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The effects of a computer-based video intervention to teach literacy skills to a student with a moderate intellectual disability.

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Abstract. The purpose of this study was to examine the effects of a computer-based video intervention, using Apple iBooks on an iPad, for teaching literacy skills to a student with moderate intellectual disability. The intervention, which combined rich multimedia features and explicit instruction sought to teach picture vocabulary, sight word recognition, and the definitions of targeted vocabulary. A multiple-probe design across conditions was used to determine the effectiveness of the intervention. Results demonstrated a functional relation between the presentation of the intervention and the number of correct picture vocabulary words learned. Additionally, pre and post measures indicated that the participant was able to generalize picture vocabulary, in addition to acquiring sight words and vocabulary definitions as a result of the multimedia video instruction. Suggestions for future research and implications for practice are provided.

Keywords: Intellectual disability, vocabulary, multimedia, computer-based video instruction, iPad.

1 Introduction

Vocabulary acquisition is recognized as a fundamental component of reading instruction that serves as a catalyst for fluency, a cusp for acquiring other new vocabulary, and enhances passage comprehension for beginning readers [14], [22], [37], [38]. However, teaching this basic skill to students with intellectual and developmental disabilities is a demanding task for teachers. Therefore, researchers and practitioners constantly search for effective instructional strategies. Although some researchers and educators look at conventional methods of delivering instruction such as flashcards [33], [38], [42] and word walls [21], others believe that the divergent needs of students with disabilities may require unique instructional approaches including the use of technology [12].

Easy access to technology has increased the use of computer-based instruction in special education classrooms [7], [8], [47], specifically for teaching skills such as vocabulary and grammar to students with intellectual and developmental disabilities [6], [10], [16], [24], [33], [49]. As the field of instructional technology advances, there is a continuous need to explore the effectiveness of emerging technologies to promote literacy skills for students with disabilities. Computer-based video instruction (CBVI), a combination of different forms of media that can be used interactively [28], has shown to be an effective tool for teaching students with intellectual disability (ID) various functional skills such as food preparation, using transportation, and functional sight word vocabulary that is encountered in everyday life [2], [27]; [32], [34]. Furthermore, CBVI serves as a means for providing visual and auditory directions to students on how to perform a task or activity. This approach allows for a repetition of prompts and delivery of feedback when needed by the student [3], [39].

Considering the versatility of CBVI, researchers have explored multisensory or multimedia instructional approaches involving kinesthetic, visual, and auditory elements along with text-based vocabulary instruction [6], [10], [16], [24], [38]. Moreover, the National Reading Panel (2000) suggests that vocabulary instruction alone is insufficient in achieving the most beneficial learning. Creating multimedia instruction becomes simple with the use of technology and supports learning while enhancing task engagement and motivation for students [36]. The premise behind utilizing a multimedia instructional program is that learning is enhanced when words are incorporated with images and animation rather than from words alone [36]. Students with intellectual and developmental disabilities are not the only population that can benefit from multimedia technology intervention for vocabulary instruction. This approach is also advantageous for teachers as they can individualize instruction based on student's specific academic needs and individualized education program goals, and re-use materials with modifications for a long period of time. Additionally, instructional material can be personalized to incorporate students' interests, so that they can relate to it, which in turn may lead to more engaging instruction and more meaningful learning.

Given the critical value of vocabulary development, researchers in the field of special education recommend using explicit methods of vocabulary instruction for children with moderate and severe ID [4], [49]. Explicit instruction consists of a range of direct, structured, and systematic instructional techniques that are grounded in unambiguous explanations, demonstrations, and feedback [1]. Although explicit instructional techniques are predominantly advocated to enhance skill acquisition, there is a body of evidence to indicate that students with ID also acquire an array of skills through observational or incidental learning [23], [31], [33], [39], [44]. Contrary to explicit instruction, observational learning is the result of an environmental interaction in which students can acquire incidental information. Whereas explicit instruction is highly structured to remove irrelevant variables and provide the most salient prompts, observational learning capitalizes on acquiring additional information void of that explicitness [19].

