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Enhancing Scientific Comprehension Through Content Acquisition Podcasts

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ABSTRACT

Enhancing Scientific Comprehension Through Content Acquisition Podcasts

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This study sought to determine the effectiveness of using Content Acquisition Podcasts (CAPs) to teach children with learning disabilities scientific vocabulary. CAPs are multimedia instructional podcasts that combine images and sound to teach supplemental vocabulary. Four children ages 9 to 10 with learning disabilities were taught vocabulary words to prepare them for end-of-year testing. Words were taken from units about rocks, soil and fossils. This study used a multiple probe multiple baseline across units design. Data analysis showed that three of four participants experienced significant improvement in at least one of three units. Social validity questionnaires showed that all four participants enjoyed being a part of the study and felt like they had learned important information. These results indicated that CAPs can be another method for delivering science instruction. They are easy to make, have an impact on learning and incorporate a modality of learning that is appealing to children.

Keywords: podcasts, learning disabilities, science, science vocabulary

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CHAPTER 1: INTRODUCTION

With the adoption of the Common Core State Standards in 43 states (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) the United States took a step toward developing a unified curriculum for English Language Arts and Math. For the states that have adopted the curriculum, there are now a set of common standards and objectives that every child must strive to meet by the end of each school year (2010). A similar proposal by the *Next Generation Science Standards* (NGSS) (National Research Council, 2011), focuses on creating common science standards that contain benchmarks in earth, life, and physical science. NGSS has been formally adopted by 16 states. For every grade level, students must demonstrate their understanding of the material in three different categories: science and engineering practice, disciplinary core ideas and crosscutting concepts. In each of these categories, students are expected to know and use various vocabulary words to describe the concepts (2011). Vocabulary knowledge is important in the science classroom due to the link that exists between vocabulary knowledge and comprehension of the topic (Joshi, 2005; Joshi & Aaron, 2000). For example, knowing the definition of science vocabulary words may help a child give a label to the phenomena or concept they observe throughout the science lesson. More specifically, knowing that "precipitation" means "rain, snow, sleet or hail that falls to the ground" helps the child understand its relevance in the water cycle.

There are over 6.4 million students in special education in the United States receiving services under the Individuals with Disabilities Education Act (IDEA). Children who have learning disabilities (LD) struggle with basic processes including reading, speaking, and writing. This literature review addresses some of the obstacles a child with LD will face in the classroom and how to help them with scientific content. Specifically, this study will describe an

intervention called Content Acquisition Podcasts (CAPs), which will be used to teach children with LD grade-level science vocabulary. Teaching grade-level vocabulary in science is crucial to science success due to the language demands of scientific content (Fang, 2006; Nagy & Townsend, 2012) and the impact vocabulary knowledge has on comprehension (Beck, Perfetti, & McKeown, 1982; Biemiller, 2003; Moghadam, 2012; Yildirim, Yildiz & Ates, 2011).

CHAPTER 2: REVIEW OF THE LITERATURE

Scientific literacy is an awareness and understanding of scientific ideas (Durant, 1994; National Research Council (NRC), 1996). Scientific literacy may not be easily achieved for children due to many complexities surrounding the "language of science" (Wellington & Osborne, 2001, p. 2). In their book, *Language and Learning in Science Education*, Wellington and Osborne (2001) equate learning the language of science to learning a new language. Every science lesson must give attention to teaching the language of the concept (2001). Quinn, Lee and Valdes (2012) also give further insight into the complex nature of scientific language by describing the obstacles in learning science vocabulary. For example, the word 'force' has a different scientific concept attached to the word, which differs from what children may be used to. In science, force can be in reference to the interaction of objects: force equals mass times acceleration. In everyday interactions, force can be used to describe coercion: someone is forcing someone else to do something. Other examples include "energy, work, cell, space and fault" (p. 5). Another obstacle is that much of the discipline-specific vocabulary that is introduced to children is completely foreign to them: "gene, biome, proton" (Quinn et al., 2012, p. 6). These are words that are not usually introduced to the child until they are in a science classroom.

It has been established that effective vocabulary instruction includes teaching children different contexts of the words (Beck, McKeown, & Kucan, 2013; Joshi, 2005; Stahl, 1986). This can be especially important for science because becoming familiar with different scientific concepts can contribute towards scientific literacy. CAPs are defined as "short, multimedia-based instructional vignettes that deliver high-quality instruction for one vocabulary term or concept at a time" (Kennedy, Romig, & Rodgers, 2015, p. 118). The CAPs intervention utilized in the current study was used in isolation and not in conjunction with any form of science

instruction that could help to reinforce the scientific concepts. However, the CAPs intervention does use multiple modes of representation as a way to introduce the concept. Multiple modes of representation theory proposes that learning does not solely rely on language (Kress, 2001). Rather, meaning-making and understanding is accomplished through "different modes of communication" (2001, p. 5), such as graphs or pictures. These models contribute towards the understanding of the content (Ainsworth, 1999; Kozma, 2003; Quinn, Lee, & Valdés, 2012). CAPs contribute towards scientific literacy by not only sharing the definition of the vocabulary term, but by providing the child with a representation of the word, in the proper context.

In order to help students with LD improve their vocabulary comprehension of these words, we need to understand, on a deeper level, how typical developing peers learn vocabulary. In a typical situation, a vocabulary word is learned through context (McKeown & Curtis, 1987). When encountering an unfamiliar word, the child must rely on the surrounding words and their background knowledge to form a representation of the word. The phonological loop, a component of working memory, is responsible for holding the unfamiliar word in the child's short-term memory, while their brain makes the representation (Gathercole & Baddeley, 1993).

Working Memory

Working memory is the storage and manipulation of information that allows an individual to perform various cognitive functions including remembering details and manipulating details (Baddeley, 2010). There are two separate coding systems in our brains that use different processes (Sadoski & Paivio, 2012). One system, or set of processes, deals with visual input and the other deals with auditory input. The central executive, a type of processing system in the brain, works at filtering input into these two short-term memory storage

components, the visuo-spatial sketchpad (for visual input) and the phonological loop (for auditory input) (Sadoski & Paivio, 2012).

The fact that the human brain has two short-term memory storage systems (visual-spatial and phonological loop) is significant for learning because it means that people are capable of computing two sources of information as long as the sources use different processes. According to Sadoski and Paivio (2012), if a human is required to process two tasks that use the same mental processes, learning will be inhibited. For example, if a person is asked to drive down the road while watching a movie, his performance will be impaired because he is trying to process two forms of visual input. However, if multiple modalities are used, this inhibition is removed.

There are several studies that establish a link between working memory and comprehension (Daneman & Merikle, 1996; Seigneuric & Ehrlich, 2005; Swanson, Howard, & Saez, 2006). This is because working memory is involved in making connections between what is being taught and what has been learned in the past. It also helps learners derive meaning from the input (Mayer, 2005; Swanson & O'Connor, 2009). The learner must organize the new information into representations. These representations are combined with past knowledge, taken from the long-term memory storage, and are used to make connections. These connections increase the learner's understanding of the subject material.

Working Memory and Children with LD

Some children with learning disabilities are often marked by their impaired working memory system (Dehn, 2008). Specifically, their central executive functioning has a harder time carrying out the demands placed on it, meaning that they struggle with organizing information, remembering information or carrying out different academic strategies. In reading, children who have deficits in working memory are not as equipped to hold representations in their mind and

make connections between what they already know and what they are learning. This can limit the amount of science vocabulary knowledge they accumulate. To meet this deficiency, the authors propose the use of CAPs to help children learn science vocabulary in a way that is conducive to their limited working memory skills.

Theoretical Foundation of CAPs

In order to understand the efficacy of CAPs, it is important to understand the theoretical framework surrounding CAPs, a multimedia instructional tool. Multimedia instruction is defined as instruction that includes words and pictures. For multimedia instruction, Richard Mayer (2005), proposes a cognitive theory of multimedia learning (CTML).

