD characteristics as measured by the Autism Spectrum Rating Scales (Goldstein & Naglieri, 2009), indicating deficits in peer socialization, adult socialization, behavioral rigidity, unusual behaviors, and social/emotional reciprocity. During free play centers, Alan engaged in parallel play with peers and displayed functional play with pretense with some classroom materials, but rarely communicated with peers during these activities. Identified reinforcers for Alan included miniature cars, edibles, Bob the Builder videos, and miniature plastic army men. It should be noted that Alan had a behavior intervention plan (BIP) for aggression towards adults, property disruption, and elopement prior to and during the course of this study. However, a review of Alan’s classroom data indicated minimal (less than one per week) occurrences of challenging behavior for consecutive months prior to participating in the study.

David, 6 years, 11 months, was diagnosed with ASD by a private physician and received full-day services (83.3% self-contained setting, 16.7% general education setting) in an adjoining K–2 grade self-contained classroom for communication, cognitive delays, and social-emotional development. David displayed relative strengths with completing routine daily living skills (e.g., hygiene routines, dressing, cleaning up his area, following a schedule). During free play activities he played alone, but was observed non-vocally initiating interactions with peers; the majority of initiations were inappropriate (e.g., touching a peer’s face or hair). David communicated his wants and needs using 2–3 word context specific phrases, but displayed difficulties with pronoun reversal and often referred to himself in the third person. Prior to the start of the study, David received instruction on reading sight words in his classroom; he acquired six sight words after 6 months of instruction. Identified reinforcers included cutting paper with scissors, Bob the Builder materials, computer games, and iPad games.

Settings and Instructor

All sessions were conducted in a self-contained special education classroom, with the exception of generalization sessions, which occurred in the school in areas containing natural presentations of environmental text (e.g., EXIT sign near classroom). Barry and Alan’s classroom teacher (first author) served as the instructor for all sessions. The teacher pulled David from his classroom for sessions, based on a pre-arranged schedule (during morning seat work and 1:1 direct instruction times) with David’s teacher. Prior to the study the teacher interacted with David on a near daily basis, due to the classrooms being side-by-side and combining for recreation and leisure activities (e.g., recess, parties). It should be noted that although the teacher occasionally provided systematic instruction to David on IEP goals amid staff absences, sustained instruction by the teacher on IEP goals, such as sight word acquisition, had not occurred prior
to this study. During instruction, all three students sat in cube chairs facing a SMART Board screen and were approximately 2.5 m from the screen. The teacher sat to the left of the SMART Board across from students. Para-professionals supervised all other children at other centers in the classroom or different areas of the school (e.g., library).

**Materials**

Environmental text and Dolch words aligned with state standards and students’ IEP objectives (see Table 1). Additionally, the first author obtained parents’ input on identification of words that would be immediately useful for their child. Microsoft PowerPoint 2007 with a 600 series SMART Board (60 in × 48 in) was used to present environmental text, exemplars of environmental text, reinforcement, and instructive feedback in the form of Dolch words. Environmental text measured 16 in when projected onto the SMART Board screen. Initials (e.g., “B” for Barry) were used to identify the learner for each trial (i.e., upper right corner of slide; size 10 Arial font and measured [1/2] in when projected). Audio played through two speakers positioned in the ceiling approximately 10 ft behind students. See Table 2 for information presented on slides during SMART Board CTD sessions. Exemplars of environmental text were images depicting the environmental text as it appears in the natural environment and were physically dissimilar from generalization stimuli (i.e., generalization targets were not presented as exemplars during instruction). Audio saying the environmental text played when the exemplar appeared on the screen. Reinforcement was presented via varied pictures of preferred cartoon characters bouncing or spinning on to the screen in conjunction with a “Ta-da” sound. Reinforcement preferences were based on results of a trial-based multiple stimuli preference assessment conducted with each student immediately prior to starting the study (Cooper, Heron, & Heward, 2007). Exemplars, reinforcement, and instructive feedback appeared when the teacher touched a designated area of the screen “activating” the presentation of the additional information. Audio was recorded in the voices of different teachers and instructional aides, varying across genders, accents, and vocal tone, with whom students interacted throughout the school day.

