The effects of self-regulated strategy development on teaching long division to students with or at-risk for emotional and behavioral disorders

by

Ashley Shaw

B.S., Kansas State University, 2010
M.S., Emporia State University, 2013

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF EDUCATION

Department of Special Education, Counseling, and Student Affairs
College of Education

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2019

Abstract

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Approved by:

Major Professor
Dr. Mickey Losinski

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Table of Contents

List of Figures

List of Tables

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Dedication

To the best family I could ever dream of: Dad, Mom, Jackie, Lindsey, and Candace. I would never have made it through without you.

Chapter 1 - Introduction

In the initial chapter, a discussion of the general characteristics of students with and at-risk for an emotional and behavioral disorder is provided. It is important to note that the term emotional and behavioral disorder (EBD), as opposed to emotional disturbance (ED), will be employed throughout the entirety of this work. The titles are in fact synonymous; EBD is referenced within the field of special education research while ED is referenced when discussing matters of federal statute (e.g., the Individuals with Disabilities Education Act of 2004). Following the explanation of characteristics will be a primary focus upon the academic needs, specifically in the area of mathematics, of students with or at-risk for EBD including a brief overview of existing evidence-based interventions used to meet the needs of students with EBD. The chapter will conclude with a description of the current study's purpose, rationale, and guiding research questions.

Students with Emotional and Behavioral Disorders

In accordance with the Individuals with Disabilities Act (IDEA, 2004), EBD is one of thirteen umbrella disability categories that constitutes a variety of specific disorders such as anxiety and depression. A student qualifies for EBD if he/she exhibits one or more of the following characteristics over an extended timeframe to a degree that impacts the child's 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 relationship with peers and teachers, (c) inappropriate types of behavior or feelings under normal circumstances, (d) a general pervasive mood of happiness or depression, (e) a tendency to

develop physical symptoms or fears associated with personal or school problems (34 CFR 300.8 (c)(4)(i)).

The uniqueness of the disability category EBD lies in its heterogeneous population and the variance of functioning level, severity, and topography of problem behaviors displayed by those experiencing the disability (Flanagan & DeBar, 2018). Students with EBD display an array of externalizing and internalizing behaviors, such as aggression, talking out, withdrawal, and social avoidance, all of which may result in negative consequences such as missed class time and a lack of appropriate social opportunities impacting the formation of peer and adult relationships (Weeden, Willis, Kottwitz, &Kamps, 2016).

The United States Department of Education reports nearly 500,000 students in the United States are identified with EBD, one-third of whom are elementary aged (Cullinan, Evans, Epstein, & Ryser, 2003). Yet, this number represents less than 1% of the school aged population that are provided services under the Individuals with Disabilities Education Improvement Act of 2004, implying that many students are unidentified and likely underserved (Pierce, Nordness, Epstein, & Cullinan, 2016).

Moreover, Forness, Freeman, Paparella, Kauffman, and Walker (2012) found in an analytic review of studies from 1995-2010 that the mean point prevalence of children with moderate to severe EBD (i.e., the number or percentage of children with EBD at a specific point in time out of a total given educational population) was 12.7% for students ages 0 to 17 and that the mean cumulative prevalence (i.e., children with EBD at any given time in their lifespan prior to high school graduation out of a total given educational population) was 38%. Cumulative prevalence is particularly important to analyze considering an individual may not display characteristics of EBD at one particular time in his/her life but may later display characteristics that onset as childhood and adolescence progress. Their findings of a mean 38% cumulative prevalence of school-aged children with EBD raise a daunting comparison of the mere 1% receiving special education services (Forness et al., 2012). Clearly, those with EBD are being underserved in today's educational settings.

Academic Characteristics for Students with EBD

Students with EBD not only face numerous social, emotional, and behavioral challenges, but they also display unique academic characteristics. Studies have shown that, on average, students with EBD typically perform one to two years below grade level (Reid, Nordness, Trout, & Epstein, 2004). In fact, 50% of students with EBD age 14 and older do not even complete their high school education (Reid, Nordness, Trout, & Epstein, 2004). Additionally, students with EBD are 13.3 times more likely to be arrested while in school than those without disabilities (Weeden, Willis, Kottwitz, & Kamps, 2016).

The National Center for Education Statistics also found that 42 of every 10,000 children ages 3 through 21 with EBD served under IDEA in 2015 were removed from their current educational setting to an interim alternative educational setting for transgressions involving drugs, weapons, or serious bodily injury (U.S. Department of Education, 2018). Despite these formidable academic statistics, behavioral characteristics of students with EBD are often what is most addressed and remediated. Considering students with EBD have tendencies to experience low grades, retention, suspension/expulsion, and failure to graduate, academics is most certainly an area of needed intervention (Wiley, Siperstien, Bountress, Forness, & Brigham, 2008).

More specifically, mathematics is an exceptionally problematic academic content area for students with EBD. In fact, students with EBD display higher deficits compared to non-disabled peers in mathematics than in any other academic subject, including reading and writing (Peltier

& Vannest, 2018). Moreover, as students move from elementary school to middle school and from middle to high school, the gap in mathematical deficits experienced by students with EBD compared to that of grade level peers increasingly widens (Ralston, Benner, Tsai, Riccomini, & Nelson, 2014). In particular, students with EBD struggle to attain and retain basic and computational mathematical skill sets over time. For instance, calculation ability and accuracy decline from the 34th percentile at the elementary level to the 28th percentile at the high school level (Templeton, Neel, Blood, 2008).

Especially when considering these consequent struggles experienced in mathematics by students with EBD, it is critical that early mathematical skills be mastered to prevent poor achievement in high school. Fractions and whole-number division, for example, are particularly crucial skills to master as they have been linked to be predictors of high school mathematical achievement. In a longitudinal study investigating data from the United Kingdom and the United States, Siegler et al. (2012) compared the computational performance of children at age 10 years to their performance on an algebra achievement test at age 16. Results from the study yielded strong correlations between both fraction computation and long division computation to later high school algebraic achievement even beyond the correlations found between addition, subtraction, and multiplication computation tasks and high school mathematics performance (Siegler et al., 2012).

Interventions for Students with EBD

Because of the high incidences of observable externalizing and internalizing behaviors associated with this particular disability, it has been the natural instinct of educators and researchers to create and implement interventions to "fix" problem behaviors with the underlying hope to consequently improve academic shortfalls as a side effect of the behavioral intervention

(Templeton, Neel, & Blood, 2008). However, there is no guarantee that academic performance will improve if only behavioral needs are addressed. Rather, there is a need to also directly attend to academic concerns. As opposed to expecting enhanced behavior to repair academic insufficiencies, the reciprocal notion can be examined in that quality instruction has great potential to prevent problematic behaviors (Rafferty & Raimondi, 2009). Additionally, students experiencing the effects of EBD often feel overwhelmed in educational settings that require the student to be evaluated, controlled, and conformed to group expectations (Jackson, 1990). Unfortunately, when considering both behavioral and academic interventions over time, these considerations are not always addressed and individual needs are not planned for.

One intervention for example, the class-wide function-related intervention team (CW-FIT) program, is a multilevel group intervention that combines group contingency, self-management, and functional assessment. The intervention program explicitly teaches classroom expectations and utilizes both reinforcement of positive behavior and strategic ignoring of inappropriate behaviors (Weeden, Wills, Kottwitz, & Kamps, 2016). While the components of the intervention offer positive elements to support the needs of all learners as a whole, research of the intervention has been shown to focus mainly upon the behavioral aspects of learners as corroborated by the study conducted by Weeden et al. (2016). In this study, the primary outcome measure examined on-task behavior and did not include an outcome measure to assess academic performance. An ample number of additional studies exist that centralize on the emotional, behavioral, and/or social needs of children with EBD yet fail to directly address academic components (e.g., Wilhite & Bullock, 2012; Allday et al., 2012; Trussell, Lewis, & Stichter, 2008; etc.).

When considering academic interventions for students with or at-risk for EBD, Ryan, Reid, and Epstein (2004) describe three categories of instructional interventions for children with EBD: (a) child-mediated intervention; (b) teacher-mediated interventions; and (c) peer-mediated interventions. Interventions are assigned to a category based upon the individual most responsible for treatment of the intervention (e.g., the teacher maintains responsibility for implementing instruction and intervention in teacher-mediated intervention). Ryan, Pierce, and Mooney (2008) explored the existing evidence-based teaching strategies used with students with EBD within these three intervention domains. While the results of their literature review found overall positive academic outcomes, there were many limitations such as small, misrepresentative sample sizes that did not allow for appropriate generalization of these positive effects.

