2021

Effects of Modified Schema-Based Instruction on Mathematical Percentage Calculation for Students with Extensive Support Needs in an IPSE Program

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Acknowledgements

It is with great humility that I conclude this journey. I am greatly aware of the many who have guided me through this process. I would like to thank the co-chairs of my committee, Dr. William C. Hunter and Dr. Luann Ley Davis. I have become a better writer and professional educator because of you. You have each taught me so much. I want to thank Dr. Michele Atkins who continually encouraged me to never give up. I am grateful for Dr. James Meindl who is truly an outstanding instructor and asked the tough questions. A special thanks to Dr. Jenny Root who graciously shares her research to help students with extensive support needs.

To my husband, I thank you for the support, prayers, and love. Joshua and Elizabeth, I have literally been in graduate school of half of your lives! I am grateful for your understanding and your cheers of encouragement.

For my Mom and Dad. Momma believed I could. Daddy snuck me the money, so I would. You did not get to see me complete the journey, but I did it. I am grateful that because of our salvation and love of Christ I will see you again.

"And let us run with perseverance the race marked out for us, fixing our eyes on Jesus, the pioneer and perfecter of faith." Hebrews 12:1-2.

Abstract

Students with extensive support needs often struggle with the reading comprehension and mathematics reasoning skills needed to approach real life word problems. There has been research completed on appropriate educational pedagogies to utilize with students at the elementary and middle school levels, but none were found discussing methodologies to use for young adults in inclusive post-secondary education programs. The purpose of this study was to determine the effects of using modified schema-based instruction on mathematical percentage calculation for students with extensive support needs (i.e., moderate to severe intellectual disability, autism spectrum disorder, multiple disabilities) in an IPSE program. Upon visual analysis of results of this single case multiple probe across participants design, researchers found a functional relation between the mathematics treatment package and solving percentage calculations. Study implications, limitations, and suggestions for further research are presented.

Keywords: extensive support needs, modified schema-based instruction, inclusive postsecondary education

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

FIGURE PAGE

Effects of Modified Schema-Based Instruction on Mathematical Percentage Calculation for Students with Extensive Support Needs in an IPSE Program

A growing body of research using modified schema-based instruction (MSBI) has demonstrated that middle school students with extensive support needs (ESN) can learn to calculate mathematical percentages to determine the amount to tip for services at video-based community settings (Root, Browder, et al., 2017; Root, Cox, et al., 2019). Since the passage of the No Child Left Behind Act in 2001 and other pieces of relevant legislation (e.g., Every Student Succeeds Act [ESSA] of 2015; the reauthorization of the Individuals with Disabilities Education Improvement Act [IDEIA] in 2004), the emphasis for students, including those with ESN, has been on teaching grade-aligned academics using evidence-based practices (EBPs; Spooner et al., 2019). According to the National Mathematics Advisory Panel (NMAP, 2008), one of the most important aspects of school curriculum and the key to the inclusion of students with ESN in the general education classroom is mathematical problem solving.

In the United States, more than 298 inclusive post-secondary education programs exist for individuals with intellectual and/or developmental disabilities (IDD; Weir, 2019). This represents a ten-fold increase since 2004. According to data from the U.S. Department of Education (2019), approximately 439,000 individuals between the ages of 3 and 21 were identified as having an intellectual disability and receiving special education during the 20182019 school year. These students represent slightly more than 6.2% of all pupils with disabilities and approximately 1% of the total school-age population (United States Department of Education, 2019). For most individuals with IDD, their educational experiences end after high school. Until recently, college was not an option; now, students may choose from programs that are 2 to 4 years in duration that are designed to meet their needs. Given that these Inclusive

PostSecondary Education (IPSE) programs are relatively new in the historical context of educational services, there are many opportunities to assess the curriculum and pedagogy of teaching life skills, such as how to calculate gratuity (e.g., a tip).

Mathematical reasoning or word problem solving can be a source of difficulty for many students because they not only require calculation but also comprehension of linguistic information (Fuchs et al., 2008). Students with ESN often struggle with the reading and mathematical calculation skills necessary to approach word problems found in everyday life (Browder et al., 2018). Teaching calculation without teaching problem solving only shows students how, but not when or why, to apply these skills. Difficulty with the generalization of learned skills is a characteristic of most students with intellectual disabilities. A review of 36 studies of evidence-based practices to teach mathematics to students with extensive support needs demonstrated that students with extensive support needs can learn to solve mathematics problems when provided with intensive, high-quality instruction (Spooner et al., 2017).

