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The Use of Video Modeling to Teach Algebraic Equations to Secondary Students With and At-Risk for Disabilities

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ABSTRACT

Identifying mathematics interventions that are efficient, effective, and increase independence are vital for students with or at-risk for mathematics disabilities. Interventions used in general education or instructional support settings must also be feasible and allow teachers to meet both individual as well as whole-class needs. Digital technologies such as video modeling can embody several high-leverage instructional practices at once to facilitate the learning of fundamental mathematics concepts, such as algebra. A multiple baseline across participant design with an additional nonconcurrent replication in an applied setting was used to evaluate the effectiveness of video modeling on student ability to solve two-step algebraic equations and word problems. This study used an interactive learning platform, EdPuzzle, to deliver the video modeling intervention to two students who were at-risk for math failure. Findings indicate improvements in students' ability to solve math problems with increases in accuracy that maintain after no video model was available. Results and implications for the field are discussed.

KEYWORDS

video modeling, mathematics instruction, algebra, word problems, technology-based intervention, instructional technology, iPad, disability

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A student's success in algebra is not limited to the outcomes of one specific course required in high school. Hwang and colleagues (2019) describe the value of algebra, the role it plays as a gatekeeper to higher-level mathematics, and the implications that poor algebra understanding has for future post-secondary and employment opportunities. For students who experience or are at-risk for persistent mathematics difficulties, targeted and intensive interventions may be needed to address these challenges and prevent the repercussions of math failure. Because most students receive their core mathematics instruction in general education classroom settings, interventions must not only be

effective but also efficient, given the pressure of content coverage experienced by most classroom teachers- as well as their limited resources for individualized instruction.

One promising intervention method that may help ameliorate the challenge of individualizing instruction while meeting whole class needs, is video-based instruction (VBI), specifically, video modeling. Morris and colleagues (2022) summarize the value and characteristics of VBI, highlighting a teacher's ability to use VBI to pre-record instructional lessons for students to engage with independently. Students can access the lessons on their personalized devices and can control aspects of the instruction such as pacing, pausing, and re-watching as needed. Using a portable technology-based delivery system, video modeling allows students to engage in observational learning (i.e., hearing and seeing the instruction), which is delivered using various evidence-based instructional practices such as modeling, explicit instruction, and cognitive strategy instruction. A video model can be brief and have a narrow focus while also incorporating checks for understanding, opportunities for practice, and immediate feedback. In addition to the value of explicitly learning skills and concepts through this approach, Satsangi and colleagues (2019) highlight further benefits of video modeling for mathematics instruction such as the use of visual representation strategies on the screen and the social validity aspects of the intervention. They point out that because video modeling uses portable electronic devices such as laptops or tablets, middle or high school students are seen using age-appropriate technology in front of their peers, even when a supplemental intervention is in place.

Despite the inherent value and utility of using video-based instructional approaches for students who struggle in mathematics, there are limited published studies on this topic, and even fewer that emphasize algebra. For example, Bouck and Long (2023) identified 26 studies published between 2011-2020 that met criteria as "evidence-based mathematics interventions" for students with mild intellectual disabilities, however, only two of the 26 incorporated video-based instruction. Of those 26, few focused on algebra, specifically (n=2). Since that time, Satsangi and colleagues have examined video modeling for algebra (Satsangi, Billman, & Raines, 2021; Satsangi, Billman, Raines, & Macedonia, 2021), but most math video modeling studies emphasize other mathematics content. Recently, a small number of additional studies used video modeling or video prompting for basic arithmetic and/or fractions (Hughes, 2019; Kellems et al., 2023; Morris et al., 2022; Yakubova et al., 2015, 2020), geometry (Satsangi et al., 2020; Satsangi et al., 2019), coding (Wright et al., 2021), as well as math-related vocational or functional skills such as money use, pricing, recipe use, etc. (Al-Mumen et al., 2019; Kellems et al., 2016; Kellems et al., 2021). Across these studies, this approach was effective with a range of student populations from elementary level through adulthood including students with high incidence disabilities such as learning disabilities or ADHD (e.g., Hughes, 2019; Satsangi et al., 2020; Satsangi et al., 2019; Satsangi, et al., 2021), autism spectrum disorder (e.g., Kellems et al., 2016; Wright et al., 2021), and intellectual disability (e.g., Al-Mumen et al., 2019; Kellems et al., 2016, 2021).

The success of video modeling may be attributed to its utility and composition. In examining the video modeling tools and procedures across these studies, it is notable that video modeling incorporates numerous high-leverage instructional practices (HLPs; Aceves & Kennedy, 2024) in its design and delivery. At minimum, video modeling uses "assistive and instructional technologies to support the needs of students with disabilities" (HLP19; p. 87) and often acts as a more intensive approach that focuses instruction "on a small number of high priority, clearly defined skills or concepts critical to academic success" (HLP20; p. 89).

Additionally, aspects of explicit instruction are central to the presentation of content through video modeling by “showing and telling students what to do or think while solving problems, enacting strategies, completing tasks, and classifying concepts,” all while guiding them through to independence (HLP16; p. 80). In many cases, video-based instruction is used to illustrate a step-by-step strategy to solve a problem, teaching the student to become more self-directed and independent in using their newly learning mathematics skills as found in HLP14, *Teach Cognitive and Metacognitive Strategies to Support Learning and Independence*. Video modeling also infuses aspects of HLP13, *Adapt Curriculum Tasks and Materials for Specific Learning Goals*. This is most notable when researchers incorporate other supplemental materials and relevant technology as part of the video model including augmented reality and concrete or virtual manipulatives. Based upon the success of previous video modeling studies, Satsangi and colleagues (2023) compiled a step-by-step guide for teachers to follow when developing video modeling to support mathematics instruction for students with disabilities. Their steps and resources highlight not just the technological aspects of creating video models, but the contribution of key instructional components such as task analysis, explicit teaching, multiple representations, and meta-cognitive strategies.

