Insights into Learning Disabilities 18(1), 1-28, 2021

Mathematics Intervention for College Students With Learning Disabilities: A Pilot Study Targeting Rate of Change

Kaitlin Bundock
Gregory L. Callan
David Longhurst
Kristen R. Rolf
Chandler M. Benney
Maryellen Brunson McClain
Utah State University, USA

Research on mathematics interventions for college students with learning disabilities (LD) is sparse, yet mathematics is critical for post-secondary success. Prior research indicates that many effective strategies for teaching mathematics to secondary students with LD (e.g., manipulatives and cognitive strategies) can also improve the mathematics performance of college students with LD. In this article, we summarize mathematics intervention research conducted with college students with LD, and report the findings of a pilot single-case design intervention implemented with one college student with LD, Ada. Results indicate that Ada made improvements in solving rate of change word problems following participation in a six-week intervention that incorporated an integrated Concrete-Representational-Abstract framework and a problem-solving heuristic (POD✓). Effect sizes were largest for the specific outcome of calculating the correct answer. These results provide initial directions for future research and practice to improve the mathematics performance of college students with LD.

Keywords: **mathematics instruction, instructional strategies, college teaching, Learning Disabilities, transition**

Introduction

Mathematics Difficulties for Students with Learning Disabilities

Students' mathematics skills play an important role in academic achievement, critical thinking, degree attainment, and career selection (Forgione, 1999; Ketterlin-Geller & Chard, 2011). Moreover, the vitality of a country's economy is dependent on a workforce with strong mathematical skills (Forgione, 1999). However, students in the United States lag behind, especially students with disabilities. Only 7% of twelfth-graders with disabilities are at or above proficiency

Insights into Learning Disabilities is published by Learning Disabilities Worldwide (LDW). For further information about learning disabilities, LDW's many other publications and membership, please visit our website: www.ldworldwide.org.

in mathematics and 75% are below even a basic level (NCES, 2019). Word problems present particular difficulty for many students (Martin & Bassok, 2005), especially for students with learning disabilities (LD; Hwang & Riccomini, 2016). Students with LD in the area of mathematics often struggle with factors central to mathematics problem solving, such as fluency, nonverbal reasoning, working memory, task organization and planning, and attention regulation (Agrawal & Morin, 2016; McGlaughlin et al., 2005), as well as forming conceptual and representational understandings of mathematics (Hwang & Riccomini, 2016; Lewis, 2014).

Underachievement in mathematics causes both short-term and long-term consequences. In the short-term, students may experience frustration and decreased motivation (Nguyen, 2015; Sierpinska et al., 2008). When mathematics underachievement is not remediated, students are likely to experience long-term setbacks, in part because higher-level mathematics (e.g., algebra) act as a gatekeeper for post-secondary education (Ketterlin-Geller & Chard, 2011; Nguyen, 2015). Not only do mathematics deficits prevent students from entering college, but many students with LD who enter college do not graduate, and even fewer of these students complete degrees within STEM fields (Newman et al., 2011).

Mathematics Interventions for Secondary Students with Learning Disabilities

Several reviews of the research demonstrate that interventions improve the mathematics performance of secondary students with LD (Hughes et al., 2014; Lee et al., 2020; Marita & Hord, 2017). Based on such reviews, the most effective interventions for teaching algebra and related pre-requisite concepts to secondary students with LD include multiple representations, visual strategies, explicit instruction, a systematic sequence of examples (Hughes et al., 2014; Lee et al., 2020; Marita & Hord, 2017), as well as cognitive and metacognitive strategy instruction (Hwang & Riccomini, 2016). Studies that utilize the Concrete-Representational-Abstract (CRA) approach and schema or model-based strategies and explicit instruction have high effect sizes (Hughes et al., 2014).

Effective Interventions for Problem Solving

In a review of problem-solving interventions for students with or at risk for LD, Hwang and Riccomini (2016) highlight three intervention approaches determined to be effective: heuristic, semantic, and authentic. Heuristic approaches involve the use of metacognitive strategies (e.g., acronyms and checklists) that guide students through the problem-solving process. Semantic approaches highlight the underlying structures of problems, primarily through the use of visual representations, diagrams, or concrete manipulatives. Authentic approaches primarily use video-based realistic scenarios to introduce problems and prompt students to identify possible solution approaches. In a systematic review of algebra interventions, Lee and colleagues emphasize visual representations when teaching word problem solving to secondary students with LD to address difficulties they encounter with problem representation and because research demonstrates that teaching students to represent problems accurately can improve word problem performance (Lee et al., 2020).

The Concrete-Representational-Abstract (CRA) Teaching Sequence

One research-based intervention that improves students' conceptual and procedural understanding of mathematics concepts is the Concrete-Representational-Abstract (CRA) teaching sequence (Bouck et al., 2017), in which concepts are taught using physical materials (e.g., centimeter cubes, base-10 blocks), representations (e.g., pictures, diagrams), and abstract depictions (e.g., standard algorithms). In an evidence-based practice synthesis examining CRA for teaching mathematics concepts, Bouck and colleagues (2017) conclude that the research base provides particularly strong support for using CRA to teach operations to elementary and middle school students with LD, but that additional research is needed to examine the use of CRA for building the conceptual understanding of algebra and geometry concepts for older students with LD. Recent research on teaching algebra concepts to students with learning disabilities and other high-incidence disabilities has utilized an integrated CRA approach (CRA-I), in which concepts are simultaneously taught using concrete materials, visual models, and algebraic notation (Bundock et al., 2019; Strickland & Maccini, 2012). The results of these studies indicate that CRA-I can help students build conceptual and procedural understanding of linear expressions, quadratic expressions, and rate of change word problems, but more research is needed to investigate the effects of CRA-I on the performance of secondary and post-secondary students with LD.

Mathematics Interventions for College Students with Learning Disabilities

Research indicates that college students with LD generally fare worse than their peers without disabilities on many indicators, including employment and college completion (Newman et al., 2011; Williams et al., 2020). Given that many majors or collegiate programs require students to pass mathematics courses or exams, it is possible that mathematics challenges may be one barrier students with LD encounter in college that contributes to their poorer outcomes. McGlaughlin and colleagues investigated the characteristics of college students with mathematics LD and found that college students with LD have similarities to elementary and secondary students (i.e., difficulties with reading comprehension, nonverbal reasoning, working memory, and mathematics fluency; McGlaughlin et al., 2005). Based on this, college students may be supported with the same types of interventions that are effective for secondary students, leading to improved post-secondary outcomes (Street et al., 2012).

Little research has examined the effectiveness of strategies to improve the mathematics performance of post-secondary students with LD (Hodara, 2013; McGlaughlin et al., 2005). In a working paper for the Center for Analysis of Postsecondary Education and Employment (CAPSEE), Hodara reviewed research on mathematics assessment, instruction, and interventions for college students (Hodara, 2013), and found only one study focused specifically on college students with learning disabilities (Hodara, 2013). Based on our review of the literature, we found three studies related to mathematics interventions for college students with LD. Zawaiza and Gerber (1993) evaluated the effects of two interventions for solving word problems (translation training versus diagramming) compared to a control group on the performance of college students with and without LD. Students in the diagram group made fewer errors on a post-test than students in either of the other groups, and students with LD made similar types of errors as students without LD. While not statistically significant, the results indicate that strategy instruction for word problems may benefit college students with LD.

Kitz and Thorpe (1995) investigated whether incoming freshmen with LD improved their basic algebra skills after receiving explicit instruction delivered via videodisc (with teacher-facilitated practice) compared to a control group (textbook instruction). Students in the videodisc condition made statistically significant improvements from pre to post-test compared to the control group. Kitz and Thorpe recommend researchers examine cognitive strategy instruction for solving word problems.

