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Using Schema-Based Instruction to Improve the Mathematical Problem Solving Skills of a Rural Student with EBD

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Schema-based instruction (SBI) is a word problem solving strategy that teaches students to identify problem types by focusing on the underlying structure of the mathematical situation. SBI is gaining an evidence-base for students with a specific learning disability; however, few experimental studies have evaluated the effects of SBI for students with emotional and behavioral disorders (EBD) and, to our knowledge, no study has evaluated the effects of SBI for students with EBD attending rural and remote schools. This study explored the efficacy of SBI to teach a third grader with EBD to solve word problems fitting three additive structures. A non-concurrent multiple probe design across behaviors was used due to resource constraints and intensity of behavioral challenges. Although we are unable to determine the presence of a functional relation due to design limitations, results suggest the student increased his word problem solving skills. Furthermore, the student increased his pre- to post-test score from 10% to 100% and was able to maintain mathematics skills and generalize to science word problems. Implications for practice and future research directions are reported.

Keywords: **Rural, Mathematics, Schema-Based Instruction, Emotional and Behavioral Disorders**

Introduction

Students with emotional and behavioral disorders (EBD) are eligible to receive special education and related services in the United States under the emotional disturbance category due to exhibiting one or more of the following characteristics over a long period of time and to a marked degree that adversely affects educational performance: (a) An inability to learn that cannot be explained by intellectual, sensory, or health factors, (b) An inability to build or maintain satisfactory interpersonal relationships with peers and teachers, (c) Inappropriate types of behavior or feelings under normal circumstances, (d) A general pervasive mood of unhappiness or depression, and/or (e) A tendency to develop physical symptoms or fears associated with personal or school problems. Students with EBD often display performance deficits in mathematics (Brigham et al., 2016; Gage et al., 2017). Responsiveness to mathematics interventions is moderated by many of the characteristics attributed to

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students with EBD (a) attentive behavior, (b) working memory, (c) executive functioning, (d) language, and (e) processing speed (Benz & Powell, 2021; Fuchs et al., 2013; Hollo et al., 2019; Snyder, 2013). In addition, challenging behavior increases the likelihood students will miss instructional time (Hagan-Burke et al., 2011) and if time is spent providing intensive interventions, it is often spent on behavior rather than academics (Vannest & Hagan-Burke, 2010). Therefore, identifying effective, efficient, and transferable mathematical practices for this population is imperative.

In a recent review, Losinski et al. (2019) identified only 17 single-case studies that investigated the effects of interventions on the mathematical performance of students with EBD. Of these, only four investigated interventions to improve the problem solving performance of students with EBD. The lack of research on mathematics interventions for this population has been emphasized in prior reviews (e.g., Ralston et al., 2014), with an urge for researchers to investigate higher-level mathematical skills.

With an insufficient research base evaluating problem solving interventions for students with EBD, practitioners and researchers are forced to identify effective practices researched with other populations. Instruction targeting the underlying structures of word problems is identified as an evidence-based practice for students with a specific learning disability (Jitendra et al., 2015), with schema-based instruction (SBI) being one specific intervention. SBI was recently identified as a potentially evidence-based practice for students with a specific learning disability by applying the Council for Exceptional Children's Standards for Evidence-Based Practices (Cook et al., 2020).

Origins and Description of Schema-Based Instruction

As the name implies, SBI was developed by consulting the literature from schema theory and its application to arithmetic word problem solving (Marshall, 1995; Riley et al., 1983). Marshall (1995) postulated students require four distinct types of knowledge to become proficient in mathematical problem solving: (a) identification, (b) elaboration, (c) planning, and (d) executive. *Identification knowledge* requires students to attend to the underlying mathematical structure presented in the situation to identify patterns of similarities across word problems. This will enable students to learn to identify similar structures and classify word problems into types. A major shift when moving from novice to expert is to focus on the mathematical properties embedded in the problem rather than surface level features (e.g., problem contexts). In SBI students are explicitly taught three problem structures for additive word problems (i.e., requiring addition or subtraction) along with the core characteristics of each structure. *Elaboration knowledge* requires students to schematically map the information presented in the word problem to the core features of the identified problem type. For example, if the student identified a word problem as fitting the total structure, during elaboration the student would identify which information corresponds with Part 1 and Part 2 and which information corresponds with the total. *Planning knowledge* requires students to use information from identification knowledge and elaboration knowledge to devise a plan to facilitate a solution. In multi-step problems, this may involve setting up short term plans and long-term plans to yield a solution to the question posed. Last, *executive knowledge* requires students to self-regulate their behaviors to carry out their plan.