Given the emerging research on using video modeling to improve mathematical performance and its promise as a tool to improve algebra skills, we conducted a study to examine its impact on students’ ability to translate and solve two-step algebraic equations and word problems, using free and readily available technology tools in secondary school settings. Using a multiple baseline across participant design with an additional nonconcurrent replication in a more applied setting, we sought to answer the following research questions (a) Is there a functional relationship between video modeling and the accuracy of translating and solving two-step algebraic equations and word problems? and (b) How much instructional time does it take for students to successfully complete the initial video model? We anticipated results similar to prior studies that found video modeling to be a valuable tool to improve student mathematics problem solving ability while taking minimal instructional time, thus being efficient as well as an effective approach for classroom use.

Method

Participants

The primary investigation included two tenth-grade students enrolled in an academic support classroom for mathematics. Student one was Nya (pseudonym), a 15-year-old Black female and student two was Sarah (pseudonym), a 15-year-old White female. Both students were identified as at-risk for persistent mathematics difficulties by their mathematics support teacher based on prior performance on a benchmark Renaissance STAR Math™ assessment as well as their prior difficulties in a pre-algebra class. Nya was not identified as having a disability but scored significantly below grade level on the Renaissance STAR Math™ assessment. Sarah had an Individualized Education Plan with math related goals and was diagnosed with ADHD. To be eligible for inclusion in this study, students had to meet the following criteria. They: (a) qualified for supplemental support in the Math Lab, (b) were enrolled in an Algebra 1 class, and (c) could independently use a tablet device.

According to Cooper et al (2007), “A two-tier multiple baseline design is a complete experiment and can provide strong support for the effectiveness of the independent variable (p.

204). Despite this, we sought to further explore the utility, feasibility, and generalizability of the video modeling intervention in a less structured, “applied” setting, and identified a third student to participate in the study in a nonconcurrent manner. We report on this replication as an example of how video modeling could also benefit students who are high performing but who could still show growth because of targeted instruction. Thus, the third participant who began the intervention around the same timeframe (but not concurrently), was Carrie. Carrie did not receive supplemental support in a Math Lab but attended eighth grade in a neighboring public school district. Carrie was included to explore the practical application of the intervention and provide an additional replication to supplement the primary study and to explore the generalization of findings to other settings and populations. Although Carrie did not specifically struggle in mathematics, she was identified to participate based on her need for individualized instruction, albeit at an advanced level. See Table 1 for participant information.

Both teachers who designed and implemented the intervention were White, female, early career teachers and graduate students enrolled in the final semester of their master’s program for secondary level special education. Both teachers completed human subject research and ethics training via the Collaborative Institutional Training Initiative CITI Program and abided by the Institutional Review Board university policy for student research, which was identified as “exempt” based on “typical teaching methods implemented in a K-12 setting”, subject only to department level review. Following the investigation, the outcomes were deemed worthy of dissemination, thus further IRB approval was sought for secondary analysis of existing data. Although not required, student assent and parent permission were obtained, and site permission secured.

Table 1. Summary of Participants’ Characteristics

Participant	Gender	Age	Grade	Disability	Race	Prior Year’s Math Class Average	STAR Math™ Assessment Grade Equiv.
Nya ^a	F	15	10	At Risk	Black	74%	6.0
Sarah ^a	F	15	10	ADHD	White	68%	6.0
Carrie ^b	F	13	8	Gifted	White	100%	8

Note. ^a Primary study participant included in concurrent multiple baseline study; ^b Participant included in applied nonconcurrent replication.

Setting

School Setting

The primary study took place during a “Math Lab” supplemental support class in a private, coeducational Catholic high school with an enrollment of approximately 180 students from suburban, urban, and rural areas in Western New York State. Of the students enrolled, 45% were White, 40% Black, 10% Hispanic/Latino, 3% Asian, and 2% were other ethnicities. Two percent of students were English Language Learners. The school was a Title I school with 70% of students receiving scholarships to attend. The school had no special education program, thus, all students were integrated into the general education classroom. The replication took place in a junior high school in a public city school district with approximately 700 students. The school is a Title I school district, with 67% of students who are at an economic disadvantage. The population of the school was comprised of 67% of students who are white, 11% Black, 12% Hispanic or Latino, and 10% other ethnicities.

Class Setting

The primary investigation took place in a Math Lab classroom, a small classroom with approximately thirteen student desks, an interactive SmartBoard, a dry erase board, and alternate seating areas where 2 to 10 students are instructed at a time. Math Lab periods lasted 40-minute and students attended the Lab at least two out of every six school days in addition to their regular math class. The nonconcurrent replication study took place in a separate classroom in a 1:1 setting before regular school hours.

Experimental Design and Independent Variable

Researchers conducting this study employed a multiple baseline across two participants design with a brief maintenance check after one week to determine the impact of video modeling via the EdPuzzle website on students’ mathematics problem solving skills. A sequential (nonconcurrent) brief replication acted as an application of the intervention with a third student and was conducted around the same timeframe in a different setting and included a maintenance check. In the primary study, video modeling was introduced to Nya followed by Sarah, staggering the implementation once a pattern of responding was noted in the first student.

