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TECHNOLOGY AIDED INSTRUCTION AND INTERVENTION TO TEACH GRADE LEVEL SCIENCE TERM DEFINITIONS TO MIDDLE SCHOOL STUDENTS WITH AUTISM SPECTRUM DISORDER

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THESIS

A thesis submitted in partial fulfillment of the requirements for Master of Science in Education in the College of Education at the University of Kentucky

By

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ABSTRACT OF THESIS

TECHNOLOGY AIDED INSTRUCTION AND INTERVENTION TO TEACH GRADE LEVEL SCIENCE TERM DEFINITIONS TO MIDDLE SCHOOL STUDENTS WITH AUTISM SPECTRUM DISORDER

The purpose of this study was to teach middle school students with autism spectrum disorder (ASD) academic, grade level science term definitions. Three students with ASD who were served in a self-contained classroom for students with moderate and severe disabilities participated in the study. A multiple probe (days) across behaviors research design was used to evaluate the effectiveness of a model-lead-test procedure delivered using a computer software program to teach three sets of five science term definitions from the general education academic standards. Generalization probes were conducted in the general education setting by giving each student terms that they learned during intervention in the context of the classroom lesson and asking them to respond by giving the definition to the term. The results indicate that students were able to learn and maintain science term definitions when using teacher created e-books with an embedded model-lead-test procedure.

KEYWORDS: autism spectrum disorder, model-lead-test, academic skills, academic standards, technology

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Section 1: Introduction

Curriculum in the general education setting is based on defined academic standards. More recently, that curriculum for general education students has now been mandated for individuals with moderate and severe disabilities (MSD) including those with autism spectrum disorder (ASD). The Individuals with Disabilities Education Act of 1997 and the No Child Left Behind Act of 2002 required that all states educate students with MSD including those with ASD on the content standards of their same-aged peers. According to the analysis conducted by Spooner, Ahlgrim-Delzell, Kohprasert, Baker, and Courtade (2008) where they examined performance indicators for science in various states alternate assessment testing, states have found it difficult to find methods and strategies to teach this population of students' academic content and specifically had the most difficulty with strategies to teach science content. However, researchers have effectively taught academics across subject areas to this population of students in language arts (e.g., Browder, Wakeman, Spooner, Ahlgrim-Delzell, & Algozzine, 2006), math (e.g., Browder, Spooner, Ahlgrim-Delzell, Harris, & Wakeman, 2008), and science (e.g., Spooner, Knight, Browder, Jimenez, & DiBiase, 2011).

It is important to examine strategies that researchers have found effective in teaching these skills so that teachers can translate these practices into the classroom where they are providing academic content instruction. Knight and Sartini (2014) reviewed 23 single case research articles and found various ways practitioners and researchers have taught academics to students with MSD and ASD. Some of the articles included strategies such as least to most prompting, direct instruction, simultaneous prompting, and model-lead-test. For example, Bethune and Wood (2013) found that least-

to-most prompting was effective in teaching students with ASD to answer reading comprehension questions. Flores and Ganz (2009) used direct instruction to teach analogies in figurative language to students with ASD. Riesen, McDonnell, Johnson, Polychronis, and Jameson (2003) conducted a comparison study to determine if simultaneous prompting or constant time delay were more effect to teach students with ASD science term definitions. Lastly, Knight, Spooner, Browder, Smith, and Wood (2013) used a model-lead-test strategy to teach science concepts to students with ASD.

In several studies that have been used to teach academic content, researchers have used a model-lead-test procedure. A model-lead-test procedure has been used widely in explicit instruction. This procedure involves using a series of components to teach a skill. The first component uses a model prompt where the teacher models the correct response for the student. The next component is the lead prompt where the student is led to respond correctly with teacher prompts. The last component is the test where the student is asked to independently complete the response. This intervention is also called, "I do, we do, you do" (Ault, Baggerman, & Horn, 2016; Martella, Nelson, Marchand-Martella, & O'Reilly, 2012; Wolery, Ault, & Doyle, 1992). In a study conducted by Knight et al. (2013), an instructional package (including a model-lead-test strategy) was used to teach the water cycle to middle school students with ASD and intellectual disabilities. When teaching specific parts of the water cycle, the teacher would say, "I do" then "We do", followed by "You do" when teaching things like the definition of evaporation and condensation. Students showed understanding and correct responding by matching pictures, answering questions, and placing arrows within the water cycle to show the flow

of the cycle. The study found that students were able to learn and maintain definitions and concepts from the water cycle.

Knight, Smith, Spooner, and Browder (2012) also found that a model-lead-test procedure was effective for teaching science descriptors to students with ASD. This study examined explicit instruction to teach three elementary school students with ASD three sets of science terms and concepts through the use of a model-lead-test procedure (e.g., wet, cold, heavy.) The teacher placed three objects in front of the student, two that were non-examples and one example. The teacher would then pick up each item and for instance say, "This is wet. This is not wet. This is not wet." as a model. Then as the lead, the teacher would repeat the phrases in the model phase again except the student was expected to verbally repeat what was said. Then for the test phase the teacher would say, "Show me wet." without providing any prompts. By using this model-lead-test procedure all three students were able to reach mastery criterion on all three sets of terms and concepts. Data for this study showed that all students were able to maintain the science descriptors that they learned and generalized them to novel objects, but were unable to generalize them to pictures of the descriptors.

Like the model-lead-test strategy, technology aided instruction and intervention (TAII) is another method of instruction that researchers and teachers have used to teach academics to students with ASD. There are several studies that have examined the effectiveness of TAII to teach various concepts to students with ASD, including communication, social, adaptive, and academic standards skills. In one study, Whitcomb, Bass, and Luiselli (2011) analyzed the effects of a TAII in teaching an elementary school student with ASD word lists and text reading skills. In another study, McKissick,

Spooner, Wood, and Diegelmann (2013) found that TAII was effective in teaching map-reading skills to students with ASD. Hopkins et al. (2011) used a technology program called *Facesay* that employed the use of avatars, to successfully teach students with ASD who were five to 15 years old communication and social skills.

Knight, McKissick, and Saunders (2013) completed a literature review of single case studies that used TAII to teach students with ASD academic concepts. The article reviewed 29 studies but only found 10 single case research studies that either met high or acceptable research standards according to What Works Clearinghouse (Kratochwill, Hitchcock, Horner, Levin, Odom, Rindskopf, & Shadish 2012.) Out of those 10 studies, the majority used some type of software or app to teach the content paired with some type of research-based instructional strategy. Based on this review, additional research is needed on TAII to teach academic content that meets What Works Clearinghouse standards for single case research for students with ASD.

One article that examined a TAII plus a research based instructional strategy was the Knight et al. (2015) study. This article examined a TAII that incorporated the instructional strategy model-lead-test. The purpose of this study was to explore the benefits of supported e-text in relation to science concepts for students with ASD. In this study, four middle school students participated. To be included in this study, students had an ASD diagnosis; qualified for alternate assessment; ability to hear and see; fundamental computer skills; the ability to vocalize; deficits in comprehension; and were in either sixth, seventh, or eighth grade.

Knight et al. (2015) evaluated a TAII with embedded model-lead-test on the number of correct responses on middle school grade level science lessons aligned with

the national science standards and the alternate assessment standards. Examples of the lessons that were given were animal classification, plant transportation, and food production. The independent variable was a teacher created e-book from the Book Builder website (www.bookbuilder.cast.org) that included a model-lead-test strategy delivered through animated avatars. The animated avatars were located in the bottom left corner of each page and look like cartoon characters. They require the students to click on each of them and push play in order to hear and read what they say. Each of the e-books had six pages and with a term or concept on each page. On each page, the avatars delivered the model-lead-test instruction for each term or concept. The students were given training on how to use the e-books on Book Builder's website, as well as how to activate each of the avatars. The intervention was split into three different phases, thus there were three different interventions. In the first phase of intervention, the students were given access to a book from Book Builder. During this phase, the avatars on each page did a "prompt", "hint" and "model" type of intervention to teach various comprehension strategies to learn the science content. The second phase included an e-book from Book Builder with explicit instruction (model-lead-test strategy), which were delivered by the same avatars in phase one. The first avatar delivered the model and would say, "My turn" and then give the definition of the science term. The second avatar delivered the lead and would say, "Say it with me" and then again repeat the definition of the science term. The last avatar delivered the test and would say, "Your turn. What word means ____?" This session taught science term vocabulary. The third phase of the intervention the researcher used examples vs. non-examples to teach the science descriptors.

