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Point of View Video Modeling to Teach Simplifying Fractions to Middle School Students With Mathematical Learning Disabilities

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Students with mathematics learning disabilities (MLD) often require more intensive intervention in addition to quality core mathematics instruction. This research evaluates the effects of a point of view video modeling (POVM) intervention including virtual demonstrating of concrete mathematics manipulatives to teach simplifying fractions. Three students receiving educational services for MLD participated in the study. This study employed a single-case multiple probe across subjects experimental design with visual analysis as the primary method of data analysis. To evaluate effects of the intervention, Tau-U was calculated. Intervention Tau-U was calculated at 1 for two students and at 0.80 for the third student. All three students favorably maintained the skills after the completion of the intervention (n = 2, 100%; n = 1, 80%), however, performance decreased when transferring skills to word problems (n = 2, 40%; n = 1, 0%). Overall, the intervention appeared to be effective to teach.

Keywords: **Math, Fractions, Video Modeling, Learning Disabilities, AHDH, Visual Representations, CRA**

Introduction

Many students with disabilities experience early and persistent challenges in mathematics (Bailey, Hoard, Nugent, & Geary, 2012; National Mathematics Advisor Panel [NMAP], 2008). In the United States (US), results from the National Assessment of Educational Progress (NAEP; 2017) indicated that only 38% of students without disabilities were at or above the proficient level on mathematics measures and this number dropped to an alarming 9% for students with disabilities. It has been estimated that 5-8% of students have mathematical learning disabilities ([MLD]; Geary, 2004). Researchers have attributed challenges with mathematics to several contributors, such as attentive behavior, language nonverbal reasoning, working memory, and mathematics-specific skills (Jordan, Hansen, Fuchs, Siegler, Gersten, & Micklos, 2013). In addition, it is widely recognized that students with disabilities may demonstrate metacognitive discrepancies, informational processing challenges, and weaknesses with self-regulation that may negatively impact mathematics performance. Though proficiency across mathematics domains is important, researchers have called more specific emphasis to rational numbers as a critical component of success (e.g., Siegler et al., 2012). By fifth grade, fraction knowledge may distinguish US students with a MLD from those who demonstrate low achievement (Mazzocco, Myers, Lewis, Hanich, & Murphy, 2013), and many young US students with mathematics difficulties demonstrate less fraction understanding than international peers with mathematics difficulties (Tian & Siegler, 2017).

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Fractions and Rational Number Systems

The importance of understanding how rational number systems operate cannot be overstated. Fraction knowledge is longitudinally linked to improved outcomes in algebra and advanced mathematics (NMAP, 2008; Siegler et al., 2012) as well as long-term success beyond school (NMAP, 2008). The Common Core State Standards in Mathematics (CCSS-M) call to attention the importance of depth of knowledge in mathematics, including conceptual and procedural knowledge, and highlight the importance of understanding fractions. Across the scope of CCSS-M, numbers and operations involving fractions are introduced in third grade, yet many students still present difficulty with fractions well into middle school years and beyond (e.g., Siegler et al., 2012; Zhang, Stecker, Huckabee, & Miller, 2014). The concepts of rational numbers present unique challenges to students (Bottge, Ma, Gassaway, Butler, & Toland, 2014; Mazzocco et al., 2013; Sanders, Riccomini, & Witzel, 2005) and are compounded for students with MLDs. Solving equations with rational numbers requires students to understand all fractions have a magnitude and follow properties unique to rational numbers (e.g., Torbeyns, Schneider, Xin, & Siegler, 2015). The relationship between the numerator and denominator presents a single magnitude (e.g., communicated by a single location on the number line), yet the numerals used to communicate the magnitude changes (e.g., $\frac{4}{8}$ is equivalent to $\frac{1}{2}$). Many students with mathematics difficulties find fraction comparison and equivalence especially difficult (Hansen, Jordan, & Rodrigues, 2017).

Educators face significant challenges meeting the learning needs of diverse students in general and special education classroom settings. When students experience acute and chronic challenges learning mathematics, additional supports and more intense interventions are required to better support learning acquisition and mastery (NCTM, 2011). Fuchs, Fuchs, and Malone (2017) address the need to intensify intervention for students with whom current instruction does not satisfy learning needs. For students who have similar skill mastery needs, it may be beneficial to intensify interventions to better support students' individual instructional needs while meeting their collective academic needs and improving outcomes. In a synthesis of literature, Shin and Bryant (2015) determined that intensive interventions composed of evidence-based instructional components are effective to support improved student performance on fraction measures.