Sullivan (2005) conducted an action research study with three college students with LD within a college mathematics class. The qualitative study used manipulatives, journal writing, and multiple forms of assessment for a unit on finances. The unit emphasized making sense of mathematics, explaining one's work, and incorporating discourse about mathematics. All three students made improvements during the unit. Sullivan calls for more research in this area, in part to provide guidance to college mathematics teachers working with students with LD.

The results of these three studies demonstrate that access to interventions can help college students with LD improve their mathematical performance. All three studies recommend the use of strategies to help students make sense of problems, such as cognitive strategy instruction, manipulatives, and diagram representations of problems. However, because these studies were all conducted prior to 2005, they do not incorporate specific intervention strategies that have been found to be effective for teaching secondary students with LD in more recent years (e.g., CRA-I). Additionally, none of the studies included a specific measure of the extent to which college students with LD found the interventions and strategies to be socially acceptable.

Mathematics Focus: Rate of Change

Rate of change (i.e., slope; ROC) is one key mathematics concept pertinent to success in academic courses, professional careers, and independent living. Examples of ROC problems include calculating average miles per gallon, creating budgets, and determining appropriate quantities when converting recipes. ROC is a foundational concept for success in algebra and higher-level mathematics, but many students struggle with understanding and using ROC (Hattikudor et al., 2012; Teuscher et al., 2010). College students without LD have difficulty understanding the concept of slope, often due to conceptual misunderstandings (Bezuidenhout, 1998; Christensen & Thompson, 2012). Researchers have yet to examine the ROC understanding of college students with LD.

Only one study thus far has investigated the effects of an intervention on the ROC understanding of students with disabilities (Bundock et al., 2019). In this study, researchers found that an intervention consisting of CRA-I and a problem-solving heuristic (POD✓) resulted in improvements in three ninth-grade students' (with high-incidence disabilities) scores on ROC assessments. Students' improvements were gradual and smaller for more complex skills, such as solving ROC word problems. Given these results, as well as the difficulties college students without LD face understanding ROC (Bezuidenhout, 1998; Christensen & Thompson, 2012), it is important to determine the efficacy of such an intervention with college students with LD.

Purpose and Research Questions

The purpose of this pilot study was to conduct a preliminary investigation of the effects of an intervention consisting of explicit strategy instruction within a CRA-I framework to teach ROC concepts to a college student with LD. Building from prior research, we developed an intervention including visual representations and a problem-representation strategy to teach concepts and procedural steps involved in solving ROC word problems. We employed single case research design (SCRD) methods to conduct a thorough analysis of the student's overall mathematics scores and specific component scores relevant to the intervention. Considering the extremely limited research in this area, the use of a small-n design is a logical preliminary step to inform future, larger intervention studies. The purpose of this pilot SCRD study is to determine initial support and proof of concept for the potential effectiveness of conducting targeted mathematics interventions with college students who have LD. Our research questions were:

1. Does implementing an explicit instructional strategy (POD✓) within a CRA-I framework result in improvements in solving rate of change problems for a college student with LD?

2. Is an explicit instructional strategy (POD✓) within a CRA-I framework socially acceptable to a college student with LD?

Method

Participant and Setting

This study was conducted at a public land-grant university within the Intermountain West in the United States of America. The in-person sessions for this study were conducted in empty conference rooms in the building that houses the College of Education and Human Services, and the virtual sessions were conducted over Zoom. After obtaining Institutional Review Board approval, participants were recruited for this study by distributing an informational flyer through an email list serve organized by the university Disability Resource Center. One potential participant (Ada - pseudonym) contacted the researchers as a result and was screened to determine her eligibility for the study. The screening procedures included Ada verifying her disability status and completing two screening assessments. The first screening assessment consisted of the Applied Problems and Calculation subtests of the Woodcock Johnston Tests of Achievement- Fourth Edition (WJ IV ACH). The WJ IV ACH (Schrank et al., 2014) is a standardized test of achievement for individuals ages 2-90+. Overall, the test evidences high reliability in secondary school populations (0.99). Mathematics domains (.98-.99) and mathematics subscales (.88-.94) are also highly reliable within this age group. The Applied Problems and Calculation subtests provide standardized scores in Mathematics Problem Solving and Mathematics Calculation Skills. Participants were eligible for the study if they scored in the bottom 25th percentile on any of the domains. The second screening assessment was a researcher-created Rate of Change (ROC) assessment (see description in measures). Participants were eligible for the study if they earned less than half of the points available on the assessment.

Ada was determined to be eligible for the study, based on having scores that were in the bottom 25th percentile; Ada scored in the bottom 10th percentile on the Applied Problems subtest, and the bottom 8th percentile for the Calculation subtest. Ada also completed a ROC assessment and was eligible for the study, based on earning less than 50% of the points available; Ada earned a total of 12 points (40%) on the ROC screening assessment.

Ada was a white 21-year-old Sophomore female majoring in Special Education. Ada reported that her income was in the range of 0-$9,525, and that she received special education services in mathematics when in K-12 school under the category of LD. The highest level of mathematics Ada reported completing in high school was Secondary Mathematics II. Ada indicated that on average, she earned C grades in her high school mathematics courses. At the time of this study, Ada had completed 4 semesters of college course work and was not enrolled in a college mathematics course.

Study Design

We used an ABC (i.e., baseline, intervention, maintenance) single-case research design (SCRD). This design was used as the intervention targeted academic skill acquisition, wherein a return to baseline (i.e., reversal design) is inappropriate. To produce evidence of an intervention effect, SCRD studies must include replication of effects across at least three points in time (Horner et al., 2015). Due to only having one participant and the ABC design, the current SCRD does not meet What Works Clearinghouse standards (Kratochwill et al., 2010; WWC, 2020). Although this limits the generalizability of the conclusions we can draw, this design is adequate for a pilot study because our purpose is to provide proof of concept.

Dependent variables

The primary dependent variable was overall points scored on the ROC assessment. We also evaluated scores on specific components of the items on the ROC assessment that consisted of the following: determining the correct answer, writing an accurate equation, creating a table, creating a graph, and including accurate numbers and labels on the graph axes. A secondary dependent variable in this study was self-regulated learning and motivation, as measured by task-specific interviews. The details and results pertaining to this dependent variable are outside of the scope of this manuscript, and are reported in another manuscript (Authors et al., under review).

Independent variable

The independent variable for this study was an intervention consisting of 12 lessons (see Figure 1) that used an explicit instructional sequence (i.e., model, guide, practice, test) to teach students how to interpret and solve ROC word problems. Two key components of the intervention were the use of a CRA-I framework, as well as the POD✓problem solving strategy.