**Response Definitions and Data Collection**

The target behavior of students during all sessions was expressive identification of a target stimulus (i.e., environmental text or Dolch word) following presentation of the task direction, “What word?” During instructional sessions responses were scored as unprompted correct, unprompted incorrect, prompted correct, prompted incorrect, or no response. During all other sessions responses were

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**TABLE 1**

**Word Assignments**

<table>
<thead>
<tr>
<th>Student</th>
<th>Word Set 1</th>
<th>Word Set 2</th>
<th>Word Set 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Environmental text</td>
<td>Dolch words (IFI)</td>
<td>Environmental text</td>
</tr>
<tr>
<td>Barry</td>
<td>Warning</td>
<td>be</td>
<td>First Aid</td>
</tr>
<tr>
<td></td>
<td>Closet</td>
<td>once</td>
<td>Principal</td>
</tr>
<tr>
<td>Alan</td>
<td>Caution</td>
<td>take</td>
<td>Flammable</td>
</tr>
<tr>
<td></td>
<td>Exit</td>
<td>walk</td>
<td>Restroom</td>
</tr>
<tr>
<td>David</td>
<td>High Voltage</td>
<td>was</td>
<td>Do Not Move</td>
</tr>
<tr>
<td></td>
<td>Clinic</td>
<td>old</td>
<td>Office</td>
</tr>
</tbody>
</table>

IFI = Instructive feedback information; Environmental text for one student acted as observational information for another student; Dolch words for one student acted as observational instructive feedback information for another student; *indicates the name of the student’s local county.
scored as unprompted correct, unprompted incorrect, or no response. Unprompted correct responding was defined as correct articulation of the stimulus within 3 s of the task direction. Prompted correct responding was defined as correct articulation of a stimulus within 3 s of the teacher’s verbal model of the stimulus. Unprompted incorrect responding was defined as any word or phrase other than the stimulus said within 3 s of the teacher’s presentation of the task direction. Prompted incorrect responding was defined as any word or phrase other than the stimulus said within 3 s of the teacher’s verbal model of the stimulus. No response was defined as absence of a verbal response within 3 s of the teacher’s presentation of the task direction and the teacher’s verbal model of a stimulus. The teacher used an inter-trial interval of approximately 3 s between all trials.

**General Procedure**

Experimental conditions were as follows: (a) Screening, (b) Environmental Text Probes, (c) Instructive Feedback Probes, (d) SMART Board CTD Instruction, and (e) Generalization Sessions. SMART Board CTD sessions occurred twice daily with at least three hours between sessions. Students were taught in a
triad during CTD sessions, and all other sessions were conducted in a 1:1 instructional arrangement. Each student was taught a total of six pieces of environmental text using CTD and exposed to their peers’ 12 pieces of environmental text. Additionally, each student was exposed to six target pieces of instructive feedback information and their peers’ 12 pieces of observational instructive feedback information. It was possible for students to acquire a total of 36 words throughout the course of the study. Instructional sessions were conducted 4 days a week in a small group instructional arrangement. Sessions were approximately 15 min with 30 trials per session with five opportunities per target word for a total of 10 trials per student. Trials were randomly sequenced with no more than one trial for every three trials presented per student during one session. Environmental text and instructive feedback information were randomly assigned to a tier of instruction per student. Pre- and post-test generalization sessions were conducted at the beginning and end of the study. Instructive Feedback Probes followed each environmental text probe session. Environmental Text Probes were conducted for three consecutive sessions, or until data were stable, prior to beginning SMART Board CTD sessions, and following all students reaching mastery criterion during each tier of instruction. See Table 3 for a description of instructional procedures by condition.

### Screening Procedures

Students were screened to identify unknown environmental text and instructive feedback information. Words were selected by conducting an ecological inventory (Snell & Brown, 2006) of words located in the students’ school and given to students’ parents and David’s teacher for additional input (i.e., parents and teacher asked to identify words to include or exclude). Screening took place over two sessions, one session for environmental text and one for instructive feedback information. Correct responses were reinforced with behavior specific praise on a continuous schedule of reinforcement (CRF) with attending behaviors reinforced with behavior specific praise on a variable ratio-three schedule of reinforce-

### Probes

**Environmental text.** Environmental text probe sessions were conducted in a 1:1 instructional arrangement to assess students’ acquisition of environmental text and observational information (group mates’ environmental text) presented during SMART Board CTD sessions. Correct responses were reinforced with adult praise and pictures and audio presented on the SMART Board on a CRF schedule. Sessions consisted of 22 trials, comprised of a student’s six pieces of environmental text (two pieces of environmental text x three word sets), 12 pieces of observational information (six pieces of environmental text x two group mates), and four known words interspersed to maintain attending. The environmental text exemplar and instructive feedback information were not presented on the SMART Board.