Mayer's CTML consists of three assumptions, all of which are addressed in CAPs. The first assumption is that humans have two processing systems for auditory and visual stimulation. CAPs use both images and text. The second assumption states that there is a limit to how much of this stimulation a person can process. CAPs address this concern by only including in the CAP what is essential for understanding the term (Kennedy, Hart, & Kellems, 2011). CAPs also try to limit the amount of information in order to avoid the *redundancy principle*, put forth by Mayer and Johnson (2008). This principle states that when there is too much stimulation being presented to the learner, learning is inhibited. The learners are not able to organize and process all of the information due to the limited capacity of the short-term memory systems. Finally, the third assumption is that the human mind is constantly engaged as it tries to create representations of the material, organize the material and form connections between what is learned and what is known (Mayer, 2005). CAPs try to help the learner organize information by combining text with images (Kennedy, Thomas, Meyer, Alves & Lloyd, 2014) and specify how the CAP will be helpful to him or her in their academic learning (Kennedy et al, 2011).

Production Process

Creating CAPs involves 3 steps. The first is to divide the words into any existing morphemes, or smaller words within the word, which could help the learner better understand the word. Then, various definitions are created for the word. Kennedy, Hart, & Kellems (2015) specify that the definitions should be easily understood by the learner and should be selected based on their appropriateness for the proper context. In this case, the context is science. Finally, images are selected that accurately portray the word.

Kennedy and colleagues explain that little research on the most effective way to create CAPs (2010). They do, however, describe the steps in actually creating the CAP (Kennedy et al., 2014). The process involves using PowerPoint. The PowerPoint includes a slide, shown at the end and at the beginning of the CAP, that is dedicated to showing the child the definitions you want them to learn. The rest of the images and the text in the slideshow illustrate the main point or ideas of the definition. Next comes narration, where an audio is timed perfectly with the appearance of animation. Finally, the movie is uploaded onto a USB that can be transferred to a school's desktop.

CAPs and Academics

A study done by Kennedy et al. (2015) shows the effectiveness of using CAPs for students with LD. All of the participants were enrolled in a high school world history course. Thirty of the participants were known to have a LD and the remaining 240 participants were either without disabilities or were receiving special education services under a different classification other than reading. The students were randomly assigned to four different interventions that taught World War 1 vocabulary words. Three of the interventions used CAPs but differed as to whether or not the CAPs used explicit instruction, keyword mnemonic

strategies, or a combination of the two. The final intervention used a podcast that contained audio and images but did not follow Mayer's Cognitive Theory of Multimedia Learning. Their knowledge of the words was scored through a multiple-choice test on the vocabulary terms. The results showed that the participants with LD who had viewed the CAPs based on Mayer's theoretical foundation scored higher on the multiple-choice test than those who did not view CAPs based on theoretical principles. The researchers also found that those with LD had similar outcomes to those without LD on their assessment scores (2015).

In a study done by Kennedy and Thomas (2012), CAPs were used with preservice teachers to teach them about Positive Behavioral Intervention Supports (2012). The undergraduates who participated in the study were either assigned to watch a CAP on a topic or read about the topic in a textbook. Those who read from the book also had access to a graphic organizer of the key parts of the topic, as well as an outline of the topic. The study showed that those who viewed CAPs on Positive Behavioral Intervention Supports were more knowledgeable about the topic than those who only had access to text-based resources (Kennedy & Thomas, 2012).

CAPs, in conjunction with case studies, were also used in a different study by Kennedy, Kellems, Walther-Thomas & Newton (2012) as a way to provide preservice teachers with information on the different aspects of the Individuals with Disabilities Education Improvement Act and special education. The participants were asked to watch a CAP, along with a textbook reading, prior to class. They were also able to watch a CAP before the final exam as a way to review the material. One of the research questions was whether or not the participants found CAPs adequately prepared them to complete various case studies on special education. Nine out of eleven of the participants responded positively by stating that CAPs did prepare them for class

and were a helpful review tool. It was also noted that those who responded negatively to CAPs were able to identify the reason as being because CAPs were not an effective learning style for them. The idea of CAPs allowing for self-reflection was also emphasized in other studies (Anzai, 2007; Lane, 2006) that were analyzed by Hew (2009). For example, in one study, 96% of the students reported that they felt their learning increase as a result of the CAPs (Clark, Sutton-Brady, Scott, & Taylor, 2007).

An important aspect of CAPs is that the images and text are shown in unison throughout the CAP, rather than one after the other. The importance of this aspect was proven in a study done by Mayer and Anderson (1991). A group of college students were informed on various aspects of mechanics. They were asked to read various passages that explained concepts using either words and then pictures or words and pictures. The researchers found that the students who read passages that used words and pictures together outperformed their peers who read passages that used words before pictures. This study reiterates the dual-coding hypothesis (Sadoski & Paivio, 2010) by suggesting that the students were better able to understand the material due to the opportunity they had to pull representations from both visual and verbal short-term memory processes. Having information from both systems gave them more information with which to make connections.

Purpose of the Current Research

The purpose of the study is twofold. First, the study sought to gauge the efficacy of CAPs in improving comprehension of science vocabulary for a child with a disability. An important reason for focusing on science instruction is that although research has been done with technology being used to teach academics to children with learning disabilities, the focus has

usually been on math and English, with very little emphasis on science (Brigham, Scruggs, & Mastropieri, 2011; Neely, Rispoli, Camargo, Davis, & Boles, 2013).

The second purpose of the study is to decide whether CAPs are a socially valid tool. Through a social validity questionnaire, teachers and students were asked questions that gauged how satisfactory they found the intervention. Social validity questions were geared towards evaluating the participants' feelings concerning the goals, procedures and results of the study (Wolf, 1978).

Research Questions

This study addresses the following research questions:

1. Do CAPs improve science vocabulary comprehension for children with learning disabilities?
2. What is the social validity of using CAPs to teach science vocabulary words?

CHAPTER 3: METHODS

Participants and Settings

The participants in this study consisted of four fourth graders from a suburban elementary charter school located in the western United States. The charter school served 700 students in grades kindergarten to sixth grade. The participants were selected based on the following criterion: (a) receiving special education services under an active Individualized Education Program (IEP), (b) enrolled in a science class, and (c) able to cognitively and visually attend to the video. The study was approved by the Institutional Review Board (IRB), which ensures that all ethical guidelines were followed. Consent and assent forms were signed before the study took place (See Appendix).

The first participant was on an IEP plan under the classification of Speech and Language Impairment. The second and third participants were classified under Specific Learning Disorder and the fourth participant was classified under Autism (See Table 1). The study took place in the school's special education resource room. The children participated in the study during their resource time for two days a week for 45 minutes each time. This was done to ensure that the children would not lose valuable learning time in their general education room. The resource room had four computers, which allowed the children to view the CAPs in the room independently of each other. The entire study lasted for four months.

Table 1
Participant Information

Participant ID	IQ	Gender
Participant 1	116	M
Participant 2	118	M
Participant 3	108	F
Participant 4	-	M

* *Participant 4's IQ was not available*

Procedures

Baseline. For baseline, the children were gathered in the special education classroom. The study consisted of three units. The units were labeled Rocks, Soil and Fossils. They were given in that order, one after the other. For each unit, the procedures were the same. Once the children were gathered, they were read a script that incorporated key vocabulary words to describe the topic. These scripts were adapted from Student Assessment of Growth and Excellence (SAGE) test preparation units. Once the script was read, the children were then asked to complete a matching vocabulary test. Each unit test consisted of 8 words. While taking the test, blinders were placed around the children to prevent cheating.

Intervention. Each child reached the intervention phase once they had attained stable baseline points. Once they were able to move on, the children were introduced to the CAPs. First, they were read the same script from the baseline stage and then asked to move to the computers. The special education classroom had a set of 4 computers, one for each participant.