As highlighted above, the core feature of SBI involves teaching students to build a rich schema for different word problem structures by identifying similarities and differences between structures and identifying how various surface level information related to the problem may vary but does not change the problem structure. This should replace less effective approaches to word problem solving such as key words, general problem solving strategies (i.e., guess and check, make a picture) or can supplement other approaches that are not sufficient for some students, such as general cognitive strategy instruction (Montague & Dietz, 2009; Jitendra & Star, 2011). Because SBI was originally created with the intent of improving the word problem solving of novice learners and learners with mathematics difficulties, the intervention is grounded in explicit instruction (Jitendra & Hoff, 1996). SBI has also been used to effectively teach students at-risk or identified with a Specific Learning Disability how to solve additive, multiplicative, and ratio/proportion word problem structures (Peltier & Vannest, 2017; Peltier et al., 2018).

The intervention also includes two other features: (1) a mnemonic that primes the critical steps in the mathematical problem solving process is used to support students with self-regulation so they can self-monitor their behavior and (2) graphic organizers to support students in building elaboration knowledge when schematically mapping information in the word problem to the core features of the problem type. Additive word problem structures are introduced first in the curriculum and include three core structures: change, group, and compare. The change structure involves a quantity that increases or decreases over time. The group (or total) structure involves a set of smaller groups that can be combined to form a total. These problems are commonly referred to as part-part-whole comparisons. The compare (or difference) structure involves two sets being compared to find the difference between their values (see Jitendra, 2007). See Table 1 for problem type exemplars.

Table 1. ***Sample Problems for Each Schema Structure***

Problem Type	Sample Problem
Group	Frankie spent 55 min on homework tonight. If he spent 25 minutes on math homework and the rest on reading homework, how much time did he spend on reading homework?
Compare	William brought 75 cents into the convenience store. He spent 51 cents on a package of gum. How many cents does he have left?
Change	Ben scored 23 points in the basketball game and Asher scored 14 fewer points. How many points did Asher score?
Generalized	Luke observed the weather daily as part of his science project. One day 1 it was 75 degrees and on day 2 it was 68 degrees. How much hotter was it on day 1 than day 2?

Note. Generalized problems were created for each target schema but aligned with science content.

To our knowledge, three studies investigated SBI for students with EBD. Jitendra et al. (2009) used a case study design, inhibiting our ability to determine a functional relation between SBI and an increase in problem solving performance. However, the article documented the need to investigate problem solving interventions for students with EBD and a rationale for why SBI may meet the needs of students with EBD. Peltier and Vannest (2016) used a single-case research design and identified a functional relation between SBI and an increase in mathematical problem solving performance of two fourth-grade students with EBD. Students improved on their problem solving performance for word problems, including additive and multiplicative structures. Peltier and Vannest (2018) used a single-case research design and identified a functional relation between SBI and an increase in mathematical problem solving performance for four second-grade students with EBD. The intervention targeted word problems with additive structures and was effective for three of four students. The authors highlighted the need to investigate the effects of SBI using school personnel rather than a researcher, which is needed for the entire SBI literature base (15 of 16 single-case studies used researchers as implementors; Peltier et al., 2018). Evidence does suggest teachers can implement the intervention with high levels of fidelity when provided training and coaching (Griffin & Jitendra, 2009; Jitendra et al., 2002; Jitendra, 2007). Griffin and Jitendra (2009) noted high levels of fidelity following two 2-hour trainings and scripted materials; whereas Jitendra (2007) identified that after a 1-hour training on the intervention and being provided with scripted materials teachers did need ongoing coaching to ensure consistent implementation was maintained.

