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### Modified Schema-Based Instruction for Solving Mathematical Word Problems for Elementary School Students with Mild to Moderate Disabilities

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Modified Schema-Based Instruction for Solving Mathematical Word Problems for  
Elementary School Students with Mild to Moderate Disabilities

by

Adam Langston Poole

A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Education

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## **Abstract**

The purpose of this study was to evaluate the effect of an intervention utilizing modified schema-based instruction (MSBI) on the mathematical problem-solving ability of elementary school students with mild to moderate disabilities. Four participants were taught to solve percent of change word problems, which required them to calculate the discounted price of an item or service after the use of a coupon or the final price of an item or service after leaving a tip. Participants were then required to count out an appropriate amount of money to cover the final cost. Effectiveness of the intervention was measured by how many steps on a task analysis the participants were able to complete correctly. Results of the single-case, multiple baseline across participants design indicated a functional relationship between the intervention and the problem-solving ability of the participants.

*Keywords:* schema-based instruction, modified schema-based instruction, word problem solving, percent of change, students with disabilities

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## **Introduction**

For most individuals, applying mathematical concepts and demonstrating math problem-solving skills are critical for navigating through and functioning in modern society (Saunders et al., 2018). The relevant nature of mathematics makes mathematics instruction an ideal vehicle to teach students reasoning, creativity, and collaboration. These characteristics make mathematics applicable in a variety of real-life situations and useful for solving real-life problems (Vos, 2018). Ideally, many individuals with disabilities would be responsible for tasks such as managing money, utilizing calendars, and understanding time (Saunders et al., 2018). These and other similar tasks require competency in a variety of mathematical skills. To connect these skills to real-world applications, mathematical word problems are used to create hypothetical scenarios that mimic real-world situations (Griffin & Jitendra, 2009). In order to equip students both with and without disabilities to be real-world problem solvers, mathematics instruction must build foundational mathematical skills and higher-level thinking skills as well as be relevant to life outside of the academic setting (Saunders et al., 2018).

Solving mathematical word problems is a complex process, wherein there exists much debate over the most effective practices and strategies (Kingsdorf & Krawec, 2016). The process becomes even more challenging when applied to students with disabilities that can affect processes necessary to solve mathematical word problems (Alter et al., 2011). These students often face skill deficits as well as performance deficits, which make mathematical problem solving more difficult for them than their non-disabled peers (Alter, 2012). Skill deficits exist when students lack prerequisite skills for solving problems correctly, such as higher-level thinking skills, computational skills, and reading ability. Performance deficits exist when students choose not to solve a problem despite having the ability to do so (Alter, 2012). Solving

word problems may require multiple steps beyond simple computation, which may lead struggling students, especially those with disabilities, to avoid them altogether. To address deficits, numerous intervention strategies have been introduced. Strategies such as explicit teaching, various metacognitive strategies, and mnemonic devices have all had some measure of success in increasing students' word problem-solving skills (Kingsdorf & Krawec, 2016). However, word problem solving remains difficult for many students, including students with disabilities, because of its complex nature and because it requires students to do more than simply extract numbers to solve an equation. It requires understanding of semantic structure and conceptual knowledge of increases, decreases, and other quantifiable relationships between quantities or amounts (Griffin & Jitendra, 2009).

Unfortunately, opportunities for students to use reasoning and make real-world connections when solving word problems are not often present in word problem solving instruction (Griffin & Jitendra, 2009). According to Jitendra and Star (2011), problem solving is inadequately addressed in many mathematics textbooks. For example, in many textbooks, all problems on a page can be solved using the same procedure, thus not providing students with opportunities to discriminate between problems that require different approaches. Additionally, problem-solving instruction is often reliant on keyword strategies, which can lead to systematic errors (Jitendra & Star, 2011). A general heuristic approach (Griffin & Jitendra, 2009), wherein students approach problem solving in a practical manner that may not be transferrable to other types of problems, is also commonly used in mathematics textbooks and problem-solving instruction. For example, in many textbooks all problems on a page can be solved using the same procedure (Jitendra & Star, 2011). This type of instruction denies students the opportunity to discriminate among problems that may require a variety of solutions. Additionally, this approach

often relies on the use of superficial cues, such as key words, to solve problems, which can lead to systematic errors and does not provide problem-solving practice akin to what would be necessary in real-world situations. For example, students may be taught to that the presence of a certain word or phrase in a word problem requires the performance of a corresponding operation. However, if that word or phrase is absent from the problem or is used in a different context, the student may be unable to determine the appropriate operation to solve the problem. Since this approach is largely focused on solving only the problem at hand, it does not lead to improvement in students' overall problem-solving skills (Jitendra & Star, 2011). However, there are evidence-based practices that specifically address these shortcomings.