Results from the Knight et al. (2015) study showed that three out of the four students were able to increase correct responding across all phases and content. Satisfaction data were collected from the special education teacher. The teacher reported the most helpful resource was the Book Builder plus the model-lead-test explicit instruction.

The purpose of the current study was to replicate part of the Knight et al. (2015) study by determining if e-Books created using BookBuilder.cast.org that incorporated a model-lead-test procedure increased the acquisition of grade level science term definitions for middle school students with intellectual disabilities including those with ASD. This investigation replicated the Knight et al. (2015) study by using the same population of students from the middle school age range who were all placed in a MSD classroom, as well as using the e-book from Book Builder with the embedded model-lead-test procedure. However, this study extended the Knight et al. (2015) by focusing on academic content grade level science terms definitions taught by only using the e-book paired with the model-lead-test intervention (i.e., Phase 2) instead of using pictures of examples vs. non-examples. The story included one or two sentences that gave a concrete example of the definition.

Section 2: Research Question

The purpose of this study was to extend the findings of Knight et al. (2015) by using the BookBuilder.cast.org technology and the same embedded instructional strategy (model-lead-test) to teach a similar dependent variable to the same population of students. The research questions included:

1. What are the effects of a technology aided instruction and intervention program incorporating a model-lead-test procedure in teaching science terminology definitions to students with ASD?
2. Will students learn the non-target information of reading the terms after completion of the intervention?

Section 3: Method

Participants

Inclusion criteria for students. To be included in the study, students were required to have a diagnosis of ASD with an intellectual disability, be between ages 12-15 years, be enrolled in the investigator's classroom, have consistent attendance (i.e., no more than one absence per week), and have hearing and vision within normal limits. In addition, students were required to be able to (a) manipulate a mouse, (b) use the computer software independently, (c) follow verbal and model prompts, (d) attend to a ten-min computer task, (e) follow multi-step directions, and (f) verbally imitate. Prior to participation in the study, the investigator obtained parental consent and student assent.

Students. This study included three students who were taught in a MSD self-contained classroom for language arts, social studies, math, and functional living skills. The students were in the general education classrooms with their same-aged peers for related arts classes (i.e., art, Spanish, computer, health, PE, and Music) and science.

Sean was a 13-year-old boy who was in the 7th grade. Sean received outside services for speech therapy and music therapy. Sean had an ASD eligibility, and received services within the MSD classroom because of his IQ and adaptive behavior scores. Sean's classroom teacher completed a Vineland Adaptive Behavior Rating Scale (Sparrow, Cicchetti, & Balla 2005) in which he scored within the extremely low range. He was given the Wechsler Intelligence Scale for Children, 5th edition (Kaufman, Raiford, & Coalson 2016) when he was 12, where he received an IQ score of 54. Sean had IEP goals in the areas of completing a work schedule, calculating sales tax, making change for a purchase, writing simple five-word complete sentences, reading

comprehension, and identifying fractions. Sean spoke in one-two word utterances and had little authentic self-generated language. When Sean replied to a comment or question, he had generally memorized appropriate responses and would say similar things in each scenario. Sean had difficulty staying on task and often engaged in self-stimulatory behavior and scripting. He had excellent rote memory and quickly learned and applied concrete concepts. Sean was excellent in navigating technology and quickly learned to use new applications/software. In his general education science class, he was learning grade level terms and definitions through repeated practice. Sean had no prior experience with the model-lead-test intervention and had never used a teacher created e-Book to learn academic standard materials. Sean also had no prior experience in using TAII for instruction in academic content.

Harold was a 12-year-old boy who was in the 7th grade. Harold received outside services for speech therapy, music therapy, occupational therapy and physical therapy. Harold had an ASD eligibility and received services within the MSD classroom. Harold was given the Universal Nonverbal Intelligence test 2 (Bracken and McCallum 2016) and received a full-scale IQ of 78. Harold was accepted for this study because he qualified for services as a student with MSD despite his 78 IQ and had ASD. His adaptive skills were assessed when he was 11 where he was given the Vineland Adaptive Behavior Rating Scale (Sparrow et al. 2005) and received a score within very low range. Harold had IEP goals in the areas of reading comprehension, memorizing multiplication facts, adding a list of prices, calculating sales tax, determining if he had enough money to make a purchase, fluency of folding household clothing items, and completing a work schedule within 30 minutes. Harold communicated through oral speech using complete sentences.

He was able to describe his wants and needs, likes and dislikes, and would occasionally request more information when necessary without adult prompting. However, when asked to explain or describe something in detail in relation to something that happened or something he did, Harold was unable to effectively elaborate by giving details of what happened. Harold had a good rote memory and was able to learn concrete concepts and apply them to various academic situations. In his general education science class, he was learning grade level terms and definitions through repeated practice. Harold had no prior experience with the model-lead-test intervention and had never used a teacher created e-Book to learn academic standard materials. Harold also had no prior experience in using TAII for instruction in academic content.

Larry was a 12-year-old boy who was in the 6th grade. He received related services for occupational therapy, speech therapy and physical therapy. Larry had an ASD eligibility and received services within the MSD classroom. Larry was given the Vineland Adaptive Behavior Rating Scale (Sparrow et al. 2005) when he was 11 and scored within the very low range. He also was given the Wechsler Intelligence Scale for Children 5th edition (Kaufman et al. 2016) when he was 11 and received a full-scale IQ of 55. Larry had IEP goals in the areas of reading comprehension, telling time to 5 minutes, reading sight words, spelling the sight words, writing three complete sentences, figuring next dollar, counting coin amounts, mopping, and sweeping. Larry was a verbal communicator and was able to give descriptions, details, and name his wants and needs with little to no difficulty. Larry was able to stay on task when working independently but had difficulty attending to a task when in a group setting. Larry was at times reluctant to complete his work but was generally able to complete a task with reinforcers. In his

general education science class, he was learning grade level terms and definitions by repeated practice. Larry had no prior experience with the model-lead-test intervention and had never used a teacher created e-Book to learn academic standard materials.

Investigator. The students' special education teacher was the investigator of this study. The teacher had a bachelor's degree in Special Education with a focus in MSD and was working toward earning a Teacher Leader Master's degree with a focus in ASD. The teacher had three full years of teaching experience in a middle school special education MSD setting. The teacher had previous experience in creating books on bookbuilder.cast.org and in implementing a model-lead-test procedure.

Reliability observer. One paraprofessional took part in this study in order to collect procedural fidelity and inter-observer agreement (IOA) data. This paraprofessional had 20 years of experience in a school setting and 7 years of experience in special education. The paraprofessional had a high school degree and some college credit hours. She had 4 years of experience in data collection (following a task analysis, recording data etc,.) within the context of a special education MSD classroom.

Instructional Setting and Arrangement

All sessions in each condition took place in the students' MSD classroom at their school, which was located in a rural district in the Southeast region of the United States. The primary ethnicity of the school that the students attended was Caucasian and was a Title I school based on free and reduced lunch qualification. The MSD classroom had five students present throughout the day. Three of the five students had ASD and an intellectual disability, one student had an intellectual disability, and one had cerebral palsy and an intellectual disability.