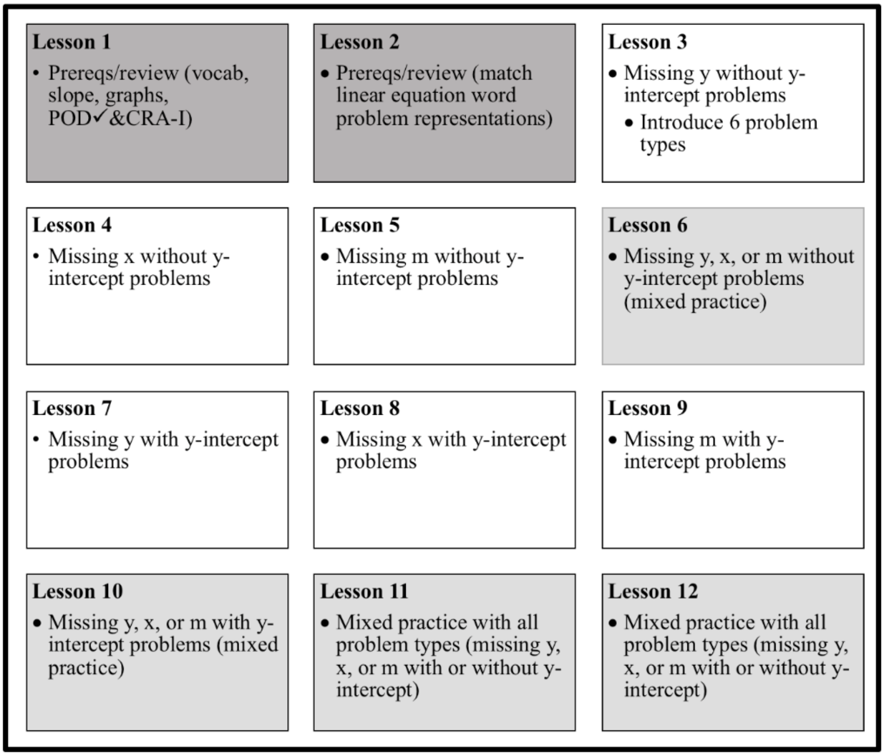

Figure 1. **Scope and Sequence of the Intervention Lessons**

CRA-I. Through a CRA-I framework, Ada was taught concrete representations of ROC using interlocking centimeter cubes, diagrams, and abstract notations (equations, tables, graphs). To depict ROC concepts using centimeter cubes, white cubes represented a foundation to build from (i.e., the x axis), and colorful cubes were used to model the problem in a similar way to graphing an equation. The representational level consisted of drawing lines to represent how each y value corresponded to each x value (see Figure 2). This representation lent itself well to bridging to the abstract notation used in tables and graphs. Ada was taught how to use CRA-I to work through the problems, and during practice problems and exit slips, was given the choice of which representation (C, R or A) to work with.

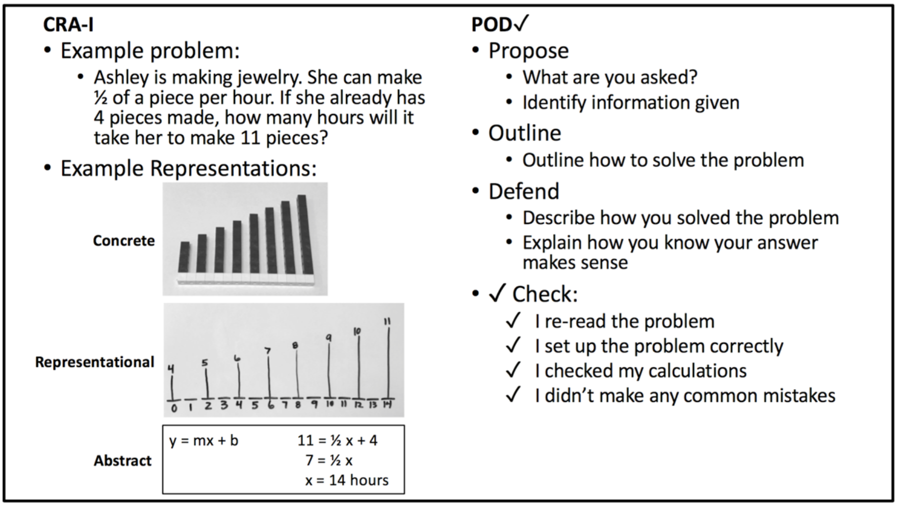

Figure 2. **Key Components of the Intervention**

POD✓ Problem Solving Strategy. In addition to CRA-I, a problem-solving strategy was also used as a key part of the intervention. The POD✓ strategy included the following components: Propose the problem, Outline steps to solve the problem, Describe how you solved the problem, Defend how you know your answer makes sense, and Check your work by re-reading the problem, checking the set-up of the problem, checking calculations, and checking for common mistakes. A graphic organizer was used to introduce the strategy to Ada, and was gradually faded. Memorization of the strategy was supported through review questions at the start of each lesson, and gradually reducing prompts for the strategy components throughout the lessons. Ada used the POD✓ to solve at least two problems per lesson.

Materials and Measures

Rate of Change Assessments

The measure used to assess Ada's progress on the main dependent variable was a researcher-created Rate of Change (ROC) Assessment. The ROC assessment included six ROC word problems for which Ada was prompted to write an equation to represent the problem, solve the problem, create a table, and sketch a graph. Six problem types were represented on the assessment (one question per type), all based on the slope intercept equation (y=mx+b). The problem types reflected different missing information in each word problem and included: missing y variable, missing x variable, missing m variable, missing y variable with a y-intercept, missing x variable with a y-intercept, and missing m variable with a y-intercept. Each item on the ROC assessment was worth 1 point with partial credit (i.e., 0.5) possible. The first author and a team of research assistants scored the assessments using a rubric, which specified what categories of responses should receive 0 points, 0.5 points, or 1 point. For each word problem, Ada received up to 1 point for writing an accurate equation, up to 1 point for finding the correct answer to the problem, up to 1 point for creating a table with at least 3 correct pairs of values, up to 1 point for setting up a graph (correct axes labels and numbering), and up to 1 point for accurately graphing at least 3 coordinate points. There were 36 total possible points on each assessment.

Researchers created a pool of 30 different ROC assessments for this study. To help create assessments of equal difficulty, the researchers ensured that there were three problems that used fractional rates and three that used whole number rates on each assessment. Additionally, only common fractions were used (denominators of 2, 3, 4, or 5), and all numbers within the problems (including the answers) were one or 2-digit numbers. Researchers first created a pool of 30 items for each of the six different problem types (for a total of 180 problems), and then reviewed the problems within each pool to control for difficulty. Second, researchers created each assessment by randomly selecting one of each of the six problem types to assign to each of 30 assessments. The researchers reviewed each of the 30 resulting unique assessments for consistency, reading accessibility, and difficulty. Following this review, the researchers randomized the completed assessments to determine their administration order for the study.

Social Validity Questionnaire

A modified version of the Children's Intervention Rating Profile (CIRP) was used to evaluate the social validity of the intervention (Arra & Bahr, 2005). The version of the measure used in this study was electronic (via Qualtrics) and included eight items, each rated on a 1-6 Likert scale, that evaluated the appropriateness and perceived effectiveness of the CRA-I and POD✓ strategies.

Materials

The materials for this study included paper ROC assessments, worksheets corresponding to each lesson, interventionist lesson scripts, centimeter interlocking cubes, individual dry erase boards, a ruler, and a calculator. During baseline and maintenance sessions, Ada had a paper ROC assessment, a calculator, and a ruler. During intervention sessions, Ada had a lesson worksheet, individual dry erase board, a set of centimeter interlocking cubes, a calculator, a ruler, and a paper ROC assessment (given at end of specific intervention sessions).

The ROC assessments were each six pages long and included one word problem on each page. For each problem, there was a two-by-two grid with one of the different problem prompts (i.e., equation, answer, table, graph) included in each of the four cells. A standard 12-inch (30.48 cm) ruler was provided for

Ada to use as needed during assessment and lesson sessions. Ada also had access to a Scientific calculator for use at any time in the lessons or on the assessments.

The worksheets corresponding to each lesson were typically five pages long. The first page included review problems, the second through fourth pages included new problems for teaching and practice, and the last page consisted of an exit slip to assess understanding of new content. The material on each page was arranged in two columns, with the problem and prompts for associated tasks (blanks for equation, key information, table, graph, and blank space) in the left-hand column and a POD✓ graphic organizer in the right-hand column. The POD✓ graphic organizer included prompts aligned with the strategy, which were gradually faded over the course of the lessons to single word prompts and eventually blank lines for the student to fill in. The interventionist lesson scripts consisted of a step-by-step script that interventionists used to conduct each lesson, and included the answers to each problem. Interventionists used the script as a guide, rather than reading from the script verbatim. Each step in the lesson was numbered and interventionists attended to addressing each step in each lesson.

In regards to the additional lesson materials, the interventionists and student used the centimeter interlocking cubes to create concrete depictions of the word problems. Individual dry erase boards were used as an instructional tool for the interventionists to model examples of diagrams, as well as how to solve equations, create tables, and sketch graphs. Each dry erase board included a blank side, as well as a side with a coordinate grid. Ada was also provided with an individual dry erase board of the same style that she could use to follow along with interventionist modeling of concepts, and/or to work through problems, as an alternative to writing on only the worksheet.