### **Teaching Conceptualization Through Evidence-based Practices**

Evidence-based practices (EBPs) include interventions that have been found effective for a certain, identified population by multiple research teams (Clausen et al., 2021). Schema-based instruction (SBI) is one such EBP that emphasizes both conceptual and procedural knowledge (Cox & Root, 2020). SBI is different from other types of word problem-solving instruction in that with SBI, students are taught to identify a word problem as belonging to a problem type and then use a schema specific to that problem type to solve the problem (Powell, 2011). SBI represents a shift from a focus on procedural skills to a process of conceptualizing mathematics instruction and fostering students' conceptual understanding of mathematical operations (Jitendra et al., 2010). Once students determine a problem type, they can apply an appropriate schematic, such as a diagram or graphic organizer, to aid them in solving the problem (Powell, 2011). Explicit instruction on how to categorize problems by their schema, use a schematic diagram to model the problem, and execute procedures to arrive at a solution can equip students to solve most word problems that they encounter (Powell, 2011).



SBI draws greatly from the realm of cognitive psychology, specifically from the area of schema theory (Jitendra & Star, 2011). It reaches beyond superficial features of word problems to allow students to analyze the semantic structure of the problem and the underlying mathematical relationships (Jitendra & Star, 2011). In SBI, problem structure is essential to the comprehension and representation of word problems. It emphasizes the use of schematic diagrams that assist students in categorizing and organizing problems by type to determine the appropriate method to arrive at a solution (Jitendra et al., 2010). SBI utilizes schema that consist of representations of problems and solutions that allow students to solve a category of similar problems (Rockwell et al., 2011).

While SBI has been shown effective in improving the students' problem-solving skills, it is possible that students with disabilities will need additional supports when learning and applying SBI. Traditional SBI can easily be modified to meet the needs of students who require more intensive supports. Particularly, students who display limited conceptual and procedural knowledge as well as weaknesses in metacognition and executive functioning may benefit from modified schema-based instruction (MSBI) (Root et al., 2019). MSBI utilizes aspects of SBI such as explicit instruction, while implementing enhanced visual supports, task analyses, and a system of prompts and feedback (Cox & Root, 2020). It uses strategies such as color coding of information and increased visual supports within currently utilized and understood schemas to decrease the cognitive and fine motor demands of traditional SBI (Root et al., 2019). Utilizing MSBI, students who require more intensive supports will receive modifications along the way which may include task analyses, graphic organizers, having schematics provided, and systems of least prompts (Root et al., 2019).

While SBI can be implemented for use with all students, these modifications make MSBI more accessible to students with more significant deficits in mathematical problem solving (Root et al., 2019). With emphases on conceptual understanding of mathematical functions (Jitendra et al., 2010) and real-world problem-solving skills, both interventions can be presented in an effort to prepare students, especially students with disabilities, for situations they may encounter as they ideally work toward becoming productive and independent members of society. Explicit, systematic instruction, the use of the various schematic diagrams, and prompt consistent feedback are critical within the implementation of both strategies. These criteria must also be found in the implementation of MSBI with the addition of enhanced visual supports and systems of least prompts.

MSBI has been shown to be an effective intervention for students with moderate to severe disabilities. However, many students with mild to moderate disabilities also struggle with mathematical problem solving and require more intensive supports that can be provided by interventions implementing SBI. Many students with mild to moderate disabilities exhibit deficits in working memory, language, and attentive behavior that negatively affects their ability to consistently solve mathematical word problems (Jitendra et al., 2015). The purpose of this study is to determine the effectiveness of a MSBI-based intervention on the mathematical word problem-solving skills of elementary students with high-incidence disabilities such as specific learning disabilities (SLD) and high-functioning autism spectrum disorder (ASD).