When specifically examining mathematical interventions implemented and studied in educational settings, a variety of strategies have been explored including schematic diagrams, problem-solving mnemonics, and explicit instruction (Peltier & Vannest, 2018). Losinski, Ennis, Sanders, and Nelson (2018) rendered an analysis of existing mathematical interventions for children with EBD in which they found 17 studies addressing mathematical objectives such as fractions, number sense, and algebra. Among the researched interventions within the studies were strategy instruction, direct instruction, and peer tutoring. Each study yielded positive student achievement outcomes; yet, no group designs were presented and only four studies met all of the Council for Exceptional Children (2014) quality indicators. The analysis failed to find any intervention to be an evidence-based practice, ergo, the need for more extensive intervention research to meet both the behavioral and academic demands of those with or at-risk for EBD endures.

SRSD: An All-Inclusive Intervention

As previously described, interventions have potential to be delivered by three general parties: student, teacher, and peers (Ryan et al., 2004). Self-Regulated Strategy Development (SRSD), created by Karen Harris, is an intervention framework designed to intertwine the responsibility of instructional delivery by all three parties. SRSD has been studied with students with EBD across a multitude of content areas and educational settings. The uniqueness of this intervention particularly lies in its inimitable combination of both behavioral and academic components and envelops some of the most prominent deficits students with EBD face such as a lack of self-regulation.

SRSD has been researched with a number of content skill areas, including writing, reading, and mathematics. SRSD has aided in successfully improving the writing process and specific writing skills of school-aged children across a variety of writing genres (e.g., Cuena-Carlino, Gozur, Jozwik, & Krissinger, 2018; Ennis, 2016; Reid, Hagaman, & Graham, 2014). Likewise, the SRSD framework has been implemented with success to improve the reading comprehension of students in elementary, middle, and high school (e.g., Sanders, 2018; Sanders, Ennis, and Losinski, 2018; Mason, Katie, Sukhram, & Kedem, 2006). While a much heavier emphasis has been placed upon SRSD research with language arts skills, there does exist some research associating SRSD to the improvement of mathematical skills, most frequently involving the proficiency of problem-solving (e.g., Cuenca-Carlino, Freeman-Green, Stephenson, & Hauth, 2016; Losinski, Ennis, & Shaw, in review).

SRSD is a systematic approach used to teach students new skills by incorporating modeling, scaffolding, and positive dialogue (Case, Harris, & Graham, 1992). The six critical elements that compose the SRSD model are developing background knowledge, discussing the concept, teacher modeling, memorization, supporting through guided practice, and independent practice (Harris, Graham, Friedlander, & Laud, 2013). Much research has been conducted to provide evidence of the effectiveness of improved academic skills through the implementation of SRSD (e.g., Harris, et al., 2001 and Harris, Graham, Friedlander, & Laud, 2013). Each stage is further described below:

Stage 1: Develop and Activate Background Knowledge

In the first stage, prerequisite skills and vocabulary are addressed. The discussion of these skills and vocabulary should be thorough enough to move the student on to the following stages. Additionally, students are introduced to self-statements. Self-statements are individualized to the student's needs and are designed to enhance self-regulation. These statements are constructed in a verbally collaborative process between the student and teacher and should be positive statements that can be referred to in moments of struggle or frustration. For example, if the student becomes frustrated in the middle of a mathematical procedure a self-statement could be, "I can do this if I just use the strategy I learned." Students' self-statements will vary depending on individual characteristics (Harris, Graham, & Mason, 2003).

Stage 2: Discuss It

In Stage 2, the teacher discusses the skill to be learned and the corresponding strategy that will be taught. If a mnemonic is to be used, the teacher also provides explanation of the mnemonic during this phase. Together, the student and teacher discuss when and where the strategy can be used, paying special attention to examples beyond simply the classroom usage. Goals to master the strategy instruction are defined and motivation is fostered. Student commitment to learn the strategy is attained in order to promote ownership to enhance self-regulation. Finally, discussing the student's present level of performance is discussed in a positive, cooperative manner. Discussing where a student begins can be beneficial in latter stages of learning the new strategy, especially if the present level of performance is graphed by the student himself. This offers a tangible means for recognizing growth throughout the SRSD process and empowers self-monitoring and goal setting. It is important to note, however, that discussing present levels of performance can be eliminated in this stage if it will create negative effects on the student (Harris, Graham, & Mason, 2003).

Stage 3: Model It

In this stage, the teacher (or a peer) demonstrates the use of the strategy for the student. The modeling should involve a verbal explanation of the steps in the strategy but also verbalization of the thought process involved, including modeling self-statements and error correction. For example, one might say, “Have I used all my steps so far? Oops, I think I missed a step. I better go back.” Dialogue should be natural, positive, and encouraging. If prompting materials such as graphic organizers or visual cues are to be used, the teacher should model the practice of these items as well. The teacher should verbally express setting a personal goal as another means of modeling the self-regulation process. Next, a discussion between pupil and teacher should occur. The discussion should include the importance of using self-statements and goal setting and is followed by the student adding to their own self-instructions (such as their personal self-statements). A review of the strategy being taught and a discussion of further areas where the strategy could be generalized conclude this phase (Harris, Graham, & Mason, 2003).

Stage 4: Memorize It

During this stage, students memorize the steps in the strategy including the meaning of any mnemonic being used to enhance the memorization of the strategy. The implementation of this stage especially will vary depending on the memory assets or deficits the student possesses.

In some cases, it may be skipped entirely or be combined with another stage (Harris, Graham, & Mason, 2003).

Stage 5: Support It

The educator offers guided support, or scaffolding in this stage. Additional self-regulation components, such as student goals, may be discussed or expanded upon to support, generalize, and maintain the learning. Students actually practice the strategy and self-instruction elements during this stage with the readily available assistance from the educator. As the teacher feels appropriate, prompts and guidance are faded until the student feels confident in performing all steps of the strategy. Because of this, students will move through this phase at different rates. Often this is the longest of all phases and should be concluded with careful discretion (Harris, Graham, & Mason, 2003).

Stage 6: Independent Performance

While self-regulation components continue to be used during the final stage, students perform the strategy independently and supports continue to fade as appropriate. The teacher and student plan for continual maintenance and generalization and evaluate the effectiveness of the strategy as well as the student's personal success (Harris, Graham, & Mason, 2003).

Mnemonics and Self-Regulation

To support the development of self-regulation, the SRSD framework commonly uses mnemonic devices. Mnemonic strategies are defined as, "…systematic procedures for enhancing memory by providing effective cues for recall…such as word, sentence, or picture devices" (Zisimopoulos, 2010, p. 119). "Mnemonics allow the use of visual imagery and auditory clues to help students recode and relate information to an existing knowledge base…" (Cade & Gunter, 2002, p. 208). This is especially beneficial for students with disabilities obtaining and retaining new skills requiring one to continue to expand upon existing, relative strengths and schema (Scruggs, Mastropieri, Berkeley, & Marshak, 2010). Because of the memory aid mnemonic devices offer, they can be very beneficial to incorporate into the SRSD framework. Joyce, Weil, and Calhoun (2015) suggest that the more creative, outlandish, and personal the cue is, the more efficiently the skill or information will be engrained into the memory. Thus, the mnemonic device, ***L**ong division **S**eems **R**eally **A**wesome* (LSRA) is used in the current study to teach students the conceptual process of computing long division.

Rationale for the Current Study

It is currently estimated that 46% of students ages 3 to 21 with EBD are served in general education settings under IDEA for 80% or more of their school day. Conjointly, an overall 82.5% of students with EBD are served in the general education setting for at least some portion of their school day (U.S. Department of Education, 2017). This implies that many students with EBD are expected to learn from general education curricula (Templeton, Neel, Blood, 2008). Thus, the achievement gap widens as students progress through grade levels and attempt to acquire mathematical skills in the regular education setting without receiving interventional strategies or instruction (McDaniel et al., 2018). As the gap continues to grow for these students, new and existing interventions are explored in hope to narrow the gap. In regard to language arts, SRSD research is vast. For instance, Losinski, Cuenca-Carlino, Zablocki, and Teagarden (2014) conducted a review of existing literature to examine the effect of SRSD instruction on written responses with children with EBD. The investigation resulted in 22 studies and large, positive effect sizes when analyzing essay elements, essay quality, and word count of the dependent variables (student produced written responses). A multitude of additional studies (e.g., Sanders, 2018; Harris, et al., 2001 and Harris, Graham, Friedlander, & Laud, 2013) stand in the field of research that further validate SRSD to be an effective strategy to teach reading and writing skills. The success the instructional strategy harvests for students with EBD continues to prove itself in these studies; yet, a call for intervention in the area of mathematics continues to resonate.