Computer-assisted interventions simultaneously allow for the use of explicit instruction [30], [32] but may also include additional information embedded within its multimedia features that allow for incidental information to be learned. Using CBVI, Lee and Vail [15] and Campbell and Mechling [9] demonstrated that incidental, or non-target, information can be strategically placed within an instructional trial sequence (i.e., antecedent, prompt, consequence) to give students with disabilities opportunities to acquire additional skills. Moreover, Mechling et al. [28] demonstrated that computer assisted instruction in small groups could be manipulated to teach both target and non-targeted grocery vocabulary to three students with ID. However, the effects of such observational learning through the use of CBVI such as iPads, has not been well documented within the literature. Traditionally, observational learning opportunities occur within the scope of small groups, yet there is little research that has evaluated how CBVI can be used to teach explicit skills and incidental information within this population [31]. Currently, there are several iPad-based instructional interventions [18] but few have examined teaching academic content [11], [40], [43] or provided examples on how to maximize instruction for students with moderate ID. Hence, this multi-faceted study sought to address the dearth of research in this area by examining the role of observational learning within a CBVI to address the literacy skills of a student with a moderate ID. The following research questions were addressed:

1. What are the effects of observational learning within a CBVI on picture vocabulary, sight word, and definition acquisition for a student with a moderate ID?
2. What is the extent the student will generalize and maintain targeted picture vocabulary?
3. What are teacher and student perceptions of the intervention?

2 Methods

2.1 Participants

The participant was a nine-year-old Mexican American second grader named Selena (pseudonym). Her parents were both born in Mexico and migrated to the United States where Selena was later born. The primary language spoken at home was Spanish; however, Selena was able to understand and speak limited Spanish and English. School records did not identify her as an English learner. At the time of the study Selena was primarily non-verbal. She did not speak in complete sentences and often replied using short phrases or single words. Selena received most of her educational instruction within a self-contained setting for students with moderate to severe ID. Skills that Selena was learning prior to intervention included, but were not limited to: (a) communicating her wants and needs through the use of augmentative and alternative communication devices; (b) expressively identifying numerals 1-10; and (c) tracing the letters of her name in sequence. Though most of her instruction occurred within the self-contained setting, Selena also participated in Art, Music, and P.E with typically developing peers. Further student characteristics can be found in Table 1.

The primary interventionist was the first author, a Puerto Rican male, who had 10 years of experience in special education and working with children with ID. Mrs. Bullock (pseudonym), the second interventionist, was a Caucasian female who was in her first year of teaching. She served as Selena's lead special education teacher and held a Bachelors of Science degree in Special Education and a state license to work with students in the adapted curriculum (i.e., students with moderate to severe ID working on extended state standards).

Table 1. Student Characteristics

Characteristic	Selena
Gender	Female
Age	9
IQ	52 WNV
EOWPVT	<55 2-4
ROWPVT	<55 4-0
Language of instruction	English

Note. WNV= *Wechsler Nonverbal Scale of Ability* (Rivers, 1982). EOWPVT= *Expressive One Word Picture Vocabulary Test, Spanish Bilingual Edition* (Brownell, 2001). *Receptive One Word Picture Vocabulary Test, Spanish Bilingual Edition* = (Brownell, 2001).

2.2 Setting

The study was conducted in a rural elementary school in the South Eastern United States. The school had Title 1 status and served 831 students. The classroom in which Selena was provided academic instruction included 10 other students, the lead special educator, and three-teacher assistants. Training, instruction, generalization, and maintenance measures were all conducted in the classroom. Throughout the study, the student and interventionists sat beside each other on the right hand side of the room at a rectangular table where there were computers and small workspaces.

2.3 Materials

The materials used for this study consisted of an iPad (third generation, black, Wi-Fi, 16-gigabyte) and a 15-inch MacBook Pro. The following computer applications were also used in the development of materials: (1) iBooks Author, (2) iBooks, (3) QuickTime Player, (4) Google Images, (5) YouTube, (6) iMovies (2015), (7) Microsoft PowerPoint, and (8) Apple's built in computer Dictionary application (2015). iBooks Author was used to create iBooks or digital books that can be manipulated to include various forms of multimedia such as music, sound effects, photographs, movies, and widgets. Multimedia was gathered from various sources and included photographs from Google Images, videos downloaded from YouTube, screen castings/movies developed using QuickTime Player, and then iMovie was used to edit screen castings/videos. Once multimedia materials were developed they were embedded into the digital books using iBooks Author, and then downloaded to the iPad via iTunes, where they could then be accessed through the iPad iBooks application.