**Instructive feedback.** Instructive feedback probe sessions assessed students’ acquisition of instructive feedback information (Dolch words) and observational instructive feedback information (group mates’ Dolch words) presented during the SMART Board CTD sessions. Procedures for the instructive feedback probe sessions were identical to the environmental text probes.

### SMART Board CTD

A 0–3 s CTD procedure incorporating SMART Board technology was used to teach 18 pieces of environmental text (six pieces of environmental text per student x three students) to students in a triadic (1:3) teaching arrangement. Each piece of environmental text was paired with instructive feedback information that appeared after prompted or unprompted correct responses. SMART Board CTD sessions began once a stable data trend was established for all students during the preceding environmental text and instructive feedback information probe sessions. Mastery for each word set was 90% unprompted correct responding, with the first trial being an unprompted correct response for each student across three consecutive sessions, when reinforced on a CRF for one session and a VR-3 schedule of reinforcement.
<table>
<thead>
<tr>
<th>Condition Components</th>
<th>Screening and Probe&lt;sup&gt;a&lt;/sup&gt;</th>
<th>SMART Board CTD&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Probe – Token Economy&lt;sup&gt;a&lt;/sup&gt;</th>
<th>SMART Board CTD – Token Economy&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Attending Cue</td>
<td>“Look”</td>
<td>“(Student’s name), look”</td>
<td>“Look”</td>
<td>“(Student’s name), look”</td>
</tr>
<tr>
<td>Task Request</td>
<td>“What word?”</td>
<td>“What word?”</td>
<td>“What word?”</td>
<td>“What word?”</td>
</tr>
<tr>
<td>Unprompted Correct</td>
<td>Descriptive verbal praise provided</td>
<td>Descriptive verbal praise provided, preferred cartoon character with audio overlay of “Ta-Da!” played, exemplar with audio saying the environmental text presented, instructive feedback information with audio saying the Dolch word played</td>
<td>Token provided along with descriptive verbal praise</td>
<td>Token provided along with descriptive verbal praise, preferred cartoon character with audio overlay of “Ta-Da!” played, exemplar with audio saying the environmental text presented, instructive feedback information with audio saying the Dolch word played</td>
</tr>
<tr>
<td>Unprompted Incorrect</td>
<td>Removal of word from SMART Board and ignore response</td>
<td>Removal of word from SMART Board and ignore response</td>
<td>Removal of word from SMART Board and ignore response</td>
<td>Removal of word from SMART Board and ignore response</td>
</tr>
<tr>
<td>No Response</td>
<td>Removal of word from SMART Board</td>
<td>Removal of word from SMART Board and ignore response</td>
<td>Removal of word from SMART Board and ignore response</td>
<td>Removal of word from SMART Board and ignore response</td>
</tr>
<tr>
<td>Prompted Correct</td>
<td>–</td>
<td>Descriptive verbal praise, preferred cartoon character with audio overlay of “Ta-Da!”, presentation of exemplar with audio saying the target word, presentation of incidental information word and audio saying incidental word</td>
<td>–</td>
<td>Descriptive verbal praise, presentation of exemplar with audio saying target word, presentation of incidental information word and audio saying incidental word, token given</td>
</tr>
<tr>
<td>Prompted Incorrect</td>
<td>–</td>
<td>Removal of word from SMART Board and ignore response</td>
<td>–</td>
<td>Removal of word from SMART Board and ignore response</td>
</tr>
</tbody>
</table>

<sup>a</sup>Sessions occurred in a 1:1 instructional arrangement.