For all sessions, the room was arranged as it would be on any typical instructional school day and no items or furniture was moved for this study. All probe sessions were conducted at the table behind the investigator's desk in a one-to-one format with the reliability collector on the opposite side of the table. A diagram of the classroom is shown in Appendix A. The investigator and student sat across from one another in chairs during all probe sessions. When reliability and IOA data were collected, a second observer sat across the table where the student and the teacher were seated. There were no materials present on the table other than those related to the study (cards with terms, definition data sheet, and data collection sheets). During probe sessions, other students were participating in usual classroom activities and were monitored by paraprofessionals who were not involved in the study. Intervention sessions took place at the student's desk using their assigned Chrome book. The e-Books were created prior to the intervention session. All probe, intervention, and maintenance sessions were conducted in 1:1 formats.

Materials and Equipment

The investigator selected 15 words and definitions at the beginning of the study in collaboration with the students' grade level science teacher (see Table 1 for eight grade terms and Table 2 for seventh grade.) The words were selected so that the students had not been previously exposed to them in class and would not be exposed to them in class for the duration of the study. The students would eventually be taught the unit containing these words within the context of their science classroom at the completion of the study. All students learned the same 15 words. In the tables below, the italicized words were the pertinent words that had to be included in order for the student to be scored as a correct response. Using those 15 words and their definitions, intervention materials (the e-Books)

were made using the website bookbuilder.cast.org and a Dell desktop computer. Book Builder.cast.org is a website

Table 1

Stimuli Assigned to 8th Grade Students

Word	***Definition***
1. Tornado	Violently *spinning column of air* that touches the ground
2. Funnel Cloud	*Spinning column of air not touching* the *ground*
3. Weather	*Outdoor conditions, including rain, temperature, and sun*
4.Precipitation	*Rain, snow, hail*
5. Hail	*Small chunks of ice* that *fall from* the *sky*
6. Rotation	*Spinning* (could also use turning)
7. Cloud	*White fluffy things in the sky*
8. Rain	*Water that falls from clouds* (can use "sky" in place of clouds)
9. Earthquake	*Shaking of the ground*
10. Shaking	*To sway or move*
11. Vibration	*Shaking or buzzing*
12. House	A *building where people live*
13. Building	A *structure with a roof and walls*
14. Bridge	A *structure built to cross* over *something*
15. Fire	The *light* and *heat from burning*

Table 2

Stimuli Assigned to 7th Grade Student

Word	**Definition**
Hair	fine *threads* (strands) *growing* (coming) *from* the *skin*
2. Teeth	a *set of hard structures used for chewing*
3. lungs	set of *organs that aid in breathing*
4. gill	set of *organs that aid in breathing of water animals*
5. fang	a *long sharp tooth*
6. beak	*hard pointy part that covers a birds mouth*
7. feathers	*light outgrowths on the body of a bird*
8. nest	*place* (where) a *bird lays its eggs*
9. fur	*thick hairy coat on an animal*
10. gland	an *organ that makes sweat, spit or bile*
11. graze	to *feed on growing grass*
12. hibernation	when *animals find shelter and sleep for winter*
13. fore legs	an *animal's front legs*
14. hind legs	an *animal's back legs*
15. migration	*move from one place to another*

published by the Center for Applied Special Technology (CASTwww.bookbuilder.cast.org) where e-Books can be accessed and created for free. For the purpose of this study, an e-Book was created on this website. There were six pages in each e-book and a total of three e-books for each student for the entire study. Page one of each e-book contained the grade level and title (i.e., eighth grade science

term definitions), and five pages with a different definition on each page. On each page, there was a picture that represented the term with one-two short sentences about the picture. For example, on one page, there was a picture of a tornado and then the sentence below the tornado would say, "The tornado was spinning so fast it lifted trucks and houses from the ground." At the bottom left of pages two-six, there were three different embedded avatars that delivered the model-lead-test intervention. These avatars looked like small cartoon characters, had voice output capabilities, and included text when clicked. The avatars can be programmed to look like various cartoon animals; however, for the purpose of this study the default avatars were used. The three default avatars were Pedro (penguin), Hali (Lizard), and Monte (dog), and can be programmed to say what you wish. Pages two through six in the e-book each include, a model avatar (Pedro), a lead avatar (Hali), and a test avatar (Monte.) The first avatar was Pedro the "model" prompt. When the student clicked on Pedro, the term and the written definition of the word appeared in a box while the avatar read the term and definition aloud (e.g., "Tornado: A violently spinning column of air that touches the ground"). The next avatar, Hali, was the "lead" avatar. When the student clicked on Hali, a prompt was given for the student repeat after them. When clicked the term and the written definition of the word appeared in a box again while the avatar read the term and definition aloud again (e.g., "Say it with me, tornado: a violently spinning column of air that touches the ground.") The last avatar, Monte, was the "test". When the student clicked on Monte, it prompted the student to recall the definition as they were taught by giving them the term and asking what the definition is (e.g., "Now it's your turn! What is a tornado?") See Appendix B for examples of each page and each avatar of a sample e-book. During intervention the

student used their student assigned Chromebook to access and use the e-Book on the bookbuilder.cast.org website.

Data sheets were created so that all probe and maintenance data as well as IOA and procedural fidelity data could be collected on the same data sheet (see appendix C). White index cards (size 15 7.62x12.70 cm) were used to create stimuli by hand writing the science term on the front of each card in black permanent marker. These cards were used during all probe and maintenance sessions. Students' reinforcers were selected from a choice of items previously identified that was specific to each student.

For this study, each student used his or her school-issued Chromebook to access and use the intervention. Their specific Chromebooks were, Dell™ Chromebook 3180 Laptop, 29.464 cm Screen. The students' Chromebooks were kept on a charging station where the students were able to independently retrieve and access them.

Dependent Variable/ Response Definitions and Recording Procedures

The dependent variable was the percent of correct responding on stating grade level science definitions. Prior to the study, the investigator and general education teacher wrote out definitions for each term including the essential words the student must say in order for the definitions to be scored as correct, as well as alternate words they could use in place of the essential words. In Table 1 and 2, the definitions are shown with some words italicized. Words that were not italicized in the definition were not considered essential, and therefore the students did not have to say those words when stating the definition for a correct response to occur. In order to be scored as correct, the student had to use all of the essential words that were italicized in each definition. This process was conducted with two middle school science teachers, who were familiar with the content.

During this study, the investigator recorded data during all probe and maintenance sessions. A discrete trial recording system was used for this study. Correct, incorrect, and no response (NR) answers were recorded during all probe and maintenance conditions. A correct response was recorded when the student verbally stated the definition to the given stimuli including all pertinent (highlighted) words of the definition beginning within five s and completing the definition within ten s. An incorrect response was recorded when the student left out any pertinent words or failed to complete the definition within ten s. A no response was recorded if the student said nothing within 5 s of the presentation of the stimulus.

Experimental Design

A multiple probe (days) across behaviors single-case research design (Gast, Lloyd, & Ledford, 2014), replicated across students was used in this study to measure the effects of the use of the e-Book through a model-lead-test instructional strategy on the acquisition of grade level science terminology definitions. There was an initial probe condition for tiers one, two and three, then an intervention condition while probes were occurring in the other two tiers followed by a maintenance condition. This design evaluated experimental control by having three different behaviors changed at three different points in time and only when the intervention is applied and not under any other circumstances. This was replicated across three different students. Multiple probe designs limited history and maturation effects by the time lagged nature of the design itself. Testing effects are limited by testing untrained items intermittently, rather than in continuous probe sessions. External validity is addressed in this design by replication across multiple students.

General Procedures

For this study daily probe procedures were conducted one to two times per day, immediately prior to students using the computer program. If the investigator collected data twice per day, there was a minimum of a 1-hour gap between each of the probe sessions. The investigator conducted a minimum of five initial probe sessions in each of tiers 1, 2, and 3. Initial probes included all 15 stimuli probed in a single session. For tier 1, there were five initial probe sessions conducted until the trend and level were stable prior to entering intervention condition. Intervention began in tier one once probe data were stable. Intervention occurred in tier 1 until the students were able to achieve a score of 100% for three consecutive sessions, while probe sessions were periodically (once per week) conducted on untrained stimuli. Once mastery criterion was met in tier one, intervention began in tier two while maintenance data were collected once a week in tier one and probe data continued once a week in tier three. The process was repeated until all three tiers met mastery level criterion and all three tiers were continuing maintenance data collection for one month after the mastery of all three tiers.