Microsoft PowerPoint was used to present all assessments to Selena using the MacBook Pro. For instance, a slide containing targeted items (e.g., four photographs of selected vocabulary) was displayed during pre-assessment, probes, and generalization. Photographs were dispersed to the four corners of each slide and Selena was asked to select the appropriate photographs in response to its name. Additional materials included data collection sheets and pencils/pens.

3 Data Collection Procedures and Response Definitions

The primary dependent variable was the number of picture vocabulary correctly selected during probes. During probe sessions the student was presented with four photographs on a slide and, when prompted, was given 4 s to initiate a correct (+) response of pointing to the picture vocabulary requested. An incorrect (-) response was counted if the student did not initiate a response within the allotted time frame or answered incorrectly. Data on additional dependent variables were also collected in a pre and posttest format. These measures included Selena's ability to generalize picture vocabulary, correctly select the sight word pertaining to picture vocabulary taught, and complete a definition activity in which she had to select the correct picture when dictated a definition. Responses to each activity were scored in the same manner as probe sessions. For generalization, sight word, and definition assessments, pretests were administered before baseline and posttests were conducted at the end of the final mastery probe administered in each condition phase.

3.1 Interrater reliability

Mrs. Bullock and the primary interventionist collected interrater reliability for student responses for 30% and 63% of baseline and intervention probes, respectively. Additionally, 50% of generalization, sight word, and definition sessions were also reviewed. During interrater reliability sessions both observers independently evaluated student's responses. Interrater reliability was then calculated using a point-by-point procedure wherein the total number of agreements was divided by the number of disagreements plus agreements multiplied by 100. The mean agreement across all observed sessions was 100%.

3.2 Social validity

At the end of the study, a social validity questionnaire was administered to Mrs. Bullock and Selena to determine the social value of the intervention. The teacher questionnaire contained seven questions, of which six consisted of items that were evaluated using a five-point Likert Scale. The final question was open ended and sought to obtain more detailed feedback about the intervention as a whole. The student questionnaire asked four questions with *yes* and *no* responses. Questions for Selena focused on what aspects she enjoyed or did not enjoy about the intervention.

4 Experimental Design

A single subject multiple probe across conditions (i.e., sets of picture vocabulary) design [46] was used to demonstrate a functional relation between the multimedia intervention and the acquisition of picture vocabulary. Single-subject research examines the relationship between independent and dependent variables using the individual as his or her own control. Repeated measures are collected across baseline and intervention phases to allow for changes in the individual's performance to be compared across conditions. If changes in the dependent variable fluctuate in accordance with the implementation and cessation of the independent variable, a functional relationship between the two can be acknowledged [17].

During baseline, data were collected for a minimum of five sessions. Once baseline data were stable, Selena was moved into the first tier of intervention. When a demonstrative change in level and trend were obtained, a probe was collected in tier two and three of the remaining baseline phases before Selena entered intervention for tier two where a new set of words would be taught to her. The same procedures were conducted before Selena entered tier three of the intervention.

5 Procedures

5.1 General procedures

The CBVI consisted of teaching 15-picture vocabulary divided evenly across three multimedia instructional presentations (see Table 2). Each iBook was split into four phases. During phase one, QuickTime Player (2015) was used to create videos of the primary interventionist providing instruction to the student and reviewing target picture vocabulary. Videos in this phase were presented with the following instructions "Stop, Play, and Listen" written underneath in a text box using 48 point Georgia font. During phase two of instruction photographs of the target vocabulary, gathered from Google Images, were imbedded within the multimedia presentation and were designed to be interactive using functions within the iBooks Author application. For example, the student could press a picture and could hear the name of the target vocabulary word. Photographs were presented with the target vocabulary word written directly underneath the picture using 15 point Georgia font. During phase three of the presentation, narrated videos of the target vocabulary were presented to the student to provide context to the word. Selected videos, downloaded from YouTube, were edited using iMovies and then uploaded to iBooks Author. Videos were presented within an iBooks page with the target vocabulary written underneath in 48 point Georgia. When videos were played they included an audible definition of the word while pictures of the target vocabulary were displayed, followed by a short, 30-35 s, contextual video of that target vocabulary. For instance, if the target vocabulary was tornado, then a video of a tornado would be presented. Finally, phase four consisted of repeating phase two. Once all iBooks were edited and validated by Mrs. Bullock, they were uploaded to the iPad using iTunes. Each presentation consisted of 14 pages that were designed to provide an interactive multimedia instructional experience.