Startlingly, only four research studies conjoining SRSD and mathematical concepts have been published to date. Of the four conducted SRSD mathematical studies, two aimed to improve problem-solving skills (Case, Harris, & Graham, 1992; Cassel & Reid, 1996), one targeted the improvement of multi-step calculation skills (Cuenca-Carlino, Freeman-Green, Stephensen, & Hauth, 2016), and the last examined the effects of SRSD when teaching students various fractions procedures (Losinski, Ennis, Sanders, & Wiseman, 2018). Nearly all students in the four studies demonstrated progress across both intervention and maintenance phases. Thus, these studies and those involving language arts objectives imply the promising potential of the SRSD framework, although additional research must be conducted to further establish its effects with students with EBD in mathematics. After all, the academic underachievement of students with EBD tends to persist and even worsen over time; hence, academic interventions must be implemented (Wiley, Siperstien, Bountress, Forness, & Brigham, 2008). SRSD clearly has a successful historical research record and thus, has potential to fulfill this need for intervention.

Purpose & Research Questions

In addition to the fact that minimal research has been conducted with SRSD and mathematics, it is especially noteworthy that two of the four published studies occurred over twenty years ago. Between the limited number of studies and the lack of up to date research, new investigations must be explored to determine the effects of SRSD on learning mathematical processes. Hence, the current study was developed to expand upon the existing literature of the effects of SRSD and students with EBD when learning a mathematical skill, specifically long division computation. The following research questions were investigated:

RQ1: Will students with or at-risk for EBD improve the accuracy of solving long division problems after learning the partial quotients SRSD intervention?

RQ2: Is the partial quotients SRSD intervention socially valid?

Chapter 2 - Review of Existing Literature

The Persistent Concern of Mathematics Proficiency: National Findings and Suggestions

The National Assessment of Educational Progress (NAEP) suggested yet again that mathematics proficiency is stagnant across grade levels in the United States. Given every two years in grades four and eight, NAEP assesses the following mathematical categories: number properties and operations; measurement; geometry; data analysis, statistics, and probability; and algebra. The most recent administration of NAEP occurred in 2017 to 149,400 fourth graders and 144,900 eighth graders across the country. Results were far from propitious especially when compared to results from prior assessments. In fact, the mean NAEP scores for fourth grade students in 2013 was 242 yet decreased to 240 in the year 2017. In 2013, the average NAEP score for eighth graders was 285 yet dropped to 283 in the year 2017. Both statistics report significant differences across years ($p < .05$) and overall flatline trends throughout the past decade. Mean scores for both fourth and eighth grade students gravely failed to meet the Proficient achievement level (National Assessment of Educational Progress, 2018).

Even more concerning than the overall findings from the 2017 NAEP are the results of mathematical proficiency for students with disabilities. The 2017 NAEP found the average score for students with disabilities in fourth grade plateaued at the Basic achievement level, failing to advance beyond this level. The mean score for eighth graders with disabilities failed to attain even the Basic achievement level. Scores for both groups depreciated in 2017 when compared to significantly higher scores in previous years ($p < .05$) and overall trends have either flatlined or declined within the past decade for students with disabilities (National Assessment of Educational Progress, 2018).

Little remedial action has been invoked to rectify this prominence of weak mathematical proficiency over the course of the past few decades. In 2008, the National Mathematics Advisory Panel (NMAP) reviewed existing literature to define effective instructional approaches for low-achieving students. NMAP's review was comprehensively unsuccessful in its quest to identify methodologically rigorous studies that investigated instructional practices designed to improve the performance of low-achieving students and students with learning disabilities although findings did report explicit, systematic instruction as a viable practice to improve computation and problem-solving skills. During explicit, systematic instruction, the teacher explains and demonstrates specific strategies while offering students opportunities to ask and respond to questions and to think aloud. It also entails planned, sequencing of problems (National Assessment of Educational Progress, 2018). More specifically, NMAP found significant positive effects on student achievement through the use of direct instruction, a distinct type of explicit instruction in which teachers are given scripted teaching materials and utilizes frequent interactions between students and teachers as well as clear feedback regarding the accuracy of student work. Nevertheless, despite the positive results discovered with explicit and direct instruction, NMAP recognized the limited existing intervention studies and ultimately deemed a critical need for more extensive, high-quality research through federal funding to improve the prominent national challenge of low levels of mathematical proficiency (National Mathematics Advisory Panel, 2008).

NMAP's final report also noted several additional key points. The panel emphasized the essential necessity of conceptual understanding, computational fluency, and problem-solving skills across all mathematical content areas. The panel suggests the influence each of these components have on the performance of tasks such as estimation, word problems, and computation. The committee also heavily stressed the significance of number sense and the gravity of understanding the meaning of computational operations (National Mathematics Advisory Panel, 2008). These suggestions are to be considered when planning much needed future research for improving the proficiency of mathematical learners.

Long Division

The four commonly practiced numerical operations are addition, subtraction, multiplication, and division. When specifically examining fourth grade mathematics Common Core Standards, the latter of these four operations is highlighted. The standards set expectations for fourth grade students to accurately calculate quotients of division problems with one-digit divisors and four-digit dividends (Common Core Standards Initiative, 2018). Calculating long division problems is a crucial skill to master for a variety of real-life experiences such as budget allocation and equal group distribution (Jong & Magruder, 2014). Yet, many students exit fourth grade lacking mastery of this standard and thus, enter fifth grade unprepared to face the additional complex skills and processes they will be expected to attain. In turn, the achievement gap continues to grow, likely contributing to the 2017 NAEP findings of increasing gaps between lower and higher performing students (National Assessment of Educational Progress, 2018).

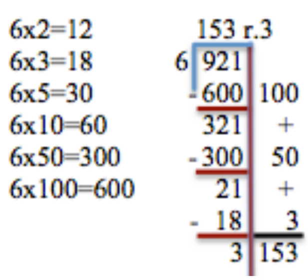
While many fourth and fifth grade students struggle with the lengthy process involved with long division, students with or at-risk for EBD have an especially challenging task to remember the numerous and laborious steps required to compute a long division equation due to their previously described behavioral and academic characteristics. Hence, quality interventions to teach long division must be explored and filtrated into educational settings to reach students, especially those with or at-risk for EBD, attempting to master this mathematical skill.

Partial Quotients Method for Teaching Long Division

Over the course of history, mathematical instruction has shifted in emphasis from basic fact fluency and rote memorization to a more contemporary view of instruction focused upon contextual understanding and problem solving (Zisimopoulos 2010). In support of NMAP's recommendation to provide conceptual understanding of number sense and computational operations, rather than expecting students to simply memorize facts and procedures, the need for a more analytical understanding of mathematical concepts is necessary. The partial quotients method is one means of offering students this opportunity to develop such understanding when presenting mathematical instruction of long division.

When computing long division via the partial quotients method, simple multiplication facts of the divisor are first listed. The products of those multiplication facts (i.e., multiples of the divisor) are then subtracted from the dividend after the partial quotient is listed in a column to the right of the problem. This process is repeated until the dividend is reduced to zero or is less than the divisor. This number becomes the remainder and all partial quotients in the righthand column are added to find the final quotient. Unlike the traditional, or standard, algorithm used to compute long division, the partial quotients method requires the student to not only break apart the dividend using familiar multiples but also requires the student to call upon number sense when choosing which multiples to utilize. See Figure 1 for a partial quotients sample problem.