Existing research has shown that components of systematic instruction (e.g., task analytic instruction, prompting procedures, corrective feedback, and discrete response training) are evidenced-based practices used to teach age-appropriate academics to students with ESN (Baker et al., 2015; Clausen et al., 2021; Spooner et al., 2019). One systematic, evidence-based practice is schema-based instruction, which incorporates identifying and completing schemas, as well as checking for reasonableness of solutions (Jitentra, 2015; Peltier & Vannest, 2017). Recent research has shown modified schema-based instruction (MSBI), which utilizes the key components of schema-based instruction and enhanced visual supports, task analysis, and systematic prompting, as a viable teaching strategy for solving mathematical problems for students with ESN (Cox & Root, 2020; Ley Davis, 2016; Root, Browder, et al., 2017; Root, Henning, & Boccumini, 2018).

Modified schema-based instruction (MBSI) has demonstrated to have a functional relation regarding teaching mathematical word problem skills to students with autism spectrum disorder (ASD) and moderate intellectual disability (ID; Root, Browder, et al., 2017). This study by Root, Browder, and colleagues (2017) used a multiple probe across participants with an embedded alternating treatments design with three elementary students with ASD and moderate ID who attended a public school. Researchers focused on the comparison word problems and compared the differential effects of concrete versus virtual manipulatives. For those who have not mastered basic math facts, manipulatives can provide concrete representations of the action of a word problem when used with a graphic organizer (Root, Browder, et al., 2017). The results of this study showed that although virtual and concrete manipulatives and graphic organizers were effective supports, there was an increased rate of independence in the virtual condition for two participants and preference among all three participants for the virtual condition.

Root and associates (2019) evaluated the effects of a universally designed mathematics intervention on mathematical problem-solving skills for three middle school students with ESN. The UDL framework was applied to identify components of MSBI that could address identified barriers for the participants to learn to tip appropriately at point of sale and the percentage of change word problems. The primary dependent variable was mathematical problem-solving skills to learn to tip appropriately at point of sale and to solve percent of change, measured by the total number of points a participant received by independently performing the six steps of the task analysis (TA). The secondary dependent variable was generalization of problem-solving skills, measured by the total number of points a participant received by independently performing the six steps of the TA when given a word problem depicting percent of change in a novel context (i.e., not tip or sale). Participants could earn the same 11 points for each generalization problem, resulting in a total of 22 possible points for each problem. This multiple probe study across participants design showed a functional relation between the UDL mathematics intervention and participants' problem-solving skills (i.e., percent of change). This current project extended the research on modified schema-based instruction completed by Root and others (2019) by including students in an inclusive post-secondary transition program. While there exists a broad range of research indicating the success of MSBI in elementary, middle, and secondary programs, there has been very little research done on the academics benefitting students with ESN at the college level. There have been studies outlining the success of universal design for learning (UDL) at the university level (Hollingshead & Carr-Chellman, 2019; Love et al., 2017; Meyer et al., 2014), but details on more specific pedagogies are lacking.

There is an emerging body of literature (Root, Browder, et al., 2017; Root et al., 2019) that has used MSBI to teach tip and sale to elementary and middle school aged students with ESN and demonstrated a functional relation for the intervention; however, none have investigated using an MSBI package to teach percentages to calculate the amount of a tip for a community service to college-aged students with ESN enrolled in an IPSE program. Introducing mathematical content that is anchored in real-world scenarios is warranted and may provide a way to further promote mathematical learning and increase generalization for students enrolled in an IPSE program with ESN. To add to the emerging body of literature, the purpose of this replication study was to investigate the effects of a modified schema-based mathematical package presented to young adult students with ESN in an IPSE program.

We sought to answer the following research question: What is the effect of a modified schema-based instruction strategy on teaching young adults in an IPSE environment to tip at point of sale?

Method

A multiple probe across participants single case design was used (Ledford & Gast, 2018). This allowed researchers to use a small number of student participants while still allowing for replication of targeted behaviors. Data were graphed following each session to provide a visual analysis to interpret the effect size and determine a functional relation between baseline and intervention (Horner & Kratochwill, 2012; Kratochwill et al., 2010; Lane & Gast, 2014). During each condition, trend, level, and stability were assessed utilizing visual analysis. Using a multiple probe across participants design allowed the researcher to adjust the intervention based on the analysis of data as the intervention progressed. All four participants entered baseline at the same time and were continuously probed. After collecting three data points from each of the four participants to confirm baseline stability, the first participant entered intervention. After a stable trend was observed, the second participant was introduced to the intervention, and the process repeated for the third and fourth participants (Horner & Spalding, 2010).