Unlike the concurrent multiple baseline design with Nya and Sarah, where each baseline was established contemporaneously, we repeatedly measured a third student’s performance nonconcurrently. Session dates and days did not fully align to Nya and Sarah but took place around the same time frame. As a result, data are not presented as a third replication on the multiple baseline graph, but as a stand-alone display. It is noteworthy that researchers recognize the flexibility and value that nonconcurrent designs (alone or in combination with concurrent designs) bring to school-based research (i.e., Harvey et al., 2004; Winn et al., 2008). As Slocum and colleagues (2022) summarize, a sequential replication in an applied setting is natural and can also control for threats to internal validity. Thus, we determined including the third student would add value to the findings.

The independent variable was video-based instruction in the form of video modeling using two pre-recorded 7-minute instructional lessons accessed by the students via their personal device (e.g., iPad) while wearing headphones. Specifically, the instruction included video modeling of lessons using explicit instruction, narrated with a step-by-step voiceover by the principal investigator while the problem solving was demonstrated on a digital whiteboard. To

enhance reliability, video scripts were created, and each included the same format, language, and pacing. Each script included a brief introduction stating the purpose, mathematics problems, embedded questions for the student, and first-person narration of how the problem is solved. The teacher recorded the videos using a Microsoft Surface Go and a Surface Pen, while solving two-step algebraic equations and word problems from a student point-of-view. Video models were recorded using the screen recording app ScreenPal (formerly Screencast-O-Matic), capturing the problems and answers displayed on a digital whiteboard app (Microsoft Whiteboard) and posted to the EdPuzzle site for student viewing.

The video model content was selected based on the participants' math deficit in the grade-level curriculum and learning objectives for Algebra 1 as defined by the New York State Next Generation Mathematics Learning Standards for Algebra (AI-A.CED.1; 2017). The videos focused first on (a) translating and solving two-step algebraic equations and then (b) translating and solving two-step algebraic word problems using "real world" scenarios. In each video, the teacher verbally and visually modeled two to three problems followed by two guided practice problems to be completed by the student. When completing the guided practice problems via the EdPuzzle website, the video would automatically pause and not progress until the students input their answers on the iPad. Students were able to rewatch any section of the video before answering questions.

Dependent Variables

The primary dependent variable for the study was each student's problem-solving ability on two-step algebraic equations and applied word problems as measured by parallel six-item paper-pencil assessment probes that were administered at the end of each intervention session. The probes were comprised of three questions per skill covered in the video models (i.e., questions 1-3 aligned to the skill in video 1; questions 4-6 aligned to the skill in video 2). Students were prompted to use graphing calculators, as needed, and to show work on each assessment probe. Each probe was worth 18 points (3 points per question) with partial credit awarded based on criteria outlined in a scoring rubric that included a point for using the correct equation, showing work, and for each step completed. A total percent-correct per probe was calculated and graphed. Additionally, for the primary study, we measured the total number of minutes the students viewed each video model.

We conducted visual analysis of the level, trend, and variability in performance on the assessment probes within and across each tier to determine if there was a functional relationship between video modeling and math problem solving ability on two-step algebraic equations and word problems (see Figures 1 and 2). In addition to visual analysis, we report a descriptive summary of findings, including mean scores and range followed by calculation of percentage of non-overlapping data to determine the intervention's effectiveness (Scruggs et al., 1987).

After the study was completed, investigators surveyed the students to receive feedback on the intervention using a 5-point Likert scale and open-ended questions. The investigators, who were also the teachers implementing the video modeling intervention, engaged in personal reflection to critique the feasibility and impact of the intervention in a typical classroom setting.

Procedure

Baseline

Baseline data were collected using the six-item assessment probes during the first three sessions for Nya and Sarah. Once a predictable pattern of responding was noted for Nya, she was briefly trained on how to use an iPad to access videos and respond to questions in EdPuzzle. Sarah continued in the baseline condition for four additional days with a lag in training and video use, until Nya began to demonstrate a change in problem solving skills for two consecutive sessions. Around the same timeframe, but not on the exact session days or calendar dates, Carrie's teacher began administering three baseline probes over three sessions.

Video Model Intervention

After the training, students moved on to the instructional video model to begin the intervention. Each intervention session took place during the 40-minute class period. To begin each session, students were given an iPad and a graphing calculator and instructed to watch the EdPuzzle video model of the skill in its entirety, pausing to answer embedded questions and re-watch portions as desired.

Video 1 focused on teaching the skills needed to translate and solve two-step algebraic equations while the second video focused on solving two-step word problems using the skills learned in video 1 in an applied example. Within each video, students were prompted to digitally input their answers to the guided practice questions before receiving the correct answer from the narration and proceeding to the next portion of the video model. Students were able to pause and re-watch parts of the video unlimited times, as needed.

Following the video model, the teacher administered the six-question paper-pencil assessment probe. Students were asked to show all of their work leading up to the solution of each problem. The teacher provided positive encouragement and answered technical questions (i.e., related to using the video tool or iPad) but did not give any instruction on how to solve the problems on the assessment. After each session, the probe was scored and if the student reached 80% accuracy on the first skill (two-step algebraic equations), then the student moved on to the next video modeling lesson (two-step "real world" word problems). Once students reached at least 80% accuracy on the first and last skills combined, students then transitioned to the maintenance phase.

Maintenance

After the intervention phase, students were given a one-week break from the video models and then asked to complete one assessment probe to act as a brief maintenance check. The maintenance assessment was parallel in format to the assessments given during the baseline and intervention phases. Participants did not view the video model during the maintenance phase.