Measures of Treatment and Assessment Fidelity

To assess the fidelity of assessment administration in all phases of the study, researchers created and used an assessment fidelity checklist. The assessment fidelity checklist included places to record the date of assessment administration, total time of the assessment administration, person administering the assessment, and participant ID code. The checklist then included columns to mark whether each component of administration was completed, not completed, or not applicable. The components evaluated included whether the assessor read the scripted directions for assessment administration, provided the student with a calculator, asked the student if they would like any of the questions read aloud to them, and provided appropriate clarifications in response to student questions (if applicable). Clarifications were considered to be appropriate if they did not give away the answer or how to find it (i.e., re-read the prompt, simplifying vocabulary in the prompt, etc.), and inappropriate if they included any explanation of how to solve the problem (i.e., explanation of what slope/rate of change is, providing an example of an equation, etc.). Researchers calculated fidelity by dividing the total number of components completed by the total number of applicable components, and then multiplying by 100%.

To assess the fidelity of lesson administration, researchers created and used procedural checklists that were unique to each lesson. Each checklist included prompts for the researcher to fill in the date, the time the lesson started and ended, participant ID code, and the name of the person completing the checklist. Each checklist included rows that corresponded with each numbered step of the scripted lesson (aligned with the lesson scripts), and columns to indicate if the step was completed, not completed, or not applicable. Each checklist included an average of 32 steps (range 26-46 steps). Researchers calculated fidelity by dividing the total number of steps completed by the total number of steps possible, and then multiplying by 100%.

Procedures

Training

The assessments and intervention sessions were implemented by an assistant professor of special education (first author) and a doctoral student in school psychology. Both interventionists were present for the majority of all intervention lessons (each missed one session due to conferences or schedule conflicts), and took turns delivering instruction using scripted lesson plans. The doctoral student conducted most of the assessment sessions across all phases.

Prior to the beginning of the study, the first author trained the doctoral student in assessment administration and intervention lesson delivery. As part of the training, the doctoral student administered a practice assessment and completed a fidelity checklist to self-assess, while the first author also completed a fidelity checklist. The doctoral student administered the assessment with 100% fidelity. The first author also modeled how to teach each intervention lesson, with the doctoral student serving as a mock participant, across 10 training sessions. The first author highlighted key components of the intervention (i.e., CRA-I and POD✓), and both the first author and doctoral student completed fidelity checklists during these training sessions.

Rate of Change Assessment Administration and Scoring

Baseline

Ada started baseline after meeting the eligibility criteria. During baseline, the interventionists met with Ada three times per week to administer the ROC assessments (twice weekly). Once per week the doctoral student conducted brief task-specific interviews to evaluate Ada's self-regulated learning and motivation (the details and results of which are outside of the scope of this manuscript, and are reported in another manuscript). Ada completed a total of five ROC assessments during baseline, which occurred over the course of two weeks. No additional activities were completed during baseline.

Intervention

The intervention phase started after five baseline data points were collected, and baseline data were stable with a slightly decreasing trend. During intervention, Ada met with interventionists to engage in lessons three times per week. Ada completed 12 lessons, which were taught by the first author and doctoral student interventionist using highly-structured lessons. Each intervention lesson followed the same format, which entailed a review of concepts taught in prior lessons (pre-requisite skills were reviewed at the start of Lesson 1), modeling of new concepts with frequent opportunities to respond incorporated, practice of new concepts with scaffolded interventionist support, and Ada's independent completion of an exit slip problem aligned with the content introduced in the lesson. Within each lesson, the interventionists taught and guided Ada in how to use the centimeter interlocking cubes to create concrete depictions of the word problems, and how to represent these concrete depictions through diagrams. The interventionists also taught Ada how to interpret word problems to set up equations, and reviewed how to solve equations, create tables, and sketch graphs. The interventionists guided Ada in how to use the POD✓ problem solving strategy to work through the problems.

Following each lesson, Ada completed either a ROC assessment (twice weekly) or a task-specific interview (once weekly). Ada completed ROC assessments at the end of the intervention sessions in which she completed Lessons 1, 3, 4, 7, 8, 10, and 11, and task-based interviews at the end of intervention sessions in which she completed Lessons 2, 5, 9, and 12. Intervention sessions lasted an average of 64 minutes per session (range 51-86 minutes) for a total of 8 weeks. There was a pause in intervention procedures in week 4 for the university spring break.

Additionally, the university IRB paused all in-person research procedures after week 5 of the intervention due to the COVID-19 pandemic, which resulted in a two-week pause to transition to a virtual format. The last week of intervention as well as all of the maintenance phase sessions were delivered over Zoom. Ada was provided with paper copies of all materials, a calculator, a ruler, an individual dry erase board, and her own set of manipulatives to use at home. Intervention procedures remained the same and continued at a frequency of three times per week via Zoom. Ada completed each ROC assessment at the end of each Zoom session, with the interventionists present. Immediately after the Zoom session, Ada took pictures of each page of the assessment she completed and emailed them to the first author.

Maintenance

Maintenance began after Ada completed all 12 intervention lessons. Ada met with the interventionists 1-2 times per week for a total of 5 sessions. During maintenance, no instruction was provided and Ada completed 1-2 ROC assessments as well as 1-2 task-specific interviews per week. In maintenance sessions 2, 4, and 5, Ada completed a ROC assessment and a task-specific interview; In maintenance sessions 1 and 3, Ada completed only ROC Assessments. Maintenance lasted 4 weeks, and Ada completed a total of 5 ROC assessments. After Ada completed the last maintenance session, the interventionist emailed her a link to the electronic social validity questionnaire and prompted her to complete it independently within one week. Ada completed the social validity questionnaire on her own, without an interventionist present.

Fidelity and Inter-Observer-Agreement (IOA)

During all phases, researchers conducted fidelity checks on ROC assessment administration and intervention implementation. Both interventionists independently completed intervention fidelity checklists that were specific to each lesson. Based on checklists completed by the first author across all 12 sessions, the overall fidelity of intervention implementation was 99.7% (range 96.9-100%). To assess IOA, the ratings on the fidelity checklists completed by each interventionist were compared to determine agreement on a total of 9 of the 12 sessions. Checklists were compared for point by point agreement, which involved identifying whether marks from each interventionist matched on each item on each fidelity checklist. Average agreement was 99.6% (range 96.9-100%).

Fidelity and IOA were also assessed for ROC assessment administration. The doctoral student interventionist administered the majority of the assessments, and self-rated fidelity using an assessment fidelity checklist (100% fidelity). To conduct IOA checks, the first author reviewed and completed a checklist for 7 of the 18 video recorded assessment sessions (100% agreement).

Assessment Scoring and Inter-Rater-Reliability (IRR)

During all phases, a team of research assistants scored Ada's completed ROC assessments. The first author scored all of the assessments. Since the first author was also an interventionist, IRR was calculated for 88.89% of the assessments. The first author developed and refined a scoring rubric with the assistance of a third-year special education doctoral student. The first author then trained a fourth-year school psychology masters' student and three undergraduate research assistants in the scoring procedures. Each person first scored three sample assessments (not completed by Ada). The scoring team then met to discuss any disagreements. The first author clarified rubric misunderstandings, and any remaining disagreements were discussed until the scoring team came to a consensus. The team then repeated this process by scoring three of Ada's assessments. Initial agreement on these assessments was 91%, and 100% after discussion. The remaining assessments throughout the study were distributed across scorers, with one scorer completing IRR for each assessment. Average agreement was 90% (range 67-100%) and was only below 80% on the first assessment.

