Using iPad-delivered Instruction and Self-Monitoring to Improve the Early Literacy Skills of Middle School Nonreaders with Developmental Disabilities

Melissa E. Hudson
East Carolina University

Abstract: Reading opens the world to individuals and is one of the most important skills learned in school. Around the world, researchers are focused on improving reading instruction for all students, including students with developmental disabilities. Much energy is spent teaching reading basics such as early literacy skills to primary-aged learners because these skills provide the foundation needed for learning to read. In fact, most reading curricula focused on foundational early literacy skills acquisition is designed for elementary-aged students. Many learners with developmental disabilities do not acquire these early literacy skills in the primary grades, however, and improving the reading ability of older students with developmental disabilities who have not yet learned to read is challenging. This study evaluated the effects of an intervention designed to teach early literacy skills to older students with developmental disabilities. The intervention included iPad-delivered early literacy lessons and student self-monitoring. One teacher implemented the early literacy intervention with three middle school students with developmental disabilities (i.e., moderate intellectual disability, autism). Experimental control was demonstrated between the intervention and independent correct responding on level assessments for two participants but not the third. Social validation data collected from the teacher participant were positive. Implications for implementing the intervention with middle school nonreaders with developmental disabilities are discussed, including suggestions for students who are initially unresponsive to the intervention.

Keywords: early literacy skills, iPad-delivered instruction, self-monitoring, developmental disabilities, autism, intellectual disability

Reading vocabulary sight words was once the goal of reading instruction for many students with moderate or severe disabilities (referred to as developmental disabilities in this article; Browder, Wakeman, Spooner, Ahlgrim-Delzell, & Algozzine, 2006). While important, reading sight words is only one of the five components recommended by the National Reading Panel (NRP; 2000) for reading instruction. According to the NRP, students need instruction in phonemic awareness, phonics, vocabulary, fluency, and comprehension to learn to read. Recently, researchers have evaluated the effectiveness of multicomponent reading interventions that addressed all five of these recommended areas with students with developmental disabilities and found improved reading skills for students (for a comprehensive literature, see Afacan, Wilkerson, & Ruppar, 2018). For example, Allor, Mathes, Roberts, Jones, and Champlin (2010) used a group design to evaluate the effects of a reading program for 28 young students with a mean age of 9.5 years and IQs between 40-55. The reading intervention included systematic and explicit instruction on concepts of print, phonological and phonemic awareness, oral language, letter knowledge, word recognition, vocabulary, fluency, and comprehension. The researchers found moderate to strong effect sizes in favor of the treatment. Likewise, Browder, Ahlgrim-Delzell, Flowers, and Baker (2012) used a group design to evaluate the effects of a reading program for 93 students with a mean age of 8.5 years and IQs between 41-43. Their two-part intervention included (a) a scripted curriculum targeting instruction on vocabulary, comprehension, phonemic awareness, and early phonics skills, and (b) read-aloud lessons built around adapted grade-appropriate stories targeting skills for interacting with books and listening comprehension. The researchers found higher posttest mean scores than the comparison group on all dependent variables.

While these results are promising, the materials in these interventions (e.g., stories) were designed for elementary-aged students and are not age-appropriate for middle and high school students who still need instruction on early literacy skills. Only one research study by Mims, Lee, Browder, Zakas, and Flynn (2012) was found that evaluated the effects of a comprehensive reading program for middle schoolers with developmental disabilities but this curriculum focused on literacy skills aligned with middle school English/Language Arts (ELA) standards, not early literacy skills. Because early literacy skills are foundational, when students with developmental disabilities do not learn these skills in elementary school, they will continue to need instruction focused on early literacy skills in middle and high school. For these older students, it remains an empirical question how best to teach early literacy skills.

In addition to becoming more independent readers, learning to monitor one's behavior is an important self-determination skill that could lead to living more independently (Shogren, Wehmeyer, Burke, & Palmer, 2017). Self-monitoring is a component of instruction that has proven effective for improving both social and academic skills of students with developmental disabilities (e.g., Agran et al. 2005; Gilberts, Agran, Hughes, & Wehmeyer, 2001). Self-monitoring involves the student in their own learning by having them monitor their progress towards a goal. For example, Agran et al. (2005) used self-monitoring to increase following-direction skills of students with moderate to severe disabilities in general education. Students made a "+" in the box on the self-monitoring sheet when they completed the step of the task analysis and a "-" for steps that were not completed. Likewise, Gilberts et al. (2001) used peers tutors without disabilities to teach academic survival skills (the behaviors deemed important for success in inclusive general education classes) to five middle schoolers with severe disabilities.

Students were given a list of the survival skills and self-monitored their use of academic survival skills during class by circling "yes" or "no" for each skill.