There were five science term definitions learned per tier and three total tiers for a total of 15 science term definitions for each student. Each of the terms in each of the tiers were from a comprehensive unit plan given by the general education science teacher and all had a common topic. The science teacher provided a list of science terms to be used during the study. To separate these terms into tiers, stimuli were separated into groups of five and placed into each of the three tiers. During probe procedures, the order in which the stimuli were presented was determined by random selection. To randomly select the order of the stimuli, the investigator shuffled the index cards prior to each session.

Technology Training Sessions

Prior to beginning probe sessions, training sessions were conducted to teach the students how to use and navigate the e-Book on bookbuilder.cast.org. The investigator created an e-Book on bookbuilder.cast.org that contained terms not related to science. The e-book used for training was identical to the one used during intervention. Each book had a title page and five pages with one term and set of avatars on each page. During the technology training sessions, the students were seated at their desks on their Chromebooks. For the first training session, the student was given a model plus a verbal prompt to be shown how to navigate the book and how to properly use each of the avatars on each page. Each session following the first, the student was given no prompts, unless they were needed within ten seconds of each portion of the book, until they were able to independently complete the book two times through for two consecutive sessions. During the training sessions, no responses and incorrect responses all received the same prompts. Once the student was able to access and use the computer software correctly with independent responses for two training sessions, they moved on to probe sessions for tiers 1, 2 and 3.

Probe Procedures

Initial Probes. For this study, the investigator conducted a minimum of five initial probe sessions, until data were stable, in each of tiers 1, 2, and 3. Initial probes included all 15 stimuli probed in a single session. The purpose of initial probes was to measure the student responding levels for the terms and their definitions prior to introduction of the independent variable. Initial probe sessions were conducted every day that the student was present or until the data were stable. The purpose of conducting probes in tiers two and three when they were not under intervention condition was to

show that there was no learning occurring while tier one was under intervention condition. There were five initial probe sessions conducted for tiers 1, 2, and 3 until the trend and level were stable prior to entering intervention condition.

Daily Probes. Daily probes only occurred within intervention conditions. Daily probes began in the respective tier once initial probe data were stable and level while intermittent probes were conducted in untrained tiers once per week. Daily probes were conducted every day that the student was present and only in the tiers that were under intervention condition. Daily probes were conducted prior to the implementation of the intervention. Daily probe sessions consisted of only the five terms that the student was being trained on in that given tier. The purpose of daily probe sessions were to analyze student learning based on the daily implementation of the Book Builder e-book. Daily probes occurred in each tier until that tier reached mastery criterion at a score of 100% for three consecutive sessions.

Intermittent Probes. The purpose of intermittent probes were to ensure that the data in any untrained tiers remained, stable, level, and at a low rate of responding. Intermittent probes occurred once per week and were conducted only in the tiers that had not had the intervention applied. Based on the tier that was under intervention criterion, intermittent probes could have five-ten terms.

For all probe sessions, the student and investigator were seated in a 1:1 arrangement. For a probe session, the investigator was seated across from the student at the table behind the investigator's desk. Prior to initiating the probe, the investigator informed the student that they would be reading a word on a card and saying the definition to the word if they knew it. The investigator explained that it was okay if they

did not know the words. The investigator then gave a general attentional cue, “Are you ready to work?” Once the student indicated they were ready to work by looking at the investigator, the investigator directed the student to point to the word that was shown on the first index card. Once the student pointed to the stimulus, the investigator paused to wait for the student to read the stimulus. If the student did not know the word, then the word was read to them. The investigator then asked, “What is the meaning of the word _____?” The student was given 5 s to begin giving a response and 10 s to complete the response. If the student gave a correct response they were verbally praised, (e.g. “Great job! That is the definition to tornado!”) and a + was recorded on the probe data sheet. If the student gave an incorrect response the teacher responded by saying, “Okay” and recording a – on the data sheet. If the student did not respond, the teacher recorded NR on the data sheet and move on to the next stimuli. An example of the data sheet has been provided in Appendix C. There was a 3-5 s inter-trial interval.

Book Builder (e-Book) Procedures

The independent variable in this study was TAII that used a teacher created e-Book that embedded a model-lead-test instructional strategy delivered by way of animated avatars. The TAII incorporated a model-lead-test strategy with an, I do, we do, you do strategy where the avatar showed the student what to do, allowed the student to practice what to do and then tests their knowledge on what they have learned. Intervention sessions were conducted every school day that the student was present. All intervention sessions took place at the student’s desk on their student assigned chrome book where the e-Book was pulled up and prepared for the student prior to beginning. Prior to the beginning of the intervention session the student was given a general

attentional cue, “Are you ready to work?” Once the student responded affirmatively, the investigator reminded them that they were to complete the e-Book two times through during each of the intervention sessions. The first page of the e-Book was a title page indicating that the student would be learning science terminology, the tier that they were on, and their grade level. In the bottom right hand corner of the book there were left and right arrows that allowed the students to navigate through the book. The student clicked the right arrow to move to the first content page of the book and the same arrow to continue to move to each other page in the book. For each step of each term in the book, the student was required to answer the avatars directions aloud so that the investigator was able to hear them. If they did not respond aloud, then procedural fidelity for that step was counted as an incorrect response. Once the student completed the e-Book through twice, the intervention session was complete and the student was given a verbal praise statement for completing their work.

During the intervention sessions, the investigator had no interaction with the student in relation to the delivery of information taught unless it was to prompt the student to continue working. However, the investigator collected data during each of the intervention sessions to determine the student’s accuracy in the use of the teaching tool. The investigator collected data during every intervention session on if they clicked the avatars in the correct order, if they advanced through all the pages, and if they followed the direction of each avatar. If the student’s use of the software fell below 80% accuracy during a given session, then that student was placed back into a technology session until they are able to complete the training book with 100% fidelity. These trainings were

conducted like the initial technology trainings. Once they were able to complete the e-Book with 100% fidelity they were permitted to return to the intervention condition.

Maintenance Procedures

Due to the nature of the research design used, maintenance was embedded into the design. Once each tier reached mastery criterion, maintenance began in the mastered tier while intervention and probes continued in the other two tiers. Maintenance probes were conducted on mastered tiers in the same manner as probe sessions and were conducted once a week until the end of the study.

Non-Target Information

Non-target information was assessed by determining if the student was able to read the word during the initial probe condition and then again once all three tiers were mastered. There were intermittent probes taken at least once a week as well. Non-target information was assessed for all 15 terms that were selected as stimuli for this study. Data were collected by giving a + for the term if it was read aloud correctly, a – for the term if it was read aloud incorrectly, and a NR if the student did not make an attempt to read the word. If the student responded by incorrectly stating the word on not responding at all, the word was read to them. If the student correctly responded to the stimuli, then they received a descriptive praise statement affirming their response (e.g., Correct! The word is tornado.")

Reliability

Reliability data (IOA and procedural fidelity) were collected for every initial probe session for each student and 56% of Larry's daily and intermittent probe sessions and 67% of Harold and Sean's daily and intermittent probe sessions.

IOA data. Data were collected on a data sheet created by the investigator that listed each student-required behavior for each stimulus in the book (see appendix D). Data were collected by one paraprofessional who worked in the MSD classroom and was trained by the investigator on how to collect data and how to follow the task analysis given. For IOA data, the percentage agreement was calculated by dividing the number of agreements by the number of disagreements and multiplied by 100% (Ayres & Ledford, 2014.)

Procedural fidelity. For procedural fidelity, data were collected and calculated separately for each of the investigators behaviors in the probe and maintenance sessions. The accuracy of each investigator behavior was calculated by dividing the number of observed teacher behaviors by the number of planned teacher behaviors and multiplying by 100 (Ayres & Ledford (2014.) Investigator behaviors were the same for all probe sessions and maintenance sessions, followed the same task analysis, and were monitored on the same data sheet. For each investigator behavior, each session's percentage were added to the percentages from other sessions for that same step and divided by the total number of sessions to find an average reliability percentage for that step. This process was completed for each step in the instructional sequence and their percentages were reported separately. The specific investigator behaviors that were assessed during probe sessions were, gains attention, shows stimulus, student reads word/reads the student the word, asks "what is the meaning of this word?", waits 5 s for the student to answer and 10 s for the student to finish, provides correct student consequences, and waits 3-5 s before delivering the next stimulus.