Data Analysis

We visually analyzed the data for level, trend, immediacy, and variability of overall scores and component scores on the ROC assessments. We also calculated two effect sizes appropriate for SCRD (Rakap et al., 2020; Yücesoy-Özkan et al., 2020): Percentage of Nonoverlapping Data (PND; Scruggs et al., 1987) and Percentage of Data Exceeding a Median Trend (PEM-T; Wolery et al., 2010). We selected these effect sizes based on recommendations of Yücesoy-Özkan and colleagues (2020), and because there was a positive baseline trend for two component scores we analyzed. The intervention effectiveness for Ada was interpreted based on PND guidelines: highly effective (at or above 90%), moderately effective (70-89%), questionably effective (50-69%), and ineffective (below 50%; Scruggs et al., 1987). No benchmarks have been published for interpretation of PEM-T (Yücesoy-Özkan et al., 2020).

Results

Mathematics Outcomes

Overall Mathematics Scores

During baseline, Ada had a mean score of 54.32% correct (range 53-58.3%), with a slightly decreasing trend and low variability (see Figure 3). Ada started intervention in the sixth session, and completed a total of 8 ROC assessments during that phase. During intervention, Ada had a mean score of 77.07% correct (range 48-66.67%) with a noticeable increase at the second and third data points and continued to have an overall slightly positive trend for the remainder of intervention. There was low variability during intervention, and the level of performance was higher than that during baseline. The PND and PEM-T effect sizes for overall scores were each 87.5% (moderate).

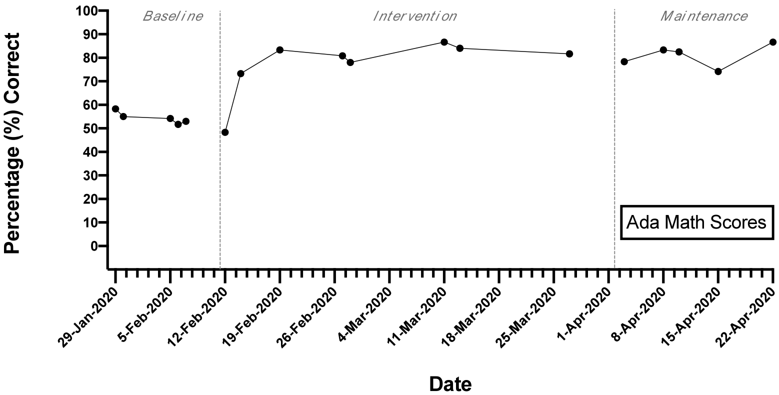

Figure 3. **Graph of Ada's Overall Rate of Change Assessment Scores**

During maintenance, Ada completed five assessments (1-2 per week), starting approximately 2 weeks following the last intervention session. Ada's scores continued to remain relatively stable, with slight increases in scores occurring during the second and fifth maintenance sessions, and slight decreases in scores occurring during the third and fourth maintenance sessions. During maintenance, Ada had an overall mean of 80.99% correct (range 74.16-86.87%). The PND and PEM-T effect sizes during maintenance compared to baseline were each 100.00% (very effective).

Answer Scores

For the component score of computing the correct answer to the word problems, Ada had a mean score of 57% correct during baseline. Her scores were somewhat variable, ranging from 50-66.67%, with a slightly decreasing trend (see Figure 4). Ada calculated the correct answer to the word problems during intervention on average 84.37% of the time (range: 58.3-100%). There was an increasing trend during intervention, with a large increase in scores on the third intervention data point, at which point Ada found the correct answer on 100% of the word problems. The increase in level was maintained throughout intervention, with moderate variability (range 58.3-100%). Lower scores occurred on the fifth and seventh intervention data points. The PND effect size was 62.5% (questionably effective), but the PEM-T effect size for this component was 100%.

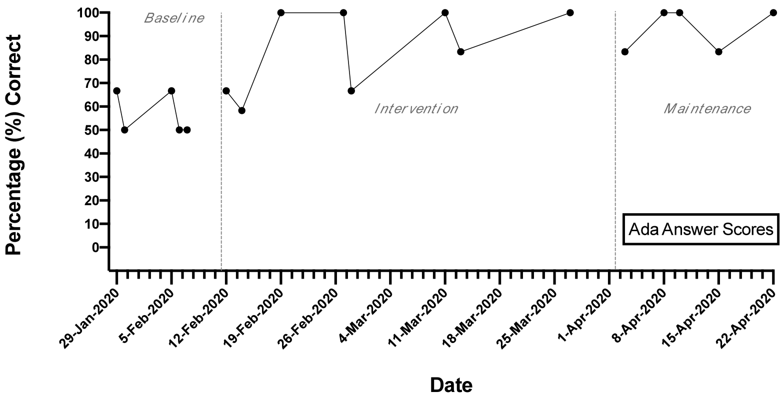

Figure 4. **Graph of Ada's Rate of Change Assessment Answer Component Scores**

On average, Ada calculated the correct answer to the word problems 93.32% of the time during maintenance. There was slight variability during this phase (range 83.3-100%), but less so compared to intervention. The level of performance on this component score was at a higher level compared to both intervention and baseline. The PND and PEM-T effect sizes during the maintenance phase compared to baseline were each 100.00% (very effective).

Equation Scores

During baseline, Ada wrote an accurate equation to represent each word problem on average 29.99% of the time. Equation scores overall were low during baseline, with moderate variability (range 16.67-41.66%), and an increasing trend (see Figure 5). During intervention, Ada wrote an accurate equation to represent the word problem on average 81% of the time (range 9-100%). After an initial drop in scores on the first intervention data point, Ada had a substantial increase in scores compared to baseline starting with the second intervention data point, and her scores continued to increase throughout intervention. Ada earned 100% of points on intervention data point five, and maintained 100% scores for the duration of the intervention. There was very low variability between the second through last intervention data points, but wider variability when the first intervention data point is considered. There was an increasing trend during the intervention phase. The PND effect size for writing an accurate equation was 87.5% (moderately effective) and PEM-T was 50%.

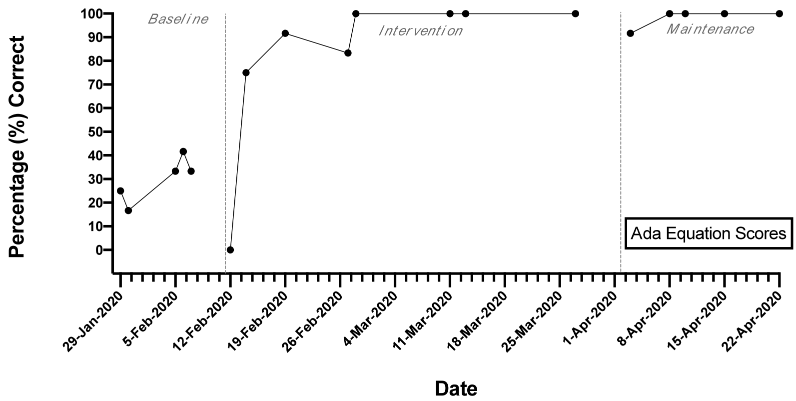

***Figure 5.* Graph of Ada's Rate of Change Assessment Equation Component Scores**

Ada wrote an accurate equation aligned with the word problems on average 98.33% of the time during maintenance (range 91.6-100%). The level was high overall, with all but one data point at 100%. There was also low variability, and the variability was lowest in this phase compared to the intervention and baseline phases. The PND for writing an accurate equation during maintenance compared to baseline was 100.00% (very effective), and PEM-T was 0%.

Table Scores

Ada created an accurate table that aligned with the word problem on average 47% of the time during baseline, with moderate variability (range 33.3-66.67%), and a slightly increasing trend (see Figure 6). Ada created an accurate table that aligned with the word problem on average 53.1% of the time (range 33.3-66.67%). There was similar variability compared to baseline, a slightly increasing trend, and a slight increase in level compared to baseline. There was not clear evidence of an immediate increase in scores. The PND was 0.00% (not effective), and PEM-T was 25%.