Comprehensive reading curricula have improved the reading skills for young learners, but it is unknown if similar strategies and activities also be effective in improving the early literacy skills in older students. Additionally, it is unknown if self-monitoring could promote engagement for older learners in their reading instruction. Therefore, the purpose of this study was to investigate the effects of an iPad-delivered early literacy intervention developed for older students and self-monitoring on the acquisition of early literacy skills for middle school students with developmental disabilities who were nonreaders. The questions addressed in this study included:

1. What was the effect of the intervention on the acquisition of early literacy skills of middle-school students with developmental disabilities who are nonreaders?
2. What was the experience of the middle school special education teacher implementing the intervention?

Method

Participants

Students with disabilities. Three middle school students aged 13-16 years who were identified as individuals with severe disabilities (i.e., autism, moderate intellectual disabilities) participated in the study (see Table 1). Pseudonyms have been substituted for the participant's actual names throughout this manuscript to maintain confidentiality. The researcher was interested in the effects of a reading curriculum on these individuals and a single-case design was selected because of the small number of participants available who met the inclusion criteria. The participants were nominated by their teacher because they needed to improve their reading skills, specifically early literacy skills and all met the following inclusion criteria: (1) had a full scale IQ of 55 or less; (2) were enrolled in grades 6-8; (3) had vision within normal limits; (4) were unable to read connected text independently, but could read some sight words; (5) had a reliable way to make selections (e.g., pointing, eye gaze); had at least one IEP goal related to reading; and (6) had regular school attendance (i.e., less than six absences in the school year prior to the study beginning).

Table 1 ***Participant Demographics***

Participant (Pseudonyms used instead of actual names)	Age	Grade	Race/ Ethnicity	Diagnosis	IQ	Adaptive Behavior
Ryan	16	8	African American	Autism, Moderate ID	52 (WISC-V)	70 (ABAS-II)
Elliot	13	7	Caucasian	Moderate ID	40 (WISC-V)	62 (ABAS-II)
Bryce	14	8	African American	Autism, Moderate ID	41 (WISC-V)	61 (Vineland-II)

Note: ABAS - II = Adaptive Behavior Assessment System® - Second Edition (Harrison & Oakland, 2008); ID = intellectual disability; Vineland™-II = Vineland Adaptive Behavior

Scales - Second Edition (Sparrow, Cicchetti, & Balla, 2005); WISC-V = Wechsler Intelligence Scale for Children – Fifth Edition (Wechsler, 2014).

Special education teacher. Five special education teachers were selected by the county's Exceptional Children Director and the Exceptional Children Program Specialist because they taught middle school students with moderate or severe disabilities and expressed an interest in receiving reading professional development. All five teachers received the initial early literacy professional development training. One teacher was not able to obtain parent permission for her students in a timely fashion and did not continue in the study. Another teacher was required by her principal to discontinue her participation in the study. Three teachers began implementing the intervention with students, but only one teacher met the demands of a single-case design by bringing three students into the intervention phase. This teacher held a current special education teaching license, had 14 years of teaching experience, and taught in a separate special education classroom in a public middle school. The teacher was familiar with iPads and had access to iPads in her classroom for students to use during the study.

Settings

Teacher Training. The author held a three-hour early literacy professional development training prior to beginning the study in a centrally-located conference room after school was dismissed for the afternoon. Five teachers completed the training that consisted of four parts: (a) study overview and phases, (b) student inclusion and parent permission, (c) early literacy curriculum components, and (d) student self-monitoring. During the first part of the training, teachers were introduced to the purpose of the study and given a brief overview of the study phases (i.e., baseline and intervention). Second, the inclusion criteria for study participants were discussed as well as procedures for acquiring parental permission. Teachers were encouraged to select four or five students who met the inclusion criteria and seek parental permission for them. At this time, teacher participants completed their informed consent permission forms. Third, each teacher received their own early literacy curriculum appropriate for middle school students. Training on the curriculum included an overview of the intervention components, an introduction to the curriculum's scope and sequence, a walk through the curriculum kit, and directions for downloading the software on a device. Fourth, teachers were trained on how to use student self-monitoring during the iPad-delivered lessons and were given a student self-monitoring sheet to use in their classrooms. Before leaving, teachers completed a demographic sheet about themselves and a training evaluation form. A follow-up email was sent the next day reviewing the steps necessary to begin the study (e.g., obtain parental permission, secure iPad for participants).

Public middle school. The teacher participant taught middle school special education students in a separate classroom in a rural school district located in the southeastern united states. The middle school had 484 students enrolled in grades 5-8. The schools' student body was diverse and 68% of students received free or reduced lunch.