Treatment Fidelity and Interobserver Agreement

To help ensure fidelity of the video model, two researchers reviewed both videos prior to implementing the intervention. Using a treatment fidelity checklist, the researchers determined that the video content was consistent and accurate across both. Fidelity was also tracked during 25% of the intervention sessions by a second observer, noting 100% fidelity with the implementation procedures by the classroom teacher. Interobserver agreement was assessed for

28% of assessment probe questions on an item-by-item basis. Two trained individuals scored the probes then divided the number of agreements by the number of agreements plus disagreements and multiplied by 100. This resulted in 100% agreement between scorers across the probes.

Results

Both Nya's and Sarah's ability to solve two-step algebraic equations and word problems improved using video modeling compared to their performance during the baseline phase. Their average performance on the assessment probes not only increased, but also continued when a maintenance check without a video model was conducted one week post intervention. Carrie started at a higher-level during baseline with no notable change after the first video model but when the second skill was introduced, an immediate improvement was noted. These findings are supported in Figures 1 and 2, which graphically display percentage of correct problems solved across baseline and intervention phases, and in Table 2, which provides descriptive details related to mean scores and range across each phase. Instructional time spent watching the initial video model is displayed in Table 3.

Student Performance

Nya

To begin, Nya was unable to solve two-step algebraic equations and word problems as indicated by her 0% accuracy across three baseline sessions. Upon introduction of the first video model (VM1), an immediate increase in level of performance was noted along with an upward positive trend from 0% correct to an average of 31% correct during the intervention phase. Nya's performance continued to increase with some slight variability during this upward trajectory, except for a drop during session 5 where she demonstrated less than 10% accuracy, however, her performance did not retreat to baseline levels. The teacher noted that Nya was experiencing some technical difficulties during this session, which may have contributed to the decrease. Nya's performance continued at moderate, stable levels for three consecutive sessions before plateauing, even when the second video model was introduced (VM2).

In addition, the primary investigator noted that during the word problem portion of the video, Nya was having trouble generalizing the video examples to the assessment questions in the probe and may not have recognized the correspondence of the model to the problem she was being asked to solve. Thus, the investigator verbally reminded Nya to "notice" and prompted her to write the number of each video example next to each assessment question. This slight modification to the intervention is noted as "VM2+Prompt" and suggests a slight modification to the original intervention phase (VM2). Once the prompt was added, an immediate increase in Nya's performance was noted via the increasing trend, culminating with 100% accuracy on the assessment probe in session 13. The high levels were maintained when after one week, Nya continued to perform at a high level.

Nya spent 20 minutes completing VM1 and 12 minutes for VM2. Percentage of non-overlapping data was calculated by comparing baseline data points to all intervention phases and maintenance, resulting in 100% of non-overlapping data. This supports the visual analysis and indicates that the intervention was highly effective (Scruggs et al., 1987). Given the zero level of performance during baseline, however, an additional calculation of effect size was measured

using Tau-U analysis. The Tau-U score, corrected for baseline trend, was 1.0 with an associated z-score of 4.76, $p < .001$, with 95% confidence interval ranging from .59-1.41 indicating strong and statistically significant effect for Nya following the introduction of the intervention across the multiple phases. This was further supported by Nya's standard mean difference equaling 2.38 (very large effect).

Sarah

During baseline, Sarah completed assessment probes over seven consecutive sessions. Her accuracy was low, ranging from 6% to 28% with a mean of 15%, indicating stable performance with a very slight increasing trend. Once the first video model was introduced the level of Sarah's problem-solving accuracy increased to 56% with a stable upward trend, placing her performance in the mid to moderately high range. Despite the slight upward trend prior to introducing VM1, Sarah's performance improved consistently during the intervention phase and there was no overlap in data points between baseline and intervention phases, indicating an effect from the video model. After introducing VM2, Sarah's performance increased immediately during session 11, then dropped slightly for session 12, before continuing an upward trend for session 13 reaching 100% accuracy. The slight decrease in performance during session 12 corresponded with what the teacher described as Sarah acting in an unmotivated and low energy manner. Sarah stated, "she did not feel like doing work" that day and left an entire problem blank. Sarah spent seven minutes completing VM1 and eight minutes completing VM2.

Across all phases, Sarah's performance was stable with an overall increasing trend starting low and moving to high levels by the end of the intervention and maintaining after one week. Despite the increasing trend over time, percentage of non-overlapping data calculation indicated 100% of non-overlapping data for Sarah, demonstrating what could be considered a highly effective intervention (Scruggs et al., 1987), however, due to the baseline trend, an additional calculation of effect size was measured using Tau-U analysis. The Tau-U score, corrected for baseline trend, was 0.38 with an associated z-score of 1.81, $p < .05$, with 95% confidence interval ranging from -0.3-0.79 indicating overall improvement for Sarah but not reaching statistical significance, likely due to the slight positive trend during baseline. Despite this, visual analysis still indicated a clear level change following the intervention which was maintained over time, and supported by mean changes across phases (4.61 standard mean difference indicating a large effect).

Carrie

Carrie's problem-solving performance ranged from 67% to 78% during the baseline phase indicating a stable, moderately high level performance. After completing the initial video model (VM1), Carrie continued to perform at the same level with 78% accuracy followed by an increase to 100% accuracy after watching VM2. Given Carrie's immediate high level of performance after VM2, only one intervention session was conducted for each video, a limitation discussed below. One week after finishing the intervention, Carrie once again answered 100% of the questions correctly, indicating a stable, high level of accuracy that maintained even after the intervention was stopped. Given the overlap in Carrie's performance between the final baseline session and the first intervention session, percentage of non-overlapping data was 67%, indicating minimal effect (although approaching the 70% "moderately effective" cutoff). Given

the ceiling effect and high performance during baseline, no statistically significant change could be detected for Carrie. Despite that, a mean change of close to 15 points was noted with a standard mean difference of 1.23 indicating a large effect even with the high levels to start. Carrie spent approximately nine minutes completing VM1 and approximately eight minutes to complete VM2.