Multiple Representations to Teach Mathematics

Researchers have utilized visual and multiple representations to teach mathematics, including fractions. NMAP (2008) recognized visual and multiple representations as an instructional approach to teach students with mathematics disabilities. Visual representations may be concrete (i.e., mathematics manipulatives) or semi-concrete (i.e., drawing representations), but essentially present a visual depiction of an abstract mathematics concept. Embedding visual representations and concrete manipulation during conceptual development allows students to more deeply develop an understanding of the mathematical concepts that may support skill acquisition and maintenance (Hughes et al., 2018). A popular approach to sequential visual representations in mathematics is the concrete-representational-abstract (CRA) sequence, where students bridge concrete representations to abstract communications with the representations of the skill using semi-concrete, or visual drawings, of the mathematics concept. CRA has been successfully used to teach students about fractions (Hughes, Riccomini, &Witzel, 2018; Butler, Miller, Crehan, Babbitt, & Pierce, 2003) as well as future topics that integrate fractions, such as algebra (Witzel, Mercer, & Miller, 2003). Some challenges encountered by teachers using CRA may include time required to present and practice skills at each phase of the instruction as well as differential dosage required by students in each of these phases. Researchers have explored other ways to support systematic visual representations during mathematics instruction, such as incorporating technology to use virtual manipulatives. Utilizing virtual manipulatives, visual images within technology that students can move as learning concepts, have resulted in positive, albeit mixed results (e.g., Shin & Bryant, 2015; 2016).

Video-Based Instruction

Advancements and availability of technology have resulted in widespread use of hand-held and table-top technologies to support intervention intensity for students with disabilities. One such practice that has an evidence base with diverse learners with exceptionalities is video-based instruction (VBI). VBI is used as an overarching term that encompasses variations of video modeling, where a skill or behavior is taught via video demonstration. Unlike instruction in real time, video of instruction can be edited for instructional precision, paused for learner processing time, and re-watched for consistent demonstration of a skill, thus allowing the intensity of the intervention to be differentiated for individual learning needs. The video provides a permanent resource that can be used over and over and to address needs of multiple students at the same time and reused to provide conspicuous review of skills. VBIs have evidence supporting use to teach mathematics with various exceptionalities. Cihak and Bowlin (2009) taught geometry skills to high school students with learning disabilities via video modeling. Most mathematics VBI research comes from the fields of autism spectrum disorders (ASD). For example, Kellems et al. (2016) taught adults with ASD to solve multi-step mathematics equations, and Burton, Anderson, Prater, and Dyches (2013) taught students with ASD and intellectual disabilities money estimation skills.

While different types of VBI have demonstrated to be effective (e.g., video modeling, self-video modeling, video prompting), point-of-view video modeling (POVM) may lend itself to effectively teaching mathematics skills (e.g., Yakubova, Hughes, & Shinaberry, 2016), as the focal point of the video is exemplary performance of the targeted skill. In POVM, the video is recorded from first-person point of view and usually shows a model's hands performing the skill accompanied by audio of explicit and metacognitive instruction. The concentrated video aims to minimize external stimuli that interfere with instruction (Hughes & Yakubova, 2016). Yakubova, Hughes, and Hornberger (2015) used POVM to teach word problems involving subtracting fractions with unlike denominators to adolescent students with ASD. In their study, they provided virtual modeling using concrete mathematics manipulatives.

The Present Study

This study aimed to extend the use of VBI to teach mathematics to students with MLDs. The instruction was anchored in use of concrete representations to model conceptual understanding of simplifying fractions. The video presentation of the instruction via POVM allows for development of procedural knowledge as students view instruction of problem-solving steps. Several questions guided the design of the present study, including: (a) Will this intervention improve the ability to simplify fractions, and if so, (b) will this acquired skill also be maintained and perhaps even transfer to word problems? Secondarily, (c) could analyses of error patterns reveal specific forms of cognitive misunderstanding of fractions? And (d) will students enjoy this kind of intervention and judge it to be of value for learning mathematics?