Figure 1. ***Partial quotients example***



Several studies across the course of time have implemented the partial quotients method with mixed levels of success. Kratzer (1971), for example, compared the partial quotients method, which he referred to as the Greenwood method (or the successive subtraction method) to the Adkins (or traditional algorithm method). While he did not discover the partial quotients method to have a greater effect on the acquisition of long division computation than the traditional method, he was successfully able to implement the method with both typically performing and at-risk learners (Kratzer, 1971). Hurts (2008) presented the prevalence of using the partial quotients method in the Netherlands, although it is referenced using different terminology and is a part of *progressive schematisation.* Progressive schematisation encourages the learner to use existing, simpler problem-solving skills that later evolve to formulate solutions. In the case of long division, the learner subtracts simple and smaller multiples of the divisor to find final quotients but eventually conceptualizes and utilizes larger multiples of the divisor to solve subtraction problems in a more effective manner. Finally, Losinski, Shaw, Theile, and Ennis (in review) conducted a study with fifth grade students with or at-risk for EBD to determine the effectiveness of the conceptual partial quotients method using the SRSD framework. Their findings displayed strong evidence of improvement between the mathematical method and students' ability to accurately solve long division problems.

To date, there is a lack of research regarding effective mathematical interventions, particularly when examining long division. Considering the predictability it offers for future high school mathematical achievement (Siegler et al., 2012), long division is a skill of critical importance to master; yet, no past or current reviews of literature exist to determine the effectiveness of various approaches to teach the procedure. Therefore, the purpose of the current review of the literature is to reveal and analyze any existing studies that implemented interventions to teach school-aged children the imperative operation of long division. The following research questions were explored:

Long Division Literature Review

Research Question 1: What are the relative effects of studies analyzing the use of instructional mathematics interventions for teaching long division?

Research Question 2: To what degree does the mathematical literature base for long division meet standards for evidence-based practices?

Inclusion and Coding

To answer the research questions, a comprehensive database search of the existing literature on interventions used to teach long division to students with disabilities was conducted on September 26, 2018. The databases consisted of Academic Search Premier, Education Full Text, ERIC, ProQuest Dissertations and Theses Global, and PsychINFO using the Boolean phrase (“math*") AND (“long division”) and included all prior dates.

Inclusion Criteria. Initially, the researcher screened all titles and abstracts of articles and dissertations resulting from the search according to the following inclusion criteria. In order to be incorporated into the analysis, studies were required to: (a) disclose results from an experimental quantitative group or single-case design study, including graphed results for single-case designs with a minimum of three data points per phase with at least three replications; (b) include participants in elementary, middle, or high school (c) investigate the implementation of an instructional intervention to teach long division as an independent variable; and (d) include a dependent variable that measured achievement of solving long division problems accurately.

Coding Process. All studies initially included in the synthesis were then independently coded by the researcher. Using a Microsoft Excel spreadsheet, the researcher highlighted and recorded the presence or absence of the following variables: (a) number and age of participants, (b) setting, (c) participant presence of a disability or at-risk characteristics, (d) independent variable, (e) dependent variable, and (f) design methodology. A second researcher was consulted in the event of a question with the data until a final agreement was confirmed upon.

Participants and setting. Participant characteristics from each included study were then coded according to student grade level, gender, and presence of a disability or at-risk status. The researcher then coded setting characteristics by distinguishing whether intervention was provided in a home or educational setting. Settings were also coded for general city demographic information (e.g., urban, suburban, etc.).

Design features. Due to the assumed lack of research on the given mathematical topic, design feature requirements were overall very general. All studies were required to contain a quantitative experimental design, and both group and single-case designs were considered acceptable.

Outcome measures. Studies were required to measure the effect of treatment on performance of long division proficiency through the application of one or more quantitative assessment tools. For example, such tools may include pretests and protest comparison or curriculum based measurement probes administered across phases of intervention. Ideally, authors would also include an effect size of the intervention. An effect size calculates the degree to which results deviate from the expected results specified in the null hypothesis. Effect sizes quantify mean differences and measures of strength using statistical calculations such as Cohen's *d* and Hedges's *g* (Sun, Pan, & Wang, 2010).

Quality of study. The quality of each included study was assessed via the Council for Exceptional Children's *Standards for Classifying the Evidence-Base of Practice in Special*

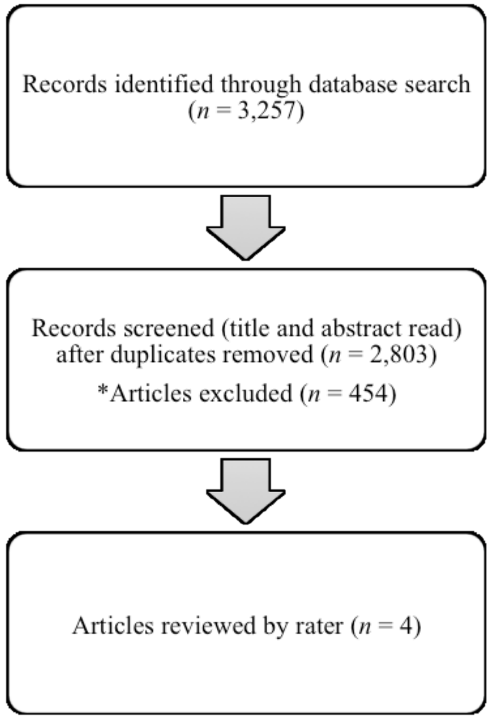
Education (CEC-EBP; CEC, 2014). These standards pose eight umbrella domains (a) context and setting, (b) participants, (c) intervention agent, (d) description of practice, (e) implementation fidelity, (f) internal validity, (g) outcome measures/dependent variables, and (h) data analysis. Each main domain houses more specific quality indicators (QI) in which the researcher determined was provided for each of the studies. According to the standards, all QIs must be met in order for a study to be considered high quality and trustworthy.

Results

The initial database search yielded 3,257 articles. Following the removal of duplicate articles (*n* = 454), 2,803 records remained. Following the screening of all remaining titles and abstracts, four articles met full inclusionary criteria.

A marginal number of the screened articles were considered for inclusion but were ultimately eliminated for various justifications. Abed (1985), for example, appeared to meet inclusion criteria but ultimately focused the dependent variable on estimation of quotients rather than accurately performing the long division calculation process. Albertoni (2014) incorporated a qualitative data collection procedure in that the study evaluated participant engagement and perceptions through the assessment of questionnaires, researcher observations and field notes, and interviews. While Bello's study (2007) incorporated long division, its emphasis on teacher training and participant opinion offered no quantitative data regarding intervention effectiveness on academic achievement. Hoy (1982) too incorporated a division intervention; however, it highlighted improvement upon basic division facts as opposed to long division.

Figure 2. ***Article flowchart***



Participants and Setting. The four studies varied in number of participants from 16 to 66 elementary age students in the third, fourth, or fifth grade. However, it is important to note that Kratzer did not specify exact number of participants; rather, a total of twelve classes was described. Brazel (2014) and Cuevas (1975) included only participants who displayed deficiencies in mathematics. Three of four studies specified gender statistics ranging from fifty to sixty percent male.

All reviewed studies occurred in elementary school settings although specific intervention locations within the schools were not readily provided. Three of four studies transpired in suburban regions of the United States while the fourth study was conducted in the Netherlands without reference to further specific demographic information. All experimental designs involved group instruction; Brazel (2014) provided instruction in small group settings while Cuevas's (1975), Krazter's (1971), and Hurts (2008) offered whole class instruction.

Table 1. ***Study characteristics***

Study	N	Grade Level	Disability and/or At-Risk Status	Setting (home/educational)	Geographical Demographics	Dependent Variable	Methodology
Brazel (2014)	25	4	At-risk	Educational	Suburban	Pretest/Posttest	N/A
Cuevas (1975)	66	5	Field Dependent/Field Independent	Educational	Suburban	Pretest/Posttest	RCT
Hurts (2008)	29	3, 4	N/A	Educational	N/A	Pretest/Posttest	RCT
Kratzer (1971)	N/A (6 classes)	4	N/A	Educational	Upper-middle SES	Pretest/Posttest	RCT

Note. RCT = Randomized Control Trial, SES = Socioeconomic status

Design Features. All studies were group designs although group size varied. Because Brazel's study (2014) employed attributes of a master's degree thesis, resemblance of an experimental design was not present. The remaining studies, Cuevas (1975), Krazter (1971), and Hurts (2008) applied quasi-experimental designs that included randomized controlled sampling to distribute treatment and control groups. Notably, Hurts (2008) applied an individualized, computerized intervention but was administered in a group setting.