<sup>b</sup>Sessions occurred in a 1:3 instructional arrangement.
for two consecutive sessions. A 0 s prompt delay was used for the first session of each word set: Teacher asked, “What word?” and immediately delivered a verbal model of the environmental text. A group criterion of 100% prompted correct for one session on a CRF schedule was required before moving to a 3 s prompt delay. For unprompted and prompted correct responses students were reinforced on a CRF. The teacher provided descriptive verbal praise for all prompted and unprompted correct responses, in conjunction with SMART Board delivered reinforcement. Following reinforcement, the environmental text exemplar and instructive feedback were presented via the SMART Board (see Table 2). A group criterion was in place for introducing the next word set; therefore, students who reached criterion before other students received overlearning trials, that is, had additional opportunities to read their environmental text until all students achieved criterion.

Modifications. To ensure students learned to read environmental text, researchers made modifications within the context of the multiple probe design. The following modifications are indicated on Figure 1:

1. Alan displayed problem behaviors (yelling, verbal task refusal, responding incorrectly to known attending cues) that interfered with instruction on the first word set in a small group arrangement. Following systematic observations by the classroom teacher across the school day, it was determined Alan’s problem behaviors were primarily maintained by access to peer attention, which aligned with school data used to develop his BIP. Since Alan was able to read both target words during instruction on the first word set (100% unprompted correct on a CRF during the fourth session), but displayed variable responding related to the problem behaviors mentioned above, the classroom teacher conducted probe sessions in a 1:1 arrangement. This modification was made to reduce the likelihood of problem behaviors related to peer attention (e.g., Barry telling Alan the correct answer after Alan yelled an incoherent response).

   a. Despite reading both target words from Word Set 1 during 1:1 sessions in Environmental Text Probe 2, Alan’s problem behaviors escalated to disrobing and elopement, requiring teacher attention (i.e., response blocking and redirection) per Alan’s BIP. In order to address Alan’s problem behavior a token economy system with which he had

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Figure 1. Percent prompted and unprompted correct responding during instructional and probe sessions for each student; ETP = Environmental Text Probe, SB CTD = SMART Board CTD Instruction; *indicates a token economy was used; David’s ETP 5 condition was conducted in a 1:1 instructional arrangement.
previous experience was implemented for all subsequent conditions.

2. David did not independently read pieces of environmental text during the first tier of instruction; however, David did read one of Alan’s pieces of environmental text (Exit). Based on this observation researchers decided to delay remediation for David’s Word Set 1 environmental text in order to assess observational learning for an observing student (similar to procedures used by Shelton, Gast, Wolery, & Winterling, 1991). An individualized token economy was implemented in all subsequent tiers of instruction, replacing the previously used reinforcement system whereby students accessed their peer’s reinforcement (i.e., preferred cartoon character appearing on screen with audio). Instruction occurred on Word Set 1 environmental text using the token economy following completion of the fourth probe condition.

3. In order to fully replace the group reinforcement contingency with an individual reinforcement contingency, researchers allowed Barry to use the same token economy system as Alan and David. All students had a previous history with token economies.

The token economy consisted of each student choosing a picture of a reinforcer from a reinforcer menu (field size of eight reinforcers) prior to starting a session. Reinforcers were selected based on student records and teacher recommendations. Each student placed his chosen reinforcer picture on a token board measuring 8 in \( \times \) 4 in. Token boards contained a 1.5 in \( \times \) 1.5 in box for the reinforcer picture, and ten 1 in \( \times \) 1 in boxes for tokens. Teacher provided tokens for prompted and unprompted correct responding along with specific verbal praise. A picture of a yellow star was printed on each token. After a student earned 10 tokens, he accessed his chosen reinforcer. If a student did not acquire 10 tokens during a study session, the teacher conducted additional trials related to letter labeling and reinforced correct responding with tokens on a CRF until students earned reinforcement. Refer to Table 3 for information on instructional procedures with the token economy present.

Reliability

Interobserver agreement (IOA) and procedural fidelity (PF) data were collected at least once per condition, or 20% of sessions, for each condition for each student. IOA was calculated by dividing the number of agreements by the number of agreements plus disagreements multiplied by 100. Probe, CTD, and generalization conditions were monitored and PF for each teacher behavior, in each condition, was calculated by dividing number of observed behaviors by number of planned behaviors multiplied by 100 (Billingsley, White, & Munson, 1980). The following teacher behaviors were assessed: (a) delivered attending cue, (b) waited for attending response, (c), presented task direction, (c) waited duration of time-delay, (d) provided appropriate consequence, (e) presented picture of environmental text exemplar, and (f) presented instructive feedback information. Across all sessions, IOA was 99.3% (range: 90–100%) and PF was 99.3% (range: 86.7–100%). During Barry’s generalization pre-test the teacher gave a neutral response, “OK,” within 3 s of Barry emitting an incorrect response on three trials during the session, resulting in 86.7% PF for teacher presenting appropriate consequence.