Special education classroom. Participants received the iPad-delivered early literacy intervention in a separate special education classroom located in a public middle school. Participants completed one lesson a day individually via the iPad, three to four times a week. All participants received most of their daily instruction in the special education classroom along with

other students with moderate or severe disabilities; however, the special education participants also had planned opportunities with their nondisabled peers (e.g., music, physical education) and peer tutors regularly assisted in the special education classroom.

Materials

iPad-delivered early literacy lessons. The iPad-delivered intervention was organized into seven levels that addressed 14 early literacy objectives and grew progressively more difficult (see Table 2). Each level contained five lessons that participants completed individually on an iPad. The lessons featured a middle school-aged girl named Sam and were appropriate for older students who had yet to obtain foundational literacy skills (e.g., phonological awareness, letter-sound correspondence). Participants selected an avatar that represented themselves in the lessons and interacted with the lessons by touching the iPad. Systematic instruction (i.e., system of least prompts, constant time delay) and direct instruction (i.e., model-lead-test) were built into the lessons and prompts were provided when needed. For example, the Sam avatar introduced vocabulary sight words for the lesson and asked the user to point to the word on the screen. When no response was given, the avatar provided a prompt (e.g., pointing to the correct word) and repeated the task direction. When the participant touched the correct word, descriptive verbal praise was delivered (e.g., "You're right! The word is *friend*.). When necessary, error correction was delivered, typically by darkening and disabling the incorrect responses and leaving only the correct response available to the user to select. At the top of the iPad screen, highlighted circles tracked their progress through the parts of the lesson. Also, students could pause instruction by hitting the pause button and resume instruction by hitting the play button. After completing the five lessons in a level, participants took a level assessment on the iPad.

Table 2. Early Literacy Objectives Addressed in the iPad-Delivered Lessons*

1. Read sight words
2. Point to sight words to complete sentences
3. Point to text as it is read
4. Say and/or point to a word to complete a repeated story line
5. Respond to questions about a story
6. Demonstrate understanding of syllable segmentation by clapping out syllables in words**
7. Demonstrate understanding of phoneme segmentation by tapping out sounds in VC and CVC word***
8. Identify letter-sound correspondences
9. Point to and/ or say the first/last sounds in words**
10. Identify pictures that begin/end with given sounds**
11. Point to letter sounds in words***
12. Blend sounds to identify pictures***
13. Point to pictures/words representing new vocabulary
14. Use new vocabulary words and personal information to create a story

Note: * iPad-delivered early literacy lessons from the *Early Literacy Skills Builder for Older Students* by Browder, Gibbs, Ahlgrim-Delzell, Courtade, & Lee (2017).
= introduced in Level 2; * = introduced in Level 4

Student self-monitoring sheets. Students used a self-monitoring sheet (see Figure 1) to record their progress through the iPad-delivered lessons in each level. Each level contained five lessons which corresponded with one of five boxes on the self-monitoring sheet. The self-monitoring sheet had a place to note the level at the bottom along with five boxes arranged in a column. To use the self-monitoring sheet, students made an "x" through a box each time they completed a lesson, beginning at the bottom box and working upward. When an "x" was made in all five boxes, participants earned a self-selected prize. At the end of the lesson, teachers used the self-monitoring sheet to review with students how many more lessons were needed to complete the level.

Figure 1. **ELSB for Older Students Self-Monitoring Sheet**

Name:					
Lessons Completed					
	5	5	5	5	5
	4	4	4	4	4
	3	3	3	3	3
	2	2	2	2	2
	1	1	1	1	1
Level:					

Research Design

A single case multiple probe design across participants (Gast, 2010) was used to establish experimental control. Single case studies can provide a scientifically rigorous alternative to random control trials for experimentally determining the effectiveness of interventions with populations that do not allow for large numbers of participants (Kratochwill et al., 2010) such as the population under investigation in this study. In single case research, each participant serves as his/her own comparison, thus controlling for many confounding variables that can impact outcome in rehabilitation research, such as gender, age, socioeconomic level, cognition, home environment, and concurrent interventions (Kratochwill & Levin, 2010). Results can be analyzed and presented to determine whether interventions resulted in changes at the level of the individual, the level at which educational professionals intervene.

A multiple probe design allowed for instruction to begin with one participant while periodic baseline sessions were conducted with all other participants, decreasing the threat of learning through prolonged testing and exposure to intervention materials. Study phases included baseline and intervention. During the baseline phase, a minimum of five data points was collected for each participant until performance data were low and stable or descending for independent correct responses. Once a stable baseline was obtained for all participants, the first participant began the intervention and other participants continued in baseline. A new participant entered intervention when a change in level for independent correct responses was evident for the participant receiving intervention. In this study, a change in level was defined as an assessment score that was 30% higher than the baseline mean. Participants entered the intervention phase in a time-lagged manner until all participants had received intervention. Experimental control was demonstrated by a change in level or trend of participant independent correct responses from baseline to intervention conditions across participants.