Table 2. Percentage of Correctly Solved Problems on Probes

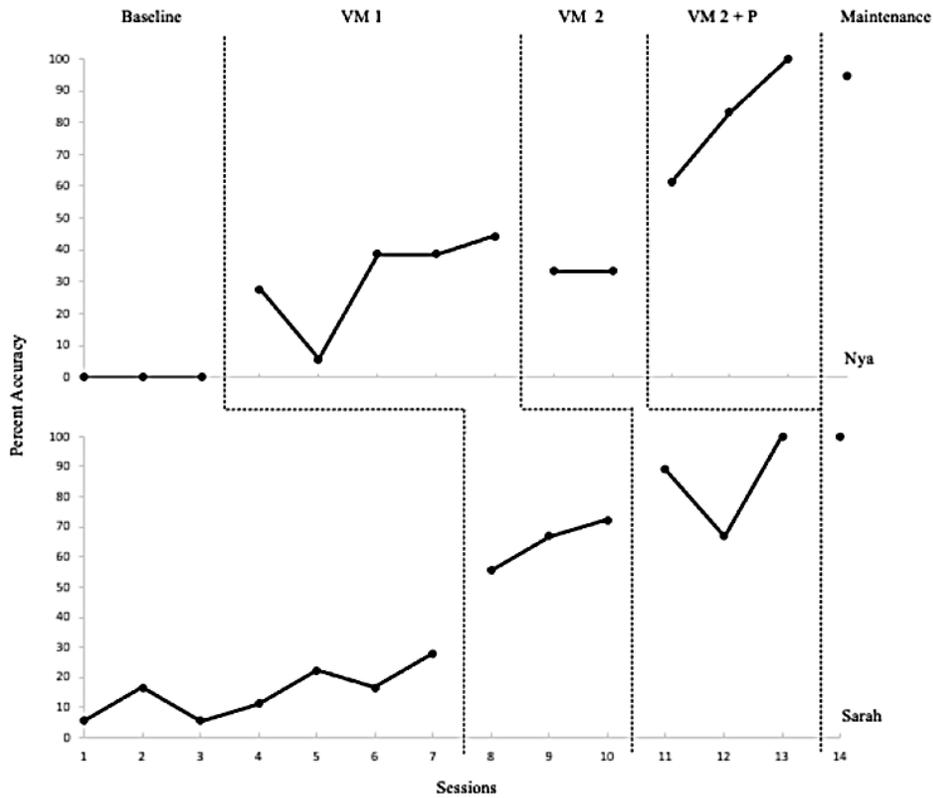
	Baseline		VM 1		VM 2		VM 2 + P		Maint Accuracy	SMD
	M	Range	M	Range	M	Range	M	Range		
Nya	0	0 - 0	31	6 - 44	33	33-33	82	6 - 100	94	2.38
Sarah	15	6 - 28	65	56 - 72	85	67 - 100	-	-	100	4.61
Carrie	74	67-78	78	-	100	-	-	-	100	1.23

Note. VM 1 = Video Model #1: Translating algebraic equations; VM 2 = Video Model #2: Word Problems; VM 2 + P = Video Model #2 paired with prompting; SMD = Standard Mean Difference (all considered very or exceptionally large based on Cohen's Benchmarks [Cohen, 1988])

Table 3. Minutes Spent Viewing Video Models

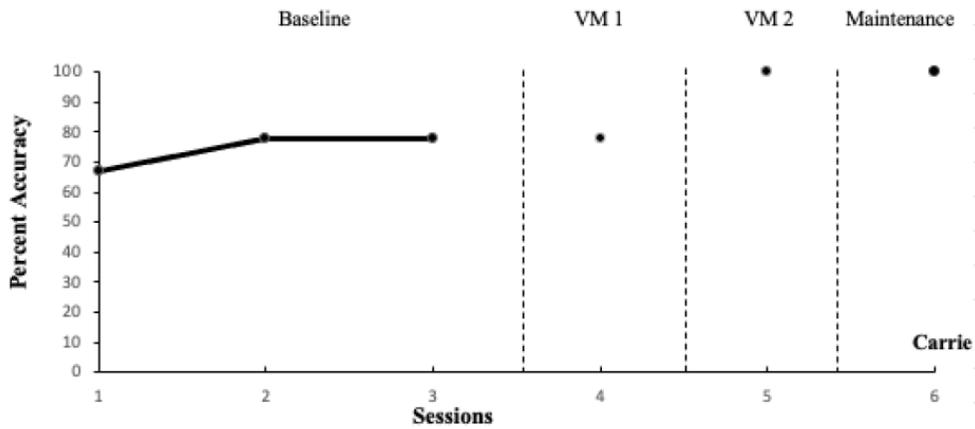
	Minutes Viewed				
	Nya	Sarah	Carrie	Participants Combined	
				M	SD
Video Model 1	20	7	9	12	5.71
Video Model 2	12	8	8	9.3	1.88
Total	22	15	17		

Figure 1. Percentage of Correctly Solved Two-Step Algebraic Equations and Word Problems



Note. VM1= Video Model #1: Transition algebraic equations; VM2 = Video Model #2: Word Problem; VM 2+P = Video Model #2 paired with prompting