Student Procedural Fidelity. Procedural fidelity was taken for 100% of the intervention sessions on the students' use of the intervention program. The investigator followed a task analysis to ensure that they read the sentence below the picture, clicked on each avatar and followed the instructions each avatar gives them, and repeated each e-book through two times. An example data sheet has been provided in appendix D.

Social Validity

Social validity data were collected through interviewing the parents of the students in this study. A phone conference call took place, and anecdotal notes were taken on the importance of their children learning and being able to recite grade level science terminology definitions. A phone conference with anecdotal notes were collected at the beginning of the study prior to instruction and then again at the end of the study to see if what their children learned or did not learn changed their opinions from the beginning of the study. Data were reported in an anecdotal format detailing the parents' opinions on the information taught to their children.

Section 4: Results

Reliability Data

IOA data were collected for 100% of all initial probes and 67% of Harold and Sean's, and 56% of Larry's daily and intermittent probes. IOA was 100% for initial, daily, and intermittent probes across all students during the study.

Procedural fidelity was collected for 100% of all initial probes and 67% of Harold and Sean's, and 56% of Larry's daily and intermittent probes. Procedural fidelity was 100% across all students and conditions during the study.

During the study, the students were scored on the use of the technology by having either the investigator or the IOA data collector collect data on the completion of the task analysis created for the software. Data were collected on 100% of the intervention sessions for each student. Larry's procedural fidelity ranged from 94%-100%. He would forget parts to a step for one stimulus or forget to read the sentence under each picture for some terms. Harold obtained 90% average for all steps for the first several sessions but was placed back into technology training because he was at 0% for the step across all stimuli where he was to repeat what the avatar said. Once he was placed back into tech training and understood he was to respond to the "test" avatar, his fidelity increased to 100%. Sean had 100% fidelity through each of the three tiers and across all three e-Books used to teach the definitions.

Effectiveness Data

Figure 1 shows the data collected during probe and maintenance sessions for Larry, Figure 2 for Harold, and Figure 3 for Sean during this study. The results of this study indicated that a student directed e-Book paired with a model, lead, test intervention was effective in teaching three students grade level science term definitions.

The data for Larry show that he was at 0% responding for all five initial probe sessions in tiers 1, 2, and 3. Once intervention was introduced in tier 1, there was two sessions at 0% responding and then a change in level and trend. Larry was able to master tier 1 at 3 consecutive sessions at 100% accuracy within 5 sessions. Prior to the introduction of tier 2 intervention, 3 consecutive intermittent probes were conducted in tier 2. The percent of correct student responding remained at 0% for any untrained stimuli. Once intervention began in tier 2, Larry was able to master the five stimuli at three consecutive sessions at 100% within eight sessions. Prior to the introduction of tier 3 intervention, three consecutive intermittent probes were conducted in tier 3. The percent of correct student responding remained at 0% for any untrained stimuli. Once intervention began in tier 3 there was an immediate change in trend and level and Larry was able to master the five stimuli at three consecutive sessions at 100% within four sessions. Larry maintained tiers 2 and 3 at 100% and tier 1 at 92% over the course of the study.

The data for Harold show that he was at 0% responding for all five initial probe sessions in tiers 1, 2, and 3. Once intervention was introduced in tier 1 the trend and level did not increase for five sessions. Due to no increase in student data for five sessions, an intervention change was made to the investigator consequences during probe sessions to increase student responding. The same thing that was found true with Sean was also true for Harold. The same intervention change was made for Harold that was made for Sean. Once this intervention change was made, an immediate change in level and trend happened and Harold was able to master tier 1 at 3 consecutive sessions at 100% accuracy within 12 more sessions. Prior to the introduction of tier 2 intervention, three

consecutive intermittent probes were conducted in tier 2. The percent of correct student responding remained at 0% for any untrained stimuli. Once intervention began in tier 2 Harold was able to master the five stimuli at three consecutive sessions at 100% within eight sessions. Prior to the introduction of tier 3 intervention, three consecutive intermittent probes were conducted in tier 3. The percent of correct student responding remained at 0% for any untrained stimuli. Harold was able to master the five stimuli in tier 3 within 14 sessions at 100% responding. Only one maintenance session was conducted in tier 3 with Harold and he was able to maintain at 100% accuracy.

The data for Sean show that he was at 0% responding for all five initial probe sessions in tiers 1, 2, and 3. Once intervention was introduced in tier 1 the trend and level did not increase for five sessions. Due to no increase in student data for five sessions, a modification of the intervention was made to the investigator's consequences during probe sessions to increase student responding. It was hypothesized that Sean was not connecting what he was learning during the intervention sessions with what he was being tested in the probe sessions. Due to this, a change was made for the consequence given for an incorrect response during probe sessions. Instead of saying, "okay" when an incorrect response was given, the investigator said, "No, I want you to tell me what Monte told you _____ was." Once this intervention change was made, there was one session at 0% and then a change in level and trend occurred and Sean mastered tier 1 stimuli at three consecutive sessions at 100% accuracy within six more sessions. Prior to the introduction of tier 2 intervention, three consecutive intermittent probes were conducted in tier 2. The percent of correct student responding remained at 0% for any untrained stimuli. Once intervention began in tier 2, Sean was able to master the five

stimuli at three consecutive sessions at 100% within ten sessions. Prior to the introduction of tier 3 intervention, three consecutive intermittent probes were conducted in tier 3. The percent of correct student responding remained at 0% for any untrained stimuli. Once intervention began in tier 3 Sean was able to master the five stimuli at three consecutive sessions at 100% within eight sessions. Sean was able to maintain all three tiers and previously trained 15 stimuli at 100% over the course of the study.