Participants

Approval for the study was received from The University of Memphis Institutional Review Board (IRB) prior to recruitment. Students were eligible to participate in the study based on the following criteria: (a) participation in an inclusive post-secondary education program for students with IDD, (b) both the cognitive and physical ability to use the calculator, (c) did not have prior knowledge in how to tip at point of sale and (d) demonstrated ability to understand basic mathematical operations as determined by existing assessment, such as mathematics subtests of the *Woodcock Johnson Tests of Achievement*, 3rd edition (WJ-III; Woodcock et al., 2001) and the *Everyday Mathematics and Attitude toward Math* subtests of the third edition of the *Test of Mathematical Achievement* (TOMA-3; Brown et al., 2012). Consent was obtained by collecting parental consent forms from guardians/parents of participants who have conservatorship or students without conservatorship who agreed to participate in the study. Four young adults enrolled in an IPSE program for students with intellectual and/or developmental disabilities participated in the study (see Table 1).

Joe

Joe was a 22-year-old male diagnosed with chromosomal duplication 7q12 and sensorineural hearing loss. Joe wears two hearing aids and often uses the text-to-speech application on his I-phone to be understood. Joe was previously tested using the WoodcockJohnson Tests of Achievement-IV, (WJ-IV; Schrank et al., 2014). His Broad Math sub-score placed at the < 1% or a standard score of < 40. On the Math Reasoning section of the Wechsler Individual Achievement Test-III (WIAT-III; Wechsler, 1992), Joe scored at the 0.1% or a standard score of 55. Joe graduated from a public high school in the region with a special education diploma.

Cindy

Cindy was a 23-year-old female who was diagnosed with Down Syndrome at birth. Her previously administered testing showed a Wide Range Achievement Test, (WRAT- 4; Wilkinson & Robertson, 2006) Math Computation score of 0.4% or a standard score of 60. Her score on the math section of the Peabody Individualized Achievement Test-R (PIAT-R; Markwardt, 1989) showed her in the 1% of achievement or a standard score of 63. Cindy’s tested IQ score was a 58. She graduated from a local public school with a special education diploma.

Ana

Ana was a 22-year-old female with a diagnosis of hearing impairment and mild intellectual disability. Ana's mother reported that she was born without a heartbeat and not breathing. She was resuscitated after 6 minutes and spent 10 days in the neonatal intensive care unit. Ana was diagnosed at age 5 with hearing impairment and began to receive special education services. Ana was homeschooled from sixth grade through high school graduation. On the Woodcock-Johnson IV Tests of Achievement (Schrank et al., 2014), Ana's performance on the mathematics calculation, applied reasoning, and math fluency tasks were at the 3.6 grade level.

Matthew

Matthew was a 20-year-old male who had a dual diagnosis of Neurofibranetisis-Type 1 and ASD. He was first diagnosed with ASD at the age of eight, along with ADHD and speech disturbances of articulation and language. When presented with the AIMSWeb Mathematics and Computation mathematical probe, Matthew scored at the sixth grade level. His IQ testing reports a full-scale IQ of 71. Matthew graduated from a local public school with a special education diploma.

Settings and Interventionists

Sessions for each participant occurred face-to-face, one-on-one, 3 days per week with each session lasting between 20-40 minutes. Due to pandemic restrictions and the end of the academic school year, sessions with Ana were conducted using the online platform, Zoom©. All other sessions were conducted in a typical classroom, seated at tables. Sessions were recorded using the recording feature provided on cellular device for interobserver data collection and calculation. The interventionist was a doctoral candidate. She had 31 years of experience in education, including 6 years of experience as the director of an inclusive post-secondary education program at the university where the participants attended. Students who participated had been diagnosed with intellectual disabilities, ASD, Down Syndrome, and other developmental disabilities. The primary researcher was a faculty member who developed the materials, analyzed the data, conducted fidelity checks of procedures, and completed the IOA data for data collected. The faculty member had over 23 years' experience in special education, including four plus years as a faculty member in special education at the university level.