Study variables. The independent variable used in this study was comprised of two components: individual early literacy lessons completed on an iPad and student self-monitoring of completed iPad lessons. The dependent variable was the percentage of independent correct responses on the early literacy level assessment completed by participants on the iPad after completing the five lessons in the level. When participants scored a minimum of 80% on the level assessment, they began the lessons in the next higher level. When the level assessment was less than 80%, the lessons in the level were repeated and the assessment was taken again.

Data collection procedures. Participant responses were collected on the iPad every time participants completed a level assessment. Each level assessment score represented the percentage of independent correct responses and was graphed for each participant (see Figure 1). No instructional fidelity or interobserver agreement (IOA) data were collected on the early literacy lessons and level assessments because they were delivered on iPad.

Procedure

Baseline. The intervention's level assessments were used to establish an appropriate starting point for participants to enter the intervention. To do this, initially all participants completed the Level One assessment. When participants' independent correct responses were 60% or higher on this assessment, they completed next higher assessment (i.e., Level Two). This process continued until their independent correct responses on the level assessment was less than 60% correct. Once identified, this level assessment was then used to establish a stable baseline performance level prior to receiving the intervention for each participant (see Figure 2).

Intervention. After baseline was established for all participants, one participant began early literacy instruction on the iPad at their baseline level and all other participants remained in baseline condition. Participants receiving instruction completed five lessons sequentially that addressed 14 early literacy objectives (see Table 2). After completing a lesson, participants used a self-monitoring sheet (see Figure 1) to track their progress in the level. After completing the five lessons in the level, participants completed the level assessment and the percent of independent correct responses was recorded and graphed. When the percent of independent correct responding was 30% more than their baseline mean, the next participant entered

intervention. When the percent of independent correct responding on the level assessment was 80% or higher, the participant began instruction in the next level. This process was repeated until participants completed all seven levels. If their percent of independent correct responding was less than 80%, the participant repeated the level again. Before a new participant began the intervention, another baseline probe was conducted with all participants not receiving instruction to ensure baseline levels remained low and stable. This process was repeated until all participants were receiving the intervention.

Results

In a visual inspection of these data, as seen in Figure 2, results indicate that two participants had increasingly higher percentage of independent correct responses after they completed the early literacy skills lessons in their level, as measured by the level assessment completed on the iPad. Visual analysis was used to determine a functional relationship between the independent variable (i.e., iPad-delivered lessons and student self-monitoring) and the dependent variable (i.e., the percent of independent correct responses on level assessments) for all participants (Barton, Lloyd, Spriggs, & Gast, 2018).

Within conditions visual analysis. Within conditions visual analysis was performed to discern patterns within conditions and to make data-based decisions about condition changes. The a priori hypothesis stated that the baseline conditions would remain stable and that there would be an immediate change in level and a gradual accelerating trend only after the intervention was introduced. A gradual accelerating trend (rather than a steep accelerating trend) is hypothesized during the intervention phase due to the academic nature of the behavior being monitored. During baseline phase, Bryce's percentage of independent correct responses were stable at 57% or less correct. After intervention, there was an immediate change in level and the percentage of independent correct responses were at or greater than 59%. Also noted is a gradual accelerating trend in a therapeutic direction for Bryce. There is no overlap in the percentage of correct responses across adjacent conditions (i.e., the minimum values of the intervention condition were higher than maximum values of the baseline condition). The immediate change, with no overlap, increases confidence in the presence of a functional relation.

Ryan began the intervention at Level 3. During baseline phase, Ryan's percentage of independent correct responses were stable at or less than 44% correct. After intervention, there was an immediate change in level and the percentage of correct responses were at or greater than 46%. Also noted was a slight accelerating trend in a therapeutic direction for Ryan. There was no overlap in the percentage of independent correct responses across adjacent conditions. The immediate change, with no overlap, increases confidence in the presence of a functional relation.

Elliot began the intervention at Level 3. During baseline phase, Elliot's percentage of independent correct responses were stable at or less than 43% correct. After intervention, there was no change in level and the percentage of correct responses were at or greater than 43%. Also noted was a zero celerating trend with the first two data points in the intervention phase and then with the last data point, movement in a non-therapeutic direction for Elliot. There was 33% overlap in the percentage of independent correct responses across adjacent conditions. The lack of immediate change, with overlap, decreases confidence in the presence of a functional relation.