Outcome Measures. All four designs utilized pretest/posttest outcome measures to determine effectiveness of treatment. All studies reported attitudes of participants toward the provided long division instruction, although some were more formal than others.

Quality of Study. After dissecting all included literature within the review, it was discovered that all studies excluded multiple fundamentals described in the twenty-four CEC quality indicators in relation to group designs. Specifically, Brazel (2014) met 7 of the total 24 indicators (29%), Hurts (2008) met 15 indicators (63%), and Cuevas (1975) and Kratzer (1971) both met 16 of the 24 indicators (67%). While all observed studies included very basic descriptions of participants and setting, all studies failed to adhere to attrition, implementation fidelity, and interrater agreement. Likewise, the studies describe outcome measures but fail to provide statistically sound data concerning effect sizes of the interventions.

Effects. While all studies offered general descriptions of effect, no quantitative effect sizes were obtained from any of the four studies. Kratzer, for example, offered average correct problems from pretest to posttest. Due to limited availability of effect size, caution must be taken when determining the overall effect of the interventions described.

Discussion

This review of existing literature aimed to discover current strategies to teach the cumbersome procedure of long division. Over 3,000 studies were initially identified through a search of multiple databases; yet, only a striking four articles met full inclusionary criteria. No study met all quality indicators outlined by the Council for Exceptional Children nor presented a quantitative effect size. In the following, the results of the literature review with respect to the studies included, research questions, limitations and suggestions for future research are discussed.

Cuevas (1975). Cuevas explored the use of precise thinking exercises (PT) to enhance performance on the computation of long division with fifth grade students after first conducting a pilot study to determine feasibility of the intervention. Precise thinking exercises involved the manipulation of objects according to provided instruction. For example, one PT activity required students to manipulate colored cards on a poster board as directed by the researcher. The pilot study focused upon how long it would take to perform the precise thinking exercises and whether or not given directions were clear enough to be understood by participants. In the final study, students were randomly assigned into groups upon the determination that the students displayed deficiency in calculating long division. All participants received the same division instruction but differed in the type of (or lack thereof) PT activity they were exposed to prior to receiving the mathematical instruction. The study examined differences in results between field independent and field dependent participants. Unfortunately, the author failed to provide clear definition as to what constituted field independent and field dependent assignment beyond stating its relation to the ability to perceive items as discrete and the ability to overcome the influence of an embedding context. The Group Embedded Figures Test was given to determine this status and the results showed no difference on division posttest scores between those trained in PT and students not trained in the intervention. There was, however, a difference between treatment level and field independence/dependence on the division posttest scores. Field independent students trained in PT did significantly better on the posttest than field dependent students trained in PT. No significant difference in division posttest data between treatment groups for field dependent students was determined. Cuevas (1975).

Hurts (2008). Hurts explored the design and use of a computerized program, the Long Division Machine (LDM), through a series of trial studies. The strategy used in the program reflects that of the partial quotients method as it requires students to use repeated subtraction to solve long division problems. Initially, the LDM was designed and piloted in a feasibility study to determine details such as amount of time needed for students to complete problems. Hurts then conducted two group studies to further analyze the effectiveness of the program. In the second experiment, the author altered a feature of the original LDM to determine whether or not students would continue to produce correct solutions without the assistance the feature offered.

In the final experiment, the author continued to alter the computerized program and compared the effects of forcing students to subtract larger multiples from the original dividend.

The intervention did not explicitly teach students how to compute the long division problems; however performance improvement was dependent merely upon the basis of practice.

Krazter (1971). Krazter compared two different approaches, the Greenwood approach (modernly known as partial quotients) and the Adkins approach (modernly known as the conventional, standard, or traditional algorithm). The study began with three different feasibility projects, first with six, low-achieving fifth graders as determined by the results of a mathematical pretest and teacher recommendation. The second and third feasibility studies involved entire classes of third and fourth grade participants and were designed to revise and improve upon the Adkins method. The final quantitative study applied the random assignment of treatment methods across a total of twelve fourth grade classes within two schools. The classes (six per school) were allocated either the Greenwood treatment method or the Adkins treatment method. Over the course of several weeks, teachers provided students instruction to learn how to compute long division problems according to their assigned mathematical method. Results found that not only did the Adkins instructional group outperform the Greenwood instructional group in terms of correct whole and partial answers on the posttest outcome measure but also were able to transfer the mathematical skill significantly better than the Greenwood instructional group (Kratzer, 1971).

Effects of studies teaching long division

Many studies exist that emphasize the improvement and importance of learning basic division facts. Hoy (1982), for example, was presented as one of the 3,257 articles in the initial database search. The study implemented a card-sorting visual task to explore the ability to discriminate between and solve different types of division problems. While it appeared to be a promising addition to the research for teaching long division, it only embodied basic division facts as opposed to long division problems. Copious similar studies exist in which multiplication and division fact mastery are dependent variables (e.g. Ezbicki, 2008; Fasko, 1994; Irish, 2001) but the more complex process of long division is rarely assessed and even more sparsely includes quantified effect sizes as displayed by this literature review.

Quality of Studies

Clearly, with a limited amount of quantitative studies, variability in results, and a lack of clear effect sizes, few conclusions can be drawn. Altogether, the reviewed literature fails to meet standards. Not only are several quality indicators lacking according to the Council for Exceptional Children standards, but the studies are unable to be replicated as procedures and relative methodological information are nonexistent. For example, Brazel's (2014) implementation of differentiated strategies of instruction to teach multi-digit multiplication and division offers vague descriptions of how to teach the strategies in that no step-by-step guide or explanation is provided. Additionally, Cuevas (1975) compares "field independent" and "field dependent" participants yet provides little insight as to what these terms refer to and what truly constitutes placement of participants into the two categories.

Beyond the lack of mathematical research, specifically when considering long division, there exists an even greater lack of research when examining interventions specifically designed to support students with EBD. Of thousands of searched articles, not one study targeted the population of students with or at-risk for EBD. Given the challenges mathematics presents to this unique group of students, current research must be designed and implemented.

Limitations. Three of four studies were conducted in suburban, middle-class elementary school settings. Because of this mutual, limited setting and the lack of setting description from the fourth study, the results of the existing research cannot be assumed to generalize across alternative settings such as rural or urban settings or locations with essentially different demographic backgrounds. Additionally, the studies included elementary-aged students but did not offer critical participant demographic information such as the presence or absence of specific disabilities so it can also not be assumed results will be generalized across a variety of differing participants.

There are several other significant limitations that must be considered when examining the reliability of the reviewed study. Participant background knowledge and experience, for example, likely factored into overall effects. All participants in the Hurts (2008) study, for instance, had received previous instruction with long division procedures, and thus, the purpose of the study was more intended for computation practice purposes. Additionally, Hurts (2008) also notes that students were not required to independently carry out all critical computational steps within the process of solving long division problems as the computerized LDM program computed many steps for the students (such as subtracting chosen multiples). Thus, a complete understanding of students' abilities to fully solve long division problems is impossible to analyze.

Finally, two of four reviewed studies were conducted over four decades ago. Standards have changed, teaching practices have changed, and research expectations have changed considering movements such as the Common Core Standards Initiative and revisions in statutes and policies described in the Individuals with Disabilities Education Act (Common Core Initiative, 2018; Individuals with Disabilities Education Act, 2018). One cannot assume practices published over forty years prior are reputable in today's classrooms without deeply analyzing every aspect of the study's experimental design and statistical results. Current mathematical research, particularly in regard to long division, is clearly in dire need.

Implications for Future Research and Conclusion. Where there is a lack of research, there lies a demand. Clearly, with a dismal number of existing studies, a lack of quality research according to CEC quality indicators, and the numerous limitations exhibited within the existing studies, there is undoubtedly a need for up-to-date, quality research with respect to mathematical interventions, particularly when teaching long division. Moreover, only one of the four studies included in the review involved students with characteristics of a disability. In order to effectively improve the mathematical achievement of students in the realm of long division (an empirically proven predictor of future mathematical achievement) it is vital that future research be conducted and repeated. For without such future research, the generalization of this mathematical concept for school-aged children is at critical risk.

Chapter 3 - Method

Due to the need for quality mathematical interventions for students with EBD and the need for the expansion of the existing literature, the current study employed a single-case, multiple baseline across participants design to further investigate the use of the SRSD framework with a specific long division computation method. The following research questions were explored:

RQ1: Will students with or at-risk for EBD improve the accuracy of solving long division problems after learning the partial quotients SRSD intervention?