Targeted Mathematics Skills

The targeted word problems for this study were all *tipping at the point of sale* problems. Emphasis was placed on teaching each student to utilize a step-by-step instructional list, or a task analysis (TA), where complex mathematical word problems are broken down into discrete steps. Prior to intervention, individualized TAs were developed to address each target skill by developing several component behaviors or steps, with each step being both observable and measurable (Worley & Gast, 1984). The use of a TA allows researchers to identify barriers and corresponding research-based practices to better support student learning, and provides a means for students to self- direct their own learning (Root et al., 2019). These task analysis and mathematical word problems on tipping at point of sale were presented to the student as preprinted handouts.

Independent Variable

A universally designed mathematics treatment package was used to teach calculating percentage to determine correct tipping at point of sale (e.g., *If you go out to eat and want to leave a 15% TIP, how much would the TIP be and how much is your total bill?*). MSBI adds supports to traditional SBI, which teaches students to recognize the problem type (e.g., percent of change) and then map the variables from the word problem onto a graphic organizer (Jitendra et al., 2015). Traditional SBI was modified to follow recommendations for systemically teaching mathematical problem-solving skills to students with extensive support needs (ESN), including: (a) interactive read alouds, (b) graphic organizers with visual supports, (c) task analysis, (d) generalization to real life activities, and (e) anchoring instruction (Spooner et al., 2017). Participants were presented with a video anchor that included a video of a person introducing the problem in a real-world scenario. The participant then used these elements of systematic instruction to solve the problem using paper/pencil, while ultimately placing their answer on the graphic. This intervention had embedded conceptual understanding of early numeracy skills so students could concurrently receive remediation of splintered mathematical skills and ageappropriate, grade-aligned, standards-based content. This intervention was delivered face-to-face during one-on-one sessions. Data were collected on each participant's progress toward solving each problem independently.

Dependent Variables and Measurement

Data were collected during probes and instructional sessions on the number of steps on the graphic organizer answered correctly. The primary difference between probes and instruction sessions was the absence of instruction, prompting, and feedback on probes. The primary dependent variable was mathematical problem-solving calculating percentage of tip at point of sale, measured by the total number of points a participant received by independently performing the six steps of the task analysis. Participants could earn a total of 6 points for each problem, with a total of 12 points across two problems in each session. After participants reached mastery criteria of 85% correct answers, independently performing the six steps of the task analysis, each received no less than two maintenance probes during the maintenance condition.

Experimental Design

A multiple probe across-participants design (Ledford & Gast, 2018) was used to investigate the effectiveness of an instructional package that included modified schema-based instruction (MSBI), system of least intrusive prompting, and task analysis on the mathematical problem-solving skills of four participants. The implementation of the design adhered to the criteria established by the What Works Clearinghouse (Kratochwill, et al., 2013; What Works Clearinghouse [WWC], 2014). There were three experimental conditions of baseline, intervention, and maintenance if a functional relation existed between the independent variable and dependent variable.

Baseline

All participants entered baseline simultaneously. During baseline, students were asked to solve two mathematical word problems about tipping at the point of sale with no instruction, prompting, feedback, or error correction to determine the student's present level of performance. In baseline sessions, the instructor presented the instructional cue, "S*how me how to solve this problem*." The instructor read the problem aloud if asked by the participant. Praise for on-task behavior was given, but no instruction, error correction, or reinforcement for correct answers were provided. This procedure continued until the participant attempted two mathematical problems. If a participant did not attempt the problem or stopped working on the problem for 10s, the student was instructed to skip the problem and move on to the next problem. If the student asked for help (other than to be provided a read aloud), the instructor replied, "*Do your best*," or another similar affirming statement that did not provide any specific feedback or prompting. Students were given a minimum of five baseline probes and were intermittently probed with no less than eight sessions in between with a cluster of three prior to entering intervention.

Training

For two sessions after baseline, the instructor provided strategy instruction to the participants following the sequence on the student self-instruction sheet. During these training days, the interventionist modeled how to complete each of the steps of the task analysis using explicit instruction to solve the problems with active student participation (e.g., "*My turn, I found the total of my bill. Your turn, find the total of the bill.*"), followed by behavior specific praise to reinforce each skill (e.g., "*Yes! Great job finding the total of the bill!*"). During the training sessions, if the student paused for more than 3 seconds after prompt, constant time delay (CTD) was paired with the system of least prompts system (SLP) for error correction and feedback.

Intervention

The intervention consists of three conditions focused on percent increase: baseline, intervention, and maintenance. A three-session probe was conducted between each intervention phase to measure maintenance of treatment effects. The order of participants was based upon a visual analysis of trend. The intervention began with the first participant to exhibit a steady baseline trend.