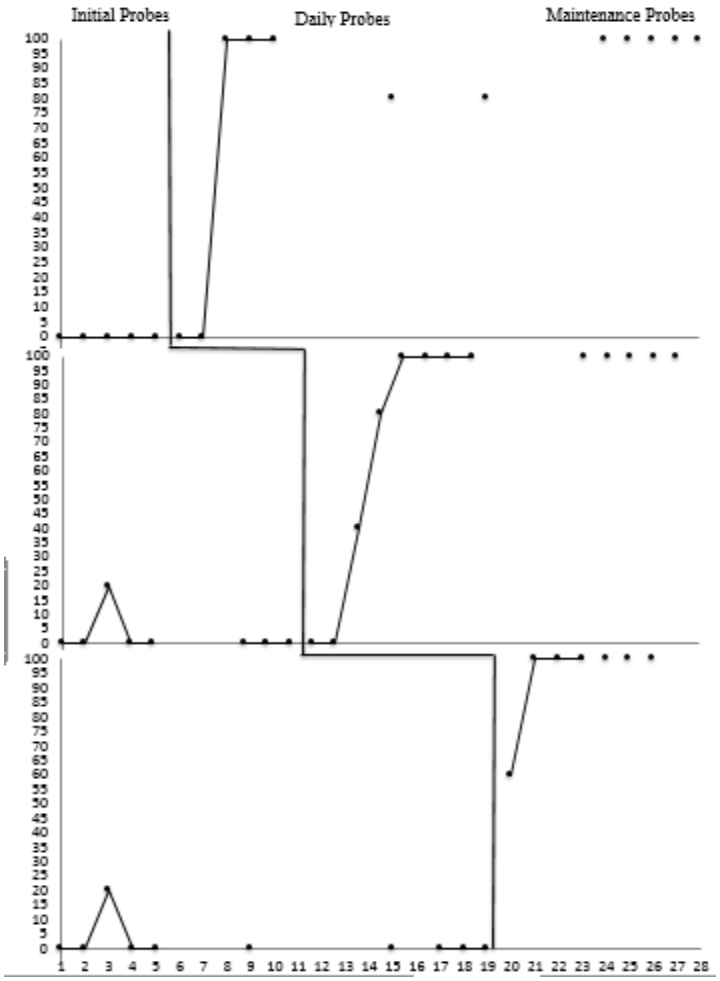

Figure 1: Percent of correct responses on science term definitions for Larry

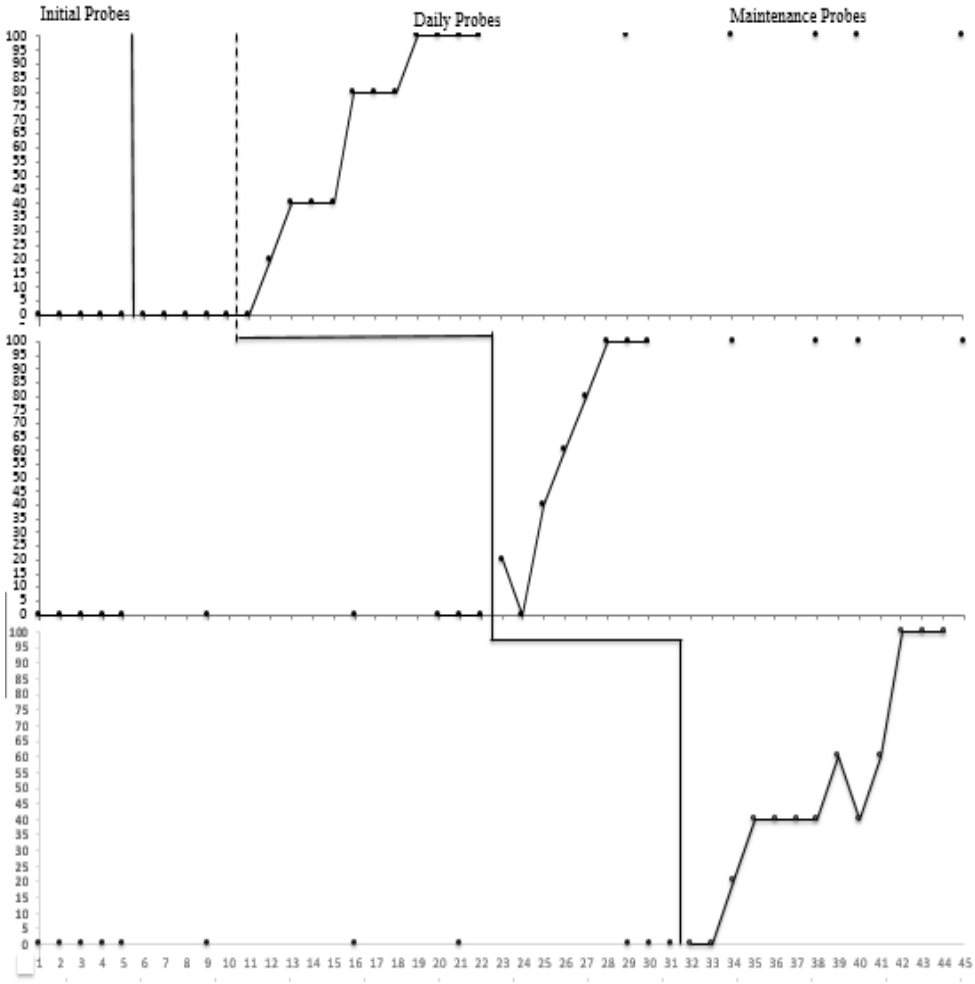

Figure 2: Percent of correct responses on science term definitions for Harold

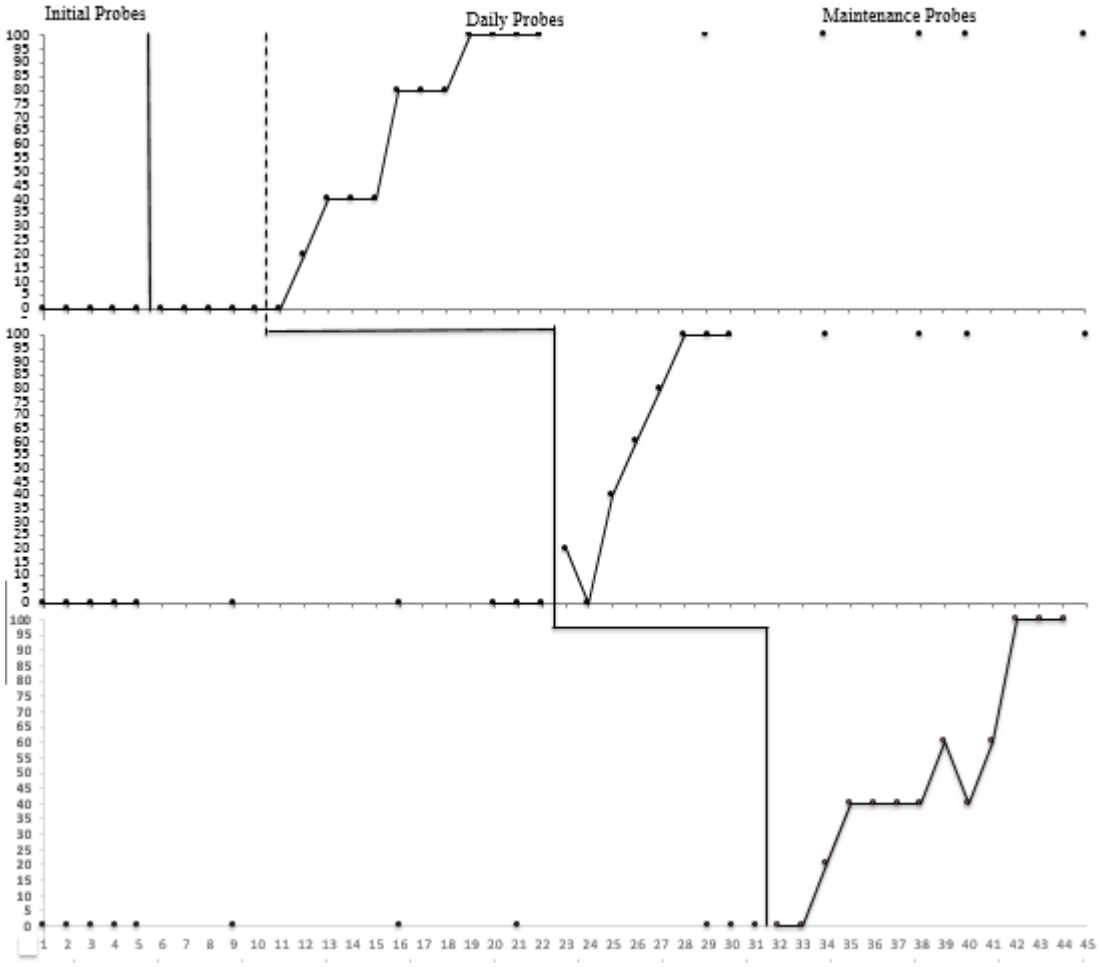

Figure 3: Percent of correct responses on science term definitions for Sean

Non-target data. During the first initial probe sessions at the beginning of the study for each student, data were collected and examined on the students ability to read each of the stimuli that were presented to them. Then, throughout the study, data were taken each probe session as the student either read the stimuli or were unable to read the stimuli. Once the study was completed, data were taken again, examined and compared to previous data to determine if the student learned to read any of the word they did not know during the duration of the study through repeated exposure of the stimuli. The only data that were compared were the initial data collection of the ability to read the terms

and the last full probe at the completion of the study. It was found that the students were able to read all 15 words at the end of the study and that they learned any words they were unable to read at the beginning of the study. Larry was able to read eight words during the pre-test and 15 words during the posttest. Harold was able to read 11 words in pre-test and 15 words in post-test. Sean was able to read all 13 words in the pre-test and 15 words in the post test. Below is table 3 that detail each student's ability to read the stimuli at the beginning of the study and at the end of the study.