Figure 2. Carrie's Percent of Correctly Solved Two-Step Algebraic Word Problems



Note. VM1 = Video Model 1; VM2 =Video Model 2

Social Validity

Social validity surveys were administered to both participants in the Math Lab classroom (Nya and Sarah) and also completed by the primary investigator who implemented the intervention. They were given statements about the intervention and asked to reply using a five-point Likert scale (strongly disagree to strongly agree). According to the survey, everyone agreed that video modeling intervention increased both participants' confidence and changed their perceptions of their abilities when completing math problems. Overall, both participants agreed or strongly agreed that the video model helped them understand the steps they needed to complete the math problems and that they would like to use video modeling in math class again and in other subjects. As their teacher, the primary investigator reflected on the video modeling intervention, stating that video models helped her students understand the steps to accurately solve math problems and helped them become more independent and confident in solving these types of math problems. Although the teacher agreed that the video model took a fair amount of time to create, she also agreed that the videos were simple to use and that she would want to use them in the future. Carrie's teacher, the second investigator, anecdotally reflected as well, stating that once created the video models were easy to use and even for high achieving students, some gains could be noted with minimal time needed for 1:1 instruction. It was also noted that Carrie was extremely motivated to watch the videos and requested them once the intervention was over. See Tables 4 and 5 for social validity results.

Table 4. Student Social Validity Statements

Social Validity Statements	Nya	Sarah	Average
BEFORE I used the video model, I felt like I was BAD at translating algebraic equations.	4	4	4
AFTER I used the video model, I felt like I was GOOD at translating algebraic equations.	5	4	4.5
The video model helped me understand the steps I needed to do to translate algebraic equations.	5	4	4.5
I would like to use a video model in math again.	5	4	4.5
I would like to use a video model in other subjects like science, social studies, writing, or reading.	5	5	5
I liked that I could look back at the videos as many times as I needed.	5	5	5
I felt confident taking the assessment after I watched the video model.	5	4	4.5

Note. Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4, Strongly Agree = 5; Completed with primary participants only.

Table 5. Teacher Social Validity Statements

Social Validity Statements	Teacher Response
The video models took a fair amount of time to make.	4
The video models helped my students understand the steps needed to translate algebraic equations.	5
It was accessible and simple to implement the intervention with my students.	4
I noticed a positive change in my students' confidence or attitude about math throughout the intervention.	5
Video modeling is something I would like to use again.	4
I felt like video modeling helped my students be more independent and self-sufficient.	5

Note. Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4, Strongly Agree = 5; Completed with primary participants only.

Discussion

The purpose of this study was to examine the effect of video modeling carried out in an applied setting when teaching two secondary students with or at-risk for persistent math difficulties how to translate and solve two-step algebraic equations and apply the skill to word problems. In both cases, video modeling improved student outcomes, was efficient, and well received by teachers and students. Although there are considerations related to the slight increasing baseline trend for Sarah, each of the students had substantial changes to the magnitude of their performance during and at the end of the intervention.

A third high-achieving student, Carrie, was included in this study to present an additional replication of effect in an additional applied setting and explore the impact of video modeling as a tool for supplemental or targeted instruction, even if a student isn't struggling on a more global level. The instructional time or 1:1 attention needed to differentiate "up" can also be challenging for teachers, thus, the value of video modeling may be strong and lead to improvements even for high achieving students. In the case of Carrie, her high performance early on may have impacted the perceived effectiveness of the intervention by traditional analysis methods (i.e., given the overlap between baseline and the first intervention phase). However, this process may illustrate the value of selecting video models for targeted skills in discrete focus areas. Carrie's performance was consistently in the 66-78% range during baseline and VM1 phases, indicating little to no effect at first (albeit higher than other participants); it wasn't until she engaged with the second video model which focused on *application* that the real gains occurred. That is, Carrie was generally successful in solving two-step algebraic equations, but she needed direct teaching on how to apply this to "real-world" word problems, leading to improvements and performance at the 100% level.

The results of this study are consistent with the findings of a similar math intervention using video modeling with students with disabilities (e.g., Satsangi et al., 2020). Similar to prior studies, gains in algebra related math skills were noted for all students, with levels of accuracy maintaining over time and remaining high when video models were not used a week later. This indicates that the students not only relied on the video models in the moment, but that they learned and retained the knowledge as well. Students were able to engage with the video models for a relatively short period of time (i.e., less than 15 minutes) and still experience success.

By conducting this study in an applied setting, we gained insight into real-world benefits as well as challenges related to implementation of video modeling. These observations are described as limitations below but led to clear recommendations and implications for future practice. These findings have very strong practical significance based on the implementation processes carried out in this applied setting.

Limitations and Recommendations

The use of additional prompting during this study may act as a limitation but can offer insight into increasing a video model's effectiveness, particularly on applied tasks. During the second video model phase (VM2) for Nya, the teacher needed to incorporate verbal prompts beyond what was planned and embedded in the video model (the word problems portion of the instruction). The addition of prompting alters some of the inherent value of this intervention as an independent activity. Video modeling has appeal given that once the initial demonstration and recording is complete, students can use the video independently. If additional levels of prompting are needed, a teacher must be available to more closely observe the student. Prompting then becomes one additional outcome that must be monitored and measured by the teacher. This adds a burden, given that the other outcomes are automatically tracked while using the video website or app (e.g., number of minutes watched, guided practice questions answered correctly, number of replays, etc.). We believe that although prompting helped Nya apply the new skill to word problems, she still gained knowledge from the video model- even when unprompted. This notion is supported by the significant change in level of performance noted between baseline to after the first video model phase (VM1) when she was instructed on how to translate and solve two-step algebraic equations (before being asked to apply to word problems).