Table 2. Targeted Picture Vocabulary Sets

Set 1	Set 2	Set 3
Petals	Cloud	Summer
Roots	Sky	Autumn
Stem	Tree	Spring
Seed	Day	Winter
Farm	Tornado	Snow

5.2 Pre-assessment

Prior to baseline Mrs. Bullock and the primary interventionist created a list of picture vocabulary, related to science terms, that the student needed to learn as part of the curriculum guide being used in the classroom. Selena was presented with two pretests, using Microsoft PowerPoint slides, consisting of different photographs of the same vocabulary. For example, in the first pre-assessment Selena was presented with a slide containing pictures of a tree, flower, grass, and a leaf. The interventionist then asked her to locate the targeted picture vocabulary. During this time Selena was given 4 s to provide a correct response by pointing to the correct picture. Responses were recorded and then a second pre-assessment was given containing the same vocabulary using different photographs. Results from the assessments were evaluated and only the incorrect words from both assessments were included for intervention.

5.3 Baseline and probe procedures

A total of 15 words were taught to Selena, which were divided into sets of five to create three conditions. A minimum of five baseline data points were collected across each set of words. During baseline, Selena was presented with 15 slides of the targeted picture vocabulary. Each slide contained three picture distractors and the target vocabulary. Selena was provided with the task direction (i.e., "I'm going to say a word and then I want you to point to the picture that matches. Ready? Find___.") and given 4 s to respond. Responses were recorded and reinforcement was not provided. For every presentation, slides and pictures within slides were shuffled to help prevent memorization. Once baseline data were stable for the first set of words, Selena was moved into intervention. Probe sessions were conducted in the same format as baseline and approximately took 1-2 min to complete. Each instructional session lasted approximately 8 min and instruction conditions lasted for 8 days. Probes were administered approximately twice a week.

5.4 CBVI and observational learning

All instruction was provided through the iBooks application. During intervention, the primary interventionist sat beside Selena and shadowed her movements, only providing assistance if she requested it or in the case of a technological mishap (e.g., Selena needed assistance zooming into a video). Before instruction began, Selena was asked to follow the directions provided in the iBook. During the first phase of instruction Selena would play a video of the primary interventionist explaining what the lesson would entail. For example, the primary interventionist would greet Selena providing the following directions: "Hola [Hello] Selena, I hope you are doing well. Today we are going to learn some new words. I need you to first listen with your ears, look with your eyes, and then point to the picture when I ask you to point. Are you ready? Let's go!" Once directions were given, a photograph of the target picture vocabulary would appear. The primary interventionist would say the word (e.g., "tornado") and ask Selena to point to the photograph. At this time an animation of the vocabulary word (i.e., incidental information) would appear under the photograph. The same procedures continued for all five picture vocabulary.