Experimental Design

A multiple probe design (Gast & Ledford, 2010) across three word sets and replicated across three students was used to evaluate the effectiveness of SMART Board technology and a 0–3 s CTD procedure on the acquisition of environmental text, observational information (group mates’ environmental text), instructive feedback information (Dolch words), and observational instructive feedback information (group mates’ Dolch words). Environmental text were functionally similar, but independent, with the likelihood of behavioral covariation “low”. Evaluation of experimental control was achieved by collecting data across tiers and staggering introduction of SMART Board CTD instruction. Staggered introduction of SMART Board CTD
instruction controlled for history, maturation, and testing threats to internal validity.

Results

Environmental Text

Figure 1 shows percentage of unprompted (closed squares) and prompted (open squares) correct responses for acquisition of environmental text for each student. During initial probe sessions and all probe sessions assessing untrained words sets, students’ data remained stable at 0% unprompted correct responding. Researchers replaced SMART Board presented group reinforcement with an individual token economy system after Environmental Text Probe 2, due to student non-responding and problem behaviors interfering with sessions (see Modifications section).

Barry. For Word Set 1, Barry reached criterion on a CRF schedule in five sessions and mastered the tier in 10 sessions with three sessions consisting of overlearning trials. Barry reached criterion on a CRF schedule in subsequent tiers of instruction in four sessions for Word Set 2 and three sessions for Word Set 3. He received overlearning trials on all word sets before reaching mastery criteria. Barry maintained all acquired environmental text in his final environmental text probe session.

Alan. Alan’s data for Word Set 1 initially indicated an accelerating therapeutic trend with Alan reaching criterion on a CRF schedule in four sessions. However, Alan’s responding shifted to a contra-therapeutic decelerating trend over the next six sessions. Anecdotal data indicated problem behaviors occurring during sessions with variable responding (see Modifications section). Problem behaviors continued throughout Environmental Text Probe 2 with responding varying between 50% and 100% unprompted correct. After introducing a token economy, problem behaviors ceased. Alan reached criterion on CRF schedule in three sessions for Word Set 2 and two sessions for Word Set 3. Alan maintained all acquired environmental text in his final environmental text probe session.

David. David’s responding remained at 0% unprompted correct throughout the first tier of instruction and following the second probe condition (see Modifications section). After introducing a token economy for the second tier of instruction, David mastered Word Set 2 and Word Set 3 in six and 10 sessions, respectively. Following Environmental Text Probe 4, David received instruction on Word Set 1 in a 1:1 instructional arrangement with a token economy, and reached mastery criteria in seven sessions. David maintained all acquired environmental text in his final environmental text probe session.

Observational Information

From Environmental Text Probe 1 to Environmental Text Probe 2 students displayed a mean increase of 41.7% (range 16.7–58.3%) unprompted correct responding for observational information (see Table 4). David, who did not provide an unprompted correct response during the first tier of instruction, read the observational environmental text “EXIT” during Environmental Text Probe 2. During Environmental Text Probe 3 correct identification of observational environmental increased from 0% to 91.7% for Barry and Alan, with no change observed for David. During the final probe condition, Barry, David, and Alan read 88.9%, 50%, and 69.4%, respectively, of observational text across all tiers.

Instructive Feedback Information

Table 4 provides information on student acquisition of instructive feedback information (Dolch words). Barry identified some of the instructive feedback information from Word Set 1 (during Instructive Feedback Information Probe 1) and Word Set 2 (during Instructive Feedback Information Probe 2) prior to instruction. His responding was variable across all word sets throughout probe conditions (0–50%). During Probe 4 Barry identified 50% (Set 1), 0% (Set 2), and 33% (Set 3) of instructive feedback information. Alan and David did not identify their instructive feedback information during probe conditions.