Method

Design

This study employed a single-case multiple probe across subjects experimental design (Horner & Baer, 1978) to evaluate the effectiveness of a video-modeling intervention to teach simplifying fractions to students with disabilities impacting mathematics. Data were collected to evaluate acquisition and maintenance of targeted skills as well as generalization to word problems that presented a situation where fractions needed to be simplified. This particular design allowed for replication of the intervention effects at three different time points and the possibility of determining a functional relation between the independent and dependent variables (Gast & Ledford, 2018).

Visual analysis, commonly used in single-case experimental design, was the primary method of data analysis (Kratochwill et al., 2013). A four-step process was implemented to evaluate potential functional relation. First, the baseline data were evaluated for pattern and stability. Next, data were evaluated for within-phase level, trend, and variability (i.e., consistency of data path). Then, between phase data were evaluated for overlap, immediacy of effect, and consistency of data. A vertical analysis was also conducted to confirm that the manipulation of the independent variable was responsible for increases in the dependent variable. Lastly, information from the first three steps was integrated to determine existence of a functional relation and strength of evidence. To evaluate effects of the intervention, Tau-*U* was calculated. Tau-*U* is a preferred nonparametric quantitative approach to analyze data from single case experimental design (Lee & Chemey, 2018). Tau-*U* combines non-overlap between phases with intervention phase trend and has the ability to control for baseline trends. An online calculator (www.singlecaseresearch.org; Vannest, Parker, Gonen, & Adiguzel, 2016) was used to determine Tau-*U*. Results closer to 1 indicate stronger effects.

To obtain an understanding of fluctuation of performance, a post-hoc error analyses was conducted. Problems missed during the intervention phase were evaluated to determine type of errors. Error types were then evaluated to determine if students demonstrated patterns of errors.

Setting and Participants

The study took place in a middle-grades public charter school in a northeastern state in the US. The school serves students from fifth to eighth grades. The school enrolls approximately 90 students per school year, with the majority of students identifying as Caucasian.

To participate in the study, the author contacted the resource room teachers at the school to identify students who may need additional mathematics instruction to support learning and achievement for students with MLD. In the US, many states categorically identify students who qualify for special education services, however, qualification for some high-incident disabilities such as learning disabilities include elements of professional judgment and subjectivity that may result in differential identification across US states, districts, and even schools. MLDs, characterized by failure to make academic progress in mathematics may co-occur with different disability identifications. For these reasons, in this study, students with MLDs are defined as students with mathematics individualized education program (IEP) goals who require more specialized and intensive interventions in mathematics. The author sent letters home to parents of students with MLDs identified as needing additional mathematics academic support. The additional instruction took place in the after-school program. When students were not actively participating in data collection, the author tutored the students by providing homework help. This served multiple purposes. First, the researcher was able to provide academic support to students, even when they were not receiving the targeted POVM instruction. Second, the researcher was able to monitor in class work to ensure the fraction intervention did not overlap with core instruction. Four students were identified and initially had permission to participate in the study. Prior to baseline data collection, the researcher assessed current performance in mathematics to target grade-level skills that the students had not yet mastered. All four students demonstrated significant deficits with simplifying fractions, therefore, it was determined that it was an appropriate skill to target. Due to scheduling changes, one student was not able to participate in the study past baseline data collection. Three students continued to participate in the research.

Amelia. Amelia (pseudonym) was a Caucasian female fifth grader who qualified for special education services under the primary diagnosis of a specific learning disability. In accordance with her IEP, she received services for reading and mathematics. Her mathematics instruction took place in a resource room setting. She was 11 years old at the time of the research. She disliked mathematics and was unsure of her mathematics abilities, but was motivated to complete her work. At the beginning of the study, she used a multiplication sheet to help her with her basic and extended mathematics computation facts on homework. She did not use the mathematics facts sheet during the intervention.

Bella. Bella (pseudonym) was a Caucasian female fifth grader. She received special education services for mathematics in a resource room setting. Bella qualified for special education services under the primary category of Other Health Impairment (OHI), and it was noted in her records that she was diagnosed with attention deficit and hyper activity disorder (ADHD). Bella was aware of what others were doing around her and was eager to help her peers (e.g., find a sharpened pencil). She was comfortable solving problems using algorithms and appeared to work best when consistently presented with the same problem solving strategies until mastery. When she was expected to demonstrate several ways to solve a problem type (e.g., long division), she appeared to make several errors and became frustrated. For example, during tutoring homework help, Bella accurately solved long division problems using the traditional algorithm (with minor mathematics fact errors). After Bella was taught to divide using partial quotients in her mathematics class she demonstrated signs of frustration and made additional errors by applying parts of each way to solve the division problem.