Once there, the children were required to click a folder on the desktop that contained the 8 CAPs for the unit. They were then asked to watch and listen to each of the CAPs. Headphones were provided to each student. When finished with the CAPs, the children were then asked to come back to the table and take the same vocabulary test that was administered in the baseline stage. No feedback was given to the child once their test was scored. In order to move onto the next unit, the child's intervention points had to be stabilized, which describes their data points being within a similar range without a decreasing or increasing slope. Once the child moved onto the next unit, the process was repeated again.

Probes. Probes are most effective when conducted at "consistent" and "strategic" times during the study (Kennedy, 2005). In the case of this study, probes were given to ensure that as the children were learning the vocabulary from one unit, through the use of CAPs, their knowledge of the other units was not being impacted. Each probe was the same vocabulary test that was used throughout the study. For example, before starting the first unit, all of the children were asked to take the vocabulary test for each unit. Once the first unit was completed and before the second unit was started, the children were asked to take the vocabulary tests for the remaining units.

Instruments

Content acquisition podcasts (CAP). For each vocabulary word, there was a CAPs that defined the word using text and images. Each CAP lasted approximately 1-2 minutes. To make them, the researcher imported free images from Google into PowerPoint to explain the vocabulary word. Text was also added to the slides. The slides were then imported into iMovie and a script was recorded. Each script provided a definition of the word and some examples of the word in the proper scientific context. One CAP took approximately 15-20 minutes to make.

For example, for the soil unit, a CAP was made for the word "organism." The first slide showed the word and an appropriate picture. The podcast then defined the term: "living plant and animal life." The slides afterwards were dedicated to giving the students context. For soil, a slide showed a picture of a worm in soil and the script talked about how living organisms can derive necessary nutrients from the soil. For a complete list of the vocabulary words used in each CAP, see Table 2.

Curriculum units. All of the vocabulary words were pulled from vocabulary units that helped the children prepare for end-of-year state testing, SAGE. The SAGE testing is the state's standardized testing that is aligned with the state core in order to hold the state accountable to the learning measures. The three units discussed different topics related to science: water cycle, soil, rocks and fossils.

Table 2
Vocabulary Words

Rock unit	Soil unit	Fossils unit
Weathering	Topsoil	Replacement
Thaws	Subsoil	Preserved
Sedimentary	Bedrock	Prehistoric
Metamorphic	Structural support	Infer
Igneous	Soil profile	Impression
Minerals	Organism	Fossil
Freezes	Nutrients	Extinct
Erosion	Nonliving	Environment

Vocabulary curriculum-based measures (CBM). Before and after each set of words (8 words in each unit), the children took a vocabulary test. Each of the tests consisted of 8 multiple-

choice questions revolving around words that were randomly selected from the SAGE preparation units. These tests were used as curriculum-based measures (CBM) in order to track the progress of the child (Espin, Shin, & Busch, 2005). The questions were created by the researcher and checked for reliability and validity by the co-authors. An example of a question is, "Which of the following definitions describe the term 'evaporation'?". The students were then asked to choose from a list of definitions that were pulled from other grade-level science vocabulary terms.

Social validity questionnaire. Data were also collected from the social validity questionnaire (See Appendix) that was developed by the primary author. At the end of the study, all teachers and children involved in the study were asked to answer questions about their opinions on the study's goals, procedures and results (Wolf, 1978). For example, the questionnaire asked the teacher how effective they thought the CAPs were and if they could see themselves using CAPs after the study finished. For the students, the questions asked them to rate, from a scale of "not much" to "a lot", how they liked using the computers and watching the videos. They were also asked if they felt that CAPs helped them in their science class.

Fidelity checklist. Throughout the course of the study, a fidelity checklist was used to ensure that both researchers were following all of the correct steps in the study. The checklist covered items such as the proper procedure of the study, the materials needed and a script of what to say. For each session, fidelity implementation was 100%.

Data were analyzed through qualitative coding procedures. Through an open coding system (Strauss & Corbin, 1990), questionnaire responses were collected and given code names to later be organized into various themes (Merriam, 2002). These themes were then examined in

order to identify any relationships that might exist in the data, which will be presented in the findings (2002).

Experimental Design

This study used a multiple probe multiple baseline across units design (Horner & Baer, 1978). This design allowed the researchers to demonstrate experimental control (Kennedy, 2005). The design helped the researchers ensure that teaching vocabulary from one unit would not affect the student's comprehension of the words on other units. Data were collected from the pretest and posttest of the CBM in order to determine if the students showed an increase of comprehension of the vocabulary words. In order to determine when to move on to the next set of words, the researchers waited until the data stabilized.

Data Analysis

Data were analyzed through charting and a visual analysis. A visual inspection was used to reach a judgment about the reliability or consistency of the intervention's effects by visually examining the graphed data according to changes in the level, trend and variability of the data. Data were gathered on the dependent variable, comprehension of the vocabulary terms, and was charted separately for each participant and each set of vocabulary words. Descriptive statistics were used to determine the median, range and standard deviation of the data. The data were also analyzed through a Tau-U calculator in order to determine significance. The results for each participant are given below, in Figures 1-5.

CHAPTER 4: RESULTS

The results are divided into four sections. The first section describes the significance of CAPs improving scientific vocabulary comprehension. The next section compares the participants' pretest scores to posttest vocabulary scores. There is also a section that describes criterion for each participant. Criterion is described as earning 75% or higher on at least three posttest scores. Finally, the social validity is discussed.

Significance

Significance and Tau-U were established through a Tau-U calculator. Overall, three out of the four participants had at least one significant unit across the three units. The results are shown in Table 2

Table 2
Significance

Participant	Rock Unit		Soil Unit		Fossil Unit	
	Tau w/Maintenance	Tau w/o Maintenance	Tau w/Maintenance	Tau w/o Maintenance	Tau w/Maintenance	Tau w/o Maintenance
Participant 1	.1250^{ns}	.2333^{ns}	.0714^{ns}	.1167^{ns}	.4400^{ns}	.4250^{ns}
Participant 2	.4250^{ns}	.3333^{ns}	.6500*	.6200*	.4800^{ns}	.4000^{ns}
Participant 3	.7000^{8}	.6667^{ns}	1**	1**	.8800**	.8500*
Participant 5	.6286^{ns}	.6000^{ns}	.9667**	.9600**	.3500^{ns}	.5000^{ns}
Combined	.4673**	.4550*	.6646***	.6650***	.5416**	.5452**

Note. *=p<.05. **=p<.01. ***=p<.001

Pretest/Posttest Comparisons

The Rock Cycle unit lasted 13 days. As seen in Figure 1, participant 1 received a mean score of 25% for questions answered correctly. The participant later scored a mean of 45.3% for the intervention phase. In Figure 2, Participant 2 had a score of 75% during baseline and 69.6% during intervention. In Figure 3, Participant 3 scored a mean of 33.3% during baseline, which

increased to 51.7% during intervention. As seen in Figure 4, Participant 4 received a score of 45.8% during baseline and a score of 64.5% during intervention.