Observational Instructive Feedback Information

Table 4 provides information on student acquisition of observational instructive feedback information (group mates’ Dolch words). Prior to instruction, Alan did not correctly
identify any observational instructive feedback information; Barry correctly read the word *went* one time, and David correctly read the word *be* one time. Barry showed a consistent increase in correct responding for word sets immediately following intervention and correctly identified 50% of his observational instructive feedback information during Instructive Feedback Information Probe 4. David showed an increase in responding during Instructive Feedback Information Probe 2 from 6.3% to 25% for information presented during Tier 1 instruction, and he maintained responding at 16.7% after Instructive Feedback Information Probe 5. David did not read any observational instructive feedback information from Word Sets 2 or 3. During Instructive Feedback Information Probe 5 for David was with a token economy; shaded area indicates percent correct after introducing intervention.

**Generalization**

Students did not read any environmental text or observational words during the pre-test occurring prior to Environmental Text Probe 1 (see Table 5). The post-test occurred after each student’s final probe session during which students were able to generalize reading some environmental text and observa-
tional information throughout the school. David was able to read 11.1% (16.7% environmental text \([N = 1]\) and 5.1% observational \([N = 1]\)) of all words, while Barry and Alan were able to read 94.4% (100% environmental text \([N = 6]\) and 91.7% observational \([N = 11]\)) and 61.1% (83.3% environmental text \([N = 5]\) and 50% observational \([N = 6]\)), respectively. It should be noted Barry and Alan had limited exposure to David’s Word Set 1 environmental text (13 presentations) during instruction due to multiple unprompted errors, which resulted in the teacher ending the trial without exposure to correct response topography.

Social Validity

Students’ parents and David’s teacher were asked to evaluate four statements regarding the appropriateness of the SMART Board CTD intervention using a Likert scale from 1–4 (i.e., 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree). Statements were as follows: (a) The words taught to my child are appropriate for use at home, school, or in the community; (b) Group instruction is an appropriate alternative to one on one instruction; (c) The use of SMART Board technology helped my child or student learn; (d) I am satisfied with results of this study. All items were rated as agree or strongly agree across all parents and teachers (mean rating 3.75). One parent noted that “group instruction” would only be appropriate for her child if it occurred in a “small group.” Additionally, the classroom teacher continued using small group direction instruction in conjunction with SMART Board technology following the completion of the study.

<table>
<thead>
<tr>
<th>Student</th>
<th>Prior to study</th>
<th>During study</th>
<th>Gen Pre-test</th>
<th>Gen Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barry</td>
<td>10</td>
<td>26</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>Alan</td>
<td>0</td>
<td>19</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>David</td>
<td>6</td>
<td>12</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Gen = Generalization.

### Discussion

This study evaluated the effects of small group instruction with an interactive whiteboard (i.e., SMART Board) as a medium for presenting environmental text, exemplars of environmental text, reinforcement, and instructive feedback information to young children with disabilities. Students had minimal experience with sight word instruction and no experience with small group instruction prior to the start of the study. Modifications were required, but overall, results indicated young children with disabilities acquired a net percentage of their (a) environmental text (100%); (b) observational information (range 48.3–88.7%); (c) instructive feedback and observational instructive feedback information (range 3.5–47.2%); and (d) generalized reading of environmental to the natural environment (range 11.1–91.7%). For Alan, who entered the study with no sight words, he correctly read 19 words in his final probe sessions (see Table 4). Barry, who entered the study with approximately 10 sight words, correctly read 26 words in his final probe sessions. David, who previously acquired just six sight words in 6 months of instruction, read 12 words in his final probe session that occurred 3 months after the study began. Additionally, all students increased access to less restrictive environments at the start of the school year following completion of the study (see Table 6). While this measure should not be interpreted as a direct result of the study’s independent variable, it warrants attention due to many researchers citing that small group instruction may prepare students for other settings such as general education environments (Wolery et al., 1992), with few studies actually reporting any information related to accessing environments.

This study replicated findings of previous studies using CTD to teach discrete information in small group arrangements (see cf. Ledford et al., 2012), but produced variable results regarding acquisition of instructive feedback information. To our knowledge, this is the first study to examine the effects of computer presented multiple exemplars, instructive feedback information, and group reinforcement delivered with an interactive whiteboard. This study also highlights considerations for early childhood teachers who pro-
vide reinforcement via SMART Board technology to students during group instruction.

