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iMath - Using Video Modeling Via iPads to Teach Mathematics Skills to Struggling Students

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A thesis submitted to the faculty of
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ABSTRACT

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There is a growing body of research that suggests that video-based interventions, such as video modeling and video prompting, are effective tools for teaching academic skills to students with disabilities. This study used a single subject, multiple-baseline-across-subjects design to evaluate whether a video-prompting intervention could effectively assist second grade students who had been identified by their teachers as "struggling" in mathematics to better solve multiplication story problems. Five second grade students (one female and four males) ages 7 to 8 viewed the intervention videos on an iPad that modeled how to solve multiplication word problems. To evaluate the effectiveness of the videos, a rubric was used as the primary measure to assess the domains of problem-solving, communicating, and representing with numbers. Based on visual analysis between baseline and intervention, there was a functional relationship between the introduction of the intervention and the performance on the math problems. In addition, a visual analysis between intervention and maintenance appeared stable for all participants. These results indicate that technology can be used to implement interventions for struggling learners and may be utilized in regular classrooms. Results also demonstrate that video modeling can be a useful instructional tool for helping many individuals, not just those with an identified disability, to learn complex tasks. Implementing video models in a classroom setting could enable teachers to consistently provide interventions to students that work more independently, allowing teachers to work on a more one-on-one or small group basis with their students.

Keywords: math instruction, video modeling, video prompting, iPad, Common Core, struggling students, elementary, multiplication, story problems, problem-solving, number representation

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CHAPTER 1

Introduction

Many students struggle with mathematics (Witzel & Riccomini, 2007). In the 2019 National Assessment of Educational Progress (National Center for Education Statistics, 2019), only 41% 4th graders and 34% of 8th graders attained advanced levels of mathematics achievement. In addition, little to no change was apparent from 2009 to 2017 where 39% to 40% of 4th graders, respectively, were identified as being at or above proficient ability for their grade. Similarly, at or above proficiency levels among 8th graders were recorded at 34% in 2009, 2017, and 2019. The unchanging status of mathematics proficiency is a problem because it means that the changes made to curriculum, or attempts to change instruction, have had little to no effect. Witzel and Riccomini (2007) further stated that there is an even greater need to improve mathematics instructional procedures for low-achieving students with and without disabilities. Although educators are implementing instruction that focuses on developing early mathematical thinking, the current scale at which this instruction is being utilized is too inadequate to affect a significant impact on students' poor mathematical performance. Effective use of instructional technology and manipulatives, improved diagnostic assessment options, afterschool remediation and tutoring programs, and increased parental involvement could increase the effectiveness and scale of instruction implementation such that a positive change in proficiency levels across K-12 education will be seen.

Within the National Council of Teachers of Mathematics Research Brief Clips (2007), researchers identified several strategies that have been found in currently available research to be consistently effective in teaching students who experience difficulties in mathematics. These strategies encompass the following activities: (a) structured learning activities that engage student peers in the learning process, (b) visual representations used to make instructions more systemic and explicit, (c) collecting data from formative, student assessments (such as in-class discussions, quizzes, and other activities) which is then used to modify instructional directions, (d) giving students the chance to think through their work aloud, and (e) formative assessments given directly to students. These strategies focus on utilizing students, in-class data, and more formative communications to assist the learning process. Despite knowing the potential effectiveness of this, collectively utilizing the strategies has been elusive to manage.

Although various teaching strategies have been implemented that incorporate a number of these strategies, discrepancies continue to persist between student academic needs and the supports or interventions available to help struggling students (Council of the Great City Schools, 2009). The Council of the Great City Schools report (2009) states that, based on estimates provided by the districts, slightly more than 50% of all incoming 9^{th} grade students performed below grade level in math, but only 31% of the students received support in the form of remedial math instruction or interventions. Without that instructional support or intervention, it is almost guaranteed that these students will not be prepared to succeed in mathematics as they progress through the school system.

In addition, Berkeley et al. (2008) stated that many students who struggle with mathematics may not meet eligibility requirements for special education, which limits their access to guaranteed tiered support. If a student does not meet the criteria for special education as defined by the Individuals with Disabilities Education Improvement Act (2004) classification, then they will not be able to receive individualized s services in mathematics and will rely solely on the fidelity of optional interventions from their classroom teacher (Berkeley et al., 2008).

The high percentage of students who are below proficiency, but also do not qualify for additional support are defined as struggling learners. The term *struggling learners* captures the difficulty that many students experience, and includes both students whose struggle may be temporary, as well as those students who experience persistent conceptual difficulties that make mathematics more difficult to learn (Allsopp et al., 2007).

In an effort to help these struggling learners, video modeling has been put forward as a potential educational solution. Video modeling is an evidence-based practice that educators are currently using with students as a means of teaching and differentiating instruction (Bellini & Akullian, 2007). With video modeling, a video of a desired task is shown in its entirety to a student. After watching a video of a desired skill or behavior being performed successfully, the student is then expected to perform the target behavior from start to finish (Mason et al., 2013). This type of intervention has had positive results in teaching critical skills in areas such as academics, language, social skills, and self-care to students (Cihak, Kildare et al., 2012). Instructional implications of video modeling include less demand on teacher instructional time, which in turn provides more time for teachers to provide targeted instruction to specific students (Blood et al., 2011). The visual aspect of video modeling has also been found to (a) be more conducive to the learning styles of students with autism (Cihak, Smith et al., 2012), and (b) require less time to acquire a new skill (Blood et al., 2011). Most importantly, visual modeling has the potential to lead to a greater generalization of the learned skill (Buggey & Ogle, 2012).

A specific type of video modeling is video prompting. Video prompting involves having a student view a video in separate clips, with the expectation that the student will perform the task depicted in the recently finished clip before moving on to the next clip in the series (Cannella-Malone et al., 2011). Functional relationships have been established between video modeling and video prompting, and with attaining behavior skills, social skills, transition skills, reading skills, vocational skills, and math skills (Kellems & Edwards, 2015).

The purpose of this study is to investigate what effects iPad video prompting may have on the ability of struggling elementary school students to acquire new mathematical skills.

This study will investigate the following experimental questions:

1. Based on a rubric that measures problem solving, communication, and the representation of numbers, what is the effectiveness of video prompting (independent variable) on the total points earned, based on a rubric (dependent variable) of students who struggle with mathematics?
2. What is the social validity of using video-based instruction to teach mathematics to elementary school students who struggle with mathematics?
3. How effective is video prompting over time after the intervention has been removed?

CHAPTER 2

Review of Literature

Educators, lawmakers, and a variety of other stakeholders are concerned with student academic performance, primarily in the subjects of reading and math (Witzel & Riccomini, 2007). The Every Student Succeeds Act of 2015 (ESSA) is the most recent legislation that relates to the success of students and schools. ESSA states, among other things, that all students in America should be taught so as to achieve the high academic standards necessary to prepare them for success in both college and future careers (Every Student Succeeds Act, 2015). Fifty years after the first educational accountability legislation, the Elementary and Secondary Education Act (1965), was passed, the legislation of No Child Left Behind Act of 2001 (NCLB) was signed into law, in an effort to update America's educational accountability measure. Despite that legislation being almost 20 years old, mathematics performance outcomes have remained consistently poor, a fact that is still the source of prevalent concerns for the nation's educators (Witzel & Riccomini, 2007).

Logan (2010) noted that stakeholders are particularly invested in early academic performance because of how that performance relates to later student outcomes. The study examined 8th grade students to determine predictor variables for students at-risk of dropping out of high school. It was determined that years retained, discipline referrals, socioeconomic status, final math grade, end-of-year math score, and absences, were the most significant predictors of high school completion or lack thereof.

McKee and Caldarella (2016) identified that the likelihood of dropping out is attributed to both social and academic risk factors. Poor high school attendance, low course completion, and low grade-point-average (GPA) were also identified as three leading indicators that points towards a student's risk of dropping out. The study also found that attendance and ACT math scores were strong predictors of 9th grade performance.

Beyond affecting graduation rates, poor math achievement has been shown to be a factor in the lives of adults as well. Tabbarok (2012) found that if students struggling with math do attend college, they often choose a career unrelated to math. These students often end up in positions with lower wages and are ultimately less likely to find work in their chosen fields, especially when compared to students that graduate in the science and mathematics domains. This relationship between struggling to learn mathematics skills and adult life outcomes was the focus of the Program for the International Assessment of Adult Competencies (PIACC; National Center for Education Statistics, 2016). PIACC is a large-scale study of adult skills and life experiences focusing on education and employment, that involved researchers utilizing basic mathematical and computational skills assessments and surveys involving numeracy, to compare the adults in participating countries. Individuals in the United States performed below the PIAAC international average in mathematics. This study provided researchers the chance to study the relationships between educational background and employment outcomes, making it possible to identify the fact that adults in the United States may have difficulty using, interpreting, and communicating mathematical ideas when they are faced with mathematical demands (National Center for Education Statistics, 2016).