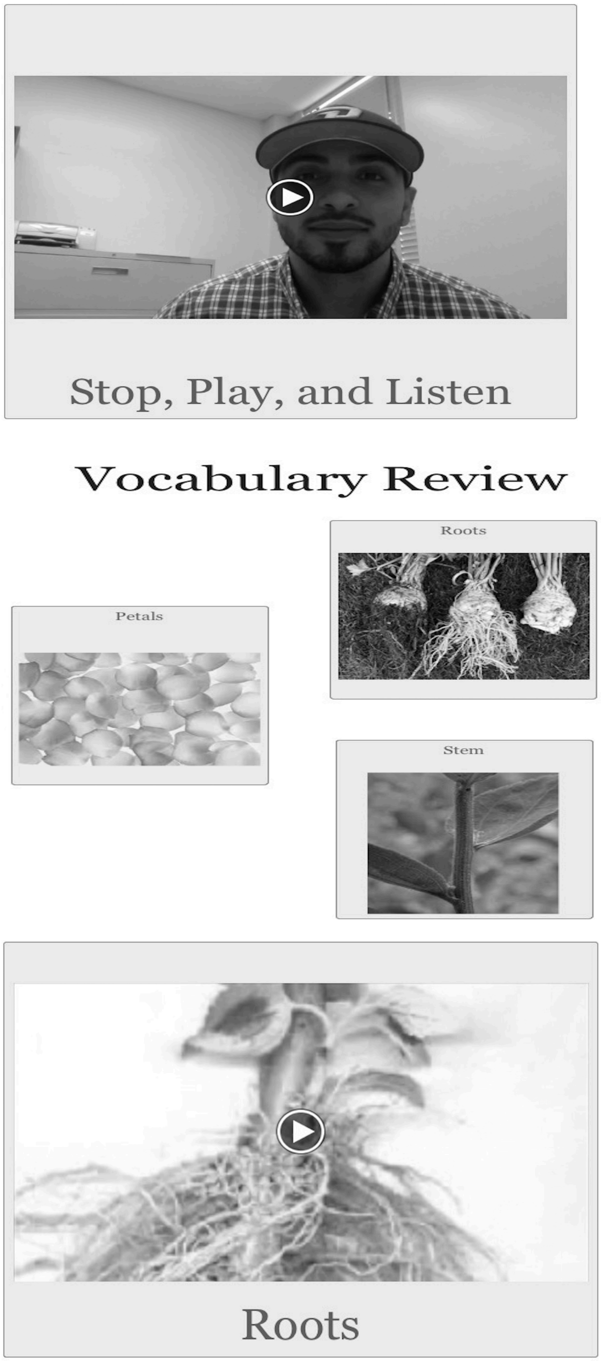

Fig. 1. Sample pages for phase 1, phase 2, and phase 3 of the CBVI.

Next, Selena played a video that provided directions on what she needed to complete in the second phase of the intervention. During this phase, Selena was presented with interactive photographs and would touch the pictures and listen to a dictation of the word. After Selena examined the photographs, she reviewed another page of instructions, which ushered her into phase three of the intervention. At this juncture Selena was asked to play and watch a series of videos, five total, and to listen to the definition of the targeted picture vocabulary (i.e., incidental information). At the end of phase three, phase two was repeated once more. Once complete, Selena played one final video of the primary interventionist providing verbal praise (see Figure 1). It is important to note that non-target information was imbedded through the use of multimedia features such as animations of vocabulary and videos providing context of definitions. These instances did not involve the interventions providing any explicit instruction to Selena but allowed her to simply observe the additional information within the CBVI.

5.5 Sight word and definition assessments

Prior to baseline Selena was given two pre-assessments for sight words and definitions. Similar to baseline procedures, Selena was first shown 15 slides containing the target sight word and three distractors. Sight words were placed at the four corners of a slide using Calibri 48 font. During the assessment Selena was given the task direction, “I’m going to say a word and then I want you to find and point to the word I say. Ready? Find ___.” During the definition pre-assessment, Selena was given the task direction, “I’m going to read a definition to you and then I want you to find the picture that matches the definition. Point to the picture that is___.” Selena was read the definition of the target vocabulary and presented with a slide containing four photographs using dimensions of 4.5 x 3, each placed at the corners of the slides. Like the probe, the presentation of the photographs included the targeted picture vocabulary and three distractors. Posttests were collected at the end of each intervention condition.

5.6 Maintenance and generalization

Maintenance data were collected one week after the conclusion of each intervention condition and used the same procedures as probes. Generalization slides utilized different photographs from those incorporated during probes and intervention sessions, and were also presented in the same format as probes. Data for generalization were collected in a pretest format prior to baseline and a posttest was collected at the conclusion of each leg of the intervention.