Summative visual analysis. A summative visual analysis was conducted after the study was completed across multiple opportunities to demonstrate behavior change to determine whether a functional relation exists between the independent variable and the dependent variable. Figure 2 shows three intra-participant replications of behavior change when the intervention is introduced. Three inter-participant replications were required to establish experimental control in a multiple baseline across participants design. This was illustrated in Figure 2 with only two participants (Bryce and Ryan), falling short of the three replications needed to establish a functional relationship. Thus, a functional relationship between the intervention and the dependent variable was not established.

Social Validity

After the study was completed, the teacher participant responded to six open-ended questions about her experience with the early literacy intervention: (1) What was your experience using the intervention over that past several months?; (2) What challenges did you experience (e.g., scheduling, materials)?; (3) How did your students react to the intervention?

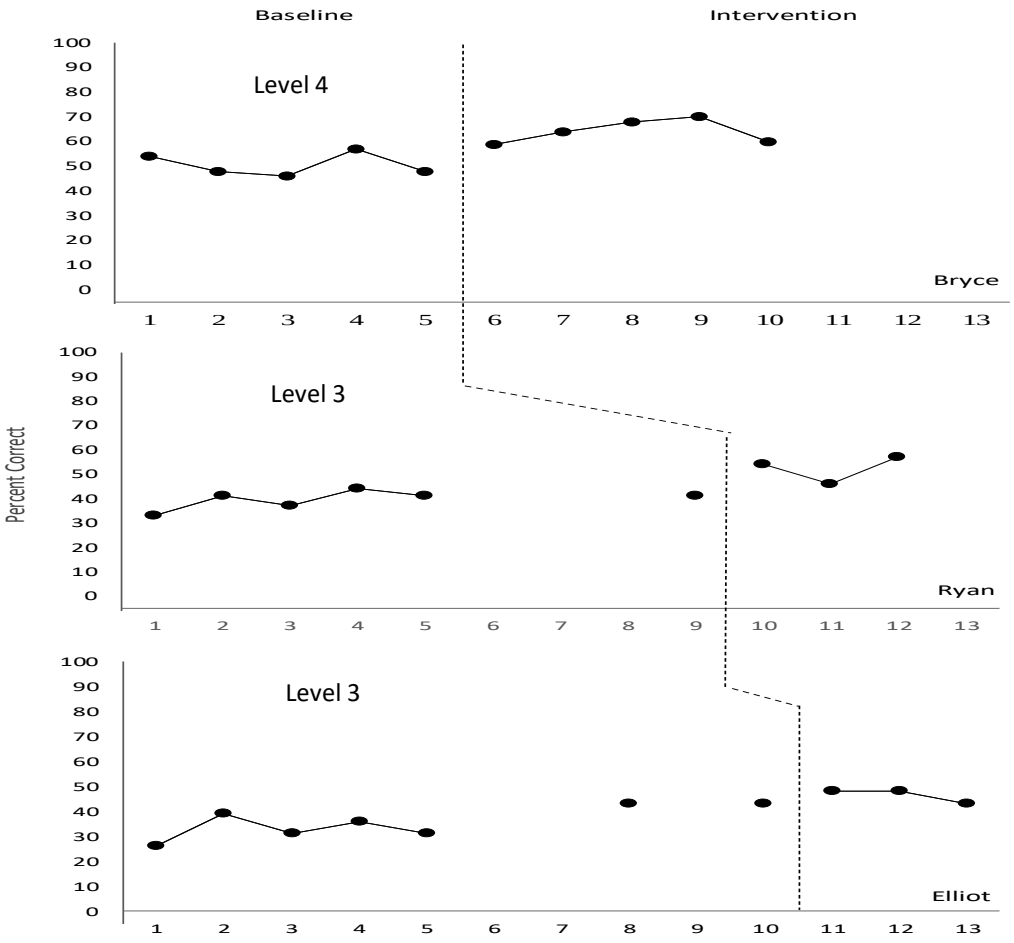

***Figure 2*. Percent of Correct Early Literacy Responses on Level Assessments**

Were there any surprises for you regarding your students' participation?; (4) Did any of your students move up a level in the curriculum? If yes, please describe.; (5) Have you shared use of intervention with any family members or colleagues (e.g., principal)? If so, what comments/feedback did they provide?; and (6) Do you plan to use the intervention next year with students?

For question 1, the teacher described a positive experience with the intervention stating that "the intervention has been a learning experience for the students and myself as well. I had the opportunity to watch these students receive one-on-one instruction with fidelity on a regular basis." For question 2, the teacher described two challenges encountered with the intervention: having time to plan the lessons for the read-aloud lessons and using the app with a student who needed extensive support for the iPad-delivered lessons. For question 3, the teacher was also positive about the reactions of their students stating that her students enjoyed the iPad lessons. She also commented that she was surprised at how well students retained what they learned from week to week. For question 4, the teacher indicated that she did not have a student move up a level in the iPad-delivered intervention. For question 5, the teacher stated that she had shared the program with her principals and other colleagues. For question 6, the teacher indicated that she planned to use the intervention next year with her students.