The National Center for Education Statistics (2016) determined that 22% of adults have not mastered enough mathematics skills to pass an 8th grade mathematics assessment, let alone the mathematics skills necessary for success in many jobs (Geary et al., 2013). Additional findings from the study discovered that 20% of adults are functionally innumerate and lack the mathematical competencies required for many modern jobs, resulting in both lower wage potentials and fewer job opportunities for the average adult in the United States.

Mathematical Learning

Traditional mathematical instruction focuses on teaching learning procedures without any connection to the meaning, understanding, or application of those procedures. As a result, too few students are attaining high levels of mathematical learning (National Council of Teachers of Mathematics, 2014). The aim of mathematics could be different. A greater focus could be placed on procedural and conceptual knowledge rather than rote memorization. Therefore, a greater focus on developing new methods of assessing deeper mathematical abilities is needed (Bahr, 2007). If the aim of mathematics is different, the instruction must also be different. If the instruction is different, mathematics needs to be assessed differently.

Mathematic instruction encompasses two types of mathematical learning: procedural and conceptual. Procedural knowledge is knowing the steps to solve a problem and conceptual knowledge is understanding the underlying mathematical ideas (National Council of Teachers of Mathematics, 2000). Effectively, these two types of learning describe the difference between knowing and understanding the mathematical principles being taught. Knowing refers to a student's ability to accurately reproduce algorithms, remember facts, efficiently find answers, and follow a precise set of directions. Conversely, understanding refers to a student's ability to make connections between mathematical ideas, see multiple avenues for solving a problem, and to think flexibly with the base principles they are taught (Tapper, 2012). If a student can be helped more towards understanding mathematics, it enables them to reach higher levels of achievement in mathematics.

Traditionally, the way that mathematics has been taught matched the traditional definition of mathematics, which is a focus on procedural knowledge or garnering students that know instead of understand mathematics. According to the National Council of Teachers of Mathematics (2000), learning without understanding has been a persistent problem since at least the 1930s. In recent decades research on learning mathematics has established the important role of conceptual understanding among students who are proficient. In one of the most robust research studies focusing on mathematical learning, researchers found that conceptual understanding is as equally important a component of proficiency as factual knowledge or procedural facility (Bransford et al., 2000). Bransford et al. (2000) identified that learning can be quite fragile when students memorize facts or procedures without the understanding of when or how to use what they know to reinforce their understanding of the procedures. Learning procedures alongside the when, how, and why to use those procedures makes subsequent learning simpler, more sensical, and easier to remember and apply (Schoenfeld, 1988).

According to the Key Shifts in Mathematics (Common Core State Standards Initiative, 2020), one of the key shifts in mathematical instruction is the new objective of pursuing conceptual understanding, procedural skills and fluency, and practical application with equal intensity. With this shift in the core definition of mathematics and the added emphasis it has on both procedural knowledge and conceptual understanding, it is necessary for the traditional methods of instruction to change as well. The pedagogy an educator should employ in order to guide a child's ability to deeply understand mathematics will include the use of models, strategies, and algorithms as an integral part of instruction (Tapper, 2012).

This system, along with the new vision of mathematics education, places new demands on instruction and forces us to rethink the manner and methods by which students' progress is measured. In an instructional environment that demands a deeper understanding of mathematics, testing instruments that call only for the identification of single, correct responses is no longer sufficient. Instead, instruments must reflect the scope and intent of instructional programs to have students solve problems through reasoning and communication in order to strengthen a deeper understanding of the concepts being tested. Furthermore, the instruments must enable the teacher to understand their students' perceptions of mathematical ideas and processes, as well as their students' abilities to function in a mathematical context (National Council of Teachers of Mathematics, 1989)

The Principles and Standards for School Mathematics (National Council of Teachers of Mathematics, 2000) identified that when assessing a student's understanding of mathematical concepts, they should be presented with an authentic task to solve. Once they have performed the task, their performance can be evaluated using a rubric. Rubrics enable judging the quality of a student's response to a task or set of tasks that call for a more holistic understanding of mathematics and mathematical learning, i.e., evaluating how well the student is gaining both procedure knowledge and conceptual understanding.

Rubrics are useful in assessing deep understanding, not just rote answers. The Principles and Standards for School Mathematics (National Council of Teachers of Mathematics, 2000) suggests teachers need to move beyond a superficial right or wrong analysis of tasks to a focus on how students are thinking about the tasks. Although less straight-forward than finding the number of correct responses on an exam, using rubrics makes it far more likely for a teacher to be able to gain a more accurate understanding of what a student knows and understands. Ultimately, a rubric should be used to assess a student's ability to take what is known about mathematics and make connections with what they can practically with that knowledge, rather than simply measuring decontextualized technical skills (Australian Association of Mathematics Teachers, 2006; National Council of Teachers of Mathematics, 2000). Rubric data informs instruction along with sending a message to the students that helps teach them the difference between knowing mathematics and understanding how to actually use mathematics (Bahr, 2007).

Rubrics are a core instrument used in performance-based assessment. A rubric that is reflective of performance-based assessment operationally defines what that holistic performance should be by combining procedural knowledge and conceptual learning into a clear goal for the assessment. Additionally, researchers can use a rubric to help create an operational definition by making the listing specific criteria that characterizes legitimate mathematical performance with the use of rating scales (National Council of Teachers of Mathematics, 2014).

One important part of performance-based assessment is that the task being presented should be designed to elicit the desired performance. The other important part is that the rubric, because it assists in that operational definition, should also be designed to allow educators to determine the depth of a student's understanding based on the assessed performance of said student (Bahr, 2007).

Bahr (2007) suggested creating high quality performance assessments in mathematics by utilizing the following steps: (a) choose a grade level topic, (b) create a performance task focused on that topic, (c) implement an inventory (i.e., pre-test) to estimate a student's current level of understanding, (d) select criteria for judging performance (e.g., problem solving, communicating, reasoning, representing, connecting, procedural and conceptual knowledge), (e) design a rubric using those criteria, and (f) create various phrases to encourage student thinking and communication.

Factors That Influence Struggling Learners

Many factors can contribute to a student's difficulty in learning mathematics. Some of the main factors identified by research into students who struggle with mathematics are environmental, learner-centered, and instructional (Tapper, 2012).

Environmental factors that influence learners include language, culture, race, parent education, and socioeconomic status (Baker et al., 2002; Blanchett et al., 2005; Tate, 1997). In relation to environmental factors, Blanchett et al. (2005) found that urban schools attended primarily by African American or Hispanic students who have limited access to technology, few resources, as well as dilapidated physical environments, each of which increases the likelihood of the school being identified as a failing school according to the NCLB (2001) standards. NCLB (2001) elaborates that a failing school is one that has failed to meet state standards for three of the four proceeding years. Thus, it is clear that poor environmental factors negatively impact students' attainment of proficient math standards.

In addition, Baker et al. (2002) found that students who had very little parent involvement, in relation to academics, scored lower on end of year assessments. This shows that students with low parent involvement may enter school with a disadvantage in their academic support system which may affect their academic success and reinforces the need for appropriate school instruction. Tate (1997) stated that ethnicity plays a factor in achievement by influencing the importance or unimportance of academics (e.g., poor attendance, low homework completion, less value placed on core content than the arts or trade work). When less value is placed on education, it is likely to affect their achievements in content areas, including math. Jordan et al. (2006) also noted that students may perform poorly due to economic disadvantage or fewer opportunities to learn mathematics, informally, in the home. Students may have difficulty drawing upon their schemas to support new mathematical learning.

Among the many learner-centered factors that influence struggling students, cognitive challenges stand out as one of the most difficult factors to overcome. Cognitive challenges such as neurologically based differences like autism, ADHD, and traumatic brain injury, can play a role in making the process of learning mathematics more difficult (Fuchs et al., 2004). Additionally, children who struggle to learn mathematics, whether due to cognitive deficits or not, have reported that they experience conditions like depression, anxiety, and/or phobias of various types (Morgan et al., 2009). Some children with neurological disorders struggle with mathematics due to difficulty with their working memory, executive functioning, and decreased alertness (Jordan et al., 2006). Traditional instruction makes it nearly impossible for students experiencing these difficulties to find success and achievement in mathematics. With the currently shifting definition of mathematics, the opportunity to develop methods of instruction that might help these students more effectively learn mathematics, which may further help them more effectively learn in general, is to important and potentially impactful to ignore.