**Implications and Future Research**

*Group reinforcement.* The reinforcement system used during instruction on Word Set 1 allowed all students to access their peers’ reinforcer simply by looking at the SMART Board. These procedures resembled those used by Campbell and Mechling (2009) with elementary-aged children with learning disabilities. An important distinction is that Campbell and Mechling’s use of graphic images and audio presented via SMART Board technology was implemented in a 1:1 arrangement, while the current study implemented said procedures in a small group arrangement. Furthermore, with Barry only having 1% errors during all of SMART Board CTD 1, David and Alan were accessing his reinforcement on a VR-3 schedule of reinforcement. Using a group reinforcement contingency may have provided non-contingent reinforcement of behaviors unrelated to reading environmental text.

Furthermore, it is also possible that the preferred cartoon characters did not function as reinforcers for David. A stimulus preference assessment does not demonstrate a functional relation between a stimulus and its reinforcing properties, and therefore, teachers should be cautious when relying on stimulus preference assessments to identify stimuli to be used as reinforcement. It should be noted that replacing the group reinforcement contingency with a token economy during the instruction of Word Set 2 was effective for increasing reading of environmental text for each student. With this in mind, early childhood teachers should consider their students’ reinforcement histories prior to introducing group reinforcement contingencies, and researchers should evaluate ecologically valid methods for systematically fading token economies to more manageable and natural contingencies (e.g., praise, fixed interval work schedules).

*Acquisition of instructive feedback information.* Students demonstrated variable acquisition and maintenance of instructive feedback information. Possible reasons include presentation of information, sequence of trials, and student learning histories. Instructive feedback information (Dolch words) was presented via audio clips saying a word as it appeared on the SMART Board. Each word had only one corresponding audio file; therefore, each word received the same intonation and pronunciation across all presentations. It is possible students may not have been able to discriminate words from their audio presentation. It should be noted, Barry attempted to read the words “walk” and “old,” and Alan attempted to read the word “round;” however, they mispronounced the words to a degree that their responses resembled different words and could not be scored as correct.

The placement of the Dolch words serving as instructive feedback may have also affected acquisition. A Dolch word appeared following the environmental text exemplar, therefore making the Dolch word the second piece of instructive feedback presented in each trial. It is unclear how the sequence of multiple pieces of instructive feedback presented in the consequent event of a learning trial effect acqui-

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**TABLE 6**

<table>
<thead>
<tr>
<th>Student</th>
<th>Pre-K</th>
<th>K</th>
<th>1st</th>
<th>Pre-K</th>
<th>K</th>
<th>1st</th>
<th>Pre-K</th>
<th>K</th>
<th>1st</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barry</td>
<td>100*</td>
<td>33</td>
<td>–</td>
<td>0*</td>
<td>17</td>
<td>–</td>
<td>0*</td>
<td>50</td>
<td>–</td>
</tr>
<tr>
<td>Alan</td>
<td>100*</td>
<td>33</td>
<td>–</td>
<td>0*</td>
<td>17</td>
<td>–</td>
<td>0*</td>
<td>50</td>
<td>–</td>
</tr>
<tr>
<td>David</td>
<td>–</td>
<td>85*</td>
<td>67</td>
<td>–</td>
<td>17*</td>
<td>33</td>
<td>–</td>
<td>0*</td>
<td>0</td>
</tr>
</tbody>
</table>

*Notes.* K = Kindergarten; *indicates grade of student throughout study.
sition of the instructive feedback. With technology such as PowerPoint and interactive whiteboards potentially making presentation of multiple pieces of instructive feedback more feasible than an instructor presenting multiple flashcards for multiple students throughout group instruction, researchers should consider additional research in this area. Lastly, none of the students entered the study with previous experience acquiring instructive feedback information, which may have affected their abilities to acquire the information. It should be noted that two students demonstrated learning to learn (Wolery et al., 1992) behaviors related to instructive feedback by increasing the amount of observational instructive feedback information acquired from the first tier of instruction to the third.