Discussion

This study evaluates the effects of an iPad-delivered early literacy intervention and self-monitoring on the acquisition of early literacy skills. Two questions are asked: (a) What was the effect of the intervention on the acquisition of early literacy skills of middle-school students with developmental disabilities who are nonreaders? and (b) What was the experience of the middle school special education teacher implementing the intervention?

The effect of the intervention on the acquisition of early literacy skills for participants is mixed. Experimental control is demonstrated between the intervention and the dependent variable for two participants, Bryce and Ryan; however not for the third participant Elliot, whose percentage of independent correct responses on the level assessments during intervention is not much higher than in the baseline condition. Elliot's lack of progress on the level assessment provides an opportunity to evaluate why he did not progress as his classmates did.

First, Elliot is the last participant to enter the intervention and stays in baseline conditions the longest. Perhaps the extended exposure to baseline conditions impacted his performance after he received the intervention. It might also be important to consider that Elliot has the lowest IQ of the three participants, although only one point separated him from Ryan (i.e., 40 vs. 41). Such a small difference in IQ seems unlikely to account for the lack of learning Elliot demonstrates during intervention. A third possible explanation for Elliot's performance is that the intervention needed to be implemented with greater intensity (more lessons) than his peers for Elliot to demonstrate gains in early literacy skills. In their study, Allor, Gifford, Al Otaiba, Miller and Cheatham (2013), found that increasing the intensity of instruction improved the early literacy skills for three participants who had not been responsive to the reading intervention previously (for details of the three-year study, see Allor, Mathes, Roberts, Jones, & Champlin; 2010).

Allor, Champlin et al. (2010) also found three other important factors when planning to increase the intensity of reading instruction for learners with intellectual disability - appropriate level of difficulty, motivation, and meaningfulness to the student. Given the low level of independent correct responding during baseline, it is evident that this is a difficult level for Elliot. Perhaps beginning the intervention at a less difficult level would improve Elliot's performance. Another thought is that there might be a specific skill assessed in Level 3 that Elliott has not yet mastered. If so, he would likely benefit from systematic instruction focused on teaching the skill (or skills). Once mastery on the missing skill is demonstrated, the iPad lessons could be resumed. Teachers can conduct an error-analysis of the questions missed on the level assessment, which are available on the iPad after the assessment is completed.

Allor, Champlin et al. (2010) also found in their research that some students required additional reinforcement for on-task behavior during lessons to benefit from reading instruction. We do not have any information regarding Elliot's on-task behavior. Perhaps adding an individualized behavior management plan to Elliot's early literacy lessons would have increased his percent of independent correct responses on the level assessment. Whether beginning Elliot at a less difficult level or adding a reinforcer for on-task behavior would have made a difference in Elliot's percentage of independent correct responding are important questions for future research.

Another interesting finding from this research is that, while two participants made gains in their percentage of correct responding (i.e., Bryce and Ryan), no participant reached the 80% correct criterion on their level assessment to begin the lessons of the next higher level, even after completing the lessons multiple time (Bryce completed his level lessons five times.) These results might not be surprising given that early numeracy skills are academic behaviors that one would expect to change more slowly than non-academic behaviors, especially for middle-school learners with developmental disabilities who have not learned these skills.

Additionally, the single-case design used in this study required that the percent of independent correct responding during baseline conditions be low and stable; therefore, participants entered the intervention at a level that was challenging for them. The seven levels of the intervention are sequential and grow progressively more difficult from Level 1 to Level 7. Bryce entered the intervention at Level 4 and Ryan and Elliott entered at Level 3. While Bryce and Ryan demonstrated gains in independent correct responding, neither participant made enough progress to begin the next level during this study. These results might have been different had they completed the intervention in sequential order, beginning at Level 1. Classroom teachers who are not confined to the constraints of a research design might experience different results for their students, who can begin the iPad-delivered intervention at Level 1 as intended.

Limitations and Suggestions for Future Research

While the results of this study are promising, they should be interpreted considering these limitations. The first limitation of the study is that the use of self-monitoring was not evaluated. The teacher reported using the self-monitoring sheets with students, but no data was collected as to how or how often they were used or if the participants found them motivating. Future research should systematically investigate the effect of self-monitoring on lesson completion for students receiving the iPad-delivered lessons.

A second limitation of this study was that information about the student participants' experiences with both the iPad-delivered early literacy lessons and the read-aloud lessons were not gathered. The teacher reported anecdotally that their students liked completing the lessons on the iPad, but the participants' opinions about their experiences were not explored. Participants have valuable insights about their own instruction that could be used to improve their learning experiences. Future research should include collecting social validity data from the participants themselves about their experiences with the intervention.