RQ2: Is the partial quotients SRSD intervention socially valid?

Experimental Design

Setting. The current study took place at a suburban, Title I elementary school in the Midwest region of the United States. The school served nearly 500 students in grades kindergarten through sixth grade; 51% of students were male. Of the entire population, 62% qualified for either free or reduced lunch services (13% reduced, 49% free). Students were predominantly White (60%), Hispanic (22%), or of mixed racial decent (10%). The remainder of the population was represented by an assortment of additional ethnicities. 19% of students received special education services and 11% received English as a Second Language support. The school district was in its second year of implementing an academic and behavioral multi-tiered system of support (MTSS). MTSS, often referred to in terms of Response to Intervention (Sailor, 2015), aims to provide leveled support for all students depending on individual strengths and need.

Students attending the school were screened three times per year using FastBridge, a universal, computerized assessment program (Christ, 2017). Results from the screener determined the placement of students within the three tiers. In accordance with Sailor (2015), students' progress was monitored throughout the year to determine their ability to successfully perform in typical instruction offered in Tier 1.

Intervention sessions for the current study were conducted within several locations in the school. Depending on availability, a special education classroom, conference room, hallway, and library were used. All non-participatory students continued general education instruction in their regular classrooms during intervention sessions.

Participants. In order to be considered for inclusion in the study, students must have been in the fifth grade and have met either the "Some Risk" or "High Risk" result category on the FastBridge aMath (Adaptive Math) and on either the FastBridge SAEBRS Student or SAEBRS Teacher universal screening assessments (Christ, 2017). These screeners were administered in the fall, winter, and spring trimesters; thus, the most current scores were observed. The FastBridge aMath assessment was an automated computer assessment that addressed skill areas such as operations and algebraic thinking, number and operations in base ten, as well as additional mathematical Common Core domains. The SAEBRS Student screener was also an automated computer assessment that required students to rate themselves across a variety of potential social, emotional, and behavioral concerns such as peer relationships and school anxiety. Similarly, the SAEBRS Teacher screener required the students' classroom teachers to rate individual students across a variety of potential social, emotional, and behavioral concerns (Christ, 2017).

Succeeding the screening process, a total number of 47 potential participants fulfilled preliminary inclusion criteria. At this stage, all students were provided with parental consent forms. Those who returned parental consent (n = 27) were then given a twelve-question, long division pretest. Students who correctly answered 50% or less of the division problems were selected for the study and were placed in three different intervention groups based upon these scores. (Students who scored the lowest on the assessment would receive treatment in the first of three phases.) A total of 20 students scored below 50% on the pre-test, although only 19 participated due to attrition.

Table 2. ***Participant characteristics***

Student	Gender	Grade	Race/Ethnicity	Disability	FASTBridge aMath	SAEBRs
			Group A			
Ann	F	5	AA	LD	High Risk	Some Risk
Cameron	M	5	W	LD	High Risk	Some Risk
Gayla	F	5	AA	-	High Risk	Some Risk
Grace	F	5	W	-	High Risk	Some Risk
Matthew	M	5	W	-	High Risk	Some Risk
Mickey	M	5	H	-	High Risk	Some Risk
James	M	5	W	EBD/LD	Some Risk	Some Risk
			Group B			
Amy	F	5	W	-	High Risk	Some Risk
Andrea	F	5	H	-	Some Risk	Some Risk
Darcy	F	5	AA	LD	Some Risk	Some Risk
Jim	M	5	AA	-	Some Risk	Some Risk
Sara	F	5	W	-	Some Risk	Some Risk
Skip	M	5	H	-	High Risk	Some Risk
			Group C			
Alex	M	5	H	-	Some Risk	Some Risk
Robin	F	5	W	-	Some Risk	Some Risk
Kristine	F	5	W	-	High Risk	Some Risk
Lane	M	5	W	-	High Risk	Some Risk
Warren	M	5	W	-	Some Risk	Some Risk
Yakir	M	5	ME	-	Some Risk	Some Risk

Note. All qualifying participants AA = African American, EBD = emotional behavioral disorder, F = female, LD = specific learning disability, ME = Middle Eastern, M = male, N = no, W = White, Y = Yes

Intervention agent. Intervention lessons were implemented by the researcher, a thirty-one-year-old doctoral student with six years teaching experience in the elementary general education setting and three years teaching experience in a special education resource setting. She served as the school's fifth and third grade special education teacher at the time of the study and had previous training and experience teaching mathematical content to at-risk students using the SRSD framework.

Procedures

Prior to intervention exposure, participants continued to complete a twelve-question, long division probe each day during either Tier 2 mathematics instruction or before school for five days. The results of these probes served as baseline data. After all students had completed five baseline probes, the seven participatory students began the five SRSD lessons with the intervention agent. Those participants not being exposed to the intervention spent time working with their regular education classrooms as not to receive premature intervention lessons.

Intervention. The intervention was delivered across five consecutive days per participant group. Each lesson lasted between thirty and forty minutes long. Absent students were taught lessons missed by the intervention agent either before or during the regular school day in order for the intervention lessons to sequentially continue as planned.

The SRSD lessons incorporated the mnemonic device **L**ong division **S**eems **R**eally **A**wesome (LSRA) created by the researcher and her doctoral academic advisor. In this study, the mnemonic LSRA aimed to enhance the memory by connecting the initial letter of each word in the phrase, "Long division Seems Really Awesome" to the initial letter of the steps required to solve a long division problem using the partial quotients method (Long division/List easy multiples of the divisor, Seems/Subtract an easy multiple from the dividend, Really/Record the partial quotient to the right of the problem and Repeat until the dividend is reduced to zero or is less than the divisor, Awesome/Add the partial quotients to answer the problem). Together, the five intervention lessons encompassed the six critical elements of SRSD's foundation: develop and activate background knowledge, discussion, modeling, memorizing, supporting, and independent practice (Harris, Graham, Friedlander, & Laud, 2013).

Lesson 1: Introduction and Investment. The initial lesson reviewed and built background knowledge regarding long division. Vocabulary terms such as "divisor," "dividend," and quotient were reviewed. Students discussed the importance of understanding how to complete long division and how it is applied in real life. The intervention agent introduced the mnemonic Long division Seems Really Awesome (LSRA) and guided students to the understanding that the beginning letter of each word in the phrase stood for a step in the long division process. A rationale for the strategy was established and students utilized a learning contract to form a personal goal to complete the intervention. The learning contracts were signed in order to promote an investment in the intervention. As with all lessons, positive praise was provided.

Lesson 2: Modeling and Self-Statements. The mnemonic was reviewed and the self-monitoring checklist was introduced. The intervention agent modeled the use of the mnemonic visual aid and the checklist, checking off each step of the mnemonic as she completed them. Students were also provided checklists to mark off each step along with the instructor as she modeled. The interventionist also modeled the use of positive self-statements such as, "Long division is a long process, but I know I can find my answer if I use each step." Students were provided multiple examples of positive self-statements they could use when working through long division problems.

Lesson 3: Guided Instruction. In the third lesson, students practiced problems with the guidance of the instructor. The mnemonic LSRA was first reviewed and students were encouraged to utilize their visual aids and checklists. The instructor provided encouragement and assistance throughout the entirety of the lesson. Students counted the number of times they were able to check off a step on their checklist and additional praise was awarded.

Lesson 4: Additional Guided Practice. Students practiced using the strategy with a peer. Students completed ten practice problems with partners using their visual aids and checklists when necessary. The intervention agent continued to be available to offer praise and assistance.

Lesson 5: Independent Practice. Students completed the LSRA quiz independently. The goal for the intervention was reviewed and students were reminded of the learning contracts signed from the first intervention lesson. Learning contracts were signed by both students and intervention agent to signify completion of the intervention.

At the conclusion of every lesson, students were given the daily long division assessment probe. Students receiving the intervention graphed the results of their probe the day after they were taught each lesson. (This occurred the following day to allow the intervention agent time to score each probe.)

Long division probes continued to be given daily for five days post intervention per student to measure short-term retention. In order to measure longer term maintenance, all students were later given three additional probes to complete.