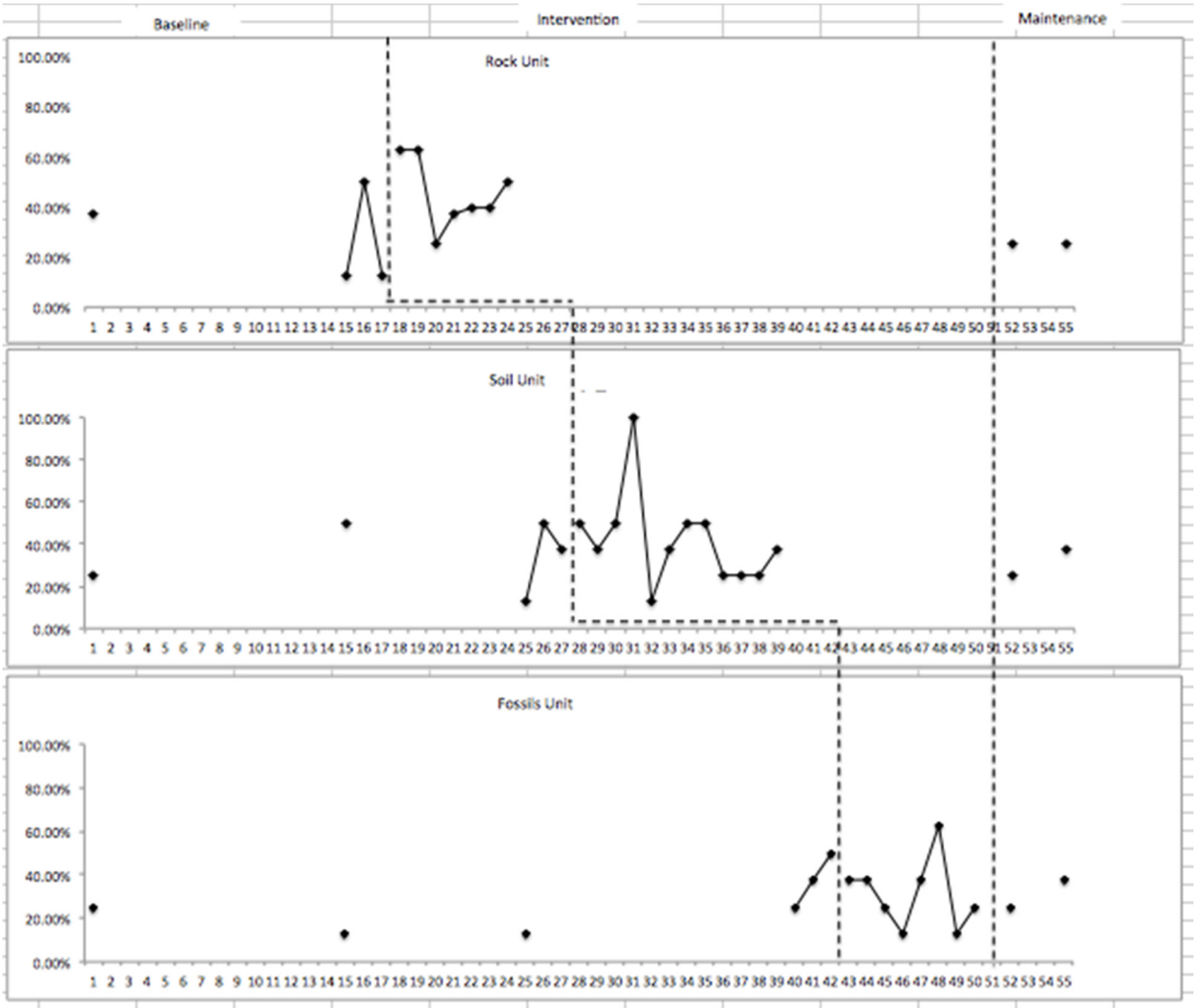

Figure 1. Participant 1 CBM Results.

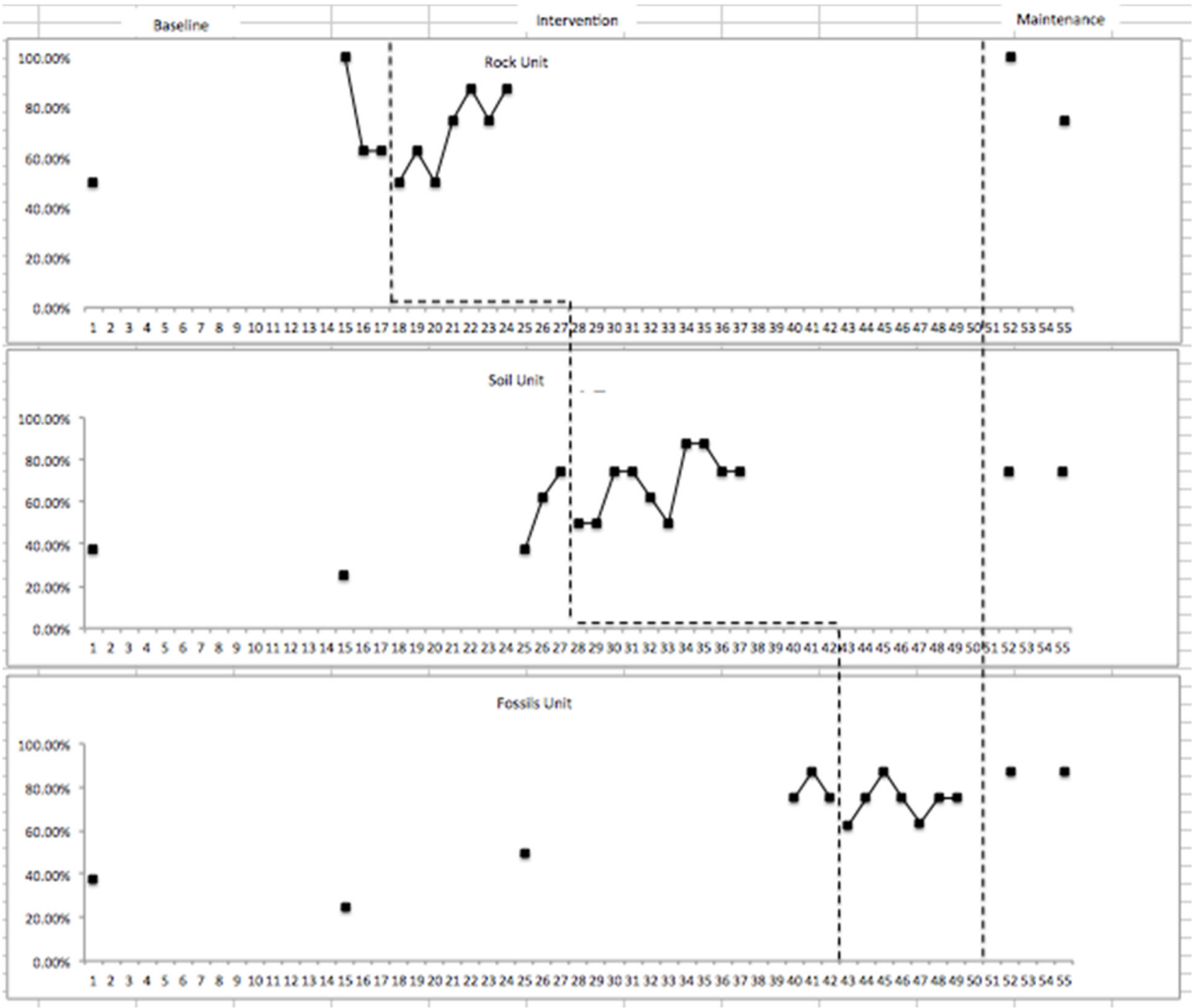

Figure 2. Participant 2 CBM Results.