A third limitation was that the length of time participants needed to complete the lessons on the iPad was not recorded consistently across participants. Although the teacher reported that the lesson didn't take long for participants to complete, having the exact amount of time needed would have allowed the researcher to be more specific about the amount of time required to implement the iPad-delivered lessons. Future research could collect these data from the iPad summary after each lesson is completed.

Fourth, data on participants' on-task behavior was not collected. For the most part, students worked independently through lessons, needing only the systematic prompting and support provided by the program. However, participants occasionally needed to be redirected to keep the program going by a teaching assistant. Without data focused on on-task behavior, we do not know how much redirection was provided to participants. On-task behavior could be collected by using a frequency count to indicate the number of times participants are redirected by others (e.g., teachers, teaching assistants, peers) to reengage with the lesson or by using an interval recording system to determine a percent of time on task for participants.

Implications for Practice

There are several importation implications for practice. First, the intervention was effective in increasing the independent correct responses for two of the participants. While not enough to indicate a functional relationship between the intervention and the dependent variable, these results are promising and warrant further research. Given the lack of age-appropriate curricula focused on early literacy skills for older students with developmental disabilities, there is a great need for early literacy curricula such as this.

Second, using a computer program to deliver the early literacy skills lessons enabled the lessons to be delivered with fidelity. Classrooms can be chaotic places and using computer-assisted instruction is a way to deliver high-quality instruction (McKissick, Diegelmann, & Parker, 2017). Delivering lessons with fidelity is important to ensure that the evidence-based practices used in the intervention (e.g., constant time delay, system of least prompts) are delivered as intended every time. Treatment fidelity is critical to improved student outcomes (e.g., Harn, Parisi, & Stoolmiller, 2013).

Third, the lessons and self-monitoring were easily implemented into the classroom routine. After a 3-hour professional development training, the teacher was able to integrate the early literacy lessons into her daily routines. A major factor that enabled the intervention to be implemented with ease was the amount of time each lesson took to complete. While the amount of time needed was not directly collected, anecdotally, the teacher reported that between 10-20

min a lesson was needed for participants to complete a lesson. Several factors could impact the length of time needed to complete the lessons including the amount of content being covered and the prompting and error correction procedures delivered during the lessons by the program.

Fourth, the iPad-delivered intervention enabled instruction focused on early literacy skills to be delivered to a wider range of students with disabilities in middle school. In the past, middle school teachers have not had a grade-appropriate intervention available to them to teach their older students who still needed early literacy skills instruction. Early literacy skills are believed to be necessary for making gains in reading independence (e.g., Allor, Mathes, et al., 2010), so age-appropriate curricula focused on teaching these foundational skills to older students are important.

Fifth, many students with developmental disabilities find iPad-delivered lessons engaging (e.g., Rivera, Hudson, Weis, & Zambone, 2017). In this study, participants individually completed one lesson a day, three to five days a week on the iPad. Anecdotal data from the teacher indicated that participants were excited and interested in completing the lessons on the iPad. As participants independently worked through each lesson, they received instruction, prompts, error correction, and reinforcement from the program's avatar. A teaching assistant sat with participants while they interacted with the lesson to ensure that participants remained focused on the lesson and did not leave the lesson to open another app on the iPad.

Sixth, self-monitoring is an important self-determination skill that students with developmental disabilities often need to be taught. Self-monitoring was used in this study by participants to track the lessons completed on each level. At the end of each lesson, participants made an "x" on their self-monitoring sheet and the teacher reviewed the number of lessons needed to finish the level. When all five boxes contained an "x", participants selected a prize.

Summary

Special education teachers have access to effective curricula for teaching early literacy skills at the elementary level (e.g., Allor, Mathes et al., 2010; Browder et al., 2012) but when students enter middle school without the early literacy skills needed to move forward in reading independence, there are few curriculum options. Reading instruction for secondary students who are nonreaders can be challenging and effective interventions are needed to help teachers deliver age-appropriate instruction to their older students. This study evaluated the effects of iPad-delivered lessons and self-monitoring on the acquisition of early literacy skills for middle school nonreaders with developmental disabilities. Results from the study were mixed. Experimental control was demonstrated for two participants who improved their percent of independent correct responses on level assessments after intervention but not for a third participant, whose intervention responses were not much higher during intervention than in the baseline condition. A middle school special education teacher implementing the intervention integrated the iPad-delivered lessons into her daily schedule and social validity data indicated that she thought the intervention was important and that she planned to continue using the early literacy intervention with her students. While these results are promising, more research is needed.