Materials. Necessary materials included (a) the teacher handbook describing lessons in more detail, (b) fidelity checklists, (c) student workbooks comprised of the learning contract, LSRA visual aid, self-statements sheet, mnemonic checklist, blank graph for results, practice problems for lessons 3 and 4, and the LSRA Quiz, (d) long division probes.

Outcome Measures

Long division probes. Daily paper/pencil long division probes served as the principal outcome measure for the first research question of the study. Each probe consisted of twelve problems for students to attempt to calculate. Each problem included a one-digit divisor and either a three or four-digit dividend. Students were given seven minutes per probe to complete in any self-chosen order. Scoring was calculated in two ways: 1) correct whole quotient; 2) number of correct digits within the participants' completed quotients. By allowing individual correct digits to be scored, students were offered an additional opportunity to display growth if even partial steps were completed correctly.

Inter-observer agreement (IOA). A second researcher, a post-doctoral fellow with previous SRSD mathematics experience, scored 30% of all long division probes. The second researcher was provided brief training and answer keys to score the probes based upon both correct answers as a whole and overall correct digits. IOA was calculated by dividing the total number of agreements between both researchers by the total number of opportunities and then multiplying by 100 to obtain an IOA percentage.

Treatment Fidelity. Treatment fidelity data was collected using a researcher created checklist outlining all major steps for each lesson. A second observer attended two of the five lessons per treatment group while simultaneously completing the fidelity checklist to ensure the intervention was being properly implemented. Fidelity was calculated by dividing the number of completed items by the total number of items on the checklists.

Social Validity. Social validity of the procedure was measured by the Children's Intervention Rating Profile (CIRP, Witt & Elliot, 1985). The CIRP required students to express their opinions of specific elements regarding the intervention using a one to six Likert rating scale. A total of seven items per survey were scored, thus offering a maximum social validity score of 42.

Data Analysis

Visual analysis provided a concrete source of data analysis in order to determine whether the results of students' probes during baseline and post-intervention displayed a significant functional relationship between the independent and dependent variables (Lane & Gast, 2014). Trend, level, and stability are addressed through the presentation of data during pre-intervention, intervention exposure, and post-intervention phases. The presence or lack of a functional relationship displayed on the graphed division probes was further determined according to calculated means and standard deviations as described below.

Chapter 4 - Results

Long Division Probes

As displayed in Table 3, the means and standard deviations were calculated for each individual participant according to the three intervention phases. Similarly, Table 4 exhibits the total means and standard deviations for the three intervention groups during each of the study's phases. (See Figure 3 for graphic representation of these outcomes). Both Table 3 and Table 4 display results for the number of whole, correctly calculated quotients as well as the number of correct individual digits calculated within attempted quotients.

Table 3. ***Individual results of daily timed long division probes per intervention phase***

	Correct Whole Quotients			Correct Digits in Quotients		
Student	Baseline *M (SD)*	During Intervention *M (SD)*	Post-Intervention *M (SD)*	Baseline *M (SD)*	During Intervention *M (SD)*	Post-Intervention *M (SD)*
		Group A			**Group A**	
Ann	0.0 (0.0)	0.4 (0.5)	1.0 (1.0)	3.0 (1.2)	2.4 (2.1)	5.5 (2.4)
Cameron	0.0 (0.0)	0.0 (0.0)	0.6 (0.7)	3.2 (0.4)	2.6 (2.4)	3.3 (3.0)
Gayla	0.2 (0.4)	0.2 (0.4)	0.2 (0.4)	4.0 (3.4)	1.0 (2.2)	2.0 (2.0)
Grace	2.0 (2.3)	0.8 (1.8)	1.6 (1.5)	10.2 (8.4)	4.6 (8.2)	5.7 (5.1)
Matthew	0.0 (0.4)	0.2 (0.4)	0.6 (0.8)	3.4 (3.4)	1.6 (1.7)	3.2 (2.2)
Mickey	0.0 (0.0)	1.0 (1.2)	1.7 (0.9)	1.2 (1.8)	3.6 (3.8)	7.8 (4.3)
James	0.0 (0.0)	0.2 (0.4)	0.5 (0.7)	1.4 (1.3)	2.2 (2.4)	3.4 (2.2)
		Group B			**Group B**	
Amy	2.2 (1.5)	2.2 (2.1)	0.3 (0.5)	10.3 (4.9)	8.2 (7.3)	1.3 (1.2)
Andrea	7.2 (1.6)	6.0 (3.5)	0.3 (0.7)	25.8 (7.6)	24.0 (12.5)	2.3 (2.4)
Darcy	3.2 (1.7)	2.6 (2.7)	0.9 (1.7)	14.0 (6.7)	9.2 (8.7)	5.4 (6.2)
Jim	3.5 (1.4)	2.0 (2.7)	1.1 (1.7)	25.9 (7.0)	13.8 (15.0)	7.4 (4.7)
Sara	4.4 (1.9)	1.0 (1.0)	0.9 (0.8)	16.8 (6.5)	4.6 (4.5)	6.1 (4.0)
Skip	1.8 (1.0)	1.8 (2.2)	0.5 (0.5)	12.4 (4.8)	9.4 (8.4)	4.9 (1.9)
		Group C			**Group C**	
Alex	4.0 (1.8)	0.2 (0.5)	0.7 (1.2)	19.6 (7.1)	2.6 (2.7)	5.7 (5.7)
Robin	6.0 (2.6)	2.8 (3.6)	1.0 (1.0)	27.4 (5.6)	11.4 (11.2)	6.7 (2.3)
Kristin	5.1 (2.7)	2.0 (1.4)	1.3 (0.6)	28.1 (8.7)	10.4 (9.7)	7.7 (2.5)
Lane	3.1 (1.4)	1.0 (1.4)	2.0 (0.0)	12.3 (5.4)	4.6 (3.8)	8.3 (1.5)
Warren	4.0 (1.3)	2.4 (1.5)	3.7 (1.5)	15.3 (5.8)	10.8 (4.3)	16.0 (2.7)
Yakir	3.5 (2.0)	4.8 (2.5)	6.0 (1.0)	11.8 (5.2)	18.8 (8.0)	24.7 (8.3)

Note. M = mean, *SD* = standard deviation.

Although SRSD has proven to be a promising means of addressing the academic and behavioral needs of those with or at-risk for EBD, no evidence of an overall functional relationship was established between the intervention and the long division probes outcome in this particular study. Yet, as represented in Table 3 and Figure 3, results for those participants who demonstrated very minimal or a lack of long division computation skills during baseline exhibited greater reaction and growth than those participants who entered intervention with stronger skills. Further explanation of results are described per intervention group below.

Group A. Of the total 19 participants, Group A (*n*= 7) demonstrated both the most need for intervention as well as the most consistency in terms of academic improvement. Of the seven participants in Group A, five students demonstrated growth from the baseline to intervention phases and from intervention to post-intervention phases for results of correctly calculated whole quotients and/or the number of correct digits calculated within final quotients on the daily probes. While results were not noteworthy enough to determine an effect size, it can be noted that overall standard deviations per individual were reported with lower and more consistent variance across Group A than with any other group. Additionally, as students became more comfortable with the partial quotients method and SRSD intervention altogether, they became more efficient and more accurate on the probes.

Group B. Group B demonstrated the most significant decrease in scores during the intervention phase. Due to several internal and external factors that will be addressed in Chapter 5, students did not demonstrate a positive improvement between the intervention and outcome measures. Variance among participants was high within this group, ranging from standard deviations of 0.5 to 15.0 throughout the study (as further represented in Table 3). Finally, as with

Group A, participants displayed improvement in the post-intervention phase performance as they became more comfortable with the new long division method and strategies.

Group C. The final group exhibited a stronger sense of pre-skill and knowledge of long division calculation as depicted by the baseline data pictured in Figure 3. While results during the intervention phase varied (*M* = 9.77, *SD* = 8.55 for correct digits in final quotients), Group C exhibited the most significant upward trend in the post-intervention phase when compared to the other two groups in the study.

Table 4. *Group results of daily timed long division probes per intervention phase*

Group results of daily timed long division probes per intervention phase.