Cora. Cora (pseudonym) was a Caucasian female eighth grader who qualified for special education services with a primary diagnosis of mild ASD and a secondary diagnosis of ADHD. She was recognized by the school as having a MLD, and her performance in mathematics class indicated she had significant gaps in mathematics knowledge. She received special education services for mathematics in a resource room. She was willing to participate in the project, but not interested in mathematics and left the tutoring sessions once she was done with her tasks.

Independent Variable

The independent variable was POVM, where the model's hands were visible completing the targeted task while the model narrated the video by explicitly annotating the instruction. During this time, the narrator demonstrated how to simplify two different fractions ($\frac{4}{12}$ and $\frac{6}{8}$) using easily accessible mathematics manipulatives (i.e., craft pom-poms). The model demonstrated how to group the numerator and denominator in groups with the greatest value where both the numerator and denominator have the same number in each group. This visually represented finding the greatest common factor. As an example, the fraction $\frac{4}{12}$ the manipulatives used for both the numerator and denominator can be grouped into groups of four, creating one group of four in the numerator and three groups of four in the denominator, or $\frac{1}{3}$. In the example for $\frac{6}{8}$, the model first provided a non-example by grouping the numerator and denominator by three and demonstrating self-talk about how eight could not evenly divide into groups of three, so the model had to try a different grouping number. Then, the model demonstrated the correct way to do the problem, yielding the fraction $\frac{3}{4}$. The video concluded by telling the viewer that the viewer would work on similar problems independently. The video lasted 3 minutes 22 seconds. See Figure 1 for a screenshot of the intervention video.

Figure 1. **Screenshot of Intervention. Figure from video with model's hand pointing to mathematics manipulatives.**

Dependent Variable

The dependent variable was a measure that listed five fractions, with values less than one, that were not in simplest form. Fractions for each measure were randomly selected from a master list. While the difficulty of simplifying the fractions varied (e.g., $\frac{2}{4}$ is less challenging; $\frac{12}{16}$ is more challenging) visual inspection suggested that there were no major differences in the overall challenge of the measures. Students were given a dry-erase board and marker as well as mathematics manipulatives modeled in the video, to use during the intervention. Students were also given pencil and paper if they elected to use that to support their work.

General Procedures

The intervention took place in an hour-long, after-school tutoring program. After time required to complete baseline or intervention activities, the researcher provided homework help with formative homework feedback and supplemental skill support on skills not related to the intervention (e.g., long division).

Baseline. During baseline, students were given the worksheet with directions to simplify the fractions and told by the researcher to, "Please simplify each fraction to the lowest term." Students were given unlimited time to complete the baseline assessments. All baseline assessments were completed in less than 5 minutes.

Intervention. Students were given a laptop connected to headphones and the dependent variable fractions measure. The video was preloaded on the laptop and students started and stopped the intervention independently. After watching the video, students completed the fractions measure independently. Sessions were monitored by the author to ensure videos were viewed in their entirety.

Maintenance and generalization. At least two weeks after completion of the intervention, students were given a maintenance assessment. Maintenance assessments were given every few weeks, as time and schedules allowed. Students were given one generalization measure, which required they read and solve a word problem involving simplifying fractions. Upon request, problems were read aloud to the students to mitigate reading difficulties.

Interrater agreement

Dependent variable measures were rescored (30%) by a research assistant. The dependent variable was scored item-by-item. Agreement was calculated as number of responses agreed upon divided by the number of responses agreed upon and disagreed upon. Interrater agreement was determined to be > 99%. Field notes were evaluated for fidelity of treatment.

Social Validity

Upon conclusion of the intervention phase, students responded to a semi-structured interview that was conducted as a small group. As part of the interview, the researcher asked pre-formulated questions, which included (a) did you like watching the video to learn how to simplify fractions? (b) would you want to use videos to help you learn math in the future? and (c) what didn't you like about the video instruction? Based on their responses, the researcher asked follow-up questions for more information or clarification of the original response.

Results

Visual analysis and Tau-*U* were conducted to determine possibility of a functional relation and effects of the intervention. Weighted Tau-*U* across students was calculated at .93 for the intervention phase. See Figure 2 for graphed data.