To date, SBI studies have failed to include students with EBD attending rural schools. Implementation of interventions in rural settings present specific challenges: fewer teachers, less discretionary resources, and geographic isolation (Rude & Miller, 2018). Although resources vary widely across rural districts, similar challenges are faced: teachers often do not have access to coaches, specialists, or quality professional development necessary to implement evidence aligned interventions with fidelity (Hott et al., 2019). Therefore, it is critical that interventions are evaluated within schools that have personnel, resources, and materials shortages.

The current study aimed to investigate the effects of SBI on the mathematical problem solving performance of a student with EBD attending a rural school with limited resources and few students with disabilities. This allowed us to extend SBI work to a rural school that served only one student with EBD, had limited resources (no dedicated interventionist to provide special education services, high poverty, few materials), and limited professional development. The following research questions were addressed: (1) Did SBI lead to an increased mean level change on mathematics word problem solving for a student with EBD receiving services in a rural setting? (2) Do SBI effects generalize to mathematical problem solving tasks in a science context for a student with EBD receiving services in a rural setting?

Method

Participant

The study included one student, Levi, identified with an ED who had received special education services for 1.5 years. Levi's Individualized Education Program (IEP) noted medical diagnoses of anxiety, depression, and attention deficit hyperactivity disorder. Levi, a White male, was 8 years old and in the third grade at the time of the study. Educational records noted that Levi scored in the low average range on the Woodcock Johnson Tests of Achievement, IV Edition Broad Mathematics cluster (SS = 84, 14th percentile) with a mathematics calculation subtest score in the average range (SS = 93, 32nd percentile). The Broad Written Language (SS = 89, 23rd percentile) cluster score was in the low average range and Broad Reading (SS = 99, 47th percentile) cluster was in the average range. However, Levi had deficits in mathematical problem solving, identified by his special education teacher, and as evidenced by classroom work samples evaluating word problem solving skills. In addition, Levi displayed challenging behaviors that interfered with instruction and displayed high-levels of non-compliance. Educational records and teacher reports indicated that maladaptive behaviors included work refusal, sleeping during class, walking out of class, throwing objects, and arguing with teachers. These maladaptive behaviors impacted Levi's ability to complete grade level work in the absence of accommodations and supports.

Setting

The study was conducted in a rural public school district located in the southeast. The elementary school was part of district within a cooperative of nine districts that pooled resources to provide needed special education services across member districts to provide services to students identified with a disability. The elementary school served students in pre-kindergarten through grade 7 (n = 104). A majority of students enrolled identified as White (46%), followed by Hispanic (22%), Black (21%), and other races including American Indian and two or more races (11%). A majority of students were economically disadvantaged and received Free or Reduced Meals (91%). Roughly 6% of students received special education and related services.

One teacher with a Bachelor of Arts in Education and 18 years of experience teaching elementary aged students was responsible for teaching third grade students. The district employed one special education teacher responsible for case management and providing specialized instruction for the district. One school counselor served the elementary and high school and a diagnostician and school psychologist were available for consult through the cooperative (n = 9 districts) that pooled resources to provide special education and related services. The study was carried out in the back of Levi's general education classroom during silent study time at a kidney-shaped table.

Dependent Variables

For the current study, we collected data on two separate dependent variables across performance on 4 separate problem-solving tasks. The two dependent variables were problems correct and problem solving process. To measure correct problems, 1 point was awarded for a correct solution. For each probe we used the following formula: (points earned/total points possible) x 100. To measure mathematical problem solving process, 1 point was awarded for each correctly completed step. We aligned our measurement of problem solving process with Marshall's (1995) description of schema knowledge for mathematical problem solving: (a) identification, (b) elaboration, (c) planning, and (d) executive. The steps included (1) drawing the correct graphic organizer (i.e., observable behavior signifying schema identification), (2) placing quantities in the appropriate place in the graphic organizer (i.e., observable behavior signifying schema elaboration), (3) writing an accurate number sentence to facilitate a solution (i.e., observable behavior signifying planning knowledge), and (4) providing the correct solution (i.e., observable behavior signifying executive knowledge). For each probe we used the following formula: (points earned/total points possible) x 100. The four problem solving tasks included (a) group structures, (b) change structures, (c) compare structures, and (d) mixed problems (see Table 1 for sample word problems fitting each problem solving task). Mathematical problem solving process could only be measured for probes that did not provide students with the graphic organizer.