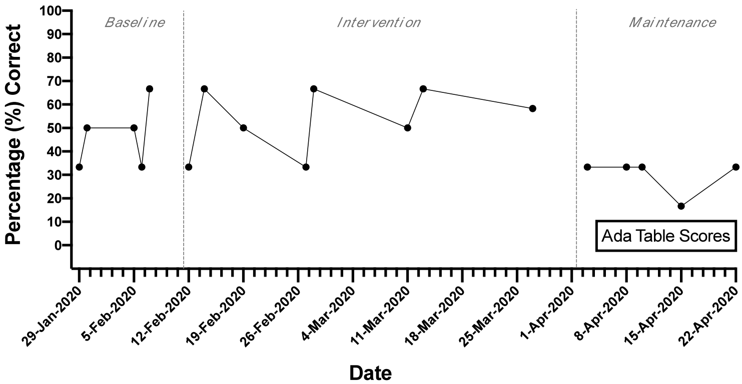

***Figure 6*. Graph of Ada's Rate of Change Assessment Table Component Scores**

Ada created a table that aligned with the word problems on average 29.97% of the time during maintenance. Scores were more stable during maintenance than during baseline or intervention (range 16.66-33.3%), but the level also dropped to below the level of scores in either intervention or baseline. There was an immediate decrease in scores corresponding with the start of the maintenance phase. The PND and PEM-T effect sizes during maintenance compared to baseline were both 00.00% (not effective).

Graph Scores

During baseline, Ada created accurate graphs on average 91.66% of the time, indicating a high level of performance. There was moderate variability (range 75-100%), and a slightly decreasing trend (see Figure 7). Ada created accurate graphs on average 98% of the time during intervention (range 91.66-100%). The level was high; only two points fell below 100%. There was lower variability compared to baseline, and an immediate increase in scores compared to the last data point of baseline. The trend overall was flat throughout intervention. The PND was 0.00% (not effective), and PEM-T was 100%.

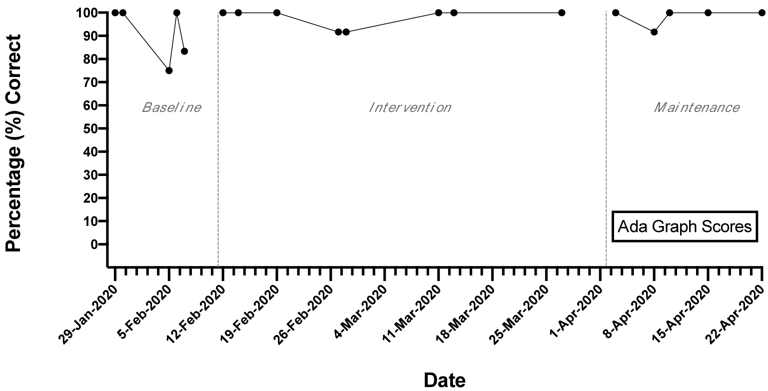

Figure 7. **Graph of Ada's Rate of Change Assessment Graph Component Scores**

During maintenance, Ada created an accurate graph on average 98% of the time (range 91.66-100%). Level remained high with low variability; only one data point fell below 100%. There was not an increase or decrease in level compared to intervention, although the overall level in maintenance was higher than the overall level during baseline. The PND during maintenance compared to baseline was 0.00% (not effective), while PEM-T was 100%.

Axes Numbering and Labeling Scores

For the component of including accurate axes labels and numbers, Ada had a mean score of 46.65% correct during baseline, with moderate variability (range 29.16-66.67%), and a decreasing trend (see Figure 8). During intervention, Ada had a mean score of 68.75%. There was an increase in scores starting at the third intervention point, which continued through the fourth intervention data point. There was wide variability during intervention (range 41.66-95.83%), and evidence of a slightly decreasing trend, although the overall level of scores remained higher in intervention than the level of scores during baseline. The PND was 75.00% (moderately effective), and PEM-T was 100%.

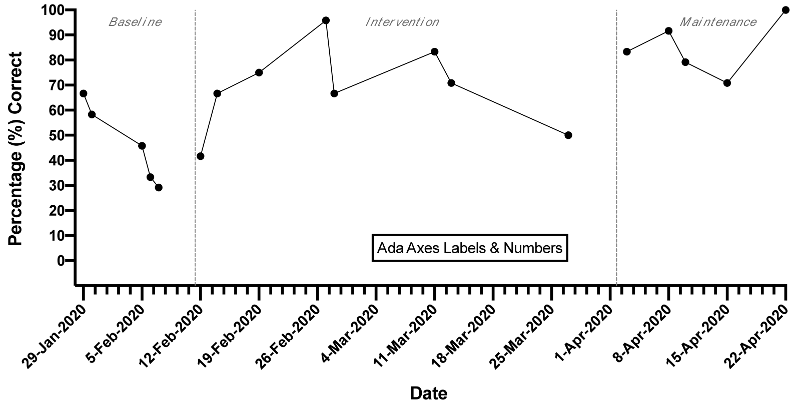

Figure 8. **Graph of Ada's Rate of Change Assessment Axes Numbering and Labeling Component Scores**

For the component score of axes labels and numbers, Ada had a mean score of 84.99% during maintenance. There was an immediate increase in scores that corresponded with the start of the maintenance phase, less variability compared to baseline or intervention phases (range 70.83-100%), as well as a higher level of performance. The PND and PEM-T effect sizes during maintenance compared to baseline were each 100.00% (very effective).

Social Validity Results

Ada completed the modified CIRP during the maintenance phase of the study in the format of an online survey (Table 1). Overall, Ada provided answers of "strongly agree" to questions 3 (easy to use), 4 (satisfied), and 6 (future use for unrelated word problems), and answers of "agree" to questions 1 (useful), 2 (practical), and 7 (helpful for other math classes). On questions 5 (future use for rate word problems) and 8 (recommend for other students), Ada answered "somewhat disagree".

Table 1. ***Modified CIRP Social Validity Questionnaire, With Ada's Responses***

Question	Rating*
1) The cubes, diagrams, and POD✓ strategies are useful for solving rate of change word problems.	5
2) The cubes, diagrams, and POD✓ strategies are practical for solving rate of change word problems.	5
3) The cubes, diagrams, and POD✓ strategies are easy for me to use for solving rate of change word problems.	6
4) I am satisfied with using the cubes, diagrams, and POD✓ strategies to solve rate of change word problems.	6
5) I will use the cubes, diagrams, and POD✓ strategies to solve rate of change word problems in the future.	3
6) I will use the cubes, diagrams, and POD✓ strategies to solve other word problems in the future (for word problems that relate to concepts other than rate of change).	6
7) Using the cubes, diagrams, and POD✓ strategies will help me do better in mathematics classes.	5
8) I would recommend that other students learn how to use the cubes, diagrams, and POD✓ strategies to help them solve word problems.	3

Note. *Ratings were on a six-point Likert scale: 1=strongly disagree; 2=disagree; 3=somewhat disagree; 4=somewhat agree; 5=agree; 6=strongly agree.

Discussion

Summary of Key Findings

The results of this study indicate that Ada improved in her ability to solve rate of change word problems following participation in an intervention involving CRA-I and the POD✓ strategy. There were slightly variable results across the six different outcomes we analyzed.

Strongest Improvements

Visual analysis, PND, and PEM-T all provide consistent evidence of the intervention being highly effective for improving Ada's overall ROC scores. Notably, the effect sizes appear to be moderately effective when baseline and intervention phases are compared, but highly effective when baseline and maintenance are compared. These promising results are consistent with prior research with secondary students (Bundock et al., 2019), because they indicate that Ada continued to make improvements up to four weeks following the end of intervention. We found similar results for the component of calculating the correct answer, although these scores were more variable during intervention than overall scores. Additionally, the PND and PEM-T effect sizes vary from one another for this component, with PEM-T being higher than PND, likely due to PEM-T controlling for the decreasing baseline trend.