## **Problem-Solving Instruction**

Identified as the cornerstone of mathematical learning by many educators, mathematics problem solving requires students to comprehend linguistic information in addition to using quantitative reasoning to arrive at and perform appropriate mathematical calculations (Root et al., 2017). Quantitative reasoning focuses on the relationships between quantities or amounts. It is this skill, rather than the performance of various calculations, that makes problem solving so especially difficult for many students (Root et al., 2022). Additionally, teaching problem solving is a vital part of any mathematics curriculum because it teaches students not only how to apply learned skills but also to recognize situations in which those skills should be applied. Problem-solving instruction should also provide students with the reasons for why skills should be applied in certain situations (Root et al., 2017). Instruction that provides the two components of conceptual understanding and procedural skills is more likely to result in student improvement in word problem solving skills compared to instruction that is mainly focused on teaching procedural skills (Cox & Root, 2020). Problem-solving instruction for individuals with disabilities emphasized functional skills such as counting objects, using money, and telling time (Root et al., 2018). This task-driven functional approach stands in contrast to a concept-driven contextual approach (Root et al., 2020). As opposed to a functional approach where emphasis is placed on learning a skill associated with completing an academic task, contextualized instruction focuses on the development of an academic concept within a real-life activity (Root et al., 2018). In order for mathematics instruction to be effective for students with disabilities, it must be taught in ways that are contextually meaningful (Spooner et al., 2017).

## **Schema-Based Instruction**

As a mathematical word problem-solving strategy, SBI emphasizes the importance of conceptual understanding of scenarios presented in word problems and their connection to real-world situations. It also emphasizes to procedural ability to carry out the steps and perform arithmetical operations required to solve the problem (Cox & Root, 2020). It is an evidence-based practice consisting of three essential components: (a) identification of a problem structure or schema, (b) use of visual representations of the structure in which to organize information, and (c) explicit instruction on the schema-based problem-solving method (Jitendra et al., 2015). According to Root et al. (2017), a schema is a framework or outline used for solving a problem that can be represented numerical equations, pictures, or diagrams.

A growing base of research exists on the use of SBI to improve the mathematics problem-solving skills of students with a variety of disabilities. Some researchers speculate that this is due, at least in part, to the ability of SBI to link mathematical concepts to familiar real-world settings and experiences (Jitendra et al., 2019).

Research also shows that SBI can be effective in improving the problem-solving abilities of students with mild to moderate disabilities (Jitendra & Star, 2011). SBI, as an alternative to general strategy instruction (GSI), can be used to enhance the problem-solving performance of students with learning disabilities (LD) (Griffin & Jitendra, 2009).

As an alternative to traditional instructional strategies, SBI integrates several evidence-based practices shown to improve mathematics problem-solving skills, such as systematic, explicit instruction and visual representations (Jitendra & Star, 2011). SBI's departure from the use of superficial cues and heuristic strategies may make it especially effective for students with disabilities. If students with disabilities are to participate effectively in real world situations, they

cannot rely on such strategies and cues. Instead, the ability of SBI to provide students with structures to categorize and analyze information make it preferable for use in the real world.

### **Modified Schema-Based Instruction**

While SBI has been shown to be an effective strategy for mathematical word problem-solving instruction, there are some students who require a more intensive level of support. Students with characteristics such as limited communication or literacy skills, poor working memory, or overall difficulty or low achievement in mathematics may require modifications above what is provided by traditional SBI (Clausen et al., 2021). MSBI provides a more intensive level of support for such students, while maintaining the key aspects of SBI (Cox & Root, 2020). MSBI has been shown to be an effective form of mathematics word problem-solving instruction for students with LD (Jitendra et al., 2015) and ASD (Cox & Root, 2020).

Researchers have noted a functional relationship between MSBI and mathematics word problem-solving in middle school students with ASD/ID (Root et al., 2022) and ASD alone (Cox & Root, 2020). Additionally, there is evidence that MSBI is an effective instructional method for students with moderate ID (Browder et al., 2018). While Clausen et al. (2021) noted that MSBI may not yet be considered an effective EBP for students with moderate to severe disabilities, in a meta-analysis, Jitendra et al. (2015), noted that when using a group design methodological criteria, strategy instruction that focuses on problem structure is considered an EBP for teaching mathematics word problem-solving skills to students with LD. Researchers have also identified a functional relationship between MSBI and problem-solving skills in secondary school students with ID and related developmental disabilities (DD) (Jitendra et al., 2015).