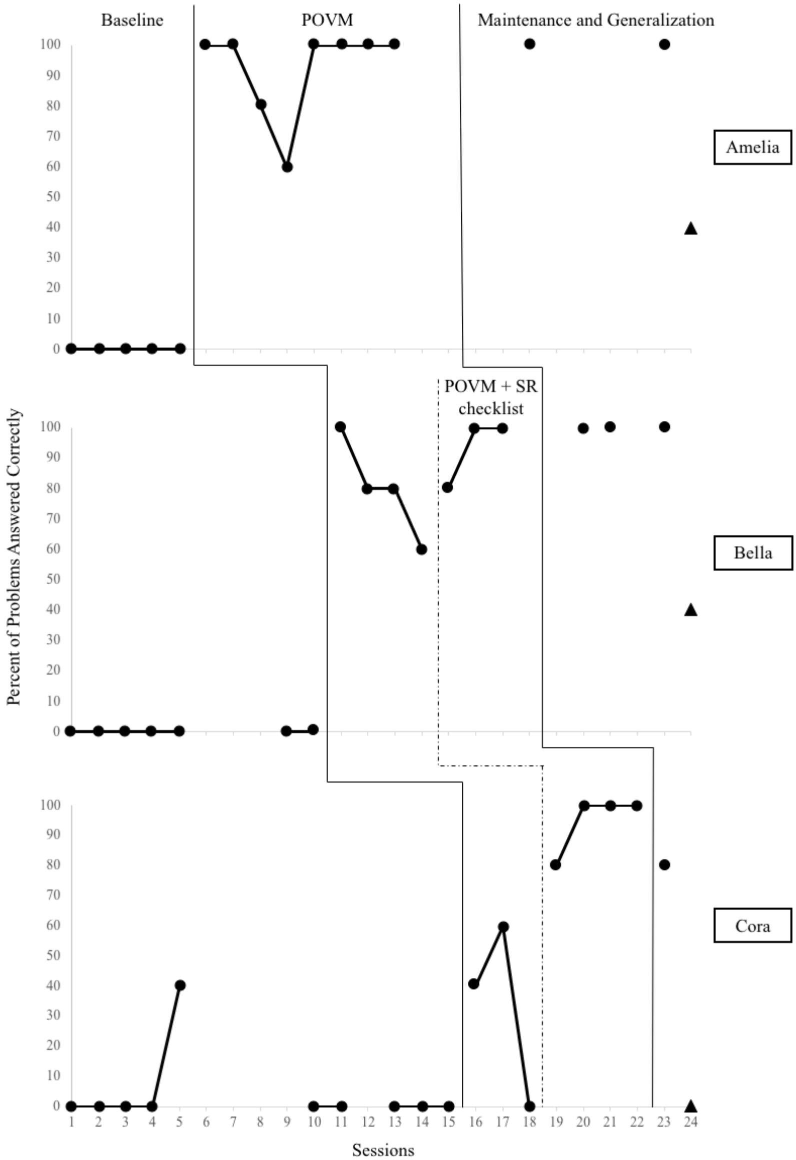

Figure 2. **Graphed data across participants. POVM = point-of-view video model, POVM + SR = point-of-view video model and self-regulation checklist, = probes, = generalization probes.**

Amelia

During the baseline period, Amelia consistently scored 0 on assessments, resulting in a 0% mean response accuracy. Her baseline was a low and stable trend. Upon implementation of the intervention, Amelia's score immediately increased to 100%. Her intervention mean was 90%, resulting in a mean level change of 90% from baseline to intervention. Tau-*U* was calculated at 1. Maintenance data points were collected four and eight weeks after completion of the intervention, with both scores at 100%. A generalization assessment was given nine weeks after the completion of the intervention, yielding a score of 40%.

Amelia missed three problems across the intervention period. For two problems, she simplified the fraction correctly, but did not simplify it to its lowest term. One error was unidentifiable, but perhaps was a result of the numerator and denominator being divided by different numbers($\frac{24}{28} = \frac{6}{4}$).