Visual analysis, PND, and PEM-T offer slightly different interpretations of the results for the component score of writing an accurate equation. Visual analysis appears to show an effect based on the increase in level and decrease in variability in intervention and maintenance phases compared to baseline, as well as the relatively immediate improvement between baseline and intervention phases. When baseline trend is accounted for, these results should be interpreted more cautiously, as evidenced by the PEM-T effect size of 50%. However, rate of improvement was higher in intervention than baseline, and the effects were maintained well during the maintenance phase, with Ada scoring 100% four out of the five data points during maintenance.

For the component of using accurate numbers and labels on the graph axes, visual analysis, PND, and PEM-T all provide consistent evidence of the intervention being at least moderately effective in improving Ada's performance. For this component, Ada had the sharpest decreasing trend during baseline. There was evidence of an immediate effect during intervention, although there was some variability during the intervention phase. While there is still a higher degree of variability during maintenance compared with other component scores, both PND and PEM-T indicate that the intervention is highly effective when that phase is compared to baseline.

Components With Evidence of Small to No Effects

The graph and table components did not show clear evidence of intervention effectiveness. Each of these components were related, because we scored graphs based on how accurately Ada graphed the points that she included on the table, rather than how accurately her graph represented the word problem. Ada had the highest level of baseline performance on the graph component compared across outcomes, which may reflect a ceiling effect related to how we scored this component. PND and PEM-T effect sizes provide conflicting evidence of intervention effectiveness for this component. In this case, PEM-T accounts for the slightly decreasing trend during baseline, while PND does not. We consider the intervention to be questionably effective for the graph component, primarily because Ada's scores in intervention and maintenance decreased in variability and increased in overall level when baseline is compared to intervention and maintenance. Additionally, Ada scored 100% for this component four out of the five data points during the maintenance phase.

For the component of table, visual analysis, PND, and PEM-T all provide consistent evidence of the intervention being unlikely to have made an effect. This is interesting, because Ada's scores in answer and equation did show evidence of intervention effectiveness. Ada often had lower scores for the table component on the assessment because she regularly constructed the table with the correct rate of change, but the incorrect y-intercept. The table results indicate that, while Ada did improve in calculating the correct answer to the word problems, she might not have made improvements conceptually regarding understanding the y-intercept. These results are consistent with prior research indicating that students struggle with understanding the concept of the y-intercept (Hattikudor et al., 2012). Future research should examine college students' understanding of the y-intercept, and strategies to improve their creation of tables and graphs for rate of change word problems.

Implications for Research and Practice

While the results of this study cannot be generalized due to the inclusion of only one participant, there are several contributions this study makes to the research base on mathematics interventions for college students with LD. First, Ada made similar improvements in solving rate of change word problems compared to those made by high-school students with high-incidence disabilities in prior research who participated in a similar intervention (Bundock et al., 2019). This finding supports Hodara's (2013) recommendation that research be conducted with college students with LD to evaluate the use of instructional strategies and interventions that are effective for teaching mathematics to secondary students with LD. Future research should be conducted with college students with LD to determine if this intervention, and other research-based interventions, lead to improvements in students' performance in specific mathematics topics and college level mathematics courses.

Second, prior mathematics intervention research conducted with college students with LD did not incorporate a specific measure of how students felt about the intervention. Ada found the intervention to be socially acceptable overall. She provided high ratings regarding her satisfaction with the intervention, ease of use of the strategies, and her likelihood to use these strategies for other types of word problems. Ada indicated that she somewhat disagreed that she would use the strategies for future rate of change word problems, and whether she would recommend this intervention for other students. Due to the measure not including open-ended questions to prompt Ada to provide more information, we cannot know why Ada included the ratings she did. Additionally, there is a chance that Ada's responses to the social validity questionnaire were biased, due to Ada being the only participant. Ada may have been hesitant to provide honest feedback, since the feedback could be attributed to her. Future research should delve further into the views of college students with LD in the context of their participation in mathematics interventions, to identify factors to consider when developing and implementing interventions.

Third, prior mathematics intervention studies conducted with college students with LD were all conducted within the context of intact mathematics or study skills classes (Sullivan, 2005; Zawaiza & Gerber, 1993), or within summer transition programs (i.e., programs students participate in during the summer before their Freshman year; Kitz & Thorpe, 1995). The current study is unique in that it involved one-on-one intervention sessions tied to a specific mathematics concept. Research is needed to identify strengths and weaknesses of different intervention delivery models within a college context.

Limitations

There are several limitations that should be considered when interpreting the results of this study. First, we only had one student contact us in response to our recruitment efforts. This limits the generalizability of the results, and also indicates that recruitment may be a potential challenge for conducting intervention research with college students with LD. We recruited participants for this study through the university's Disability Resource Center. However, research indicates that only approximately 17% of students with LD receive supports or accommodations through their post-secondary school (Newman et al., 2011). This may be due to the differences in how students access supports in post-secondary contexts compared to K-12 contexts; in post-secondary contexts students have to proactively pursue formal access to any accommodations, which can often present a challenge (Williams et al., 2020). Future research should include broader and more innovative recruitment efforts to reach college students with LD who might not yet be accessing supports through their post-secondary institution. Additionally, one strategy future researchers should consider using when faced with low participant numbers is the use of a multiple-baseline design across sets, which would entail examining students' response to the same intervention (e.g., CRA-I and POD✓ problem solving strategy) across different mathematics concepts.

Two additional limitations should be considered when interpreting the results. First, this study occurred as the COVID-19 pandemic initially hit the U.S., resulting in an abrupt pause in the study and then a transition to virtual sessions. The COVID-19 disruption and switch to virtual sessions may have impacted Ada's performance, in particular because it encompassed a change in intervention procedures and because the maintenance phase could not be a return to the exact conditions of baseline. However, the study procedures were consistent enough across the in-person and virtual sessions that it is unlikely the virtual delivery significantly impacted Ada's performance. Second, the intervention amounted to a total of 12.7 hours across 12 lesson sessions; this may be too much time to reasonably expect of college students, in particular if they are managing challenging coursework as well as employment. Future research should focus on designing interventions that are time and resource efficient to maximize broader implementation and impact.

Conclusion

The purpose of this pilot study was to conduct a preliminary investigation of the effects of an intervention consisting of explicit strategy instruction within a CRA-I framework to teach ROC concepts to Ada, a college student with LD. Results indicate that Ada made improvements in solving rate of change word problems following her participation in an intervention that incorporated an explicit instructional strategy (POD✓) within a CRA-I framework, and Ada found the intervention overall to be socially acceptable. Given the lack of mathematics intervention research conducted with college students with LD, the results of this study provide proof of concept and promising preliminary evidence to support implementing targeted mathematics interventions with this population. Given that college students with LD currently complete post-secondary school at a lower rate than their peers without disabilities (Williams et al., 2020), researchers and practitioners should direct more efforts to exploring the effectiveness of a variety of different interventions, with the goal of improving the post-secondary outcomes of students with LD.

References

Agrawal, J., & Morin, L. L. (2016). Evidence-based practices: Applications of concrete representational abstract framework across math concepts for students with mathematics disabilities. *Learning Disabilities Research & Practice, 31*(1), 34–44. https://doi.org/10.1111/ldrp.12093

Arra, C. T., & Bahr, M. W. (2005). Teachers' and students' preferences for mathematics interventions: Implications for teacher acceptability in consultation. *Journal of Educational and Psychological Consultation, 16*(3), 157–174.

Authors et al., (in review). [Information blinded for review].

Bezuidenhout, J. (1998). First-year university students' understanding of rate of change. *International Journal of Math Education Science and Technology, 29*(3), 389–399.