Table 3

Student Responding to Reading Stimuli

Word	**Pre-Intervention**	**Post Intervention**
Sean	87%	100%
Harold	73%	100%
Larry	53%	100%

Social Validity. Anecdotal records were collected during phone conference calls prior to the beginning of the study with each of the students' mothers and then again at the end of the study to determine if their opinions had changed. Sean's mother stated that it was important to her that Sean is in the general education setting and learn as much of the content as he could. She expressed hopes for Sean's future and the importance of some of the topics covered in the general education science curriculum. Once the study was completed and Sean's results were shared with his mother, she stated that, "I knew

that he was capable of learning things that his peers learn. These results solidify my previous thoughts that Sean should continue to learn the things that his peers learn."

During the pre-study phone conversation with Harold's mother, she expressed that general education classes were important to her so that Harold was with his peers and able interact with them in a typical classroom setting. She stated that the curriculum and content were less important to her because of the skills and knowledge of basic life and care that Harold lacked. Once the study results were shared with Harold's mother and she found that Harold was able to learn and maintain core content grade level material, she was encouraged but still felt as though there were more important and pertinent things for Harold to be learning.

Larry's mother found core content material to be important during her pre-study interview and believed that Larry was capable of learning but expressed frustration in the level of supports they had to provide at home for Larry to be able to learn and maintain core content curriculum. Once the study results were shared with Larry's mother, she expressed that she still felt core content was as important as she did before and was happy that there were tools (like Book Builder) available that took some of the stress and responsibility away from Harry and their family to help him learn and maintain core content material as well as stay organized.

Section 5: Discussion

The purpose of this study was to replicate the Knight et al. (2015) study and to further the research on students with ASD learning grade level core content science term definitions through student directed technology paired with a model, lead, test intervention. Results from this study provide evidence that using a teacher created e-book paired with a model-lead-test strategy increased the knowledge of grade level science term definitions in students with ASD. The data show that student learning occurred when and only when the intervention was applied during the three time-lagged tiers. All students in the study were able to master all 15 science term definitions. Sean was able to master tier 1 words in 11 sessions, tier 2 words in ten sessions, and tier 3 in eight sessions. Harold was able to master tier 1 words in 16 sessions, tier 2 words in eight sessions, and tier 3 words in 14 sessions. Larry was able to master tier 1 words in five sessions, tier 2 words in eight sessions, and tier 3 words in four sessions. All students were able to maintain all 15 words at a rate of 90% or higher. Sean and Harold were able to maintain all words at 100% where Larry had two maintenance sessions at 80% and the rest at 100%.

Results from this study provide an additional demonstration that students with MSD including those with ASD can learn academic content that is similar to their same aged peers. For Larry there was a functional relation between the intervention and the dependent variable because there were three demonstrations of effect within this study. There was also a functional relation between the intervention and the dependent variable for Harold and Sean. Both Harold and Sean had three demonstrations of effect in relation to the intervention. Since there were three students with a functional relation, there were a total of nine demonstrations of effect and no non-effects. This study also shows that TAII

can be effectively used to teach academic skills to students with MSD including those with ASD. This study adds to the literature by providing another example of where a TAII paired with a research based instructional strategy can teach students with ASD. This particularly adds information for teachers and researchers who are searching for ways to teach the alternate assessment standards/core content standards to their students with MSD including those with ASD.

Practical Implications

Results from this study also provide researchers and teachers with some practical implications for the classroom. The first implication is that the e-books effectively taught alternate assessment standard material to students with MSD and ASD. MSD teachers often have difficulty teaching their students alternate assessment standards, especially middle school and older, due to the increasing difficulty of the content to be delivered. These results provide evidence that using a TAII based program to teach student alternate assessment terminology would not only be effective but would allow for unassisted teacher instruction. Another practical implication that it has in MSD classrooms is that the e-books are easy to create and take no more than 15 minutes for the teacher create the e-book. MSD teachers are often looking for ways to lessen the length of their preparation and planning time in the classroom and this particular TAII is a way to achieve that.

Another practical implication for this study in the classroom setting would be a modification to the way the students are taught to use the avatars. During the study, Sean would go back and look at the model avatar when he was unsure of the answer to the question the test avatar would ask. If a teacher embedded this into their original

technology training, it would serve as an extra embedded prompt for the student during instruction.

Lastly, one practical implication that is not as positive for the classroom is the length of time that it took Harold and Sean to master two of the tiers. One possibility for this could be that even though they had high fidelity with the implementation of the intervention they could have not been attaining to the information closely enough to commit it to memory at a rapid pace. Having the students complete the e-Book two times through possibly increased the efficiency of their correct responding and could have been even more efficient had the e-book been repeated more than 2 times.

Limitations and Conclusions

One limitation of this study is that Harold and Sean would at times include verbiage from the story in the e-book into the definition when probed. For instance, for stimulus earthquake there was a picture of a road and story about the earthquake breaking the road in the e-book. When Harold would respond to the stimulus earthquake during the probe, he would sometimes add things like, "it cracked the road", into the definition. This is not necessarily a bad thing in a practical sense; however, these responses would cause him to receive an incorrect response based on the definition of a correct response. Further investigation is needed to determine if the same thing would occur with similar populations of students and if so, if separating the page that the story and the avatars are on, would decrease student confusion.

Another limitation of the study was the lack of planning generalization. Since these three students were taught in their MSD classroom and not expected to use their learned knowledge within the context of their general education classrooms, it cannot be

said if the students would have been able to apply their knowledge in that setting.

Future research should include replicating the study with the same TAII and embedded model-lead-test strategy to teach grade level science term definitions to students of the same diagnoses, from different age ranges. Future data would provide information on the effectiveness of the intervention on younger and old populations of students with ASD and an intellectual disability. Future research could also include the same TAII and model-lead-test strategy with other academic content such as social studies, language arts, and math. Further data on student fidelity would also further this study by providing information on the abilities of younger students to be able to learn to use the intervention as well as learn the stimuli.