Materials

Before starting the study, typical instruction consisted of students completing work created by the teacher or from online resources. No prescribed curriculum or district-adopted curricula were available. The teacher reported relying heavily on Khan Academy, an open source online mathematics tutorial tool, and teachers-pay-teachers to locate class materials. She aligned her lessons with the Common Core Standards for grade 3 mathematics but, due to budgetary constraints, did not have access to student textbooks or consumables.

All instructional materials and assessment probes were from *Solving Math Word Problems: Teaching Students with Learning Disabilities Using Schema-Based Instruction* (Jitendra, 2007). The interventionist used the scripted lesson plans from the teacher manual. Student workbooks were created using the CD–ROM that provided graphic organizers and word problems for modeling, guided practice, and independent practice problems. The first page of the student workbook included the FOPS (see below for acronym) mnemonic in a plastic sleeve and square boxes to check off each step during the instructional phase. The graphic organizers were also placed in sleeve protectors so the student could use a dry erase marker for modeling and guided practice problems.

Experimental Design and Measurement

A nonconcurrent multiple probe design was selected because (1) the student experienced significant difficulty with anxiety and failure so repeated measures at 0% may have been detrimental, (2) limited staffing and support as the diagnostician served several districts and worked with the student in addition to her assigned duties, (3) the target behavior was not reversible, and (4) there was an insufficient number of students with EBD (1 elementary student with EBD within a 50 mile radius) to use a multiple-baseline design across participants. In addition, the student displayed high levels of non-compliance, particularly for academic tasks he was not successfully completing, thus we opted to collect less baseline data than recommended by the *What Works Clearinghouse Standards Handbook* (WWC; Version 4.1) (2020).

We used a fixed schedule to determine progression through the intervention. It was determined a priori that a minimum of 3 baseline probes would be collected per target structure, three intervention sessions per structure (explicit instruction for each problem type, Group, Change, Compare), two intervention sessions with graphic organizers provided (word problem and graphic organizer provided), and three intervention sessions with no diagrams provided (word problem provided). In accordance with previous research, we choose to teach group, then change, and finally compare problems. We then assessed a mixed set of problems.

Measures

Baseline probes

For group, change, compare, and mixed problem baseline probes, the student completed six problems representing the target structure. No graphic organizers were provided. Computation included 2-digit addition & subtraction and 3-digit addition & subtraction, with and without regrouping. Each probe contained six problems: 1, 2-digit addition; 1, 2-digit subtraction; 2, 3-digit addition (one with regrouping and one without); and 2, 3-digit subtraction problems (one with regrouping and one without).

Instructional probes

For group, change, and compare instructional probes, the student completed six problems representing the target structure. For each word problem the graphic organizer was provided to the student. Each probe contained six problems: 1, 2-digit addition; 1, 2-digit subtraction; 2, 3-digit addition (one with regrouping and one without); and 2, 3-digit subtraction problems (one with regrouping and one without).

Intervention probes

On each probe sheet, six-word problems fitting the target problem structure were included. For the first two group, change, and compare intervention probes, the graphic organizer was provided for each word problem. For the final three intervention probes, the student was not provided the graphic organizer. Each probe contained six problems: 1, 2-digit addition; 1, 2-digit subtraction; 2, 3-digit addition (one with regrouping and one without); and 2, 3-digit subtraction problems (one with regrouping and one without).

Mixed and maintenance probes

Mixed and maintenance probes contained six word problems, two per structure. For each structure, the unknown quantity was randomly placed. No graphic organizers were provided. Each probe contained six problems: 1, 2-digit addition, 1, 2-digit subtraction; 2, 3-digit addition (one with regrouping and one without); and 2, 3-digit subtraction problems (one with regrouping and one without).

Generalization probes

Generalization probes included six problems, two for each problem structure. The probes were created by the science teacher in consultation with the first author to align with the space and weather units. All the contexts were aligned with the science standards the students were currently learning. No graphic organizers were provided. As with mathematics probes, each probe contained six problems: 1, 2-digit addition; 1, 2-digit subtraction; 2, 3-digit addition (one with regrouping and one without); and 2, 3-digit subtraction problems (one with regrouping and one without).