The quality of instruction can also be a factor in the low math achievement of some struggling students. Quality of instruction is defined as the relationship between instructional strategies, skills, and a student’s readiness to learn. An example of low-quality instruction would be a teacher who focuses only on facts and provides no opportunities for students to apply or practice those facts. Other examples might be teachers who do not utilize evidence-based instruction or a teacher who does not provide interventions in the curriculum to account for struggling learners (Allsopp et al., 2007; Tapper, 2012).

Environmental, learner-centered, and instructional factors might influence the access to a quality education, the capability to understand the content, the student's readiness to learn, and the support to achieve grade-level criteria. It is important for educators to identify students who are struggling and address those challenges with appropriate interventions. In addition, poor classroom management, insufficient performance assessments, and lack of progress on targeted skills are contributing factors to student difficulties (Tapper, 2012)

Due to the high numbers of students below proficiency in math, it is important that educational institutions provide evidence-based math instruction. Adopting more targeted, instructional strategies earlier on in general education would, in many cases, be more appropriate and effective in meeting the needs of many struggling learners (Duffy, 2007). An evidence-based practice showing promise with students as a means to teach and differentiate instruction is video modeling (Kellems et al., 2016).

Video Modeling

Video modeling is an evidence-based practice that educators use as a means of teaching and differentiating instruction (Bellini & Akullian, 2007). With video modeling, a video is recorded modeling the completion of the desired task, a video that is then shown in its entirety to a student. After watching video of a model that successfully completes the desired skill or behavior, the student is then prompted to perform the target behavior (Mason et al., 2013). This type of intervention has had positive results in teaching critical skills in the areas of academics, language, social skills, and self-care to students (Cihak, Kildare, et al., 2012). After the initial recording and video creation, video modeling would decrease the demand on a teacher's instructional time, which ultimately allows that teacher to focus more on providing targeted instruction, such as time focused on helping struggling students. (Blood et al., 2011).

Additionally, the visual aspect of video modeling is more conducive to the learning style of students with autism and may go a long way to mitigate the difficulties that other students with academically affecting deficiencies experience (Cihak, Smith, et al., 2012). The express purpose of utilizing video modeling in this way is to lessen the time needed by students to acquire a new skill and to progress the generalization of the newly learned skill (Blood et al., 2011; Buggey & Ogle, 2012).

One variation of video modeling is video prompting. Video prompting is when a student views a video in separate clips and is expected to perform that task before the next clip is shown (Cannella-Malone et al., 2011). Video prompting focuses on utilizing procedural instruction (the step-by-step process of each clip) while also giving a teacher a place to insert conceptual, or big picture instruction along the way. Instead of waiting until the end of the video to show the student that they have learned a new skill, video prompting allows a teacher to show the student first, how to perform he step, and second, how that step conceptually connects to the previous steps and future goal. Because of this combination of knowing and understanding instruction, video modeling and video prompting have been shown to be effective across a wide range of settings and skills including, but not limited to, behavioral, social, transitional, reading, vocational, and mathematical skills (Kellems & Edwards, 2015).

In 2016, Kellems et al. conducted a study that demonstrated that teaching math using video prompting had significant gains in acquisition among 18-21 year old adults with autism, specific learning disabilities, intellectual disabilities, and other health impairments. The adults were tasked with making several multi-step math calculations, including calculating a 15% tip, calculating item unit prices, and adjusting a recipe for more or fewer people. Eight out of nine adults in the study showed significant gains in the percentage of steps completed correctly.

Burton et al. (2013) conducted a study with students who have autism or intellectual disabilities. During the study, Burton et al. assigned these students with the task of identifying the cost of a list of products. The students would then be required to gathering the correct amount of money and estimating the amount of change they should receive back. The students' performances were recorded, edited to show successful completions of the task. The videos were then shown to the students as a means of using self-modeling as instruction for future task completion. The data Burton et al. collected displayed a functional and positive relationship between video self-modeling and accuracy of mathematical calculations for all four participants.

Cihak (2009) examined the use of handheld computers and video modeling to deliver geometry instruction to students who had been identified as having a learning disability. The handheld computer had various clips that demonstrated how to solve problems related to perimeter of various polygons. The students watched the clips independently and were tasked with completing other related problems. All three participants acquired and maintained the skills represented in the video models across a number of questions, showing that the students were able to apply the skills gained to different types of questions.

Purpose of Study and Research Questions

To date, much of the research surrounding video modeling has been focused on and worked with individuals with disabilities. While there have been several studies using video modeling to teach math, there is less literature related to the efficacy of using video modeling or video prompting as an instructional intervention for teaching elementary level mathematics to students who struggle but may not have a formal disability classification. After a thorough review of the literature, it was discovered that a study published in 1989 entitled *Self-Modeling and Children's Cognitive Skill Learning*, investigated self-modeling among children who had experienced arithmetic difficulties (Schunk & Hanson, 1989). The children viewed video tapes of themselves and peers successfully completing mathematical tasks. The results of the study demonstrated that self-model video tapes highlighting progress in skill acquisition further enhanced self-efficacy and success among students.

The purpose of this study is to investigate the effects that video modeling may have on mathematics skill acquisition by struggling elementary students. To achieve this, video prompting via an iPad was used on the participating elementary students. Specifically, this study will use a video prompting intervention to teach multiplication skills to elementary students identified by their teachers as at-risk for failure in math. The instructional content will be based on the Utah State Common Core Standards for 3rd grade. The participating students will be 2nd graders in order to ensure that students have not been exposed to the content of the video models outside of the study.

This study will investigate the following experimental questions:

1. Based on a rubric that measures problem solving, communication, and the representation of numbers, what is the effectiveness of video prompting (independent variable) on the total points earned, based on a rubric (dependent variable) of students who struggle with mathematics?
2. What is the social validity of using video-based instruction to teach mathematics to elementary school students who struggle with mathematics?
3. How effective is video prompting over time after the intervention has been removed?

CHAPTER 3

Method

Setting

This study was conducted in a suburban elementary school located in the Western United States with a total school population of 407. Forty-two percent of the students were considered economically disadvantaged. The participants were students found in 2nd grade, general education classes. Prior to the intervention, math instruction for these students consisted of teachers delivering math content to an entire class at once or within small groups. The interventions performed for this research project occurred 2 to 3 days per week in a vacant satellite classroom (trailer) at the elementary school. The interventions took place during science or social studies instruction, or during weekly free time periods.

Participants

Teachers

In order to find students with the necessary characteristics for this study, teachers who would agree to work with the study had to be found. To do this, teachers were recruited using the script in Appendix A. Once a teacher agreed to participate, they directed me towards specific students that fit the criteria you will find below.

Parents and Students

Participating students were selected based on whether they

- were enrolled in elementary school,
- were of any gender,
- were between 6-12 years old,
- had received parental permission,

- had agreed to participate,
- had the ability to follow and respond to directions in English,
- had not been receiving any special education services, and
- had been identified by teachers or administrators as being at-risk for failure in math as defined by repeated failure on math curriculum-based assessments, unrelated to multiplication, for 3 consecutive months.

Among the participants that were identified, four were male and one was female. As mentioned before, all students came from 2nd grade classes and were between 7-8 years old. See Table 1 for demographic details on each specific participant.

Table 1

Participating Student Demographic Data

Participant	Gender	Age	Grade	Ethnicity
1	M	8	2	Hispanic
2	M	7	2	Hispanic
3	M	7	2	Caucasian
4	F	8	2	Caucasian
5	M	7	2	Caucasian

After these students were identified by their teachers, the parents were approached first in order to obtain consent, the form for which is in Appendix B. After that, the script in Appendix C was used to get the child's consent to participate as well.

Data Analysis

Data comparing baseline and intervention phases were visually analyzed for changes in level, trend, and variability. The objective of the research was to show a functional relationship between the dependent variable (total points earned based on a rubric) and the independent variable (video prompting intervention) by observing changes in the independent variable. Kennedy (2005) explained that "if changes in the dependent variable occur only when the independent variable is introduced, then a functional relation is demonstrated." (p. 152.)