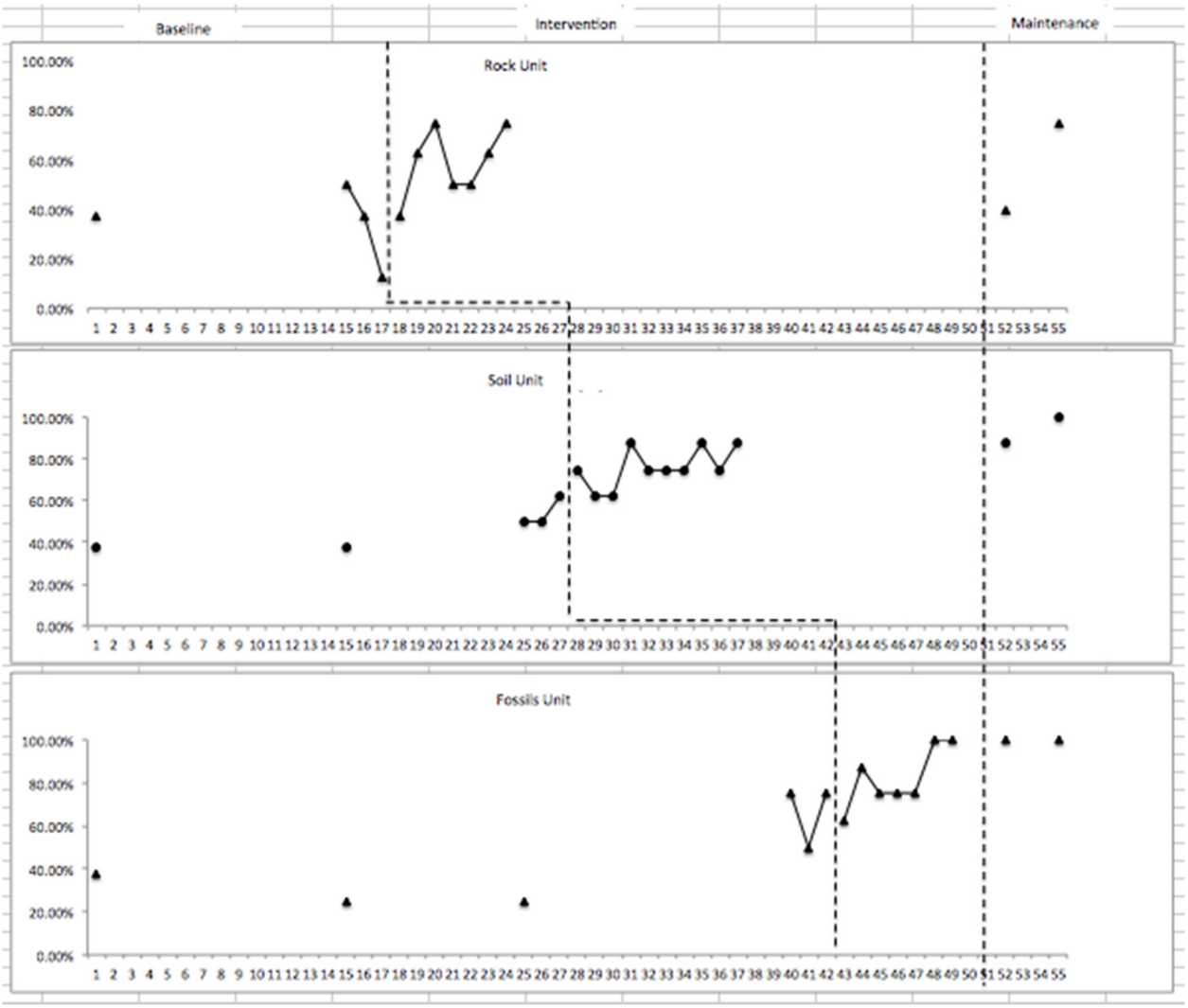

Figure 3. Participant 3 CBM Results.

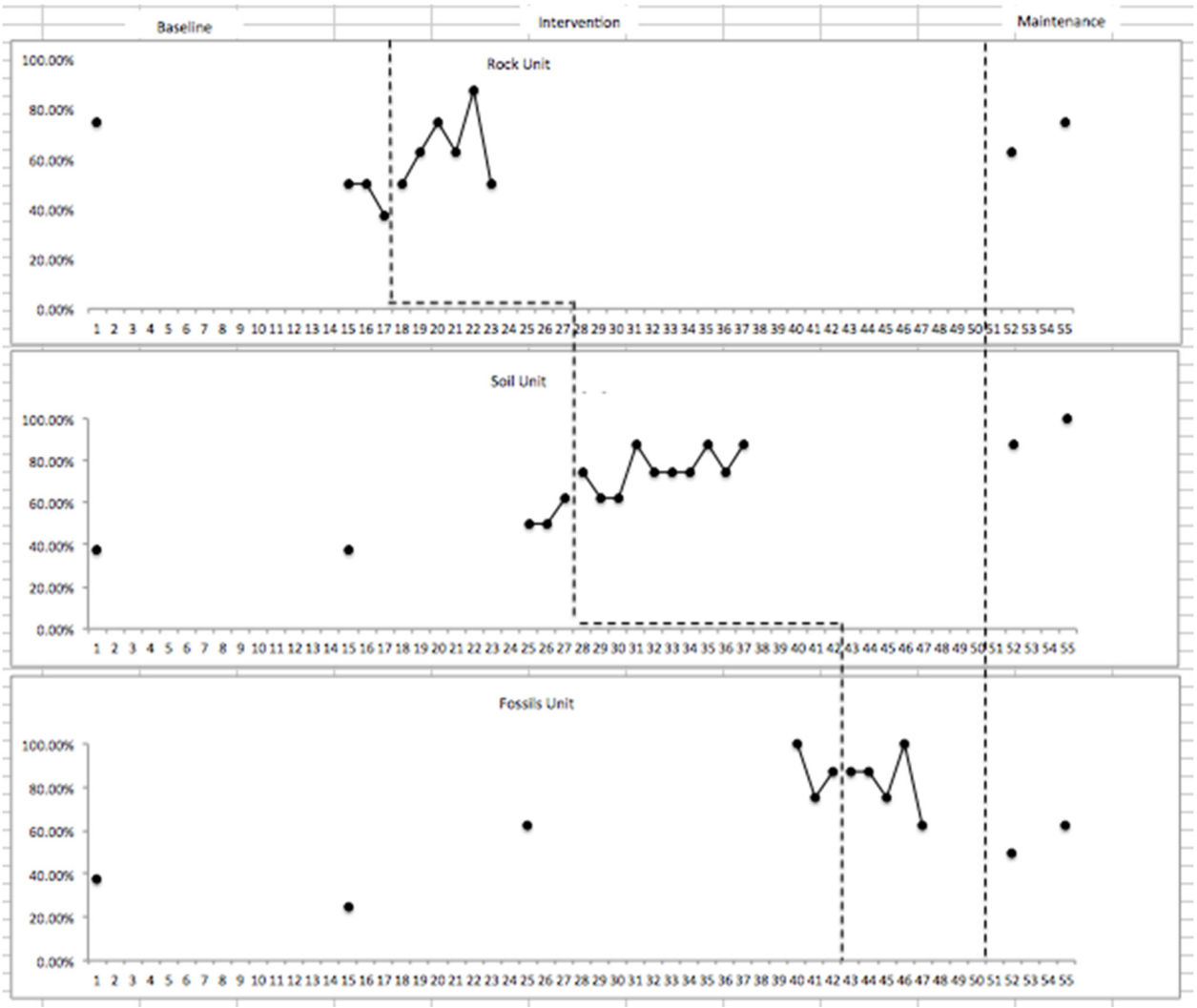

Figure 4. Participant 4 CBM Results.

The Soil unit lasted 14 days. Participant 1 scored a mean of 33.3% during baseline and a mean of 41.6% during intervention. Participant 2 scored a mean of 33.3% during baseline and 68.7% during intervention. Participant 3 scored a mean of 45.8% during baseline, which increased to 78.1% during intervention. Participant 4's baseline mean was 45.8% and intervention mean was 75%.

The Fossil unit lasted 24 days. Participant 1's baseline mean was 16.6% and intervention mean was 33.7%. Participant 2 had a baseline mean of 37.5% and an intervention mean of 75%.

Participant 3 received a mean score of 29.1% during baseline and a mean score of 77.5% during the intervention phase. Participant 4 had a baseline mean of 41.67% and an intervention mean of 84.3%

Criterion

Participant 1 did not earn criterion across the three units. Participant 2 earned criterion in all three units with an average of five times per unit and a range of 75% to 87.5%. Participant 3 earned criterion in two out of three units with an average of seven times per unit and a range of 75% to 100%. Participant 4 earned criterion in two out of three units with an average of six times per unit and a range of 75% to 100%.

Social Validity Results

The students and teacher were given a questionnaire that asked them to describe whether or not they liked CAPs and if they would want to use them again. When asked if the teacher thought CAPs was an appropriate intervention for students, the teacher said, "Yes, students were taught new vocabulary words in different learning styles. Each student has different learning needs." The teacher went on to write that, "The students loved watching the videos," and that she could see herself using CAPs in the future because, "…students should learn with multiple learning styles."