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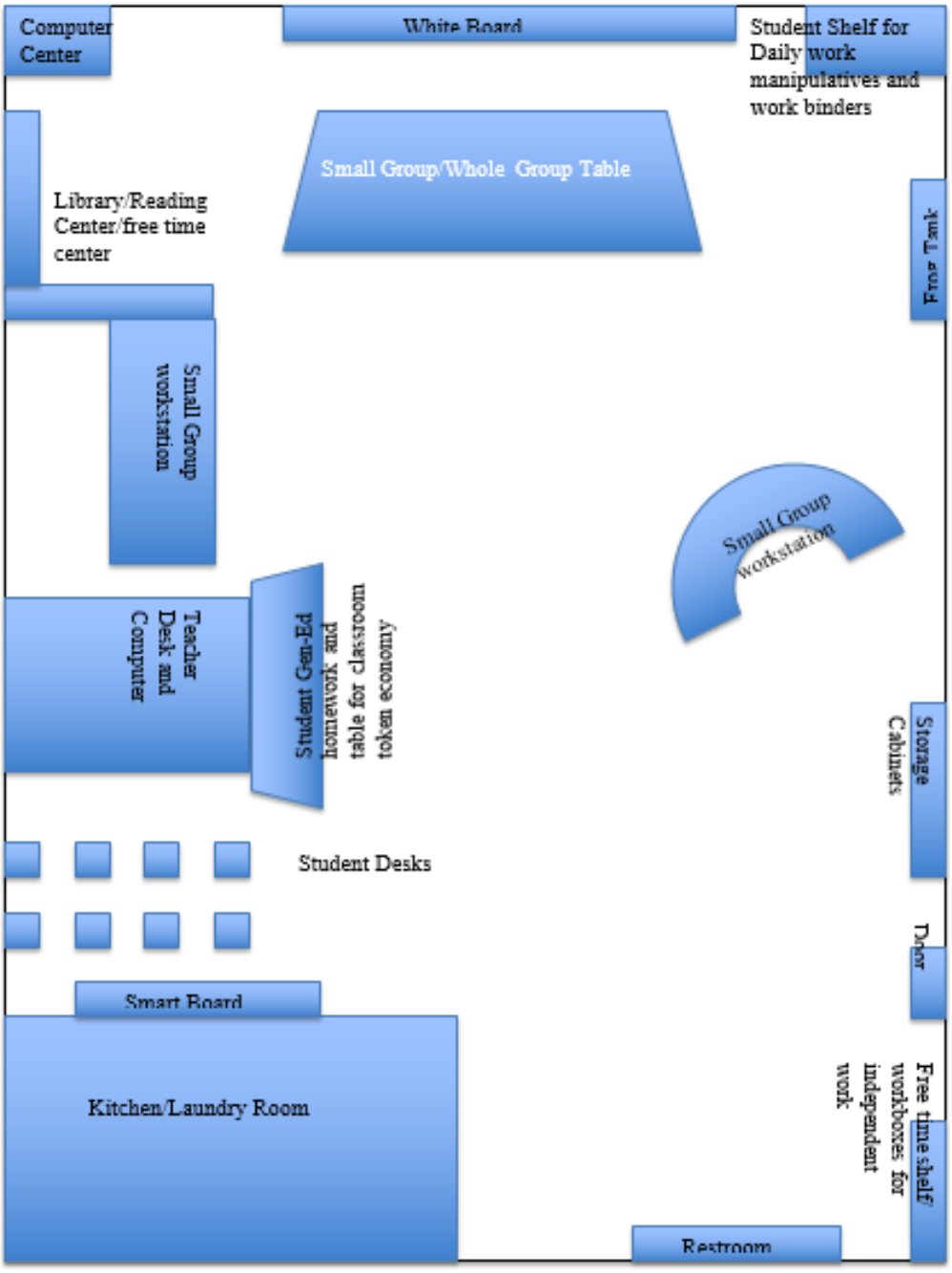
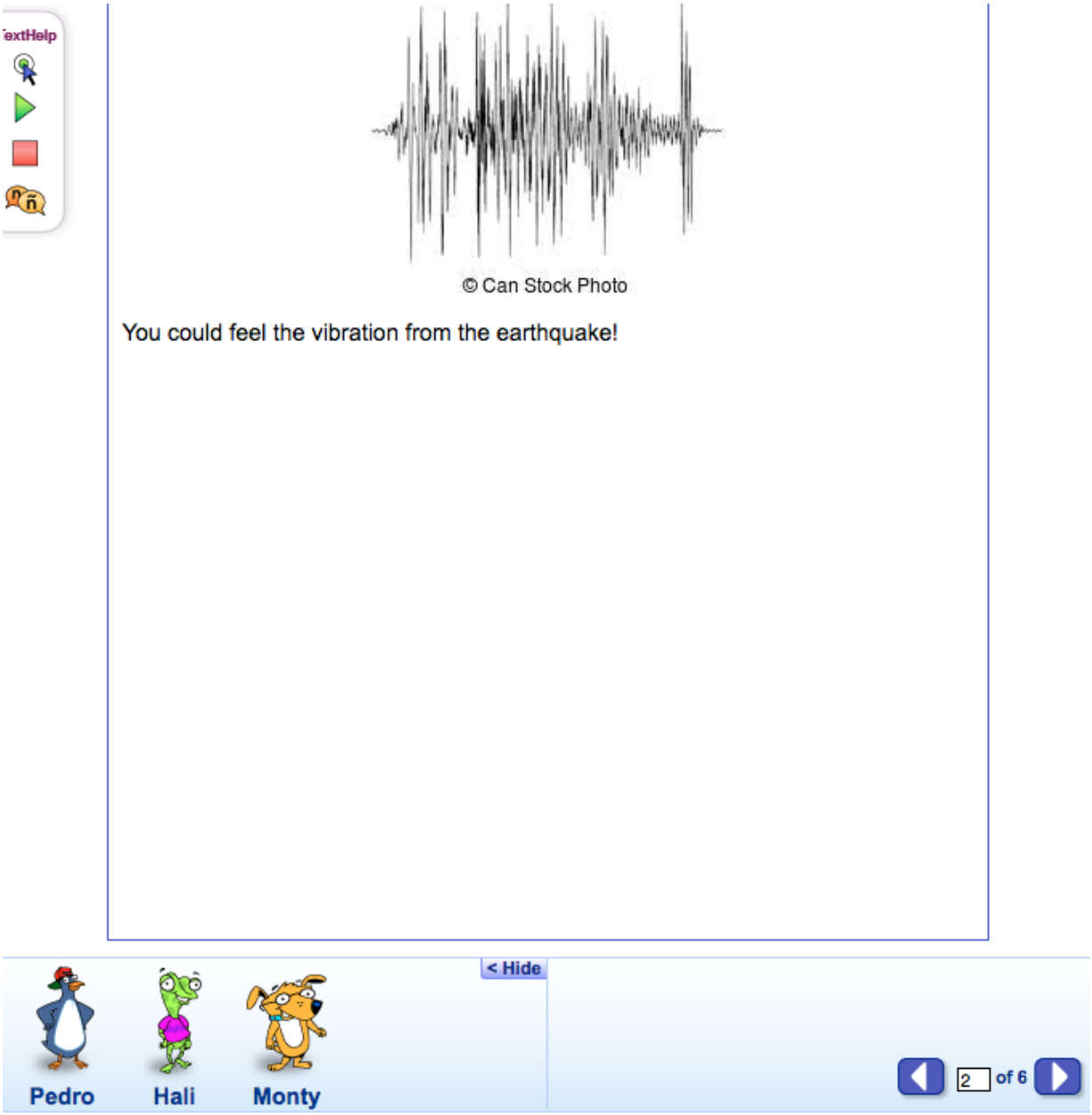
Appendix A: Room Arrangement



Appendix B: Story, Model, Lead, and Test Examples




8th grade science definitions tier 3 - Google Chrome
bookbuilder.cast.org/view.php?op=view&book=127169&page=2
TextHelp
© Can Stock Photo
You could feel the vibration from the earthquake!
Pedro
Vibration: shaking or buzzing
< Hide
Pedro
Hali
Monty
2 of 6
Created with CAST's UDL Book Builder
CAST would like to thank Texthelp Systems Inc. for use of the Texthelp Toolbar

© Can Stock Photo

You could feel the vibration from the earthquake!

Hali

Say it with me! Vibration: Shaking or buzzing.

< Hide

Pedro Hali Monty

2 of 6

Created with CAST's UDL Book Builder

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You could feel the vibration from the earthquake!

Monty

Now it's your turn! What is vibration?

Pedro

Hali

Monty

2 of 6

Created with CAST's UDL Book Builder

Appendix C: Probe, Reliability, and IOA Data Sheet

All Probe and Maintenance, Procedural, and Interobserver Reliability Data Collection Sheet

Name of Observer:_____ Date: _____ Session: _____ Start time: _____

Stop time: _____ Condition: _____ Responses: Correct: + Incorrect: - No Response: NR

Trial	Gain attention	Show Stimulus	Reads student the word	"what is the meaning of this word?"	Waits appropriate delay _____ sec	Student response		Provides correct consequences	Waits 3-5s intertrial interval
1.						Before	After		
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									
11.									
12.									
13.									
14.									
15.									
IOA percentage									
Observed/Planned									
Percent Accuracy									

Appendix D: Student reliability data sheet

Student Reliability	*Definition 1*	*Definition 2*	*Definition 3*	*Definition 4*	*Definition 5*
1. Student clicks to read the story.					
2. Student clicks on Pedro					
3. Student waits until Pedro is finished before clicking on the next avatar					
4. Student clicks on Hali					
5. Student repeats what Hali has said					
6. Student waits until Hali is finished before clicking on the next avatar					
7. Student clicks on Monty					
8. Student attempts to respond to Monty or repeats definition.					
9. Student clicks to go to the next definition or to be completed.					
10. Student completes each page twice.					
Percent of appropriate responding					

Vita

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