A second limitation of this study is the repeated measurement of Carrie's performance during the intervention phases. Only three assessment probes were administered following Carrie's baseline phase (one per each video model and one during maintenance), thus a functional relationship between Carrie's ability to solve two-step algebraic equations and the first video model cannot be determined. However, given the immediate increase in her performance once the second video model with word problems was introduced, one can posit that Carrie benefited from targeted instruction in a specific area of need (applying to real-world problems). Therefore, although there are limited data points, growth was noted when instruction focused on her specific area of need.

A third limitation of this study relates to the technology used to create, watch, and replay the video model but also leads to recommendations that can improve these areas in the future. The teachers reported that the videos were somewhat time consuming to create and although beneficial, may not be a feasible aspect of daily instruction. In their recent paper, Satsangi and colleagues (2023) remind teachers that once developed, the videos exist "in perpetuity" every semester for students to use. They also suggest streamlining creation by having general and

special education teachers “collaborate on building and sharing video libraries of skills” (p. 359), adding that school administrators aid in the process by dedicating professional development time during work hours to this collaboration and video development. An additional recommendation that stemmed from the current study is that although using free software tools for recording and creating videos is appealing, the free versions often limit the teachers’ ability to edit or modify videos once they are created. Satsangi and colleagues (2023) also offer detailed hardware and software recommendations in their paper that would have addressed some of the concerns brought about in the current study. For example, as previously noted, researchers would have liked to add prompting to the video to remind Nya to connect the video model examples with assessment problems. However, with the free software used, this was not possible, requiring the implementer to monitor and give verbal prompting.

During replay, students and teachers reported that accessing the free EdPuzzle site on a tablet works well for simple viewing from start to finish, but when students needed to re-watch portions or scroll through the video to reach specific embedded questions on the device, it was not as smooth, and frustration ensued. This was notable during Nya’s session-five performance when the technical difficulties led her to “give up” watching the video, leading to poor performance. On a positive note, however, this uncharacteristic drop in performance may have acted as an unplanned mini “withdrawal of treatment” data point, providing further evidence of the effect of video modeling.

A fourth limitation was that the calculation of effect size using Percentage of Non-overlapping Data. Although supported by visual analysis and mean phase changes, the magnitude of the effect may have been overstated, particularly for Sarah. The addition of the Tau-U calculation helped support this notion. Thus, caution in interpreting the effect should be heeded given patterns of responding prior to the intervention phase and limited number of replications across additional participants.

A final limitation relates to the study design employed, leading to potential threats to internal validity based on testing experience. The repeated measurement that occurred during the multiple baseline design study could have influenced the outcome; that is, the frequency of testing could impact (and accumulate) over time while also proving to be aversive to the student given the repeated measurement. A variation of the multiple baseline design that may have been better suited for this study is a multiple probe design where intermittent measures (or probes) are used. We attempted to rule out these threats through replication (i.e., Nya and Sarah in the primary study and Carrie in the second “practical application”, nonconcurrent replication) while also validating the social acceptance of this intervention in applied settings. Despite this possible threat, Slocum and colleagues (2022) remind researchers that by adding multiple tiers beyond the single AB within-tier comparison, this threat can be controlled, strengthening the evidence of a treatment effect; and as previously stated, Cooper et al (2007) report that the two-tiered design provides strong evidence of effectiveness (without including Carrie’s performance).

Implications for Future Practice

Incorporating video modeling into daily lessons allows teachers to utilize technology readily available to them while allowing students to receive step-by-step instruction, infusing multiple high-leverage practices. Video modeling can be an effective way to supplement instruction for students who are struggling academically or for whom enrichment or more focused instruction is warranted. The “just-in-time” or on-demand nature of the technology-based models can benefit

students both in and out of the classroom, or anytime immediate access to a teacher is not feasible. Low or no-cost tools can be used to create and access the videos, which will “live in perpetuity” once the initial development takes place. Students and their teachers appear to value video modeling as a tool. The efficiency, effectiveness, and overall social validity of video modeling in mathematics may lead to increased independence, resulting in feelings of confidence, and improved self-efficacy in the area of math. The practical significance of the real-world use of this tool during every day instruction as illustrated in this applied study should be noted; when paired with the acceptability of this intervention, feasibility is strengthened even more.

Conclusion

After reviewing student performance, conducting a visual analysis, and calculating PND across three participants, we determined that there is a functional relationship between the use of video modeling and student performance in solving two-step algebraic equations and word problems. In addition, we determined that video modeling is a feasible intervention that can be easily incorporated into the classroom as supplemental instruction both for students who struggle in mathematics and for those who need individualized instruction to enrich their learning, as well. Students and their teachers appear to find video modeling accessible, helpful, and something they would use in the future.