Pre- and post-test

The pre- and post-test each contained 10-word problems representing the three target structures (i.e., group [n = 3], change [n = 4], compare [n = 4]). No graphic organizers were provided. Computation included 2-digit addition (2 problems) & subtraction (3 problems) and 3-digit addition (2 problems) & subtraction (3 problems), with and without regrouping. See Table 1 for sample problems by type.

Procedures

A special education teacher working in the capacity of a diagnostician, testing students for special education and related services and facilitating meetings, served as the interventionist. She served the entire cooperative and had 11 years of experience working in the district. The interventionist was selected because she had time, resources, and willingness to receive training necessary to implement the intervention. She had a Bachelor of Science Degree in Mathematics and a Master of Education Degree with a concentration in Special Education. She was pursuing an Educational Doctorate in Curriculum and Instruction.

The first author trained the interventionist during two, 3-hour afternoon sessions. During the first session, the interventionist practiced implementing the intervention with an undergraduate while the first author provided feedback. The interventionist received a copy of Jitendra's (2007) book and CD. The interventionist then independently implemented the intervention across all three problem types and the mixed problem type on two separate occasions during the second training session. A checklist included the following steps: (1) interventionist stated the objective for the day, (2) the interventionist stated the purpose of being a problem solver, (3) the interventionist reviewed behavioral expectations, (4) the interventionist modeled two problems using the FOPS acronym, (5) the interventionist used the four steps of FOPS to assess treatment fidelity of treatment. The interventionist scored 100% across problem types during both sessions.

Pre-test

The interventionist pulled the student to the kidney table located in the back of the classroom. The interventionist presented the probe sheet and told the student to try his best.

Probes

Each probe contained six problems. Computation included 2-digit and 3-digit addition and subtraction problems, with and without regrouping.

Baseline probe sessions. The interventionist pulled the student to the kidney table located in the back of the classroom. The interventionist presented the probe sheet and told the student to try his best.

Instructional probes. For each target schema, the student received three instructional sessions. The interventionist worked with the student at the kidney table located in the back of the classroom. The intervention was grounded in explicit instruction and followed the procedures in the *Solving Math Word Problems: Teaching Students with Learning Disabilities Using Schema-Based Instruction* (Jitendra, 2007). The interventionist started the lesson by stating the objective for the day, stated the purpose for being a problem solver, and reviewed behavioral expectations. The interventionist modeled two problems using the FOPS acronym. FOPS has these four steps: (1) Find the problem type; (2) Organize the information; (3) Plan to solve; and (4) Solve the problem. During the instructional phase, she modeled *finding the problem type* by reading the problem aloud, underlining information, and evaluating the question to determine the structure. Then, she placed a check mark by F to self-monitor her usage FOPS. Next, the teacher *organized the information* by drawing the corresponding graphic organizer and placing the information into the correct location. The teacher checked O self-monitor strategy usage. Next, she *planned to solve* the problem by identifying an appropriate number sentence to facilitate a solution. Last, the interventionist *solved the problem* by carrying out the computation. The solution was labeled. She checked S to self-monitor strategy usage. For guided practice, the teacher provided practice opportunities. The sequence of steps during guided practice mimicked those of modeling. At each step, the interventionist prompted the student to chorally respond. To conclude the lesson, she restated the objective and purpose for being a problem solver. Last, the teacher provided independent problems for the student to complete. Lessons were implemented in accordance with Jitendra's curriculum (2007).

Post-test

As with the pre-test condition, the interventionist pulled the student to the kidney table located in the back of the classroom. The interventionist presented the probe sheet and told the student to try his best.

Interobserver Agreement and Fidelity of Implementation

Inter-observer agreement (IOA) was calculated using the following formula (agreements/ total opportunities to agree) x 100. The second author provided a rubric to measure the student's mathematical problem solving process and a 30-min training consisting of providing worked examples, guided practice, and independent practice. Both scorers earned 100% IOA on training probes.

The first and third author independently scored probes. IOA was collected on 33% of baseline, 33% intervention, 100% of maintenance, and the pre-test, post-test, and generalization probes. IOA was 100% for baseline, 94% for intervention, and 100% for maintenance for group problems and 100% for baseline, intervention, and maintenance phases for compare and change problems. IOA was 100% for pre-test and post-test and 100% for all generalization probes.