## **Purpose of Study**

While a substantial research base exists on the effectiveness of MSBI as an instructional method for teaching mathematics word problem-solving skills to individuals with moderate to severe disabilities, particularly students in middle and high school, less is known about its effectiveness relative to students with high-incidence, such as LD or high-functioning ASD. The research base shrinks even more when narrowed to students in elementary grades. Mathematical problem solving is a skill that is especially difficult for students with ASD (Cox & Root, 2020). Additionally, many students with LD exhibit deficits in working memory, language, and attentive behavior (Jitendra et al., 2015) as well as reading or phonetic fluency (Root et al., 2017) and comprehension skills. While these students may not have extensive support needs (ESN) (Ley Davis et al., 2022), students, specifically elementary students, may require supports beyond those provided by SBI.

The purpose of this study was to evaluate the effectiveness of an MSBI intervention on the mathematical word problem-solving ability of elementary students with high-incidence disabilities by extending the work of Root et al. (2018) to a different population. Students were tasked with solving multiplicative mathematical word problems related to personal finance that imitated situations that may be encountered outside of the academic setting through a single case research design (SCRD). Participants were asked to determine mathematical operations, perform multiple calculations, and determine a final monetary amount necessary to complete a certain transaction. The following research questions were addressed: 1) What are the effects of a MSBI intervention on the ability of students with high-incidence disabilities to solve mathematical word problems involving percent of change? 2) Were students with high-incidence disabilities

able to independently determine the appropriate mathematical operation to correctly solve percent of change word problems?

## **Method**

### **Participants**

This study took place in a public elementary school with an enrollment between 800 and 900 students, located in a suburb of a larger city in the southeastern United States. Participants were in the fourth or fifth grade for the 2021-2022 school year and received special education services based on diagnoses of a high-incidence disability, with programming outlined by their respective individualized education programs (IEP). See Table 1. The participants received instruction in all academic subjects in a general education environment and 45 minutes of daily resource intervention in a special classroom during the school's regularly-scheduled intervention/enrichment period. On the quarterly curriculum-based benchmark assessment most recently preceding this study, all participants scored below the fifth percentile in the area of mathematics. Because all participants are minors, consent was obtained from their parents for them to participate in the study and for the study to be video recorded. Additionally, assent forms were read aloud to the participants and each signed a form indicating that he or she agreed to take part in the study. All participants were assigned pseudonyms.

Chase, an African-American male who was in the fourth grade at the time of this study, held a diagnosis of a specific learning disability in the area of basic reading skills. Hunter, a white male who was also in the fourth grade, was eligible for special education services under the eligibility category of ASD. Ellen, an African-American female in the fifth grade, received special education services under the eligibility category of a specific learning disability in the area of reading fluency. Ellen also held a medical diagnosis of ADHD. Cole, a white male in the fifth grade, held a diagnosis of ASD. Based on the results of their most recent evaluations, all

students had a full-scale IQ within the average range. Each participant also had at least one IEP goal in the area of mathematics problem solving.

### **Setting**

The study took place in a special education classroom during the students' 45-minute resource intervention period. In the fourth-grade resource intervention period there were a total of eight students. In the fifth-grade period, there were nine total students. Students not participating in the study worked independently on academic tasks pertaining to their individual IEP goals, while individual participants receiving the intervention sat with the researcher at a table in the back of the classroom. The secondary researcher providing the intervention was a doctoral student at a local university as well as the students' IEP case manager, who was trained in the intervention by the primary researcher. The primary researcher was an associate professor of special education at the same university. Following the administration of a prescreening tool, the study ran for approximately two months.

### **Materials and Procedures**

Each participant was administered a prescreening tool to determine whether that participant possessed the prerequisite mathematical skills to access the intervention. Beginning in the baseline phase, participants utilized a community theme menu, generated by Root et al. (2018), from which they selected a community location from a selection of 15 pictures to serve as the subject of their mathematical word problem. For each community location, there was a corresponding video anchor to help familiarize the participant with the location and task. Students were presented with worksheets specific to their chosen community location with one word problem on each side. Sample word problems are depicted in Figure 1. In addition to the word problem, worksheets also contained a 6-step task analysis and graphic organizer, which are