Bella

During the baseline period, Bella consistently scored 0 on assessments, resulting in a 0% mean response accuracy. Her baseline was a low and stable trend. Upon implementation of the intervention, Bella's score immediately increased to 100%. Across the first four sessions into the intervention, Bella's performance score began to decrease. Error analysis showed that Bella was accurately simplifying the fractions, but not to the lowest terms. A checklist reminding Bella to check her work was instituted during the fifth session, resulting in immediate improvement. Her intervention mean was 85.7%, resulting in a mean level change of 85.7% from baseline to intervention. Tau-*U* for the intervention was calculated at 1. Two maintenance data points were collected three weeks after completion of the intervention, with both scores at 100%. Bella was not given the behavior checklist during the maintenance phase. A generalization assessment was given three weeks after the completion of the intervention, yielding a score of 40%. An example of Bella's work is shared in Figure 3.

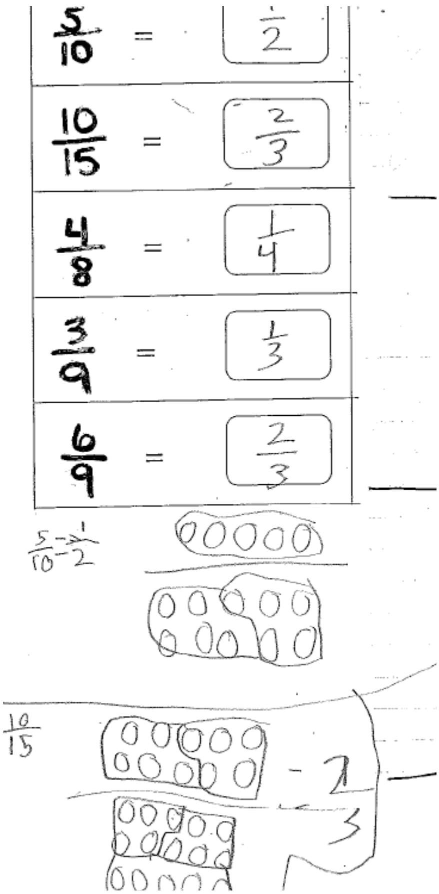

Figure 3. **Sample of Bella's work, including use of representational illustrations to simplify the fractions.**

Bella made six errors across the intervention phase of the study. For four problems, Bella simplified the fractions, but did not simplify to the lowest terms. One of the errors also included a translation error (i.e., flipping the numerator and denominator). Two errors were unidentifiable (e.g., $\frac{4}{10} = \frac{1}{3}$).

Cora

Cora's first four baseline data were consistent at 0% correct. For the fifth baseline, Cora correctly answered two of the five problems, resulting in a score of 40%. The next six baseline points were each 0% correct. Her mean baseline response accuracy was 3.6%. Her baseline was a low and stable trend, with one outlier. Upon implementation of the intervention, Cora's scores gradually increased. On the third day of the intervention, Cora willingly worked with the researcher, but expressed her disinterest in the activity by writing answers on the assessment without attempting to solve the problem. This resulted in a score of 0. Prior to the start of the fourth intervention session, the researcher asked Cora to try her best during sessions. The researcher introduced the checklist behavioral support. This resulted in an immediate increase to 80% accuracy. Her intervention mean was 63%, resulting in a mean level change of 59% from baseline to intervention. Tau-*U* for the intervention was calculated at .80. One maintenance data point was collected two weeks after completion of the intervention, with a score of 80%. A generalization assessment was given one week after the completion of the intervention, yielding a score of 0%.

Cora made 11 errors during the intervention phase of the study. On one problem, she simplified the answer, but did not simplify it to lowest terms. Cora made division errors on two problems. The rest of Cora's errors were random and unidentifiable. On the 18th session, Cora received a 0/5. All of her answers were unidentifiable (e.g., $\frac{7}{14} = -\frac{9}{4}$) and followed no error pattern because she just wrote any answer.

Social Validity

Social validity was collected in a semi-structured interview. First, students were asked if they liked watching the videos to learn how to simplify fractions. All three students communicated that they liked the intervention. When asked why, they shared that the video was "organized," "easy to understand," and presented and explained in a way that "was easy to learn." These elements are not surprisingly characteristic of explicit instruction expressed in their own words. All three students communicated that, if given the opportunity, they would like to use videos again to help them learn math. When asked what they didn't like about the video or intervention, all of the students agreed that they felt like they had to watch the video too many times. During the interview, Amelia shared that she liked watching the video because, "now I know how to simplify fractions," at which point the other two chimed in with agreement.