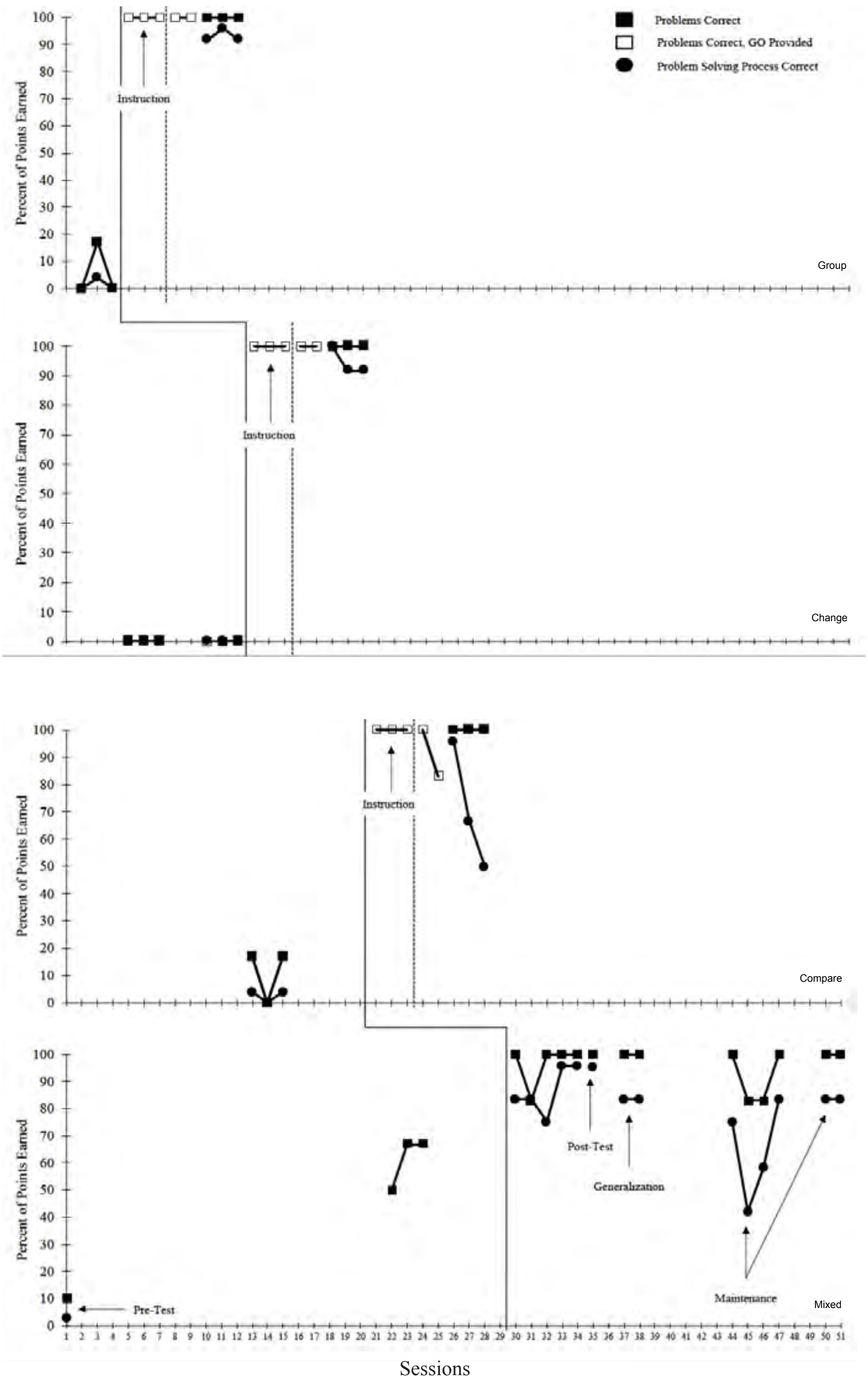
Fidelity of implementation was calculated by using the following formula: (number of observed steps completed/total number of steps to complete) x 100. Fidelity of implementation was collected on 30% of intervention sessions. The first author used a fidelity checklist for all observation sessions. Fidelity of treatment across all sessions was 100%.