shown in Figure 2. Worksheets were presented in clear plastic sleeves so that participants could write on them with a provided dry-erase marker. Worksheets, task analysis, and graphic organizer were adapted from previous study conducted by Root et al. (2018). Students were also provided calculators that they used periodically during their general education mathematics instruction. Students were, therefore, familiar with their operation. Participants used play money to show the final amount needed to correctly complete the task. The secondary researcher recorded participants' performance on a mastery rubric which measured participants ability to complete the six steps of the task analysis and provide the correct monetary amount using the play money. The researcher indicated on the mastery rubric whether participants completed each step independently or with a verbal prompt, specific verbal prompt, model, or error correction. Each mastery rubric also contained a section for the primary researcher to score the procedural fidelity of each trial. Trials were recorded using an iPad.

### **Design and Measurement**

Researchers chose a single-case multiple probe across participants design (Ledford & Gast, 2018). A withdrawal type design was deemed inappropriate due to the non-reversible nature of the mathematical problem-solving skills taught through the intervention (Root et al., 2018). The study contained four experimental conditions: a) baseline, b) teaching, c) intervention, and d) maintenance. All participants entered the baseline phase simultaneously. No prompting, error correction, or feedback will be given during the baseline phase. Upon all participants' completion of five baseline probes, one participant entered the teaching phase, wherein he was taught the steps of the task analysis using the graphic organizer and following a system of least prompts (SLP). Participants' performance was not scored in the teaching phase, and no data was collected. In utilizing the SLP, if participants failed to correctly complete a step

on the task analysis, they were given a verbal prompt. If the step was still not completed correctly, the researcher gave a more specific verbal prompt. If a specific verbal prompt was not sufficient, the researcher modeled the correct way to complete the step. Following the step being modeled and the participant's continued inability to correctly complete the step, the researcher corrected the error, and the participant moved to the next step on the task analysis. After two teaching sessions, the first participant entered the intervention phase while the other participants remained in the baseline phase, undergoing regular administration of baseline probes.

Participants in the intervention phase were deemed to have reached mastery, thus completing the intervention phase, after solving both problems correctly on two consecutive days and receiving at least 22 out of 24 possible points (91.67%) based on their ability independently follow the steps on the task analysis, according to criteria outlined on the mastery rubric. The mastery rubric is depicted in Figure 3. If participants were not able to accumulate at least 22 points on the rubric for two consecutive days, they continued in the intervention phase until they were able to demonstrate mastery. Approximately one week after demonstrating mastery in the intervention phase, participants entered the maintenance phase, which consisted of two probes, each requiring them to solve two percent of change problems and spaced approximately one week apart. The study concluded once all participants completed two maintenance probes.

The dependent variable measured by the study was the number of correct steps on a task analysis worth 24 possible points according to a mastery rubric, targeting the progressions for each of two percent of change problems worth 12 points each, randomly selected based on each participants' choice of community setting. All mathematical problems, formatting, and solving sequence were verified by a mathematics content expert. To ensure the presence of procedural fidelity, the primary researcher utilized a procedural fidelity checklist to verify the degree to

which the system of least prompts procedure was implemented as intended and consistently by the secondary researcher. Procedural fidelity was calculated by the total number of procedural elements and multiplied by 100 to arrive at a percentage.

## **Results**

The dependent variable of number of correct responses according to the task analysis are shown in Figure 4, which depicts graphs constructed with y-axes that show the dependent variable related to number of correct responses ranging from 0-24 because each percent of change word problem was worth a maximum of 12 points, and participants completed two problems per session. The x-axes show the number of sessions completed by each participant in each phase: baseline, intervention, and maintenance.

Hunter received 0 points during his first baseline session, followed by 1 point in each of the subsequent four sessions. He reached mastery after three intervention sessions, scoring 20, 23, and 23 points respectively. Hunter earned 22 points on his first maintenance probe and the same score on his second. On his first baseline probe, Cole also earned 0 points. On his both second and third probes in the initial phase, he earned one point, but failed to earn any points on his fourth or fifth probes. Since only one participant entered the intervention phase at a time, Cole completed three additional baseline probes and earned a score of zero on each. Cole earned 17 points on his first intervention probe and 20 on his second. He achieved mastery criteria by scoring 24 points on both his third and fourth intervention probes. He earned 22 points on his first maintenance probe and 24 on his second. Chase completed nine baseline probes while the two prior participants progressed through subsequent phases. On his first five baseline probes, he earned scores of 0, 2, 0, 1, and 0 points. He followed the initial five probes with scores of 0, 0, 1, and 0 points. Gavin completed the intervention phase in three sessions. In his first session, he