Intervention began with the student choosing from a menu of community locations, followed by watching a video anchor representing the skill at the specific community location. The researcher then provided instruction and the problem followed by the prompt, "*Show me how to solve this problem*." The MSBI intervention involved teaching students to use a selfinstruction sheet (TA) and virtual graphic organizer to follow steps to solve two mathematical word problems about tipping at the point of sale.

Following the two-day training using explicit instruction, the interventionist provided the participant with a probe consisting of two problems to determine participant ability to correctly solve the problem. Each step of the TA the participant responded correctly was marked with a (+) and the total number of steps solved independently correct for each problem were totaled and graphed. A System of Least Prompts (SLP) was implemented if the participant failed to respond within 3s to any step of the problem, or responded incorrectly and the step was counted as incorrect (-). If the participant responded incorrectly or paused for 3s the SLP hierarchy would be given with the first being a verbal prompt, "*Refer/look back to your chart*" if the participant still provided an incorrect response or did not respond in 3s, a gestural prompt was given "Here is step one" while pointing to the step, and if the participant still did not respond in 3s, a model prompt was given, "*Look at Step 1. It says 'Find the total amount of the bill in the sentence'. Watch me find the total amount.* (Instructor identifies the total of the bill for the student) *Your turn. Find the total of the bill*." This provided for errorless learning where the student is guided to the correct response each time to ensure they master each step of the TA to be able to accurately solve the word problem. The interventionist used behavior specific praise after each correct response (prompted or unprompted), such as "*Great job using your calculator to multiply*." As participants demonstrated proficiency on steps of the task analysis, behavior specific praise was faded by less utilization of praise at each step to the point of only praise with the correct final answer.

The interventionist collected data on the total number of steps the participant was able to complete independently correctly on the task analysis with each step given a (+) if correct, and a (-) if incorrect or the student paused for more than 3s in responding. The participant was given the opportunity to perform each step without assistance to demonstrate mastery of each step and provided SLP as needed to complete the step prior to moving to the next step. Due to the chained nature of solving a word problem, each step is contingent on the prior step, therefore, the student had to solve each step independently correct (+), or respond correctly using SLP and receive a (-) for that step, but this allowed the student to be able to continue with each step and have opportunity to correctly solve each of the two problems. The third and final series of probes following intervention also served as a maintenance measure.

A response guided approach was used to make decisions about introduction of participants to intervention (Ledford & Gast, 2018). The first participant, Joe, entered intervention after the establishment of a stable pattern of responses over a minimum of five data points. After the first participant met the criteria for mastery of three consecutive correct problems with all steps completed correctly, the were moved to the maintenance conditions and the second participant, Cindy entered intervention. This systematic introduction to intervention continued for the third participant, Ana, and the fourth participant, Matthew. Each student continued through the phases at their own pace of learning.

Interobserver Agreement (IOA)

The primary researcher conducted IOA on results obtained by the interventionist. A randomly selected 30% of sessions from each study phase were coded for Interobserver agreement. Reliability was calculated by dividing the number of agreements by the number of agreements plus the number of disagreements and multiplying by 100, and a Kappa coefficient was computed. A Kappa coefficient is a statistical measure of inter-rater reliability or agreement that is used to assess qualitative documents and determine agreement between two raters. It is deemed more reliable than a simple percentage. IOA was determined to be 99.1%.

Social Validity

Single case design research can be used to identify educational pedagogies that are effective, socially important, feasible, and produce meaningful results (Horner et al., 2005). Families were asked to complete a Likert scale survey with five questions to evaluate the effectiveness of the intervention on the student's ability to independently perform mathematical percentage calculations. Each response to the five statement could range in agreement from 1-5 with 5 being complete agreement. Three of the four families responded to the survey. The average score was 4.6 for the statement, "I believe this was a beneficial project for my student to participate in and grow in knowledge." For the statement, "My student was pleased with his/her performance during the project," the average score was also 4.6. For the statement, "My student discussed attending sessions and learning a new skill," the average score was 3.3 with one parent scoring the statement a 1. "I believe that learning to tip at point of sale helps my student gain independence in real world situations," was scored a 4.0. Parent responses indicated that overall, participating in the study was beneficial for their student.