Analyses

A nonconcurrent design with probes was used to evaluate the relation between SBI and word problem solving accuracy. We relied on visual analysis (Kennedy, 2005) to determine if Levi increased his word problem solving skills across three problem types: change, group, compare, and mixed (2 of each problem type). To systematize this approach, we adhered to the steps provided by the *WWC* (2020): (1) analyze baseline to determine if a concern is demonstrated and stable data were obtained; (2) assess level, trend, and variability within each phase (i.e., baseline and intervention across skills); and (3) examine overlap, immediacy, and consistency by comparing adjacent phases. Stability was determined by visual inspection when there was no evidence of upward or downward trend, level was determined by finding the mean of the phase, and trend was determined by the presence of an increase or decrease in performance (Cooper et al., 2020).

Results

Did SBI lead to an increased mean level change on mathematics word problem solving for a student with EBD receiving services in a rural setting?


Problems Correct
Problems Correct, GO Provided
Problem Solving Process Correct
Percent of Points Earned
Instruction
Group
Change
Compare
Mixed
Pre-Test
Post-Test
Generalization
Maintenance
Sessions

Review of each phase of study indicated that Levi increased his mathematical problem-solving performance between baseline and treatment phases (see Figure 1 for time-series graph of data). Baseline performance across word problem structures was low for problems correct (group = 0% to 17%, change = 0%, compare = 0% to 17%). Similarly, the student's mathematical problem solving process was also low (group = 0% to 4%, change = 0%, compare = 0% to 4%). Furthermore, although baseline data were not collected in accordance with the WWC (2020), the data were stable (i.e., within 20%) and demonstrated low levels of performance. Without the aid of the pre-drawn graphic organizers, the student answered 100% of problems correctly on the last three intervention sessions for group, change, compare, and mixed problems. The student's mathematical problem solving process was above 90% for group and change; his performance showed a decreasing trend on the compare probes. The mean level change between baseline to intervention was large for problems correct across structures: 94.3% group, 100% change, and 88.7% compare. The mean level change between baseline to intervention was large for problem solving process correct across structures: 92% group, 94.4% change, and 68.2% compare. The student's maintenance performance was above 80% on all probes; however, his problem solving process was more variable (42% to 83%). Last, the student improved from 10% correct on the pre-test to 100% correct on the post-test. Similar growth was shown for problem solving process from 4% correct on the pre-test to 95% on the post-test.

Do SBI effects generalize mathematical problem solving tasks to a science context for a student with EBD receiving services in a rural setting?

To assess generalization, Levi completed mathematical word problems in the context of science standards the student was currently learning. Levi's teacher wanted to see if he could answer word problems outside of the mathematics block and without the diagnostician present. Further, state science testing included word problem solving tasks. Levi answered 100% of the generalization problems correctly, with 80% on the problem solving process. See Figure 1 for graphed results.

Discussion

Study findings add to the SBI literature base and provide additional evidence that SBI interventions merit further investigation in rural settings to support students with EBD who struggle with word problem solving. Levi stated during the pre-test that he did not know how to solve problems with words, only worksheets (referencing mad minutes, timed multiplication worksheets) that his teacher sometimes provided at the beginning of class. This comment supports testing and anecdotal teacher reports that that Levi did not understand how to solve problems rather than work refusal or calculation difficulties being the source of Levi's struggles. The educational record noted that Levi could solve calculation problems as evidenced by his Woodcock Johnson calculation score, which fell within the average range. Levi learned to use the schematic diagrams to solve word problems as evidenced by independent practice scores on three consecutive probes across problem types and with mixed problems as well as the post-test. Furthermore, there is some evidence that Levi may have begun to solve problems without reliance on diagrams. He was able to correctly answer mixed problem types without drawing diagrams on the mixed problems condition and on the post-test.

There are several takeaways given the rural context of the study. First, at the time of the study, Levi was the only student who received special education services under the ED classification in the elementary grades. Given limited resources available, many rural localities may struggle to implement an SBI intervention for 51 sessions (including pre- and post-testing, instruction, and maintenance) that were required to complete the study. Options for implementation may include teaching the strategy in general education classrooms rather than using SBI as an intervention due to limited staffing. The cooperative may also consider using e-interventions delivered by the special education teacher at one school and include students attending neighboring schools using Zoom, Skype, or another teleconferencing software as an instructional delivery tool (Lawless & Pellegrino, 2007).