earned 23 points, followed by 22 points in each of the two following sessions. He received the maximum of 24 points in each of his two maintenance sessions. Being the last participant to enter the intervention phase, Ellen completed nine baseline probes. She earned 1 point on each of the first two probes, followed by scores of zero, one, and three. On her sixth probe she did not earn any points. On her final three baseline probes, she earned scores of 2 points, 0 points, and 1 point respectively. In the intervention phase, Ellen independently completed 19 steps of the task analyses on each of the first two probes. On each of the two subsequent intervention probes, she earned 23 points. She independently completed 23 steps on the combined task analyses on her first maintenance probe and 24 on her second.

### **Procedural Fidelity and Interobserver Agreement**

The primary researcher trained the secondary researcher to deliver the intervention and collect participant data and used video recordings of the sessions to collect procedural fidelity data. A secondary researcher was trained to fidelity to deliver the intervention to (a) train participants to follow a task analysis for the change problem type, (b) provide explicit instruction using scripts, and (c) provide the SLP for non-responses or remediate errors made by the participants. To ensure the secondary implemented the intervention with fidelity, a procedural fidelity checklist was used by the primary observer to verify the degree to which the SLP procedure was implemented consistently as designed and trained (Billingsley et al., 1980; Ledford & Gast, 2018). To calculate procedural fidelity, the number of elements correctly implemented were divided by the total number of procedural elements, then multiplied by 100 (Billingsley et al., 1980). Fidelity was collected for all participants over all sessions in the intervention and baseline phases. Overall, the mean procedural fidelity across all participants was 97.23%.

Video recordings of the sessions were used to collect interobserver agreement (IOA) data by the primary researcher across at least 30% of all sessions, across all participants, and conditions on word problem-solving steps. Scored-interval IOA was calculated using only intervals in which at least one researcher scored the occurrence of the behavior. Scored-interval IOA was used because researchers were looking for instance where the occurrence of a particular behavior, correctly completing steps on the task analysis, was present. Agreements of both observers were then divided by the total number of trials in which at least one researcher scored the occurrence of the behavior and then multiplied by 100 (Cooper et al., 2020). IOA data were collected during baseline for 40% of baseline sessions for Hunter (2 out of 5 sessions), 37.5% of baseline sessions for Cole (3 out of 8 sessions), 33.33% of baseline sessions for Chase (3 out of 9 sessions), and 40% of baseline sessions for Ellen (4 out of 10 sessions). IOA data were collected during intervention for 100% of intervention sessions for all participants. IOA data were collected during maintenance for 50% of maintenance sessions for Hunter (1 out of 2 sessions), 33.33% of maintenance sessions for Cole (1 out of 3 sessions), 50% of maintenance sessions for Chase (1 out of 2 sessions), and 50% of maintenance sessions for Ellen (1 out of 2 sessions). Scored-interval IOA calculated over intervention and maintenance phases was 98.8% for Hunter, 100% for Cole, 99.6% for Chase, and 100% for Ellen, resulting in a mean of 94.1% across all 4 participants. Total IOA of data was 99.6%

## **Discussion**

The purpose of this study was to evaluate the effectiveness of an MSBI intervention on the ability of elementary students with high-incidence disabilities to solve percent of change mathematical word problems that required them to perform tasks related to common monetary transactions in community locations. Visual analysis of results indicates a functional relation

between the MSBI intervention and problem-solving ability of the participants. Additionally, as evidenced by the final step on the task analysis, participants were able to determine the amount of money to the next highest dollar that would be required to successfully complete each transaction, a skill that is independently useful in regularly-occurring, real-world scenarios. The ability to solve problems related to personal finance, particularly those that model necessary skills for purchasing goods and services, can serve to increase independence and community integration in the extracurricular or post-academic lives of students with disabilities (Root et al., 2017). Following initial exposure to MSBI in the teaching phase, participants were able to demonstrate mastery in no more than four intervention sessions. This speaks to the effectiveness of the intervention and addresses the first research question posed by this study.