5.7 Procedural fidelity

Mrs. Bullock and the primary interventionist collected procedural fidelity for probe, intervention implementation, generalization, sight word, and definition sessions. Procedural observation protocols were developed for each of the aforementioned phases to ensure that items were presented in a consistent manner. Observers determined the occurrence and non-occurrence of each item to obtain a fidelity score. Fidelity was collected for 45% across probe conditions and 50% of generalization, sight word, and definition sessions with a mean agreement of 100%. Procedural fidelity, for CBVI sessions, was collected for 40% with a mean agreement of 96% (range = 92% to 100%).

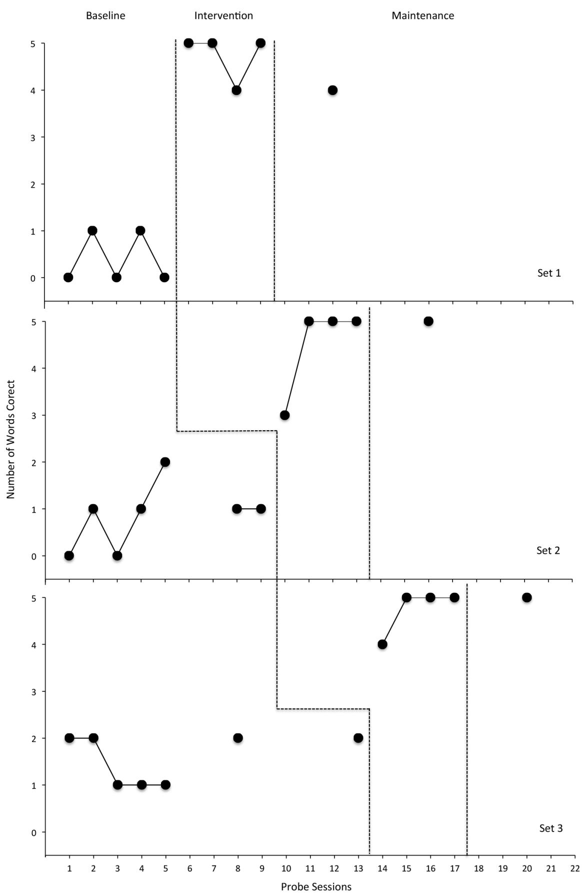

Fig. 2. Number of picture vocabulary correctly selected across three sets of five picture vocabulary words.

6 Results

Figure 2 represents Selena's results during probe sessions. During the first set of picture vocabulary Selena had an increase from baseline (*M* = .5; range 0-1) to intervention (*M* = 4.75; range 4-5). Results were similar in set 2 (baseline *M* = .86, range 0-2; intervention *M* = 4.5, range 3-5) and 3 (baseline *M* = 1.6, range 1-2; intervention *M* = 4.75; range 4-5). Maintenance results demonstrated that Selena was able to maintain fours words from set 1 a week after intervention, five words from set 2 a week afterwards, and five words from set 3 a week after intervention.

Figure 3 represents data for generalization, sight word and definition assessments. For generalization Selena had an increase from pre to posttest with scores of 20% to 93%. Similar results were obtained for the sight word (pretest = 20%, posttest = 73%) and definition assessments (pretest = 6%, posttest = 100%).