Discussion

When core instruction is not enough to address skill deficits of students with MLD, more intensive interventions are required to support student learning (L. S. Fuchs et al., 2017). Fraction interventions with strong instructional components may be used to help improve achievement of students with mathematics difficulties (Shin

& Bryant, 2015). The intervention evaluated in this study combined video-based explicit instruction with concrete and visual representations to teach concepts and procedures for simplifying fractions. Omnibus Tau-*U* indicated that the intervention was indeed effective. As teachers have students with individual learning needs, but similar skill gaps, it is important for teachers to have access to interventions that meet the instructional needs across individual learners. The intervention incorporated two evidence-based instructional components that have history of evidence for students with disabilities in a packaged intervention that is versatile, practical, and utilizable in heterogeneous educational settings. The POVM incorporated systematical and explicit instruction coupled with concrete manipulations of the mathematical skill.

All three students not only demonstrated mastery of the skill, but also maintained the skill several weeks after the intervention ended. Consistent mastery performance on delayed outcomes are important, as understanding fractions is foundational for future success in mathematics (Siegler et al., 2012). These findings suggest that students mastered the skill and complement previous work supporting that concrete representations support long-term understanding of fractions (Hughes et al., 2018). Due to time restraints, this intervention did not include a semi-concrete component to instruction, which differentiates this research from previous studies evaluating the entire CRA sequence (e.g., Witzel et al., 2003; Yakubova et al., 2016). Researcher field notes indicate Amelia and Bella self-initiated this step by drawing the pictures instead of using the manipulatives. These actions were unprompted by the researcher, but field notes documented that Amelia and Bella were highly motivated by using the dry erase boards and markers provide by the researcher, which might have contributed to this natural bridge, as they wanted to draw the pictures instead of using the manipulatives provided. Cora elected to use the manipulatives during the intervention phase.

Visual analysis and Tau-*U* communicated the impact and collective effects of the intervention on mathematics performance, but did not fully communicate the variability of performance on mathematics outcomes within the intervention phase. While the intervention has evidence to support effects across students, students responded to the intervention in different ways. Attentive behaviors uniquely contribute to students' success learning fractions (Jordan et al., 2013), and the academic-focused instruction was not enough for two students (i.e., Bella and Cora). A self-regulation component needed to be added to increase the intensity of the intervention for both of these students. The researcher needed to add a check-list to help the students self-regulate their academic-related behavior during the video intervention. Once this self-regulating behavioral support was in place, Bella's and Cora's performances improved. These findings complement the work of King, Radley, Jenson, Clark, and O'Neill (2014) who utilized self-video modeling coupled with self-monitoring as a behavioral intervention for on-time task during independent mathematics work.

This research design followed a system of least prompts, where self-regulating supports were only put in place after it was determined that there was a need for the more intensive support. Recognizing that students' individual differences related to their disability may necessitate behavioral supports, future research may evaluate initial support of a self-regulating checklist and fade supports as students demonstrate mastery of the skill. L. S. Fuchs et al. (2017) recognize behavioral supports as a key dimension to intervention intensity. Accordingly, interventions that incorporate self-regulation components, such as the checklist accompanying the VBI, are more intensive than programs without such components. Even though the academic components were the same, Bella and Cora required a more intensive intervention than Amelia, which necessitated a checklist to support Bella's and Cora's self-regulation.

Teachers orchestrate instruction in complex educational settings. In a classroom, VBI may be able to supplement teacher instruction, as it can be individualized based on student need to master requisite skills, and students can access video instruction independently and repeatedly as needed. Findings from this study add to evidence for use to support learning in academic areas (e.g., Decker & Buggey, 2014) and specifically to teach mathematics (e.g., Cihak & Bowlin, 2009). The ease to create the video and make it accessible to students with relatively basic technology may make it accessible to teachers, but the implementation of VBI in this study did not afford for immediate feedback.