One of the themes that emerged after analyzing the participants' questionnaire was enjoyment. All four students stated that they enjoyed being a part of the study and that they felt that they learned important things. Another theme was helpfulness. Three out of four participants said that they felt like what they learned would help them in their science class and wished they could have used the videos to learn more vocabulary words. Finally, when given the choice of "not much," "a little," or "a lot," all four participants liked watching the videos "a lot."

CHAPTER 5: DISCUSSION

The purpose of this study was to increase a child's scientific literacy through the use of CAPs. CAPs used multiple modes of representation (Kress, 2001) to help teach the context of the word. CAPs also tried to adhere to Mayer's cognitive theory of multimedia learning by using images with text and by limiting the amount of information presented in the video (Mayer, 2005).

The combination of text and images supports previous research that has shown how effective this technique can be in improving comprehension (Mayer & Anderson, 1991). The combination of text and images within CAPs may have also helped to decrease the demands on a child's working memory (Sadoski & Paivio, 2013). With two short-term memory systems, the phonological loop and visuospatial sketchpad, the text and images provided two different forms of input, decreasing the burden placed on the child. Through these efforts, this study confirmed that CAPs can impact vocabulary comprehension (Kennedy, 2015) by demonstrating that CAPs were beneficial for three of the four participants. The study also confirmed that CAPs can be effective for children with learning disabilities.

Across units, all four participants saw an increase between baseline and intervention points, except for Participant 2 for the rock unit. This may be explained through the fact that Participant 2 scored a 100% for one of the baseline points, which greatly increased the baseline average. However, the other two units were found to be successful for Participant 2.

In determining significance among the results, a statistical difference between baseline and intervention points were not readily apparent upon visual inspection. However, once the points were analyzed through a Tau-U calculator, a significant difference was found among the units. Each participant had at least one significant improvement throughout the three units,

except for Participant 1. Throughout the study, Participant 1 had a difficult time concentrating on the intervention. During the reading of the script, Participant 1 would talk to fellow peers and play with the pencil on the desk. While watching the CAPs, Participant 1 saw the videos as something to race through so that there could be a winner. These factors may have contributed to Participant 1's outcome scores.

For the rock unit, only Participant 3 attained significant results. This may be attributed to the fact that the pretest/posttest used for the rock unit used difficult distractors on the multiple-choice test. The distractors used were possible answer choices for the other questions. This may have caused confusion for the students. For the subsequent two units, the distractors were changed to be grade level definitions for vocabulary terms that were never tested.

This study was also aimed at discovering how well liked the intervention was. Social validity data revealed that teacher and students found CAPs to be worthwhile tools in the classroom. When considering whether or not to implement this intervention, teachers should consider whether CAPs are suited for their students. A benefit of CAPs is that the production process is simple and does not require extensive amounts of time to create. Each CAP is only 1-2 minutes long and can consist of as little as five slides. Once made, the CAPs can be used year after year.

Limitations

The first limitation was due to the distractors used on the first unit test. Because they weren't appropriate distractors, they may have changed the outcome of the results. This limitation was not a factor in the other units.

A few limitations existed due to the participant population. The sample size only consisted of 4 participants. Although this is typical with single subject designs, the small sample

size makes the study hard to generalize. Also, only one of the participants was a girl. This was due to a lack of availability. Finally, all of the participants were in the fourth grade, which contributes towards a lack of age diversity among the sample size.

Another limitation was due to the semester ending. Because of this, maintenance data were collected only two weeks after the students had finished the unit. We do not know if their knowledge was maintained over a longer period of time. Also, due to the lack of time, we were not able to see the impact CAPs had on their end-of-year testing.

Limitations might also exist in the setting of the study. The method of delivery in this study was done in a group setting, rather than in an individualized setting. A disadvantage of a group setting is that the negative behavior of one child could impact the behavior of other children.

Suggestions for Future Research

CAPs have been used for high school children (Kennedy et al., 2015), but this study is the first study involving elementary schools. More research could be done in elementary classrooms. As mentioned before, the sample size of this study was small. In the future, more data could be collected on the effectiveness of CAPs through the use of more students. By utilizing a group design, there would be an increase in gender and age diversity. Data could also be gathered to determine if CAPs are favorable in a general education classroom, rather than a special education classroom. There may also be additional benefit to use CAPs as enrichment or supplemental material that can be viewed at home.

Due to the timeline of the study, the researchers were not able to determine if SAGE scores improved through the use of CAPs. It would be informative for any future studies to have

follow-up data on whether CAPs is effective for helping those with disabilities achieve higher standardized testing scores.

Research could be devoted to determining how well CAPs teach science content when compared to other modalities. Studies could be designed that compare CAPs against explicit instruction, implicit instruction or any other form of classroom learning.

Data could be collected to understand the importance of both the auditory and visual component of CAPs. For some students, auditory may need more of an emphasis and with other students, the visual component may have more of an effect. It would also be interesting to discover how much of each component is necessary. For example, CAPs may be more effective depending on the number of pictures or the amount of text.

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APPENDIX

Teacher Social Validity Questionnaire

Please answer these questions about the vocabulary videos the participants viewed.

1. What are your overall impressions of using vocabulary videos in your classroom?

2. Do you think that this was an appropriate intervention for students with Learning Disabilities?

3. How do you think the students enjoyed watching the vocabulary videos?

4. Do you think the videos had a positive impact on the students' performance in science?

5. Do you think there are any negative side effects to watching the videos?

Student Participant Questionnaire

1. Did you like being a part of this study? Yes_____ No_____

2. What did you like best about being in the study?

---

3. Did you like….	Not Much	A Little	A Lot
Using the computer?			
Listening to the videos?			
Watching the videos?			

4. Do you feel like you learned important things? Yes_____ No_____
If so, what did you feel is the most important thing you learned?

_____

5. Do you feel like you learned things that will help you in your science class? Yes_____ No_____

6. Do you wish you could use the videos to learn more vocabulary words?
Yes_____ No_____

Adapted by (Lane & Beebe-Frankenberger, 2004)

Fidelity Check for Baseline Data

Step 1. Have the Correct Equipment	Yes	No	Notes
Pretest			
Posttest			
Timer			
Cheating Dividers			
Vocabulary Tests			
Step 2: Administer Pretest			
Read Script: "Okay students, I'm going to hand out vocabulary test. Please do your best work. Let me know when you are finished."			
Step 3: Read Unit 1 Passage			
Read script: "Okay students. I am going to read a passage."			
Read Unit 1 Passage			
Step 3: Administer the Posttest			
Read from Script: "Now that I am done reading, we will take a test on the vocabulary words in the passage. I will hand out the test. When I tell you to, turn the paper over and complete the test. Just do your best work. When you are finished, raise your hand and I will collect your paper."			
For each child, record completion time and number scored correct. (You are not allowed to answer any questions regarding content or clarify any words…)			
Once child has maintained a score of 75% he/she is ready to receive intervention.			

Fidelity Checklist for Protocol and Data

Step 1: Have the Correct Material	Yes	No	Notes
Computer for each child			
First set of words for each child on the desktop of the computer			
Headphones for each child			
Pretest			
Posttest			
Cheating Dividers			
Vocabulary Tests			
Step 1: Administer Pretest			
Read Script: "Okay students, I'm going to hand out a vocabulary test. Please do your best work. Let me know when you are finished."			
Step 2: Read Unit 1 Passage			
Read script: "Okay students. I am going to read a passage."			
Read Unit 1 Passage			
Step 2: CAPS			
Read from Script: "Today we are going to do something different. In order to help us learn the vocabulary words, we are going to listen to some podcasts that will explain the vocabulary words that were in the passage that I just read to you. When I tell you to, go to your assigned computer and click on the folder on the desktop that says "CAPs". There will be eight vocabulary words, one for each of the podcasts. You will watch each of the podcasts. Only watch each video once. When you are done, raise your hand.			
Step 3: Administer the Posttest			
Once the child has finished watching the CAPs, guide them back to the table.			
Hand out the test and Read from Script, "You are now going to take the vocabulary test. Just do your best and let me know when you have finished. You may begin"			
For each child, record completion time and number scored correct.			