Materials and Videos

Target word problems were printed on task cards (see Appendix D) and then read to the participants to solve. The format of the problems was vetted by an expert with an EdD in curriculum and instructional science. Along with the card, participants were given scratch paper, pencils, and single unit counting cubes to aid participants in solving the target problems. The video obtained of the students was recorded using a digital video camera (JVC Kenwood Holdings Inc, n.d.). The male model in the video, i.e., the student showing the successful completion of the target problems, was a similar age to the students viewing the video. The video was uploaded to the VideoTote mobile application (Prevention Group, 2012) on the iPad, which allowed for the videos to be cut into individual segments that were then used as video prompting instructions aimed at solving the target problems.

The video was presented using an iPad (Apple Inc., 2011). The target problems followed the same format as the questions from the intervention video, "There are 2 cars. Each car has 4 wheels. How many wheels are there in all?" The 25 target questions were designed by a research assistant using different equations with factors ranging from two-six. Different descriptors and numbers were also used to increase variability of the questions. The 25 questions were based on the 3rd grade common core standards established by the Common Core State Standards Initiative (2010). The standards include the requirement that 3rd grade students should be able to "interpret products of whole numbers, e.g., interpret 5 × 7 as the total number of objects in 5 groups of 7 objects each. *For example, describe a context in which a total number of objects can be expressed as 5 × 7.*"

The questions were randomized for each session using a number sequence randomizer from Random.org (2020). Each participant had his or her own randomized sequence. A table was created that used a row to display session numbers which were then aligned with the unique card numbers. After completion of the session, the participant was given a small prize or piece of candy as a reinforcer.

Dependent Measure and Data Collection

A 9-point rubric was used to assess the percentage of correct solutions based on a participant's use of problem solving and communication, as well as how well they represented target problems with numbers. A rubric was completed every time a problem was solved, whether correctly or incorrectly, by a participant. A blank version of the rubric can be found in Appendix E.

The problem-solving portion of the rubric was based on how well the student demonstrated a reasonable strategy for solving the target problem. A score of 3 was given for to students that demonstrated a reasonable strategy and who correctly solved the question. A score of 2 was given to students who demonstrated a reasonable strategy but got an incorrect answer or got a correct answer but did not use a reasonable strategy to reach the correct answer. A score of 1 was given to participants that did not display either a reasonable strategy or a correct answer. A score of 0 was given when a participant did not attempt a question, or they gave the response "I don't know."

The communication portion of the rubric was based on how clearly explaining the steps taken to solve a problem, regardless of the correctness of the answer. A score of 3 was given for those that could clearly describe the steps they took to solve the problem. A score of 2 was given to those participants that could clearly explaining most (more than half) of the steps taken to solve the problem. A score of one was given for clearly explaining some (less than half) of the steps taken to solve the problem. And a score of 0 was given when a participant did not attempt to solve the problem, or they gave the response "I don't know."

The number representation portion of the rubric was based on a participant's ability to write a numerical representation of the given story problem. The correct representations consisted of factors, the product, and the multiplication sign, and could be written with or without the equal sign. A score of 3 was given when a participant was able to use all the required parts in a correct, sensible order. A score of 2 was given when a participant used three of the four required parts. A score of 1 was given when a participant used two of the four required parts. And a score of 0 was given when a participant used only one of the four of the required parts, made no attempt to represent the problem numerically, or gave the response "I don't know." The same, 9-point rubric was used during each student's session to record scores based on how a participant solved each question presented in the session.

Procedures

Preassessment

Before participants started attempting to solve baseline problems, each was required to complete a 10-question, multiplication test. Five questions were multiplication story problems and five questions were multiplication equations, based on the 3rd grade Common Core standards. For example, the following story problem was included: "There are 6 elephants. Each elephant has 4 legs. How many legs are there in all?" The other four questions were similar but used different numbers and descriptors. The preassessment questions were sufficiently spaced on the page, allowing students to work through the problems. The five equations were presented in a typical number sentence, (i.e., 3 X 5 =). Again, the questions were sufficiently spaced, allowing the students to work through the problems. See the Appendix F for a list of the pretest questions.

Baseline

At the beginning of each session, the student received a randomized, multiplication story problem with different numbers and descriptors, similar s to the word problem that was solved in the intervention video. Twenty-five word problems were developed, and the order of the questions was randomized for all participants. They were also provided with a pencil, paper, and single unit counting cubes.

Intervention

Pretraining. Students who participated in the study completed a pretraining session where they learned how to operate the iPad, as well as how to play the video in the VideoTote app (Prevention Group, 2012). During these sessions, how to open the app, find the video, play the video until it stopped, follow a prompt, complete the task demonstrated in the prompt, and press play again and continue was demonstrated for each student. The specific tasks modeled to the student were the steps of brushing one's teeth. After the pretraining session were finished, participants were asked to access an unrelated video to confirm that they were able to independently navigate the iPad, based on a checklist of skills used to confirm they could continue through the rest of the study. All of the participants were able to pass the pretraining and could access the videos independently. (See thesis training script in Appendix G)

Intervention Sessions. Participating students viewed the videos using an iPad (Apple Inc., 2011) with a video demonstrating how to solve the equations and/or word problems. Intervention sessions took place approximately 3-5 times a week. No additional prompts were given on how to complete the tasks. All questions from the participants received a redirect to the videos.

Any spoken words were also visible, on screen, in text form. The model student was provided with the following materials that he could choose to use: place value blocks, paper, and a pencil. The video model shows the following steps for solving the target problem:

1. An adult reads the following word problem to the model student (student of similar age) in the video: "I have two cars. Each car has four wheels. How many wheels are there in all?"
2. At this point, the video has a voiceover that says, "There are two cars. That means there are two groups. Each car has four wheels. That means there are four in each group. Think about your problem. How many groups are there? How many are in each group?
3. The model student then creates a visual representation (two groups with four in each group) of the word problem using the counting cubes. The voiceover narrator and says, "That is his first group. There are only four in that group. That is his second group. There are only four in that group. Do you see his two groups, with four in each group?
4. The voiceover narrator continues, "Now he is going to do it a different way by drawing a picture." The model student then draws two larger circles (the groups) with four smaller circles in each group, making the picture resemble the aerial view of two cars. The voiceover narrator then says, "Do you see his picture of one car with four wheels and a second car with four wheels? Think about your problem. Show it with blocks, draw a picture, or do both."

5. The app stops the video at this point, and the student follows the following prompt: "Think about your problem. Show it with blocks, draw a picture, or both."
6. The student then presses play in the app and the adult in the video asks: "Tell me how you did it." The model student proceeds to explain, "So for the blocks, I did two groups of four blocks in them because of the four wheels in each car. And then for the picture, I did one box with four wheels on the outside, and then for the other car, I did four wheels on the outside of that car and I got eight wheels."
7. The voiceover narrator then says, "Your turn. Tell me how you did it."
8. The video then pauses at this point so that the student can follow the prompt to tell the attending adult how they did it.
9. The student then presses play to resume the video. The adult in the video then asks, "Can you show me your thinking with some numbers?" As the model student writes, 2 X 4 = 8, the voiceover narrator says, "He is writing two times four. Two, because he has two groups. Times, and then four, because he has four in each group. Two groups of four is eight."
10. The model student then says, "I did two multiplied by four because the two is for the two cars and the four is for the four tires on each car. And then, all the tires on each car equals eight tires."
11. The video pauses with the equation displayed and the voiceover narrator says, "We call this a number sentence or equation. We read it like this: two times four equals eight. There are two groups. That 'X' means times or multiply. That means we are working with equal and fair groups. That four means there are four in each group. That eight is the total of all things in the groups. Remember, multiplying means you

are working with equal and fair groups. Your turn. Show me your thinking with some numbers."

The video, which was four minutes and thirty-three seconds, was edited using iMovie (Apple Inc., 2019) and viewed on an iPad in the Video Tote app (Apple Inc., 2011; Prevention Group, 2012). In the VideoTote app, the video was edited into short clips of each step of solving a multiplication story problem.

Maintenance

The students were asked to complete the tasks the same way they were asked during the baseline data collection exercise that did not provide access to the iPad (Apple Inc., 2011) or intervention video. Participants were asked to complete story problems from the same set of questions they were asked to complete during baseline and intervention phases. The data collector read the questions to the student, and the student was given a pencil, piece of paper, and place value blocks. Maintenance data was collected between 1 to 20 days after the last intervention session and was collected for 2 to 6 weeks, depending on the participant.

Post Assessment

A month after a participant reached the predetermined criterion in the intervention phase, he or she was given a posttest. All participants received an intervention probe with the video prompting intervention the day prior to taking the posttest. This assessment was identical to the pretest and had the same procedures (see Appendix F). The posttest data was used to compare answers with the results from the pretest to determine if the video prompting intervention had effectively taught the participants how to independently obtain the correct answer for multiplication story problems.