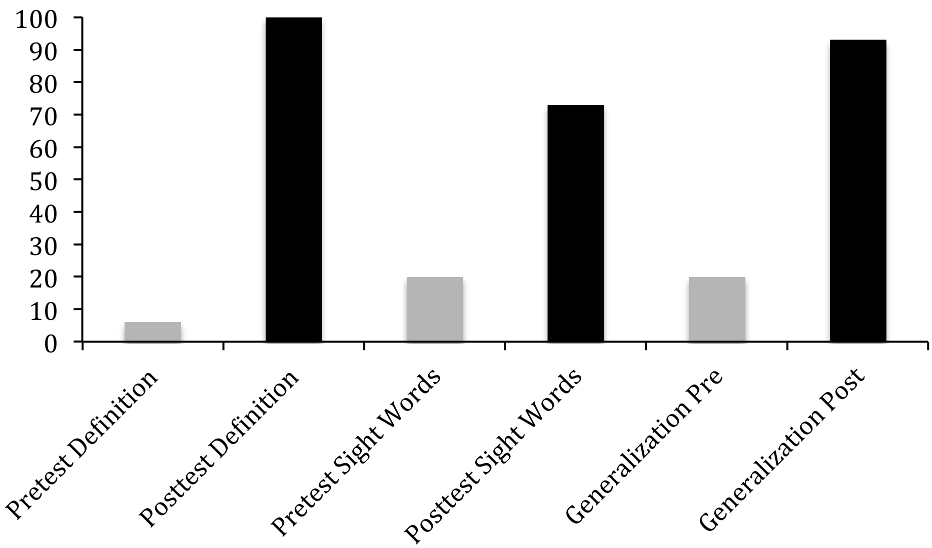

Fig. 3. Pre- and posttest results across definition, sight word, and generalization assessments.

6.1 Social Validity

Data from the social validity questionnaires revealed that both Mrs. Bullock and Selena felt the intervention was appropriate and helpful. Mrs. Bullock strongly agreed that (a) the skills taught were essential; (b) technology can be used to assist students to take lead in their learning experiences; (c) she felt comfortable with the inclusion of the intervention; (d) she felt confident that, if given the opportunity, she could easily integrate the lesson into the student's daily activities; and (d) the technology used was appropriate for Selena's needs. Selena was also asked questions about her experiences with the intervention. Given a choice of *yes* or *no*, Selena replied yes to enjoying learning new words using the iPad, learning the words by herself, and also enjoying the videos and pictures used in the intervention.

7 Discussion

Results from Figure 2, suggest a functional relation between the CBVI and picture vocabulary acquisition. Selena met the criterion of four out of five words correctly identified for three consecutive sessions. Moreover, Selena maintained 93% of picture vocabulary after a one-week hiatus. It is not understood why the drop in performance occurred for set 1, though an additional probe for maintenance would have been useful to verify the decrease in correct responding. Generalization and definition posttests yielded positive results; however, Selena demonstrated some difficulties identifying sight words. A reason for this could be a lack of systematic instruction. Research has shown that students with moderate ID often require forms of explicit instruction (e.g., time delay, hierarchy of prompts) to acquire sight words [5]. Although sight words were not explicitly taught through the multimedia intervention, consistent exposure to words during instruction assisted Selena in increasing her sight word performance by 53%.

Particularly noteworthy in the current investigation was the use of observational learning within the CBVI to address the vocabulary deficits of the participant. Exposing students to non-target information as a means of making instruction more efficient has been widely demonstrated in the literature [23], [33], [39], [44]. What is rarely discussed, however, is the extent to which computer-based interventions can imbed incidental information to teach skills to students with moderate to severe ID. In Selena's case, she mastered the picture vocabulary, definition assessments, and demonstrated an increased performance on the sight word assessment. By incorporating additional instructional information using multimedia-rich features, educators can save on instructional time alleviating the need for one-on-one instruction while possibly reaping the benefits of what students can acquire in small groups. Even if secondary objectives are not entirely mastered, the multimedia exposure appears to give learners with moderate ID like Selena a strong foundation off of which to build.

The multiple-probe design employed in this investigation was appropriate for demonstrating the efficacy of CBVI across three sets of vocabulary words. Specifically, it allows for multiple points of comparison by staggering the onset of the intervention across each novel set of picture vocabulary. When CBVI was implemented for the first set of picture vocabulary, an immediate increase to mastery-levels of responding can be seen only for the set to which CBVI was applied. Sets 2 and 3 remained at baseline levels of no more than two correct responses (40%). Similarly, when the CBVI intervention was applied to Set 2, a clear increase in Selena's responding to these picture vocabulary was observed, while a probe of Set 3 once again remained at baseline levels. Finally, the application of CBVI to Set 3 also brought this set of picture vocabulary words up to mastery levels.

A critical feature of the multiple-probe design is that it controls for distributed practice across each leg of the intervention. The effects of repeated practice would be most noticeable within the extended baselines of Sets 2 and 3. Threats to internal validity are mitigated by the stable frequencies of responding throughout each respective baseline conditions (Miller, 2006). Increases in the frequency of Selena's picture vocabulary identification can only be seen when CBVI is applied directly to each set of words.