Procedural Fidelity

All sessions were videotaped and coded with pseudonyms to protect participant confidentiality. The primary researcher used a procedural fidelity (PF) checklist to ensure the interventionist was implementing the intervention with fidelity by randomly selecting >30% of all sessions and providing feedback to the interventionist as needed. The PF checklist included indicators to determine if prompts were used according to the prescribed instructional script (e.g., interventionist/teacher followed scripts) and if the prompting hierarchy was used according to the predetermined guidelines of SLP. Procedural fidelity was determined to be 94.1%

Results

This study sought to answer the research question, what is the effect of an MSBI strategy on teaching young adults in an IPSE environment to tip at point of sale. Figure 1 demonstrates the outcomes of this study through visual analysis of level, trend, variability, and overlap to interpret the effect size and determine a functional relation between baseline and intervention. The graph shows the number of steps independently completed on the task analysis across baseline, intervention, and maintenance phases for each participant. All students entered simultaneously and exhibited a stable baseline, and all four participants demonstrated a change in level and trend with no overlapping data from baseline performance. Visual analysis of the graph indicated a functional relation between the MSBI package and participants correctly tipping at point of sale. These results demonstrate that MSBI may be an effective instructional method to teach students with ESN how to calculate percentage of change. Each individual student entered intervention upon demonstrating a positive trend during baseline. Discussion of each student in the order that they entered intervention follows.

Joe

During baseline Joe received five baseline probes delivered by the interventionist. On each of the first four probes, Joe correctly performed 4 of the 12 steps, but on the fifth probe of baseline he could not perform any of the steps without prompting. Joe's range was 0-4 during baseline, with a mean score of 2.4. Joe entered the intervention stage at session six. In each of the three intervention sessions, Joe successfully reached mastery by completing 12 of 12 steps of the task analysis. He was able to maintain 100% accuracy during each of the two maintenance probes. While Joe completed his intervention phase, other participants remained in baseline.

Cindy

Cindy was the next participant to enter the intervention phase after having received eight baseline probes. Cindy's range during baseline had been 0-2 steps of the task analysis independently completed, with a mean of 0.5. Once she entered the intervention stage, Cindy demonstrated a jump in both level and trend. Cindy's range was 11-12, with a mean of 11.6. Cindy was able to maintain mastery through the maintenance stage with a range of 10-11, with an average of 87.5% mastery (10.5 steps performed independently).

Ana

Ana was the third participant to enter the intervention stage after having received nine baseline probes. During baseline, her steps performed independently ranged from 2-4, with two steps being the steady trend as she entered intervention, with a mean of 2.6. During intervention Ana's scores ranged from 11-12. Two maintenance probes were performed with scores of 10 and 11 respectively, which indicated 87.5% mastery.

Matthew

The fourth participant to enter intervention was Matthew. Matthew showed a positively inclined trend after receiving 10 baseline probes. His first baseline score was two, but by the 10^{th} probe, Matthew was independently performing eight steps of the task analysis, yielding a mean of 5.8 during baseline. Matthew had a steady trend of eight steps of the task analysis being performed independently correct. Upon entering intervention, Matthew began earning 100% mastery and continued to do so during the maintenance phase.

Discussion

Browder et al. (2018) discussed students with ESN often struggle with reading and mathematical calculation skills necessary to approach work problems found in everyday life situation; Fuchs et al. (2008) also shared this being a source of difficulty for students with ESN. Existing literature has shown schema-based instruction, specifically modified schema-based instruction (MSBI), as a viable teaching strategy for solving mathematical problems for students with ESN (Cox & Root, 2020; Ley Davis, 2016, Root, Henning, & Boccumini, 2018; Root, Browder, et al., 2017). Several research studies have been conducted by implementing MSBI to evaluate the effects of a universally designed mathematics intervention to teach tip and sale to elementary students (Root, Browder, et al., 2017) and middle school students with ESN (Root et al., 2019). However, no literature exists on using MSBI to teach percentages to calculate tip to college-aged students. Thus, the purpose of this study was to extend the research to an IPSE program to determine the effects of using MSBI on mathematical percentage calculations to college-aged students with ESN.

Upon completion of the intervention each of the four participants had reached mastery level for this study (85% of steps performed unassisted/unprompted). There were positive trending data points with no overlap in baseline performance (See figure 1). Visual analysis demonstrated a functional relation between MSBI and the success of students with ESN to perform mathematical percentage calculation. As shown in the demographic information (Table 1) there is variability in the cognitive abilities and math scores of the students. Joe rebounded and was independently able to perform all twelve steps of the task analysis, and maintained that level throughout the maintenance phase. Cindy was independently able to perform 10-12 steps independently throughout the intervention and maintenance phases. Ana demonstrated variability throughout all three phases of the research. During baseline her scores were in the 2-4 steps performed independently, but ranged 10-12 steps during intervention and maintenance. Matthew was able to perform all twelve steps of the task analysis throughout intervention and maintenance.