The post assessment results were analyzed to determine if either (a) "Yes, the student can do the skill," or (b) "No, the student cannot do the skill." The participants will still be scored according to the rubric to determine if the steps were maintained over time. To determine interrater reliability, the primary observer trained the reliability coder, who then viewed and scored randomly selected session recordings using the rubric. The interrater reliability is as follows: baseline, 86.4%; intervention, 86.3%; and maintenance, 87.1%.

Experimental Design

A multiple baseline design was used to determine whether or not a functional relation between the independent variable and the dependent variable existed (Kennedy, 2005). The independent variable was systematically introduced to different participants across different baselines. Once one participant received a 77% score based on the rubric across 3 consecutive sessions, the intervention was introduced to the next randomized participant. Baseline and intervention probes were conducted on participants as they started each intervention. The quality indicators of single-subject design were followed. Specifically, the What Works Clearinghouse (2010) Single-Case Design Technical Documentation was followed.

CHAPTER 4

Results

In this study, a multiple baseline across five participants design was used to evaluate what effects video prompting intervention might have on elementary school children and their ability to solve multiplication story problems. Data analysis was performed for all five participants, ultimately showing a functional relationship between video prompting and each child's learning of the steps required to solve the target story problems. All of the problems were outside their grade range, guaranteeing that they had not be introduced to the same material beforehand. It also helps show the efficacy of the video prompting for developing a student's conceptual understanding versus procedural ability.

During the baseline phase, the average score was 38%. After the interventions were introduced, the average score increased to 87% across five to seven sessions for each participant. During the maintenance phase, the average was 93% across five to six sessions per participant.

Participant Results

The study provides evidence that video prompting instruction helped participants acquire the skills to communicate, problem solve, and represent multiplication story problems with numbers. The average scores for each participant during each phase of the study are shown in Table 2.

Table 2

Average Scores During Study Phases

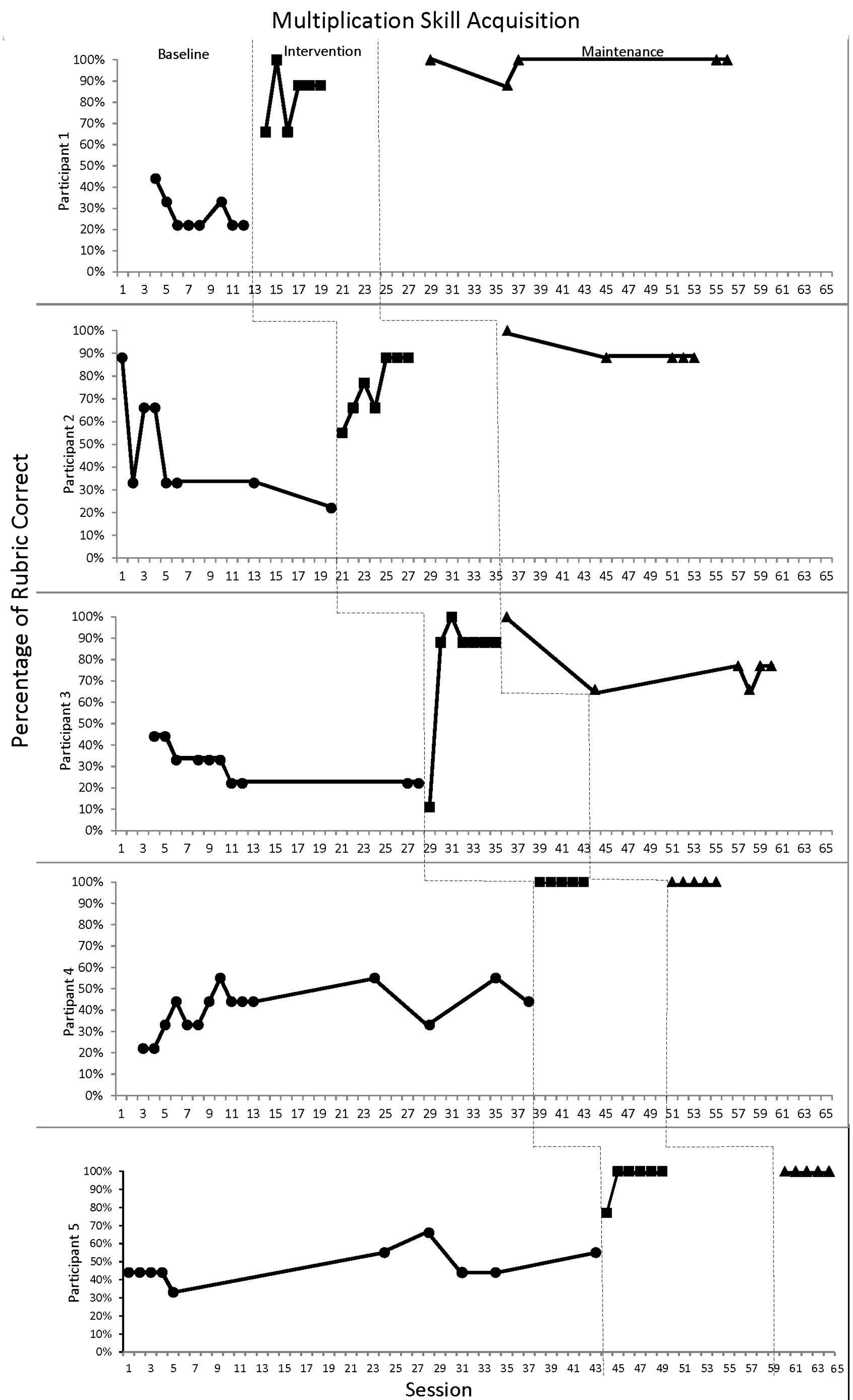
	Pretest	Baseline	Intervention	Maintenance	Posttest
Participant 1	0%	28%	83%	98%	40%
Participant 2	0%	47%	75%	90%	90%
Participant 3	0%	31%	79%	77%	10%
Participant 4	50%	40%	100%	100%	60%
Participant 5	50%	53%	96%	96%	60%

Baseline

During the baseline phase, the averages for participants 1-5 across 51 trials on a 9-point rubric, respectively, were as follows: 28%, 47%, 31%, 40%, and 53%, for an overall baseline average of 40%. As shown in Figure 1, the range of scores varied from 22 to 66, for an average of a 35-point range. Before the introduction of the intervention, all participants had stable baseline scores. Participants 1, 2, and 3 were stable at 22%-33%, while participants 4 and 5 were stable at 44%; however, participant 4 and 5 had averages of 47% and 55% during their later baseline probes as they received the intervention toward the end of the study, taking maturation into account.

Figure 1

Multiplication Skill Acquisition: Session Breakdown



Intervention

During the intervention phase, as seen in Figure 1, all five participants acquired the skill with 30 demonstrations of a positive effect with an overall average of 87%. When compared with the baseline average of 40%, the steep upward trend observed in all five participants indicates the effectiveness of video prompting as a teaching tool. Individually, participants 1-5 scored, on average, 83%, 75%, 79%, 100%, and 96%, respectively. Standard procedure, according to the scripts in Appendix G, were followed, with the exception of one non-standard session for two participants. The first intervention session of participant 3 yielded a negative effect score of 11%. At this point, additional teaching occurred, in the form of further explaining to him that he is to copy what the boy does in the video but use the numbers he is given in the story problem. During the second through the seventh intervention sessions, participant 3 scored an average of 90%.

Participant 3 wasn't the only student that needed further instruction on how to solve the problems. During the first intervention session participant 5 scored 77%. After this, the research assistant noted that she "told him to use the numbers in his questions after writing [the] equation wrong." Across the next five intervention sessions participant 5's score was stable at 100%. No other instructions were given to any of the participants during their individual intervention phases. Participant 1 and 2 had a range of 35 and 33 points, while participant 3 had a range of 12 points. Participants 4 and 5 had a range of 0 points even after the initial clarification to participant 5 where he received further direction from the research assistant.