Second, the district also relied heavily on open resource materials, such as Khan Academy®, and the third-grade teacher used teacher-pay-teacher, online resources, and created her own materials to teach mathematics in accordance with the Common Core Standards for grade 3 mathematics. The use of resources and curricula that lack empirical validation can lead to implementation of practices that are less efficient and difficult for students with disabilities who benefit from explicit instruction to effectively learn (Hott et al., 2019). Consideration of using evidence-based strategies and more robust resources such as those offered at no cost through federally funded projects such as Project STAIRR (see https://www.smu.edu/Simmons/Research/Research-in-Mathematics-Education/Explore/STAIRR) have the potential to improve mathematics instruction and accessibility for all students.

Third, the district faced many barriers common to rural localities including geographic isolation and limited access to specialists (Rude & Miller, 2018). Levi was the only elementary student who received special education services under the ED category within a 50 mile radius. Therefore, we chose to use a multiple baseline across problem types (behaviors) design rather than participants and consider implications for practical implementation given district challenges. Many rural teachers also experience difficulty accessing quality professional development (Hott et al., 2019). For example, the third grade teacher had the opportunity to attend one professional development in the last three years and relied on the diagnostician for access to resources and supports to assist Levi. The district has one special education teacher to serve grades Pre-Kindergarten to 12. She completed some online trainings that the cooperative special education director shared but has not had the opportunity to attend a face-to-face professional development within the last five years. Given her diverse and large case load, the special education teacher had limited time to provide direct and systematic instruction often necessary for students with EBD to access academic content and positive behavioral supports. School/university partnerships have the potential to assist with providing professional development, addressing practitioner questions, and sharing evidence-based resources (Maheady et al., 2016).

Finally, SBI is gaining an evidence-base for students with exceptionalities (see Cook et al., 2020; Jitendra et al., 2015). SBI interventions could also be used to teach word problem solving as the class-wide instructional method (Fuchs et al., 2006). The third grade teacher anecdotally shared that she would like to teach all her students using SBI, as it would likely help others struggling to differentiate problem types. Using a class-wide intervention also has the potential to decrease windshield time (time spent by an interventionist traveling the 18 miles one way from the elementary school to high school and in the case of the diagnostician district to district which span 104 miles from the closest to farthest district) and maximize use of teacher time and resources. It may also be feasible, as suggested by Levi's teacher, to consider whole class interventions using SBI as it is affordable, less than $70 for a teacher manual and sample problems (Jitendra, 2007), and unlikely to cause harm to students who are able to obtain word problem solving skills through traditional means of instruction.

Limitations

The major limitation to the current study was that we relied on a nonconcurrent multiple probe design. Only one student participated in the study and only three probes were administered as baseline across problem types. This design did not allow for use of baseline logic due to lack of prediction and verification needed to determine the presence of a functional relation between SBI and mathematics problem solving. This design was necessary due to resource constraints and student need. The student had demonstrated difficulty with work completion and time allotted. The student completed six to ten problems daily. Asking the student to complete additional probes on which he was unsuccessful may have led to the student "shutting down" on refusing to complete work after repeated ongoing failure.

Another important note is that a diagnostician with significant training and experience in mathematics, curriculum and instruction, and special education served as the interventionist with support from university faculty. Additional investigation, and study replication, under routine conditions is warranted.

Finally, it may be helpful to add additional positive behavioral supports such as behavior specific praise. The interventionist did share behavioral expectations and explain the importance of being a problem solver at the start of each lesson. The student also had access to sufficient opportunities to respond during each session (Scheuermann & Hall, 2011, p. 208).

Conclusion

This study explored the use of SBI to support the word problem solving skills development of a student with EBD. Given the challenges presented in rural settings, there is some evidence that SBI might be a viable option to support rural students as a whole group instruction model or as an individual intervention. Despite limitations which included only three probes in baseline due to low scores and teachers wanting to support the student who could become easily frustrated and only one participant, further exploration of SBI interventions with rural students who have SBI appear warranted.

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