The use of the intervention demonstrated that Selena acquired literacy skills in a relatively short and independently operated lesson. Results were positive; however, there are limitations that should be noted for future research endeavors. For instance, a primary limitation was the inclusion of only one participant, indicating the need to replicate similar interventions across a larger sample size. While single-subject methodologies are powerful for demonstrating functional relationships and experimental control, they cannot demonstrate the generalizability of our findings across other students with disabilities. Future researchers should address this limitation.

Another limitation was the low number of words used within each condition restricting the possible variation that could be displayed across conditions if more words had been taught. Technical difficulties, such as accidently exiting out of an application, rarely occurred. In cases where Selena encountered some user or technical error, she would turn to the primary interventionist to correct the problem. A pre-training of iPad use may have been beneficial [20] ; providing Selena with the skills and confidence to trouble shoot some of the encountered issues herself. A final limitation would be determining the efficiency of the intervention. Data on picture vocabulary, sight word, and definition acquisition demonstrated that Selena was able to make positive gains and did so within relatively short instructional sessions. Nevertheless, future research should examine the comparative effects of such an intervention compared to other multimedia interventions or traditional instructional techniques [24], [29] to determine potential benefits and caveats (e.g., usability, practicality) in both one-on-one and small group instructional sessions.

Despite the study's limitations there are several implications for practitioners and researchers. First, the intervention was created using free software that is accessible using Apple products. While there may exist a learning curve in using software provided within this study, as Mechling [28] argues, all teacher created materials take time to make and can be an arduous process. A benefit of using a computer-based intervention, such as the one presented, is that the user has the ability to create a contextual intervention that can be tailored to meet the specific needs of a student and is not tied into how a specific computer based program may operate [40]. Another implication is the use of the iPad itself. Kagohara et al. [18] has argued that mobile devices are beneficial because of their mobility, accessibility (touch screen operation), and because students find mobile based interventions engaging. A final implication was the simplicity of the intervention. Selena enjoyed working on the iPad and seemed very comfortable during the intervention. Some students with disabilities, particularly those with autism, may encounter stress or anxiety when learning new skills, working with adults, or even in groups with their peers. The use of multimedia interventions may be advantageous in these particular situations [28] and offer practitioners flexibility in their instructional schedules.

This study demonstrated that a CBVI enhanced the acquisition of academic content knowledge of a learner with a moderate ID, thereby extending the research on the use of mobile devices in special education classrooms [11], [18], [40], [43]. Additionally, this study further demonstrates that CBVI can incorporate instances of observational learning to teach incidental information, which create an efficient learning tool for a student with moderate ID [23], [31], [33], [39]. Though limitations exist, the benefits of creating personalized lessons that can incorporate various forms of instructional strategies while using current technologies is advantageous. What continue to be needed are replications of similar studies spanning across various academic content for students with moderate and severe ID.

As mentioned above, the findings of this study have several implications for teachers of students with intellectual disabilities. The use of mobile technology has been well documented within the literature on educating general education students [25] and students with mild disabilities [15]. However, the implications for mobile technology as an educational tool for the population of students with moderate to severe disabilities are still only emerging. Teachers can utilize technology to overcome many challenges that impede learning for students with ID. The specific use of mobile technology holds an advantage for students with disabilities in today's classrooms because of its ubiquitous nature, which avoids any negative attention from peers [41]. A majority of teachers and students are familiar with the use of the iPad in particular.

Mobile devices such as the iPad that do not require the use of a pointing device are easy to use by students with disabilities who may have problems maneuvering a mouse. A mobile device is deemed more personal and less cumbersome since it is closer to the user's person in comparison to a desktop computer. It has also been noted that students with intellectual and developmental disabilities show sustained engagement and focus on academic tasks when using mobile devices, which positively impacts student achievement [13], [41]. Given the benefits of computer-based instruction and affordances of mobile technology, it behooves special education teachers to take advantage of these tools to facilitate learning for students with intellectual disabilities.

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