References

Afacan, K., Wilkerson, K. L., & Ruppar, A. L. (2018). Multicomponent reading interventions for students with intellectual disability. *Remedial and Special Education, 39*, 229-242. doi:10.1177/0741932517702444

Agran, M., Sinclair, T., Alper, A., Cavin, M., Wehmeyer, M., & Hughes, C. (2005). Using self-monitoring to increase following-direction skills of students with moderate to severe disabilities in general education. *Education and Training in Developmental Disabilities, 40*, 3-13.

Allor, J. H., Champlin, T. M., Gifford, D. B., & Mathes, P. G. (2010). Methods for increasing the intensity of reading instruction for students with intellectual disabilities. *Education and Training in Autism and Developmental Disabilities*, *45*, 500-511.

Allor, J. H., Gifford, D. B., Al Otaiba, S., Miller, S. J., & Cheatham, J. P. (2013). Teaching students with intellectual disability to integrate reading skills: Effects of text and text-based lessons. *Remedial and Special Education*, *34*, 346-356. doi.org/10.1177/0741932513494020

Allor, J. H., Mathes, J. K., Roberts, K., Jones, F. G., & Champlin, T. M. (2010). Teaching students with moderate intellectual disabilities to read: An experimental examination of a comprehensive reading intervention. *Education and Training in Autism and Developmental Disabilities, 45*, 3-22. doi:10.1007/s10864–008-9065–2

Barton, E. E., Lloyd, B. P., Spriggs, A. D., & D. L. (2018). Visual analysis of graphic data. In J. R. Ledford & D. L. Gast (Eds.), *Single Case Research Methodology* (pp. 179-214). New York, NY: Routledge.

Browder, D., Ahlgrim-Delzell, L., Flowers, C., & Baker, J. (2012). An evaluation of a multicomponent early literacy program for students with severe developmental disabilities. *Remedial and Special Education, 33*, 237-246. doi:10.1177/0741932510387305

Browder, D., Gibbs, S., Ahlgrim-Delzell, L., Courtade, G., & Lee, A. (2017). *Early literacy skills builder for older students*. Verona, WI: Attainment

Browder, D., Wakeman, S., Spooner, F., Ahlgrim-Delzell, L., & Algozzine, B. (2006). Research on reading instruction for individuals with significant cognitive disabilities. *Exceptional Children, 72*, 392-408. doi:10.1177/001440290607200401

Gast, D. L. (2010). *Single subject research methodology in behavioral sciences.* New York, NY: Routledge.

Gilberts, G. J., Agran, M., Hughes, C., & Wehmeyer, M. (2001). The effects of peer delivered self-monitoring strategies on the participation of students with severe disabilities in general education classrooms. *The Journal of The Association for Persons with Severe Handicaps, 26*, 25-36.

Harn, B., Parisi, D. & Stoolmiller, M. (2013). Balancing fidelity with flexibility and fit: What do we really know about fidelity of implementation in schools? *Exceptional Children*, *79*, 181-193. doi.org/10.1177/001440291307900204

Kratochwill, T. R., Hitchcock, J., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M., & Shadish, W. R. (2010). Single case designs technical documentation. *What Works Clearinghouse: Procedures and standards handbook*. Retrieved from: What Works Clearinghouse website: http://files.eric.ed.gov/fulltext/ED510743

Kratochwill, T. R., & Levin, J. R. (2010). Enhancing the scientific credibility of single-case intervention research: Randomization to the rescue. *Psychological Methods*, 15*(2)*, 124-144.

McKissick, B. R., Diegelmann, K. M., & Parker, S. (2017). Using technology to address barriers in rural special education for students with autism: A do-it-yourself guide. *Rural Special Education Quarterly*, *36*, 155-159. doi:10.1177/8756870517707712

Mims, P. J., Lee, A., Browder, D. M., Zakas, T., & Flynn, S. (2012). Effects of a treatment package to facilitate English/language arts learning for middle school students with moderate to severe disabilities. *Education and Training in Autism and Developmental Disabilities, 47*, 414-425. doi:10.1080/09500693.2018.1432915

National Institute of Child Health and Human Development. (2000). Report of the National Reading Panel. *Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction: Reports of the subgroups* (NIH Publication No. 00-4754). Washington, DC: U.S. Government Printing Office.

Rivera, C. J., Hudson, M. E., Weiss, S. L., & Zambone, A. (2017). Using a multicomponent multimedia shared story intervention with an iPad® to teach content picture vocabulary to students with developmental disabilities. *Education and Treatment of Children, 40*, 327-352. doi:10.1353/etc.2017.0014

Shogren, K. A., Wehmeyer, M. L., Burke, K. M., & Palmer, S. B. (2017). *The Self-Determination Learning Model of Instruction: Teacher's Guide*. Lawrence, KS: Kansas University Center on Developmental Disabilities.