This study's findings corroborate the findings of Root, Browder, and associates (2017) and Root and others (2019). Their research found elementary and middle school students with ESN demonstrated a functional relation for the intervention, thus learning how to teach tip and sales. The graphic organizer with task analysis, video anchors, and visual supports helped these four students to translate the information correctly, and successfully solve the word problems. The findings for this study were very similar with college-aged students with ESN as a functional relation was demonstrated by the four participants in this study. Thus, this added to the body of literature regarding MSBI and its effects on college-aged students with ESN in an IPSE setting.

Limitations

One of the contributions of the current study is that it demonstrated MSBI is an effective instructional method for teaching students with ESN to calculate percentage of change, however, limitations must be considered. Due to the pandemic restrictions on public exchanges, generalization was not a component of this study. Also, due to the limited time frame, maintenance probes were over a week long period only. It is suggested that in future studies maintenance probes be done over a longer period to test for maintenance of the skill. This study was incorporated into the life skills course of an inclusive post-secondary education program. The population of this course was five, four of which met the qualifications for the study, therefore, a final limitation would be to have a larger sample size in future studies.

Future Research

In order to fully evaluate the effectiveness of the study, future research should include a generalization of the skill component. This could include community based visits to local restaurants, spas, and/or coffee shops that would require students to utilize the skill set that they have been taught and demonstrated mastery of in the classroom situation, in the actual venue, with a system of faded supports. Supports from the MBSI could be faded; as example, reducing the number of steps in the TA, omitting the graphic organizer. This would allow for generalization across locations. As noted above, future research should allow for the maintenance stage to be done over a longer period of time to further investigate the retention of the skill. Finally, a replication study is needed to further research the MSBI with students in IPSE programs.

Implications for Practice

Calculating mathematical percentage correctly is an important mathematical skill for all students, but doing so in financial situations, such as tipping at point of sale, is especially so for those with ESN. MSBI that is anchored in real-world scenarios has proven to be an effective tool in teaching students enrolled in an inclusive post-secondary education program for young adults with extensive support needs to learn mathematical skills, including the ability to tip at point of sale. Practitioners who utilize evidence-based practices that support the learning of students with diverse needs, will find MSBI to be an effective tool. Schemata and real-world video anchors could be used to teach a variety of skills, including daily living skills (i.e. laundry, cleaning) and academic skills.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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Table 1

Demographic Information for Student Participants

Student	Testing Date	Age	Gender	IQ	Diagnosis	Math Achievement	Reading Achievement

Joe	3/16	21	Male	53	ASD, 7Q12	WJF: 40SS	WJ3: 63SS
Cindy	1/16	21	Female	58	DS, IDD	WRAT4: 64	WRAT4: 55
Ana	3/17	21	Female	63	HI, IDD	WJIV: 62SS	WJIV: 75SS
Matthew	3/18	20	Male	71	ASD, IDD	Aimsweb6: 73%	WRMT4: 69SS

Figure 1.

Points earned for critical steps of the task analysis completed independently.