References

- Aceves, T. C. & Kennedy, M. J. (Eds.). (2024, February). *High-leverage practices for students with disabilities*. 2nd edition. Council for Exceptional Children and CEEDAR Center.
- Al-Mumen, H. A., Al-Muhareb, K.A., & Al-Rowaished, N. R. (2019). The impact of video modeling in teaching money skills for students with moderate intellectual disability. *Journal of Education, 33*(132), 27-55.
- Bouck, E. C., & Long, H. (2023). Academic mathematics instruction and intervention for students with mild intellectual disability: An updated review. *Education and Training in Autism and Developmental Disabilities, 58*(2), 144–161.
- Cohen J. (1988) *Statistical power analysis for the behavioral sciences*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum.
- Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied Behavior Analysis* (2nd ed.). Upper Saddle River, NJ: Pearson Education.
- Harvey, M.T., May, M.E., & Kennedy, C.H. (2004). Nonconcurrent multiple baseline designs and the evaluation of educational systems. *Journal of Behavioral Education, 13*(4), 267-276.
- Horner, R. H., Carr, E. G., Halle, J., McGee, G., Odom, S., & Wolery, M. (2005). The use of single-subject research to identify evidence-based practice in special education. *Exceptional Children, 71*(2), 165-179.
- Hughes, E.M. (2019). Point of view video modeling to teach simplifying fractions to middle school students with mathematical learning disabilities. *Learning Disabilities: A Contemporary Journal, 17* (1), 41-57.
- Hwang, J., Riccomini, P. J., & Morano, S. (2019). Examination of cognitive processes in effective algebra problem-solving interventions for secondary students with learning disabilities. *Learning Disabilities: A Contemporary Journal, 17*(2), 205–220.

- Kellems, R. O., Frandsen, K., Hansen, B., Gabrielsen, T., Clarke, B., Simons, K., & Clements, K. (2016). Teaching multi-step math skills to adults with disabilities via video prompting. *Research in Developmental Disabilities, 58*, 31–44. <https://doi.org/10.1016/j.ridd.2016.08.013>
- Kellems, R. O., Cacciatore, G., Hansen, B. D., Sabey, C. V., Bussey, H. C., & Morris, J. R. (2021). Effectiveness of video prompting delivered via augmented reality for teaching transition-related math skills to adults with intellectual disabilities. *Journal of Special Education Technology, 36*(4), 258–270. <https://doi.org/10.1177/0162643420916879>
- Kellems, R. O., Steinburg, M., Bahr, D., & Hansen, B. D. (2023). Using video modeling via iPads to teach multiplication to struggling learners. *Journal of Special Education Technology, 0*(0). <https://doi.org/10.1177/01626434231180584>
- Morris, J. R., Hughes, E. M., Stocker, J. D., & Davis, E. S. (2022). Using video modeling, explicit instruction, and augmented reality to teach mathematics to students with disabilities. *Learning Disability Quarterly, 45*(4), 306–319. <https://doi.org/10.1177/07319487211040470>
- New York State Education Department (2017). *New York State Next Generation Mathematics Learning Standards*. <https://www.nysed.gov/sites/default/files/programs/curriculum-instruction/nys-next-generation-mathematics-p-12-standards.pdf>
- Satsangi, R., Billman, R. H., & Raines, A. R. (2021). Comparing video modeling to teacher-led modeling for algebra instruction with students with learning disabilities. *Exceptionality, 29*(4), 249–264. <https://doi.org/10.1080/09362835.2020.1801436>
- Satsangi, R., Billman, R. H., Raines, A. R., & Macedonia, A. M. (2021). Studying the impact of video modeling for algebra instruction for students with learning disabilities. *Journal of Special Education, 55*(2), 67–78. <https://doi.org/10.1177/0022466920937467>
- Satsangi, R., Hammer, R., & Bouck, E. C. (2020). Using video modeling to teach geometry word problems: A strategy for students with learning disabilities. *Remedial and Special Education, 41*(5), 309–320. <https://doi.org/10.1177/0741932518824974>
- Satsangi, R., Hammer, R., & Hogan, C. D. (2019). Video modeling and explicit instruction: A comparison of strategies for teaching mathematics to students with learning disabilities. *Learning Disabilities Research & Practice, 34*(1), 35–46. <https://doi.org/10.1111/ldrp.12189>
- Satsangi, R., Sigmon, S. D., & Bouck, E. C. (2023). Video modeling in mathematics: Supplemental instruction to support student learning. *Intervention in School and Clinic, 58*(5), 355–360. <https://doi.org/10.1177/10534512221114388>
- Scruggs, T. E., Mastropieri, M.A., & Casto, G. (1987). The quantitative synthesis of single subject research: Methodology and validation. *Remedial and Special Education, 8*, 24–33. <https://doi.org/10.1177/074193258700800206>
- Slocum, T. A., Pinkelman, S. E., Joslyn, P. R., & Nichols, B. (2022). Threats to internal validity in multiple-baseline design variations. *Perspectives on Behavior Science, 45*(3), 619–638. <https://doi.org/10.1007/s40614-022-00326-1>
- Winn, B.D., Skinner, C.H., Allin, J.D., & Hawkins, J.A. (2008). Practicing school consultants can empirically validate interventions: A description and demonstration of non-concurrent multiple-baseline design. *Journal of Applied School Psychology, 20*(2), 109–128. <https://doi.org/10.4324/9780203725887-11>
- Wright, J.C., Knight, V.F., Barton, E.E., & Edwards-Bowyer, M. (2021). Video prompting to

teach robotics and coding to middle school students with autism spectrum disorder. *Journal of Special Education Technology* 36(4), 187-201.

<https://doi.org/10.1177/0162643419890249>

Yakubova, G., Hughes, E., & Hornberger, E. (2015). Video-based intervention in teaching fraction problem-solving to students with autism spectrum disorder. *Journal of Autism & Developmental Disorders*, 45(9), 2865–2875. <https://doi.org/10.1007/s10803-015-2449-y>

Yakubova, G., Hughes, E. M., & Chen, B. B. (2020). Teaching students with ASD to solve fraction computations using a video modeling instructional package. *Research in Developmental Disabilities*, 101, N.PAG. <https://doi.org/10.1016/j.ridd.2020.103637>