Maintenance

During the maintenance phase, all five participants demonstrated an average of 93% across 26 sessions, which is a 6% increase from the intervention phase (see table 2). Participant 1 increased 11 points after intervention and achieved a stable average of 98% with an overall range of 12. Participant 2 increased 15 points after intervention and achieved a stable average of 90%, resulting in a maintenance range of 12. Participant 3 decreased 2 points after intervention yet achieved a stable average of 77% during the maintenance phase with a range of 34. Participants 4 and 5 achieved stable maintenance scores at 100%, comparable to their intervention scores of 100% and 96%, respectively. When an increase from intervention to maintenance was observed, it appears that when intervention sessions stabilized, the results are comparable to the average maintenance sessions. For example, though participant 2 increased 15 points from intervention to maintenance, the participant's last three intervention and four maintenance session scores were 88%.

Pretest/Posttest

In addition to the single subject, multiple-baseline-across-subjects study, separate pretests and posttests were given to each participant. The tests assessed the students' abilities to find the correct answer for five multiplication equations and five multiplication story problems. The same format of test was used for both assessments. The tests were given before and after collecting baseline, intervention, and maintenance data, ensuring that the scores would be valuable data to show the difference in ability for each student from before and after the study. The average pretest score for the five participants was 22%. The average post test score for the five participants was 52%. In addition, the posttests were given to each participant 6–15 days after the final maintenance probe was collected.

Social Validity

A subjective measure of social validity was collected from the stakeholders to determine how well-received the intervention process was. The participant's and their teachers' answers to the open response questionnaire were analyzed and evaluated to understand the effects the intervention process had on the participating students. When asked, "What did you think about watching the videos on the iPad?" four out of the five participants indicated that they had a positive impression saying, "It was really fun," "It was good," "It showed me examples how to do it," and "I just started to learn more." The one participant that didn't indicate a positive impression of the videos stated, "I don't like the videos. They made no sense to me."

The second question was, "What did you think about watching the videos at school?" Four out of five participants indicated a positive impression giving the following responses: "It was great," "I think it was more so I can get smarter in math," "It was fun," and "I liked watching them at school." The student indicating a negative response said, "I don't watch it at my house," which may indicate he misunderstood the question.

For the third and fourth questions, there were more limited responses. All five participants responded positively to the third question, which was "Would you like watching more videos at school showing you how to do things?" The fourth question was "Who have you told about using the iPad at school?" Four out of five participants responded with "Nobody," And the last participant responded, "Maybe my friends and my family."

On the teacher side of things, two of three teachers returned their social validity questionnaires. The third was not returned due to the teacher's maternity leave. But despite that, both of the other teachers indicated that they believed the students enjoyed watching the videos at school. When the teachers were asked, "What impact did watching the videos have on the performance at school?" They responded that they believed it helped [the students] understand what multiplication means and that their confidence in their ability increased. Both teachers indicated that watching the videos on iPads (Apple Inc., 2011) is something they can see students doing in the future. They mentioned that it could be beneficial and that ". . . we should be using more technology in the classroom." Both teachers believed the intervention was socially acceptable. See Appendix H to see blank versions of both the student and teacher social validity questionnaires.

CHAPTER 5

Discussion

The purpose of the research was to investigate the effects iPad (Apple Inc., 2011) video prompting intervention has on struggling elementary students' ability to acquire and maintain mathematics skills. Once evaluated, data from the study indicated that there was a functional relationship between the independent variable, the effectiveness of the video prompting, and the dependent variable, percent correct based on a scoring rubric. This functional relationship was observed because the dependent variable changed for each participating student when the intervention was introduced to them.

The results of this study were similar to the results found by other video prompting intervention studies that had been successful for participants with an identified disability (Burton et al., 2013; Cihak, 2009; Kellems & Edwards, 2015). Additionally, this study was similar to Schunk and Hanson's (1989) study in that the only qualification for inclusion in the study was for a student to be displaying below grade level ability in mathematics, which was unique from the other studies because they focused on participants with identified disabilities who were receiving special education services. A functional relationship identified in this study is reinforced by other video modeling research specific to students receiving mathematics interventions (Kellems et al., 2016). In addition, the use of iPads (Apple Inc., 2011) in delivering the math intervention supports the existing research (Burton et al., 2013). Lastly, the use of rubrics in determining the dependent variable, or percentage correct, supports the existing research focused on understanding the depth of student understanding, rather than only recording correct or incorrect responses (Bahr, 2007).

This study also attempted to answer the question of whether or not the intervention was successful in helping students solve multiplication story problems. To that end, the data shows that all participants made significant gains in their ability to correctly solve, communicate, and numerically represent multiplication story problems. The average range from baseline to maintenance was a growth of 53%: baseline average was 40%, intervention average was 87% and maintenance average was 93%. Regarding the separate assessment given prior to, and upon completion of the study, the average pretest score was 24%, while the average posttest score was 48%. This study is significant because it demonstrates the effectiveness of video modeling for general education students. Furthermore, it teaches and reinforces the importance of demonstrating understanding, rather than providing a rote answer. This study is also significant because it demonstrates the ability to teach students core content that is considered above their grade level as was demonstrated when the 2nd graders showed gains in 3rd grade content.

In addition, this study attempted to determine the social validity of using video-based instruction to teach mathematics to elementary school students who struggle with mathematics. Social validity is important to determine how well-received the intervention is by the stakeholders. In this case, the elementary school participants and their classroom teachers. To establish the potential social validity of video-based instruction, open response questionnaires were given to the participating students and their teachers. Each participant's answers were analyzed and evaluated to establish the overall perceived effects of the intervention. Overall, the video prompting used in the study was received positively, especially the use of iPads (Apple Inc., 2011) because they make including such video instruction fairly simple for teachers and also easy for students. Given the overwhelming presence of smart devices in the world today, utilizing these devices will be require almost not effort for most students. If the focus remains on struggling students, the social validity of video-based instruction for elementary students will be further established, making potential future integration of such methods far more likely.

This study, and especially the results of this study, are beneficial to the overall literature because it extends the current literature related to video modeling and video prompting in three major ways. First, in the current literature landscape, this is the first study to evaluate the effects of a mathematics video prompting intervention on elementary students identified by teachers to be struggling academically rather than focusing on students with identified disabilities. Second, this research utilizes and adds to the current literature related to using video modeling for the purposes of mathematics-related interventions. And third, this study shows the effectiveness of using a rubric to evaluate the depth of student understanding instead of their ability to only answer questions correctly. The core purpose of the rubric was to allowed students and researchers to look beyond the traditional, rote memorization nature of mathematics instruction and delve further into how a student is communicating, representing, and problem solving when tasked with a multiplication story problem. This is a key shift when looking at video-based instruction because it will help establish students on a foundation of conceptual understanding in mathematics that those students can then apply to later classes and skills.

Once the main phases of the study were finished, the students were able to maintain their performance without access to the video-model intervention, which further demonstrates that the intervention helped establish conceptual understanding rather than procedural understanding in the participating students. These students came into the study with a very low ability to solve the multiplication story problems, and after the substantial growth observed during the baseline and intervention phase, that growth continued to be significant during the maintenance phase. Procedural learning often fails to produce similar learning outcomes, so given the positive results found in this study, it stands to logic that in some ways video-based interventions overcome traditional aspects to mathematics instruction, such as rote memorization, that continue to fail in producing positive learning outcomes. While traditional methods will never completely vanish from the teaching landscapes, if those methods can be paired along with new instruction, the efficacy of our mathematics programs would drastically improve.

Limitations

The study was limited in five main ways. First, the method of coding could have been more uniform. The reliability coder used only the video recordings of the sessions to establish their coding, while the primary observer established codes while watching the participants live, in session. Because of this, the reliability coder would sometimes experience issues understanding a participant's response, which could have been clarified had they been viewing the live session.

The second limitation is that this is the first time this rubric (see Appendix G) has been used to evaluate the depth of understanding in students. The results from this study could inform future forms of the rubric, but because the study used this rubric to better align with the method of video modeling and prompting, the efficacy of the rubric may need to be further tested. While the primary observer trained the reliability coder, clear instances of different interpretations of the rubric arose (e.g., what qualified as a "reasonable strategy"). For example, instances arose where the rubric should have allowed for repeated addition (5+5+5=15) to be considered just as reasonable a strategy as the standard multiplication equation response of 5X3=15, but instead, the rubric failed to allow for a comparable score as the standard response. More explicit explanations for scoring could be adjusted to make the rubric more effective and adaptable to student strategies.

The third limitation relates to the size of the participant pool. Because this study is meant to determine the efficacy of video prompting in mathematics instruction, it inevitably calls into question how these new methods would work with traditional instruction methods. With only five participants and three teachers (one of which was unable to respond to the after study questionnaire) it is possible that these results only tell us the efficacy of the study on these children who are with these teachers. A much more robust, and if possible national, subset of struggling students could help give a more generalized view of the efficacy of video prompting intervention as an instructional method.