Fossils Unit

Participant #: _____

1. What does “prehistoric” mean?
    a. A low area where the land is soaked with water
    b. An inactive, sleep-like state during winter
    c. An animal without a backbone
    d. Belonging to a period of time before recorded history

2. Environment describes:
    a. Coldblooded animals
    b. Plants which lose their leaves in the fall and grow new leaves in the spring
    c. The surroundings and conditions in which an organism lives
    d. Heat transfer through a substance

3. Which of the following is the definition of “fossil?”
    a. An area of land that receives less than ten inches of rainfall a year
    b. The remains or evidence of ancient organisms
    c. The circling of an object in space
    d. The part of an experiment that is changed in order to find out its effect

4. Impression is:
    a. The visual disappearance of a substance
    b. A mark or design made on a surface by pressure
    c. Reflection from the sun
    d. A change in form or matter

5. Which of the following describes what “infer” is?
    a. A process of reasoning from something known or assumed
    b. The space between objects
    c. The ability of a substance to dissolve
    d. The light energy that bounces off objects

6. Preserved is:
    a. The pull of gravity on an object
    b. The energy of motion
    c. The loudness of sound
    d. Kept from harm or change

7. What does “replacement” mean?
    a. The reflection of a sound
    b. The process of an organism’s hard parts being dissolved and replaced by other minerals
    c. The characteristics of a substance
    d. Melted rock material that is formed deep within the Earth’s crust

8. What does “extinct” mean?
    a. The concentration of matter in an object
    b. How fast a sound moves through an object
    c. No longer exists
    d. Stages a living organism will go through in its lifetime

Fossils Unit

Participant #: _____

9. What does “preshistoric” mean?
    a. A low area where the land is soaked with water
    b. An inactive, sleep-like state during winter
    c. An animal without a backbone
    d. Belonging to a period of time before recorded history

10. Environment describes:
    a. Coldblooded animals
    b. Plants which lose their leaves in the fall and grow new leaves in the spring
    c. The surroundings and conditions in which an organism lives
    d. Heat transfer through a substance

11. Which of the following is the definition of “fossil?”
    a. An area of land that receives less than ten inches of rainfall a year
    b. The remains or evidence of ancient organisms
    c. The circling of an object in space
    d. The part of an experiment that is changed in order to find out its effect

12. Impression is:
    a. The visual disappearance of a substance
    b. A mark or design made on a surface by pressure
    c. Reflection from the sun
    d. A change in form or matter

13. Which of the following describes what “infer” is?
    a. A process of reasoning from something known or assumed
    b. The space between objects
    c. The ability of a substance to dissolve
    d. The light energy that bounces off objects

14. Preserved is:
    a. The pull of gravity on an object
    b. The energy of motion
    c. The loudness of sound
    d. Kept from harm or change

15. What does “replacement” mean?
    e. The reflection of a sound
    f. The process of an organism’s hard parts being dissolved and replaced by other minerals
    g. The characteristics of a substance
    h. Melted rock material that is formed deep within the Earth’s crust

16. What does “extinct” mean?
    a. The concentration of matter in an object
    b. How fast a sound moves through an object
    c. No longer exists
    d. Stages a living organism will go through in its lifetime

Fossils Unit

Participant #: _____

17. What does “preshistoric” mean?
    a. A low area where the land is soaked with water
    b. An inactive, sleep-like state during winter
    c. An animal without a backbone
    d. Belonging to a period of time before recorded history

18. Environment describes:
    a. Coldblooded animals
    b. Plants which lose their leaves in the fall and grow new leaves in the spring
    c. The surroundings and conditions in which an organism lives
    d. Heat transfer through a substance

19. Which of the following is the definition of “fossil?”
    a. An area of land that receives less than ten inches of rainfall a year
    b. The remains or evidence of ancient organisms
    c. The circling of an object in space
    d. The part of an experiment that is changed in order to find out its effect

20. Impression is:
    a. The visual disappearance of a substance
    b. A mark or design made on a surface by pressure
    c. Reflection from the sun
    d. A change in form or matter

21. Which of the following describes what “infer” is?
    a. A process of reasoning from something known or assumed
    b. The space between objects
    c. The ability of a substance to dissolve
    d. The light energy that bounces off objects

22. Preserved is:
    a. The pull of gravity on an object
    b. The energy of motion
    c. The loudness of sound
    d. Kept from harm or change

23. What does “replacement” mean?
    i. The reflection of a sound
    j. The process of an organism’s hard parts being dissolved and replaced by other minerals
    k. The characteristics of a substance
    l. Melted rock material that is formed deep within the Earth’s crust

24. What does “extinct” mean?
    a. The concentration of matter in an object
    b. How fast a sound moves through an object
    c. No longer exists
    d. Stages a living organism will go through in its lifetime

Fossils Unit

Participant #: _____

25. What does “preshistoric” mean?
    a. A low area where the land is soaked with water
    b. An inactive, sleep-like state during winter
    c. An animal without a backbone
    d. Belonging to a period of time before recorded history

26. Environment describes:
    a. Coldblooded animals
    b. Plants which lose their leaves in the fall and grow new leaves in the spring
    c. The surroundings and conditions in which an organism lives
    d. Heat transfer through a substance

27. Which of the following is the definition of “fossil?”
    a. An area of land that receives less than ten inches of rainfall a year
    b. The remains or evidence of ancient organisms
    c. The circling of an object in space
    d. The part of an experiment that is changed in order to find out its effect

28. Impression is:
    a. The visual disappearance of a substance
    b. A mark or design made on a surface by pressure
    c. Reflection from the sun
    d. A change in form or matter

29. Which of the following describes what “infer” is?
    a. A process of reasoning from something known or assumed
    b. The space between objects
    c. The ability of a substance to dissolve
    d. The light energy that bounces off objects

30. Preserved is:
    a. The pull of gravity on an object
    b. The energy of motion
    c. The loudness of sound
    d. Kept from harm or change

31. What does “replacement” mean?
    m. The reflection of a sound
    n. The process of an organism’s hard parts being dissolved and replaced by other minerals
    o. The characteristics of a substance
    p. Melted rock material that is formed deep within the Earth’s crust

32. What does “extinct” mean?
    a. The concentration of matter in an object
    b. How fast a sound moves through an object
    c. No longer exists
    d. Stages a living organism will go through in its lifetime

Parental Permission for a Minor

Introduction

My name is Caroline Williams and I am a graduate student from Brigham Young University. My supervisor is Ryan Kellems, a professor in the Special Education department at Brigham Young University. I am conducting a research study about the effects that instructional podcasts can have in teaching science vocabulary. I am inviting your child to take part in the research because (he/she) may need help learning science vocabulary.

Procedures

If you agree to let your child participate in this research study, the following will occur.

1. Your child's records will be reviewed to ensure that he/she is receiving services under IDEA for Specific Learning Disability.

2. Your child will take a pretest to gauge his/her knowledge of different science vocabulary words.

3. You child will then watch videos that combine images and text to teach your child the vocabulary words. Your child will watch these videos 2-3 times a week.

4. After your child has become familiar with the words, he/she will then take a posttest to see how much of the content they learned.

This process will repeat four times with a new set of science vocabulary that consists of 5 words. The entire study will last for 3-4 months and your child will have learned 25 new science vocabulary words. All sessions and interventions will take place in your child's Special Education resource room, at a time that is convenient for the teacher. This is to ensure that minimal instruction time will be lost.

An example of the videos can be found at: https://vimeo.com/102763488

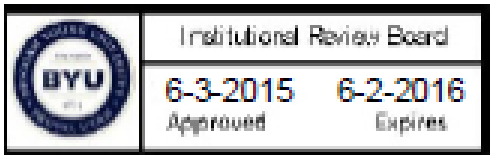
Once the study is finished, your child will fill out one more test, called a Social Validity questionnaire that asks whether or not they liked the videos.