Baseline Intervention Maintainence

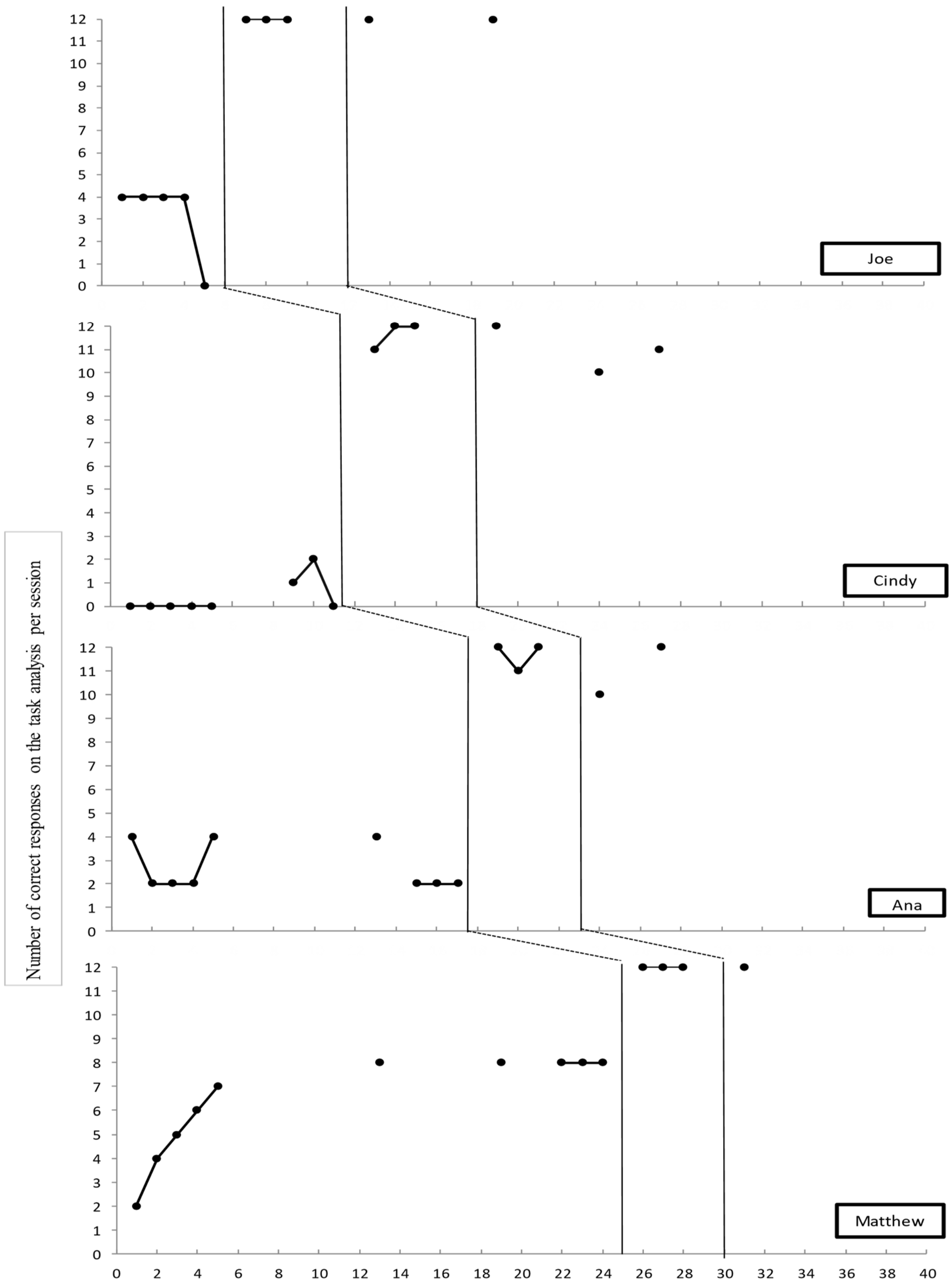

Figure 2

Blank Schemata and Personal Task Analysis

1.		Talk about the problem out loud ❑ What do we know about the problem? ❑ What do we want to find out? ❑ What kind of problem is it?
2.		□ Mark and label original cost
3.		△ Mark and label percent of change
4.		Calculate amount of change △ of □ is ▽
5.		+ or -
6.		Calculate final cost □ then ▽ now ⬭

#1 John wanted to order flowers for his grandmother.

His bill was $90.

He had a 10% off coupon.

What was his total bill?

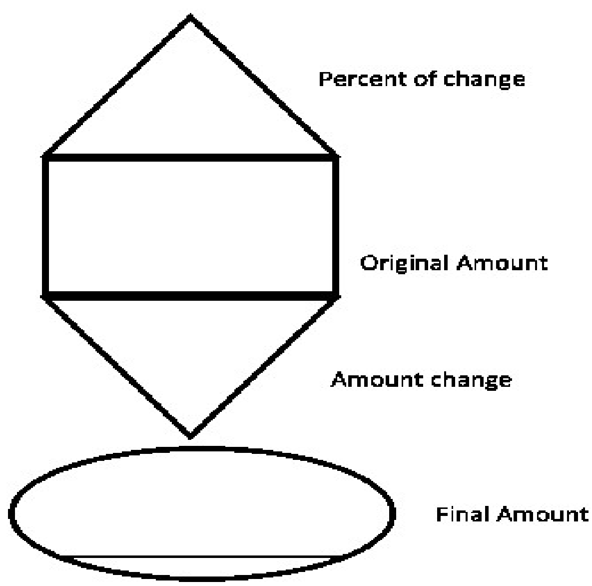

Figure 3 *Interventionist Scoring Sheet*

TIP REPLICATION STUDY

Participant:

Date:

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

Interventionist:

Steps of TA	Measured Behavior	IC	V	SV	M	EC	PF
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					