Managing behavior during small group instruction. The students in the current study did not have a history with small group instruction and thus represent a portion of students who are rarely reported in research. In a review of systematic teaching during small group instruction, Ledford et al. (2012) report that small group instruction “is not a well-studied approach for naïve learners who do not have small-group teaching experiences” (p. 419). Ledford et al. continue that 40% of identified studies required students to have a previous history with small group instruction and were unable to identify studies that included students without previous experience. Early childhood teachers should plan to teach these learning to learn behaviors, such as attending to an instructor and waiting appropriately, in a small group arrangement before conducting instruction (e.g., Ledford & Wolery, 2013; Lane, Gast, Shepley, & Ledford, 2015). Future studies should evaluate effective and efficient strategies to promote these behaviors, thus maximizing the benefits of small group instruction.

In addition to limited experience, a student in this study engaged in various forms of disruptive behavior during instruction, requiring modifications to procedures. Alan’s co-occurring challenging behavior and variable responding starting during session five of SMART CTD 1 and occurring through Environmental Text Probe 2 may have been a result of testing fatigue. Alan may have become satiated on the SMART Board delivered reinforcement since he was exposed to it any time a member of the group provided an unprompted or prompted correct response due to the group reinforcement contingency. While only minimal occurrences of Alan’s problem behavior were reported for months prior to the study, the group instructional arrangement introduced by this study highlights a learning environment for which Alan did not have previous experience and one in which numerous challenging behaviors were reported. It is necessary and pertinent that teachers and researchers better understand how to prepare students with limited experience working in group instructional arrangements for these settings so as to facilitate and promote transitions to less restrictive learning environments that incorporate group learning.

Limitations

The primary limitation in this study is the modifications required for Alan and David to ensure they were able to read environmental text from the first tier of instruction. By modifying two variables across conditions (i.e., adding a token economy while removing SMART Board delivered reinforcement) researchers limited the number of demonstrations of effect that are possible and potentially risked the experimental nature of the design for one that may more closely resemble a descriptive analysis. Multiple options were considered prior to introducing modifications during instruction to address problem behaviors (Alan) and non-responding (David) in SMART Board CTD 1 and Environmental Text Probe 2. While there are demonstrations of the effects of using CTD to teach environmental text presented on a SMART Board, Alan and David’s data potentially indicate a “weak” effect regarding the first tier of instruction within the context of a multiple probe design. It should be pointed out that since the study was conducted in a public school setting by an indigenous service provider (classroom teacher) during typical classroom activities (classroom teacher with the students while classmates were engaged in related preschool academic, play, and art activities with paraprofessionals), we had an obligation to promote
learning while managing classroom instructional time, especially since research questions were directly related to students’ IEP objectives, and consent agreements stated students would be taught to read environmental text. Modifications were made in order to ensure all students learned to read their target words, as well as promote ecological validity, providing early childhood teachers and related providers with “relevant” and “real world” modifications for students who display similar pre-intervention behaviors and similar behaviors during direct instruction in a small group (Gast, 2010, p. 103).

Conclusion

This study contributes to the literature by adding to the small but growing body of work on teaching young children with disabilities in small groups, especially those with no experience with instruction in a group arrangement. While limitations to the design effect the establishment of a functional relation between the independent (SMART Board technology with teacher presented CTD instruction) and dependent (reading of environmental text) variable, the most interesting finding of this study still maintains that children may not benefit from group reinforcement presented via interactive whiteboards during small group instruction. Early childhood teachers should be cautious when utilizing group reinforcement presented on interactive whiteboards (e.g., SMART Board), as it may inadvertently reinforce non-target behaviors (e.g., idiosyncratic, socially inappropriate, and/or disruptive behaviors). Also, early childhood teachers should consider teaching children expectations for engaging in small group instruction prior to beginning instruction. This may allow early childhood teachers to focus on teaching socially appropriate behaviors (e.g., turn-taking, sharing; cf. Lane et al., 2015) when working with groups, as well as reduce the amount of errors young children may display during later small group instruction (Ledford & Wolery, 2013). Considering the potential benefits of small group instruction as they relate to later prosocial and learning behaviors (Wolery et al., 1992), teachers should consider maximizing instruction by including technology as an assistive tool and recognizing the limitations and benefits of these tools when designing instructional programs.

References