The fourth limitation was that the story problem equations only went as high as 6x6=36. The study did not determine if the same intervention could help solve a story problem and/or equation with multiplication factors beyond two, three, four, five, or six. While it may seem logical to assume that such would be the case, it will be up to future research to determine if video intervention works for other mathematics skills and problems.

The fifth limitation is particular to this study. When using a multiple baseline design, the order in which participants receive the intervention is determined by the baseline averages. Based on the design, the student with the lowest baseline percentage should receive the intervention first, and so on. But in this study, the order that participants should have received the intervention was missed. Participant 3 should have received the intervention second, Participant 4 should have received the intervention third and Participant 2 should have received the intervention fourth.

Suggestions for Future Research

Replication of this study would help to validate and strengthen the current research questions, especially if a broader sample of struggling students is used. Additionally, this study could form a foundation to test how effective video modeling/video prompting instruction helps students who don't struggle with the traditional forms of instruction, furthering our ability to teach students a conceptual understanding rather than simply rewarding a student's ability to perform procedural steps.

Also, this study could be used to compare the effectiveness of a video modeling/video prompting intervention in reteaching the concept of multiplication to older children, especially older children that have a proven record of struggling in mathematics. While this study was designed for students ages 6-12 who are not receiving special education services, a study could be conducted to determine the effectiveness of video prompting for an older student population, potentially with updated video models to match the participant population.

Lastly, because a peer model was used for the intervention video, the voiceover work done by the research assistant could have been provided by the model or a similar-aged peer. Perhaps hearing a peer's voice describing the steps needing to solve the problems at hand could have helped participating students to further access the intervention.

Implications for Practice

This research shows that the iPad (Apple Inc., 2011) technology can be used to implement interventions for struggling learners and may be utilized in regular classrooms. Results also demonstrate that video modeling is a useful instructional tool for helping many individuals learn, not just those with an identified disability. Implementing video models in a classroom setting could enable teachers to consistently provide interventions to students as they work more independently, allowing teachers to work on a more one-on-one or small group basis with their students.

Additionally, this research study shows the development of a more conceptual understanding in students identified as struggling in mathematics. The effect of video prompting on students with passable or even accelerated performance is unknown, but because this research provides data showing that this method of instruction works for students other than just those receiving special education services, it is possible it could be extended to classroom use in general rather than only as a method of reteaching or improvement.

Conclusion

With the high number of students who struggle with mathematics, newly identified, evidence-based strategies for teaching and learning math, along with an increase of in-depth of understanding of mathematical concepts, this research is particularly relevant to field of education. The use of video modeling and video prompting in instruction can be both academically and socially valid. The inclusion of a rubric that provides an operational definition of specific criteria relevant to the assessment of deep understanding of mathematical concepts makes the viability of using video prompting as a method of instruction easier to approach by current teachers. Because rubrics are part of many traditional learning methods, combining the traditional with the new, especially with technology added as well, makes for a better step forward towards teaching students in an ever-evolving world.

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APPENDIX A

Teacher Recruitment Script

Teacher Recruitment Script and Consent Form

Introduction

My name is Ryan Kellems, PhD. I work at Brigham Young University. I am conducting a research study about the effects of watching a video on an iPad can have to teach a functional academic skill to elementary students with disabilities or at-risk for failure in math. I am inviting some of your students to take part in this part of the research because his/her feedback is important. I want feedback on the perceived effectiveness and usefulness of the intervention. The research will take place at the school. The research will take about 10 weeks as we, the researchers, collect data. Someone will be observing the student performing the task. Each session should take less than 30 minutes and we will come in about two to three times per week. If you decide you want a student part of the study, here's what will happen:

- We will ask you to view participant selection criteria and identify students that fit the criteria that you believe could benefit from the intervention.

If the student agrees and the parents give permission, the researcher may request verification of their qualification for Special Education services from the Individualized Education Plan (IEP) through the school. Teachers will also identify students at-risk for math failure in the general population for participation.

Procedures

An informal pre-assessment will take place to determine the student's iPad use proficiency as well as understanding of an academic skill needed prior to performing the target skill. Data will be collected on how well the student can navigate the technology as well as answer simple questions about the pre-skill. Baseline observations will occur after the pre-assessment. Baseline observations will last a few weeks with two to three observations per week. Baseline observations will consist of the student being asked to complete a functional academic task on a worksheet. After baseline results have been established, the intervention phase will be introduced. The intervention will consist of the student watching a video on an iPad of someone successfully completing the task. After viewing a step of the task, the student will be asked to perform what he or she saw in the video. This process will continue until all the steps in the task are complete and the final product is obtained. The research will take place in the setting where the task would normally be performed. Observations of the interventions will occur over a few weeks with two to three observations per week. After the intervention phase, students will participate in a maintenance phase, which will occur about two weeks after the intervention phase is finished. Maintenance will involve the student being given a worksheet of academic problems that were similar to the ones they learned from the video model to assess whether or not the effects of the intervention lasted over time. The total time of observations will occur for about ten weeks. All components of the study may be video or voice recorded if consent is given. Your student will be asked to complete a questionnaire with some questions about how well he or she like the videos and if he or she thought it helped him or her complete the identified tasks better. The questionnaire will most likely not take more than 30 minutes to complete. It will be in an open-ended format with space to write or dictate notes. In addition, you will be asked to complete a questionnaire with some questions about how you perceived the effectiveness of instruction via iPads.

Risks/Discomforts

There is no expected risk to you for a student's participation in the study.

Benefits

The child may gain self-awareness of how the study affected him or her. The participant may benefit from being involved in the study and learn a functional academic skill that can potentially help him or her throughout life.

Confidentiality

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. Your identity will be kept confidential. Your name will not be associated in any way with the information collected about you or with the research findings from this study. This information will be used by the investigator for a period of three years from the study's start date. Your permission indicates that this information will be kept open to the investigator for that time period, but your name and any identifying information will not be shared or distributed through this study.

Compensation

There will be no compensation for participation in this project.

<u>Participation</u>

You may refuse to take the questionnaire.

<u>Questions about the Research</u>

If you have any questions, please feel free to contact Ryan Kellems, PhD, (801) 422-6674, 237-C MCKB, Brigham Young University, Provo UT 84602. Questions about your 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.

Statement of Consent

I have read, understood the above consent and desire of my own free will to participate in this study.

Name (Printed): ____________________ Signature: _____________Date: ________________

APPENDIX B

Parent Consent Form

Parental Permission for a Minor

Introduction
My name is Ryan Kellems and I am an assistant professor at Brigham Young University (BYU). I am conducting a research study about the effects watching a video can have on teaching math to students struggling with math. I am inviting your child to take part in the research because (he/she) could benefit from the instruction.

Procedures
If you agree to let your child participate in this research study, the following will occur:
Pre-Assessment
There will be a pre-assessment to determine their current math ability.
Baseline
Baseline observations will occur for two to three observations per week. The researcher will ask your child to perform a task he or she may not have been taught yet. These observations may be recorded if prior consent is given by you.
Intervention
The intervention phase will involve your child watching a video of someone successfully performing the academic skill. They may watch the video in steps. After each step, your child will be asked to perform what he or she saw in the video. The research will take place in the setting where similar academic tasks are usually performed. Your child will be receiving the intervention in math class because your child will be learning a math skill. Observations, such as in the classroom or library, will occur for a few weeks with two or three observations per week.
Maintenance
Maintenance observations will occur about three weeks after the last intervention observation occurs. The maintenance phase will only consist of three to five sessions. Maintenance will involve the student being given a worksheet of academic problems that were similar to the ones they learned from the video model to assess whether or not your child can complete the math problems without the video.
The study will take approximately ten weeks to complete. The observations may be video taped for the researchers to review. The videos will only be used for purposes consented to on the video consent document.
Questionnaire
After the intervention, the students will answer a questionnaire asking about his/her thoughts and feelings about the intervention.

Risks
If you agree to have your child participate in this study, there may be some slight anxiety involved when a researcher observes your child. Additionally, your child may also feel discomfort or embarrassment about performing a task after having watched it on the iPad.

Preparation on how to use the iPad should minimize the risks associated with the intervention. Your child will be told that if he or she does not want to participate in the study for any reason, he or she can let us know and the study with your child will be stopped.