Error analysis indicated that many errors did not follow a logical pattern of cognitive misunderstanding of fractions, especially for Cora. For the first two students, the most common error was not simplifying the fractions to the lowest term. It is primarily important to note that Amelia and Bella demonstrated a basic understanding of fraction equivalency- as they wrote an equivalent fraction as an answer; however, the error occurred as they did not solve the problem to find the fraction in simplest form. First, the students may have made the error in not finding or recognizing the *greatest common factor*. As Amelia and Bella were building conceptual understanding of simplifying fractions, they found a common factor and simplified the fraction, but did not recognize that the numerator and denominator had another common factor. A second explanation is related to greatest common factor, but presents a different focus for explaining the error. Perhaps the students did not fully understand the language presented in the problem, in this case: *simplest.* A fraction that is presented in simplest form is one where the numerator and denominator share the greatest common factor of 1. If the students did not understand the difference in the language (simplify vs. simplest form/ simplify to lowest term) used to communicate expectations that may have contributed to the errors present in this study.

Recognizing patterns in errors can help teachers anticipate systematic problems and address these pitfalls during initial instruction (Riccomini, 2005). In the example provided above, Amelia and Bella may benefit from targeted instruction about finding the greatest common factors or instruction to support specificity of mathematical language (Powell, Stevens, & Hughes, 2019). For the students whose errors appear not to follow patterns, it is possible that the students did not have a foundational understanding of rational numbers and fraction magnitude. The video demonstrated conceptual understanding by using mathematical manipulatives, but did not connect the concepts to understanding of fraction magnitude as communicated by a number line. Given the support of addressing fraction magnitude via a number line instruction (e.g., Schneider et al., 2018; Schumacher & Malone, 2018), incorporating this component into the VBI instruction may enhance students' conceptual knowledge base about fractions and rational number properties.

In this intervention, Cora made the most unidentifiable errors but also demonstrated a positive trend over time, suggesting that she developed conceptual understanding after multiple instructional sessions. This draws attention to the importance of dosage of the intervention when planning instruction. Efficient interventions require sufficient intensity of interventions in addition to proper fidelity of treatment.

Limitations and Future Directions

Limitations of empirical research are inevitable in school-based instruction. Within this context, understanding the reality of implementation allows researchers to better understand bridging the research to practice. For this reason, several *limitations* of this study are related to the authentic realities of teaching. First, this research took place in an afterschool program. This allowed the researcher to provided supplemental intervention support without taking away precious instructional time during the standard academic day. There were some days when a participant went home on the bus instead of staying for afterschool, or had a doctor's appointment, or did not attend our scheduled session. This presented situations when there may be unscheduled gaps in the intervention; however, the success of the intervention suggests that the occasional interference of attendance did not impact the overall findings. Another reality of this intervention is that schools are busy. The research took place in a room divided by a partition, but other students entered and exited the room throughout the time for various reasons, causing irregular distractions. Additionally, the classroom overlooked a yard used occasionally for outdoor activities. This created challenges because there were certain days when the students did not want to work with the researcher on the intervention. This was most apparent on Cora's third intervention session. Although she was willing to work with the researcher, she did not want to be there and rushed through the intervention. This resulted in a 0 score and a researcher reminder about the importance of attending to the task and trying one's best as well as the introduction of the self-regulating checklist. Along those lines, the researcher took fidelity of treatment to ensure the students watched the entire video, but it was not possible to ensure that they attended to the information presented in the video. For Bella and Cora, a system of least prompts for performance and behavior was necessary. The intervention was successful despite these real-world limitations, which is promising as bridging research to practice requires interventions that can be utilized under classroom and school conditions.

Directions for future research may include replication of this and previously published studies, as there is growing recognition to build the field of special education with replication research (Travers, Cook, Therrien, & Coyne, 2016). Future research extending this study may evaluate ways to incorporate self-regulation, such as self-correcting worksheets with the option to re-watch a video if items were missed. In order to assess true utility of POVM to teach mathematics, it is important that future research evaluate effects of the intervention when implemented by the classroom teacher. This would allow researchers to evaluate utility and further examine social validity, especially in inclusive or response to intervention settings.

Conclusion

The importance of understanding fractions, coupled with awareness that students with learning disabilities present additional challenges to acquisition and mastery of fractions, emphasize the need for targeted interventions aimed to improve conceptual understanding and mastery achievement. POVM depicting a model narrating and manipulating concrete materials may be an effective intervention to teach simplifying fractions and support conceptual understanding of rational numbers for students with learning disabilities. VBIs can be easily accessed and viewed using common technology. Students shared that they enjoyed learning about fractions using the video instruction, supporting the social validity of such an intervention and future use by students. The intervention was effective for students with heterogeneous learning disabilities with more intensive instructional needs in mathematics.

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