As to the second research question, in order to arrive at the correct answer to each word problem, participants first had to determine the operation necessary to solve the word problem and determine whether the given scenario required them to add or subtract once they determined the percent of change. The success of the participants in determining operation is evidence of the contextualized, concept-driven nature of SBI (Root et al., 2020). Additionally, the ability of the participants to not only choose the appropriate operation but also arrive at a correct answer and count out the amount of money to complete the transaction reflects positively on the possible social validity of the current study. However, in order to truly study the social validity of the intervention, participants would be required to perform the acquired skills in a real-world setting. Problem-solving skills, such as the ones measured by this study, can be applied within multiple real-world contexts and will increase the quality of life for students with disabilities (Root et al., 2018).

## **Limitations and Future Research**

Although the study imitated transactions in real-world settings it did not measure generalization to actual real-world settings. While the results of the intervention indicate that it was effective with regards to the problem-solving ability of the participants, the question remains as to whether participants could generalize that ability into a successful transaction outside the classroom setting. Future research may seek to generalize these problem-solving skills to actual real-world settings, such as those depicted in the community location choice menu utilized in the intervention. Additionally, surveying the participants on their level of comfort in performing the identified tasks in real-world settings both before and after the intervention would address the social validity of the intervention.

Feasibility of conducting similar interventions on a broader scale or in less restrictive environments should also be considered in future research. In the current study, the intervention was presented on a one-to-one basis by an experienced teacher who was familiar with and to all participants. It is unknown whether similar results could be reproduced in a whole- or small-group setting or with a different interventionist. Future research could attempt to replicate the current study in these different settings.

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Table 1

*Grades and Special Education Eligibility Categories of Participants at the Time of Intervention*

Name	Grade	Eligibility Category
Hunter	4 <sup>th</sup>	ASD
Cole	5 <sup>th</sup>	ASD
Chase	4 <sup>th</sup>	SLD (Basic Reading Skills)
Ellen	5 <sup>th</sup>	SLD (Reading Fluency)

#1 Paige went to pick up some coffee for her coworkers.

Her total bill was \$24.

She had a 10% off coupon.

How much was her total bill?

#3 Brett got coffee from the local coffee shop.

His coffee cost \$5.

He wanted to leave a 15% tip.

What was his total bill?

*Note.* The first sample problem in the figure requires students to determine a discounted price after using a coupon, while the second requires students to calculate the final cost after leaving a tip. Both problem types begin with an expository first sentence.

Figure 1

*Sample Word Problems*













1.	✓	 <b>Talk about the problem out loud.</b> <ul style="list-style-type: none"> <li>• What do we know about the problem?</li> <li>• What do we want to find out?</li> <li>• What kind of problem is it?</li> </ul> 
2.		 <b>Mark and label original cost.</b>
3.		 <b>Mark and label percent of change.</b>
4.		<b>Calculate the amount of change.</b>  of  is 
5.		<b>+ or -</b> 
6.		<b>Calculate the final cost.</b>  then  now 
7.		<b>Choose the correct bills to pay for the total.</b> 

Figure 2

*Sample Task Analysis*

## TIP REPLICATION STUDY

Participant:

Date:

Phase & Number (i.e., BL 4):

Interventionist:

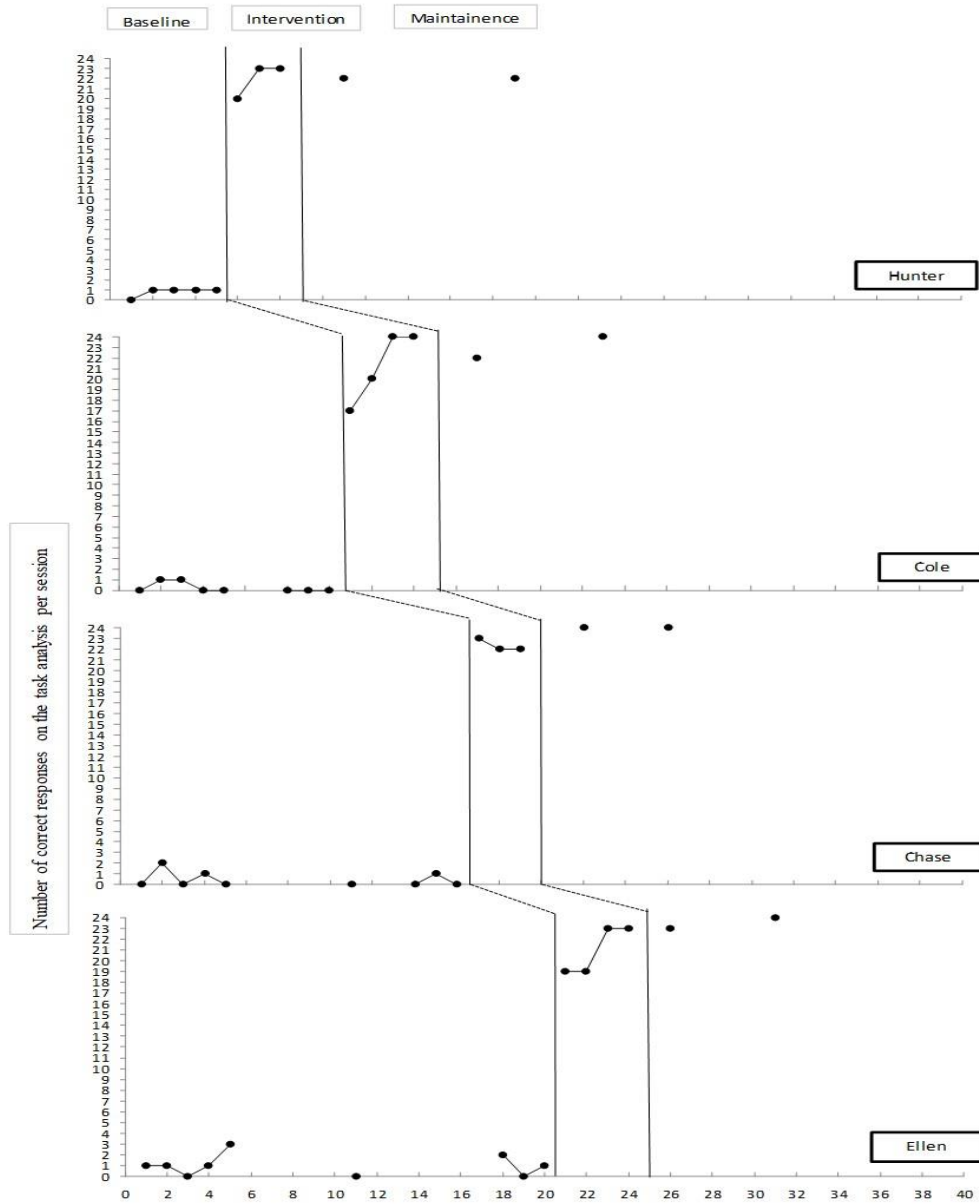
Steps of TA	Measured Behavior	IC	V	SV	M	EC	PF
7.	7. Gives more money than the final cost	7a	7a	7a	7a	7a	7a
6. Calculate final cost	6b. Writes correct final cost on graphic organizer (including \$ symbol)	6b	6b	6b	6b	6b	6b
	6a. Adds amount of change from original cost	6a	6a	6a	6a	6a	6a
5. + or -	5b. Writes correct operation (+)	5b	5b	5b	5b	5b	5b
	5a. Says or shows rule/think aloud for problem type	5a	5a	5a	5a	5a	5a
4. Calculate amount of change	4b. Writes amount of change onto graphic organizer (including \$)	4b	4b	4b	4b	4b	4b
	4a. Multiplies percent of change by original amount	4a	4a	4a	4a	4a	4a
3. Mark and label % of change	3. Writes percent of change on graphic organizer (including % symbol)	3	3	3	3	3	3
2. Mark and label original cost	2. Writes original cost on graphic organizer (including \$)	2	2	2	2	2	2
1. Understand the problem (picture needs)	1c. Show the rule for the problem type (decrease, subtract with thumb)	1c	1c	1c	1c	1c	1c
	1b. Underline the question	1b	1b	1b	1b	1b	1b
	1a. Underline what we know (original cost & percent of change)	1a	1a	1a	1a	1a	1a
	Total:	/12					

Notes:

Figure 3

*Mastery Rubric*





*Note.* This figure displays the number of steps on the task analysis correctly completed by each participant during each session throughout the three phases of the intervention.

Figure 4

*Number of Correct Responses on the Task Analysis per Session*