Confidentiality

Any information that is obtained in connection with this study and can be identified with your child will remain confidential and disclosed only with your permission. Your child's identity will be kept confidential. Any write-up or published material about the findings of the study will use a pseudonym for your child. Your child's name will not be associated in any way with the information collected from the study. The researchers will not share information about your child unless required by law or unless you give permission. Electronic information will be stored on a password-protected computer and paper information will be stored in a locked office.

Benefits

Your child can benefit from participating in the study by learning a functional math skill that can help him or her throughout life. However, benefits are not guaranteed.

Compensation

There will be no compensation for participation in this project.

Questions about the Research

Please direct any further questions about the study to Ryan Kellems at (801) 422-6674, 237-C MCKB, Brigham Young University, Provo, UT 84602.
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 your child's participation at any point without penalty. If you choose to allow your child to participate, please fill out the information below.

Child's Name: ______________________________

Parent Name: ____________________ Signature: ___________________ Date: ____________

APPENDIX C

Child Assent Script

Child Assent (7-14 years old)

What is this research about?
My name is Melissa Steinberg and I am a graduate student at BYU. 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 how to help you learn skills by watching a video on an iPad. You are being asked to join the study because we think you can learn from using an iPad.

If you decide you want to be in this study, this is what will happen:
- We will ask you to try to do a skill that you may not have learned before. It is okay if you cannot do it. We just want you to try. You will only be asked to do a few questions each time we come.

-We will show you a video about how to do what we are asking you. You will watch and listen to the video and then try to do what you have seen. It will only take 30 minutes or less. We will come back a few times and do the same thing.

- You may be recorded if you provide permission.

- After the process is finished, we will ask you to answer a few questions about your thoughts and feelings about the study.

Can anything bad happen to me?
There may be some discomfort or embarrassment when we ask you to do what you have watched on a video. If you do not want to do what we ask you to do, let us know and you can stop.

Can anything good happen to me?
We hope that you will be able to learn a great skill from watching the video that will help you throughout your life.

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 happens if I get hurt?
We talked to your parent(s) before the study. If you get hurt, they will know what to do.

<u>What if I do not want to do this?</u>
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.

Before you say yes to be in this study; be sure to ask Melissa to tell you more about anything that you don't understand.

If you want to be in this study, please sign and print your name.

Name (Printed): ____________________ Signature: __________________ Date: ______

APPENDIX D

Task Cards

(1) I have 6 plates. There are 6 cookies on each plate. How many cookies do I have in all?	(2) I have 5 bags. There are 6 balls in each bag. How many balls do I have in all?	(3) There are 5 houses. There are 5 people in each house. How many people are there in all?
(4) I have 6 cows. Each cow has 5 spots. How many spots are there in all?	(5) I have 6 books. Each book has 3 pictures. How many pictures are there in all?	(6) I have 3 boxes. Each box has 6 crayons. How many crayons are there in all?
(7) I have 6 bowls. There are 6 apples in each bowl. How many apples are there in all?	(8) I have 6 cats. Each cat has 4 paws. How many paws are there in all?	(9) I have 4 dogs. Each dog has 6 bones. How many bones are there in all?

(10) I have 2 cars. Each car has 4 wheels. How many wheels are there in all?	(11) I have 4 cookies. Each cookie has 2 chocolate chips. How many chocolate chips are there in all?	(12) I have 4 ice cream cones. Each cone has 2 scoops of ice cream. How many scoops are there in all?
(13) I have 5 drinks. Each drink has 2 straws. How many straws are there in all?	(14) I have 5 dolls. Each doll has 2 arms. How many arms are there in all?	(15) I have 2 shirts. Each shirt has 5 holes. How many holes are there in all?
(16) I have 2 bags. Each bag has 5 brownies. How many brownies are there in all?	(17) I have 3 bags. Each bag has 4 M&Ms. How many M&Ms are there in all?	(18) I have 3 boxes. Each box has 4 toys. How many toys are there in all?

(19) I have 4 cats. Each cat has 3 stripes. How many stripes are there in all?	(20) I have 4 jars. Each jar has 3 candies. How many candies are there in all?	(21) I have 3 buckets. Each bucket has 5 baseballs. How many baseballs are there in all?
(22) I have 3 babies. Each baby has 5 blankets. How many blankets are there in all?	(23) I have 5 birds. Each bird has 3 babies. How many babies are there in all?	(24) I have 5 sharks. Each shark has 3 teeth. How many teeth are there in all?
(25) I have 4 backpacks. Each backpack has 4 books. How many books are there in all?	(26) I have 4 presents. Each present has 4 bows. How many bows are there in all?	(27) I have 4 horses. Each horse has 4 legs. How many legs are there in all?

(28) I have 4 friends. Each friend has 4 toys. How many toys are there in all?	(30) I have 4 rings. Each ring has 5 diamonds. How many diamonds are there in all?	(31) I have 4 bags. Each bag has 5 suckers. How many suckers are there in all?
(32) I have 5 monkeys. Each monkey has 4 bananas. How many bananas are there in all?	(33) I have 5 trees. Each tree has 4 branches. How many branches are there in all?	(34) I have 5 bowls. Each bowl has 5 fish. How many fish are there in all?

APPENDIX E

Thesis Training Script

Pre-Training

"I'm going to show you a video on this app."

"This app is called Video Tote."

"I'm going to push it." (Push the application icon)

Show brushing teeth. Train to push "ON" "You have to push it every time." "I'm going to listen to it, and every time it stops and it tells me to do something, I'm going to do that thing. Just watch me." "When it stops, pretend and do what it tells you to do." Show how to watch it again. "Back, then play to play it again if I forgot." "It stopped. Do what it asked you to do, push play again." "Put down the toothpaste. Watch it again." "Every time it stops, it tells me what I'm supposed to do." "If I want to watch it again, I push back to watch it again." "See those lines? It will stop in certain spots for you. You don't need to push pause."

The participants were then instructed to practice using the app by following the directions for a different video. The specific task practiced by the students was peeling a banana and cutting it.

Practice "What do you do first?" (Push Chapters On) Have the kids follow the video by cutting the banana. Prompt, "Then what?" If they stop. "What do you do if you need to watch a step again?" "What do you do if you want to watch the whole video again?"

The students were then instructed to watch the actual video.

Real Video "The video you're going to watch is right here, but I'm going to read you your problem first so you can think about it." Read problem.

Place card at the top of paper.

“I will read this to you as many times as you need.”

“Go ahead and click video. What do you do first?” (Click Chapters ON)

APPENDIX F

iMath Asessment Story Problems

iMath Assessment

Name_________________________________ Date____________________ Participant _______________3.OA.A.1

(1) There are 6 elephants. Each elephant has 4 legs. How many legs are there in all?
(2) There are 3 giraffes. Each giraffe has 4 spots. How many spots are there in all?
(3) I have 5 vases. Each vase has 6 flowers. How many flowers are there in all?
(4) I have 5 fish. Each fish has 4 fins. How many fins are there in all?
(5)

I have 3 jars. Each jar has 6 gumballs. How many gumballs are there in all?
(6) 3 X 5 =
(7) 6 X 2 =
(8) 6 X 6 =
(9) 4 X 2 =
(10) 4 X 4 =

APPENDIX G

Rubric

Rubric Level	Problem Solving	Communicating	Representing with Numbers
3	**3** Reasonable strategy and correct answer	**3** Can clearly explain all that he or she did, regardless of the correctness of the answer.	**3** Both factors product X with or without = sensible order
2	**2** Reasonable strategy and incorrect answer OR Correct answer and no reasonable strategy	**2** Can clearly explain most that he or she did, regardless of the correctness of the answer. (More than half)	**2** 3 of the 4
1	**1** Neither correct answer nor reasonable strategy	**1** Can clearly explain some that he or she did, regardless of the correctness of the answer. (Less than half)	**1** 2 of the 4
0	**0** No attempt/ "I don't know"	**0** No attempt/ "I don't know"	**0** 1 of 4 or no attempt

APPENDIX H

Social Validity Questionnaires

Participant Social Validity Questionnaire

Participant #________________

Please answer these questions about the videos you watched. You can choose to write your answers or say them out loud.

1. What did you think about watching the videos on the iPad?

2. What did you think about watching the videos at school?

3. Would you like watching more videos at school showing you how to do things?

4. Who have you told about using the iPad at school?

Teacher Social Validity Questionnaire

Please answer these questions about the videos the participant watched on the iPad

1. How do you think they enjoyed watching the videos on the iPad?

2. What do you think they thought about using the iPad while they were at school?

3. What impact did watching the videos have on their performance at school?

4. Is this something you can see them using in the future? Why or why not?

5. Was it socially acceptable for them to watch the videos while they were at school?