Risks

There is a risk of loss of privacy, which the researcher will reduce by not using any real names or other identifiers in the written report. Your child will be given a pseudonym, which will be put into a master list. This list will be destroyed once the information from the study has been put into a spreadsheet under your child's pseudonym. The researchers will also keep all data in a secure location. Only the researchers will have access to the data. At the end of the study, data will be held onto for 2 years and then destroyed.

There is a risk of a loss of instruction time. The researchers tried to reduce this risk by running the study in your child's resource room, rather than their science classroom where they would miss instruction that covers new material.

Your child may also experience some test anxiety. The researchers will aim to provide a safe and warm environment in order to reduce this anxiety.



Confidentiality

The research data will be kept in a locked cabinet on BYU campus and only the researcher will have access to the data. At the conclusion of the study, all identifying information will be removed and the data will be kept in a locked cabinet or office. After 2 years, the data will be destroyed.

Benefits

We aren't aware, yet, of any direct benefits from this study. We are hoping that after viewing the podcasts, the children will experience a better understanding of the science concepts that are being taught in their classroom.

Compensation

Participants will receive a $15 card for participating. They will be given the gift card regardless of whether they complete the study. If they become bored, or decide that they no longer want to participate, there are no consequences.

Questions about the Research

Please direct any further questions about the study to Caroline Williams at ceander04@gmail.com You may also contact Ryan Kellems at rkellems@byu.edu

Questions about your child's rights as a study participant or to submit comment or complaints about the study should be directed to the IRB Administrator, Brigham Young University, A-285 ASB, Provo, UT 84602. Call (801) 422-1461 or send emails to irb@byu.edu.

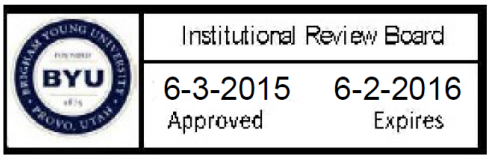
You have been given a copy of this consent form to keep.

Participation

Participation in this research study is voluntary. You are free to decline to have your child participate in this research study. You may withdraw you child's participation at any point without affecting your child's grade or standing in the school.

Child's Name: _____

I allow my child to participate in the study. Yes ☐ No ☐



Child Assent (7-14 years old)

What is this research about?

My name is Caroline Williams and I am a graduate student at Brigham Young University. I want to tell you about a research study I am doing. A research study is a special way to find the answers to questions. We are trying to learn more about the effect that podcasts can have on teaching science vocabulary. You are being asked to join the study because you are in a science class. Your parents have given their permission for you to participate, but they will not see your results.

If you decide you want to be in this study, this is what will happen.

You will be involved in the study for 3-4 months. 1. You will answer 25 questions about different science vocabulary words. 2. You will then watch some videos that describe what these words mean. I will come into your resource classroom 2-3 times a week and show you the videos. 3. After you feel like you know the science words, you will answer some more questions about the words. 4. Once the study is finished, you will fill out one more test, called a Social Validity questionnaire that asks whether or not you liked the videos.

Can anything bad happen to me?

You may not want to answer some questions about science. Or you may get nervous.

Can anything good happen to me?

There are not benefits to being in the study and we don't know if being in this study will help you. But we hope to learn something that will help other people some day.

Do I have other choices?

You can choose not to be in this study.

Will anyone know I am in the study?

We won't tell anyone you took part in this study. When we are done with the study, we will write a report about what we learned. We won't use your name in the report.

What if I do not want to do this?

You don't have to be in this study. It's up to you. If you say yes now, but change your mind later, that's okay too. All you have to do is tell us.

You will receive a $15 gift card for being in this research study. If you have any questions, ask Caroline to explain anything to you.

If you want to be in this study, please sign and print your name. A copy of your assent form will be given to you.

Name (Printed): _____ Signature _____ Date: _____

Youth Assent (15-17 years old)

What is this research about?

My name is Caroline Williams and I am a graduate student at Brigham Young University. I want to tell you about a research study I am doing. A research study is a special way to find the answers to questions. We are trying to learn more about the effect that podcasts can have on teaching science vocabulary. You are being asked to join the study because you have are currently in a science class. Your parents have given their permission for you to participate, but they will not see your results.

If you decide you want to be in this study, this is what will happen.

You will be involved in the study for 3-4 months. 1. You will answer 25 questions about different science vocabulary words. 2. You will then watch some videos that describe what these words mean. I will come into your resource classroom 2-3 times a week and show you the videos. 3. After you have watched the videos, you will answer some more questions about the words. 4. Once the study is finished, you will fill out one more test, called a Social Validity questionnaire that asks whether or not you liked the videos.

Can anything bad happen to me?

You may not want to answer some questions about science. Or you may get nervous.

Can anything good happen to me?

There are not benefits to being in the study and we don't know if being in this study will help you. But we hope to learn something that will help other people some day.

Do I have other choices?

You can choose not to be in this study.

Will anyone know I am in the study?

We won't tell anyone you took part in this study. When we are done with the study, we will write a report about what we learned. We won't use your name in the report.

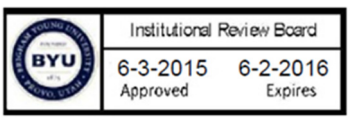
What if I do not want to do this?

You don't have to be in this study. It's up to you. If you say yes now, but change your mind later, that's okay too. All you have to do is tell us.

You will receive a $15 gift card for being in this research study. If you get bored and no longer want to participate, you will still receive your gift card. If you have any questions, ask Caroline to explain anything to you.

If you want to be in this study, please sign and print your name. A copy of your assent form will be given to you.

Name (Printed): _____ Signature _____ Date: _____



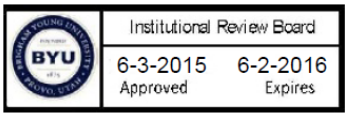
Teacher Recruiting Script

My name is Caroline Williams. I am a graduate student at Brigham Young University in School Psychology. I am currently working on my thesis. My research involves using Content Acquisition Podcasts (podcasts that combine audio and visual) to teach science vocabulary to children with learning disabilities.

I am hoping to conduct my study at _____ and was wondering if you would be willing to help. Here is what it involves: Next fall, I would like to come into the resource room 2-3 times a week and have the students watch podcasts on vocabulary words that have been chosen by science teachers at _____. These are words that the teachers will be teaching later on in the year. Here is an example of what the podcasts will look like: https://vimeo.com/102654447

The entire study will last 3-4 months. I am in the process of getting both IRB approval and have attained district approval. Please let me know if this something that you would be interested in letting me conduct in your department.

Thanks,
Caroline Williams



Parent Recruiting Script

My name is Caroline Williams. I am a graduate student at Brigham Young University in School Psychology. I am currently working on my thesis. My research involves using Content Acquisition Podcasts (podcasts that combine audio and visual) to teach science vocabulary to children with learning disabilities. I am inviting your child to take part in the research because (he/she) may need help learning science vocabulary. If you agree to let your child participate in this research study, the following will occur.

1. Your child's records will be reviewed to ensure that they are receiving services under IDEA for Specific Learning Disability.

2. Your child will take a pretest to gauge their knowledge of different science vocabulary words.

3. You child will then watch videos that combine images and text to teach your child the vocabulary words. You child will watch these videos 2-3 times a week.

4. After your child has become familiar with the words, they will then take a posttest to see how much of the content they learned.

This process will repeat four times with a new set of science vocabulary that consists of 5 words. The entire study will last for 3-4 months and your child will have learned 25 new science vocabulary words. All sessions and interventions will take place in your child's Special Education resource room, at a time that is convenient for the teacher. This is to ensure that minimal instruction time will be lost. An example of the videos can be found at: https://vimeo.com/102763488 Once the study is finished, your child will fill out one more test, called a Social Validity questionnaire that asks whether or not they liked the videos.

Please let me know if you would be willing to hear more about the study and are interested in allowing your child to be a part of the study.