Bouck, E. C., Satsangi, R., & Park, J. (2017). The concrete–representational–abstract approach for students with learning disabilities: An evidence-based practice synthesis. *Remedial and Special Education, 39*(4), 1–18. https://doi.org/10.1177/0741932517721712

Bundock, K., Hawken, L. S., Kiuhara, S. A., O'Keeffe, B. V., O'Neill, R. E., & Cummings, M. B. (2019). Teaching rate of change and problem solving to high school students with high Incidence disabilities at Tier 3. *Learning Disability Quarterly, 44*(1), 1–15. https://doi.org/10.1177/0731948719887341

Christensen, W. M., & Thompson, J.R. (2012). Investigating graphical representations of slope and derivative without a physics context. *Physical Review Special Topics-Physics Education Research, 8*(2), 1–5. https://doi.org/10.1103/PhysRevSTPER.8.023101

Forgione, P. D. (1999). *Achievement in the United States: Are students performing better?* House of Representatives, Committee on Education and the Workforce.

Hattikudor, S., Alibali, M. W., Prather, R. W., Knuth, E. J., Asquith, P., & Nathan, M. (2012). Constructing graphical representations: Middle schoolers' intuitions and developing knowledge about slope and y-intercept. *School Science and Mathematics, 112*(4), 230–240.

Hodara, M. (2013). *Improving students' college math readiness: A review of the evidence on postsecondary interventions and reforms.* Center for Analysis of Postsecondary Education and Employment.

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., Witzel, B. S., Riccomini, P. J., Fries, K. M., & Kanyongo, G. Y. (2014). A meta-analysis of algebra interventions for learners with disabilities and struggling learners. *The Journal of the International Association of Special Education, 15*(1), 37–47.

Hwang, J., & Riccomini, P. J. (2016). Enhancing mathematical problem solving for secondary students with or at risk of learning disabilities: A literature review. *Learning Disabilities Research & Practice, 31*(3), 169–181. https://doi.org/10.1111/ldrp.12105

Ketterlin-Geller, L. R. & Chard, D. J. (2011). Algebra readiness for students with learning difficulties in grades 4-8: Support through the study of number. *Australian Journal of Learning Difficulties, 16*(1), 65–78. https://doi.org/10.1080/19404158.2011.563478

Kratochwill, T. R., Hitchcock, J. R., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M., & Shadish, W. R. (2010). *Single-case designs technical documentation.* Retrieved from https://ies.ed.gov/ncee/ wwc/Docs/ReferenceResources/wwc_scd.pdf

Kitz, W. R., & Thorpe, H. W. (1995). A comparison of the effectiveness of videodisc and traditional algebra instruction for college-age students with learning disabilities. *Remedial and Special Education, 16*(5), 295–306. https://doi.org/10.1177/074193259501600506

Lee, J., Bryant, D. P., Ok, M. W., & Shin, M. (2020). A systematic review of interventions for algebraic concepts and skills of secondary students with learning disabilities. *Learning Disabilities Research & Practice, 35*(2), 89–99. https://doi.org/10.1111/ldrp.12217

Lewis, K. E. (2014). Difference not deficit: Reconceptualizing mathematical learning disabilities. *Journal for Research in Mathematics Education, 45*(3), 351–396. https://doi.org/10.5951/jresematheduc.45.3.0351

Marita, S., & Hord, C. (2017). Review of mathematics interventions for secondary students with learning disabilities. *Learning Disability Quarterly, 40*(1), 29–40. https://doi.org/10.1177/0731948716657495

Martin, S. A., & Bassok, M. (2005). Effects of semantic cues on mathematical modeling: Evidence from word-problem solving and equation construction tasks. *Memory & Cognition, 33*(3), 471–478. https://doi.org/10.3758/BF03193064

McGlaughlin, S. M., Knoop, A. J., & Holliday, G. A. (2005). Differentiating students with mathematics difficulty in college: Mathematics disabilities vs. no diagnosis. *Learning Disability Quarterly, 28*(3), 223–232. https://doi.org/10.2307/1593660

National Center for Education Statistics. (2019). *NAEP mathematics report card: National achievement-level results.* The Nation's Report Card. Retrieved from https://www.nationsreportcard.gov/mathematics/nation/achievement/?grade=12

Newman, L., Wagner, M., Knokey, A., Marder, C., Nagle, K., Shaver, D., (with Cameto, R., Contreras, E., Ferguson, K., Greene, S., & Schwarting, M.). (2011). *The post-high school outcomes of young adults with disabilities up to 8 years after high school: A report from the National Longitudinal Transition Study-2 (NLTS2) (NCSER 2011-3005). SRI International.* Retrieved from https://ies.ed.gov/ ncser/pubs/20113005/pdf/20113005.pdf

Nguyen, G. T. (2015). A case study of students' motivation in college algebra courses. *Community College Journal of Research and Practice, 39*(8), 693–707. https://doi.org/10.1080/10668926.2013.824394

Rakap, S., Yücesoy-Özkan, Ş., & Kalkan, S. (2020). Effect size calculations in single-case experimental research design: An investigation of nonoverlap methods. *Turkish Journal of Psychology, 25*(85), 61–64. https://doi.org/10.31828/tpd1300443320181023m000015

Schrank, F. A., Mather, N., & McGrew, K. S. (2014). Woodcock-Johnson IV tests of achievement. *Journal of Psychoeducational Assessment, 33*(4). 391–398. https://doi.org/10.1177/0734282915569447

Scruggs, T. E., Mastropieri, M. A., & Casto, G. (1987). The quantitative synthesis of single-subject research: Methodology and validation. *Remedial and Special Education, 8*(2). 24–33. https://doi.org/10.1177/074193258700800206

Sierpinska, A., Bobos, G., & Knipping, C. (2008). Sources of student's frustration in pre-university level, prerequisite mathematics courses. *Instructional Science: An International Journal of the Learning Sciences, 36*(4), 289–320. https://doi.org/10.1007/s11251-007-9033-6

Street, C. D., Koff, R., Fields, H., Kuehne, L., Hardin, L., Getty, M. & Parker, D. R. (2012). Expanding access to STEM for at-risk learners: A new application of universal design for instruction. *Journal of Postsecondary Education and Disability, 25*(4), 363–375.

Strickland, T. K., & Maccini, P. (2012). The effects of the concrete–representational–abstract integration strategy on the ability of students with learning disabilities to multiply linear expressions within area problems. *Remedial & Special Education, 34*(3), 142–153. https://doi.org/10.1177/0741932512441712

Sullivan, M. M. (2005). Teaching mathematics to college students with mathematics-related learning disabilities: Report from the classroom. *Learning Disability Quarterly, 28*(3), 205–220. https://doi.org/10.2307/1593659

Teuscher, D., Reys, R. E., Evitts, T. A., & Heins, K. (2010). Slope, rate of change, and steepness: Do students understand these concepts? *The Mathematics Teacher, 103*(7). 519–524.

What Works Clearinghouse. (2020). *What Works Clearinghouse standards handbook, Version 4.1.* U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance. Retrieved from: https://ies.ed.gov/ncee/wwc/handbooks.

Williams, S. C., Militello, M. & Majewski, D. (2020). Sorting out important elements for successful college transition and completion for students with learning differences. *Preventing School Failure: Alternative Education for Children and Youth, 64*(4), 326–338. https://doi.org/10.1080/1045988X.2020.1776671

Wolery, M., Busick, M., Reichow, B., & Barton, E. (2010). Comparison of overlap methods for quantitatively synthesizing single-subject data. *Journal of Special Education, 44*(1), 18–28.

Yücesoy-Özkan, Ş., Rakap, S. & Gulboy, E. (2020). Evaluation of treatment effect estimate in single-case experimental research: Comparison of twelve overlap methods and visual analysis. *British Journal of Special Education, 47*(1), 67–87. https://doi.org/10.1111/1467-8578.12294

Zawaiza, T. R., & Gerber, M. M. (1993). Effects of explicit instruction on math word-problem solving by community college students with learning disabilities. *Learning Disability Quarterly, 16*(1), 64–79. https://doi.org/10.2307/1511159

Authors' Note

Correspondence concerning this article should be addressed to Kaitlin Bundock, Ph.D., Department of Special Education and Rehabilitation Counseling, Utah State University, 2865 Old Main Hill, Logan UT 84322-2865, USA, Email: kaitlin.bundock@usu.edu.