	Baseline *M (SD)*	During Intervention *M (SD)*	Post-Intervention *M (SD)*
Correct Whole Quotients			
Group A	0.34 (1.08)	0.40 (0.88)	0.90 (1.02)
Group B	3.72 (2.33)	2.60 (2.77)	0.65 (1.12)
Group C	4.29 (2.20)	2.20 (2.38)	2.44 (2.09)
Correct Digits in Quotients			
Group A	3.77 (4.45)	2.57 (3.70)	4.41 (3.62)
Group B	17.53 (8.69)	11.53 (11.06)	4.54 (4.19)
Group C	19.12 (9.13)	9.77 (8.55)	11.5 (7.94)

Note. M = mean, *SD* = standard deviation.

Interobserver agreement (IOA).

Following a second researcher scoring 30% of all long division probes taken from each design phase, both researchers agreed upon 100% of scoring when assessing correctly completed, whole quotients. When scoring 30% of all probes based upon the number of correct individual digits within quotients, both researchers agreed on an average of 98% of all scores.

Treatment Fidelity

Both the intervention agent (the current researcher) and a second observer reported high levels of fidelity according to the self-reports recorded throughout the lesson checklists. The intervention agent and second observer reported a mean of 100% treatment fidelity on all delivered/observed intervention lessons. Refer to Table 5 for additional treatment fidelity data.

Social Validity

The social validity of the partial quotients SRSD intervention was measured by student results on the Children's Intervention Rating Profile (CIRP) in which a maximum score of 42 indicates the highest possible level of acceptability (Witt & Elliott, 1985). Students were asked to individually score their level of agreement regarding statements such as, "The math intervention was fair." Scores of the 19 participants ranged from 25 to 42 with a mean score of 36.6 and median score of 37.0. Many participants offered comments such as, "This way [of dividing] is different but cool!" and were anxious to show their families and classmates. One student in particular refused to attempt any of the long division problems on the daily probes during baseline and within the first days of intervention leaving comments on his probe such as, "I don't know," and "I hate this." By the closure of the SRSD intervention lessons and post-intervention probes, this student displayed a much more positive attitude and sense of confidence as he was able to successfully calculate quotients and ceased to write negative comments on the probes. Additional information regarding social validity scores can be located in Table 5.

Figure 3. ***Group mean results of long division probes***

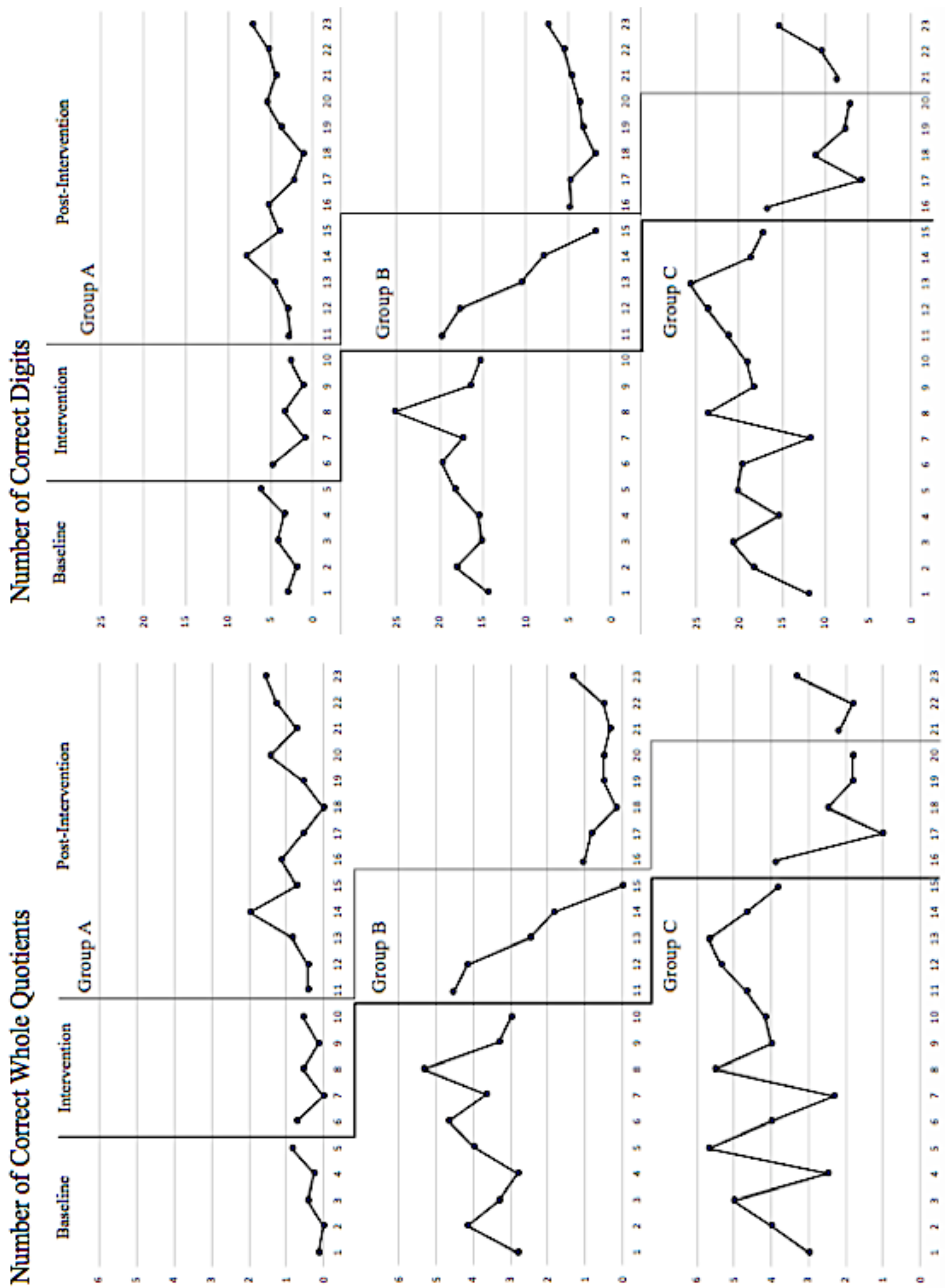


Table 5. ***Treatment fidelity and social validity***

Intervention Group	Treatment Fidelity		Social Validity
	IOA Completed[1] *M (SD)*	Researcher Completed[2] *M (SD)*	CIRP Total *M (SD)*
Group A	100 (0)	100 (0)	37.71 (3.04)
Group B	100 (0)	100 (0)	35.5 (4.64)
Group C	100 (0)	100 (0)	36.42 (4.01)
Total for all participants	-	-	36.6 (3.8)

Note. 1 = IOA completed fidelity was observed for 40% of all sessions and was conducted at least once for each treatment lesson, 2 = researcher completed fidelity was conducted for 100% of all treatment sessions, CIRP = Children's Intervention Rating Profile (Witt & Elliott, 1985), IOA = interobserver agreement, *M* = mean, *SD* = standard deviation.

Chapter 5 - Discussion

The purpose of this study was to examine the effectiveness of the self-regulated strategy development framework on teaching long division, via the partial quotients method, to students with or at-risk for EBD. While previous studies exist that have proven the effects of SRSD on the academic improvement of students with disabilities in a variety of content areas, very few studies exist in which mathematics is the academic subject of the targeted intervention. Moreover, minimal studies exist in the current literature that aim to improve the performance of long division calculation for students with disabilities using the SRSD framework involving more than three individual participants. For example, Losinski, Thiele, Shaw, and Ennis (in review) conducted the study implementing the SRSD framework with long division; however, only three participants were used and all were provided intervention in a one-on-one environment. Hence, while the current study did not result in the finding of a functional relationship, it was the first of its kind to explore the effectiveness of the SRSD framework and long division skills with a larger number of participants exhibiting characteristics of EBD while also meeting all required Council for Exceptional Children (2014) quality indicators to be considered truly evidence-based practice. Hence, this study can be used as a springboard for similar forthcoming research which is further emphasized in the following discussion of specific limitations of the study, implication for practice, and recommendations for future research

Limitations of the Study

A fair number of limitations are to be attended to when considering the procedures and results of this study. After meeting the preliminary inclusion criteria, only students who demonstrated a need for intervention on the long division pre-test were intended to be included in the study's final experimental design. However, the researcher quickly discovered throughout the following baseline long division probes that many of these students did not in fact appear to need the intervention as they had successfully mastered long division calculation through prior knowledge of the traditional algorithm. Further evidence can be found when examining the visual analysis provided in Figure 3. In addition, many students who required intervention did not return parental consent and thus, were unfortunately unable to participate in the study.

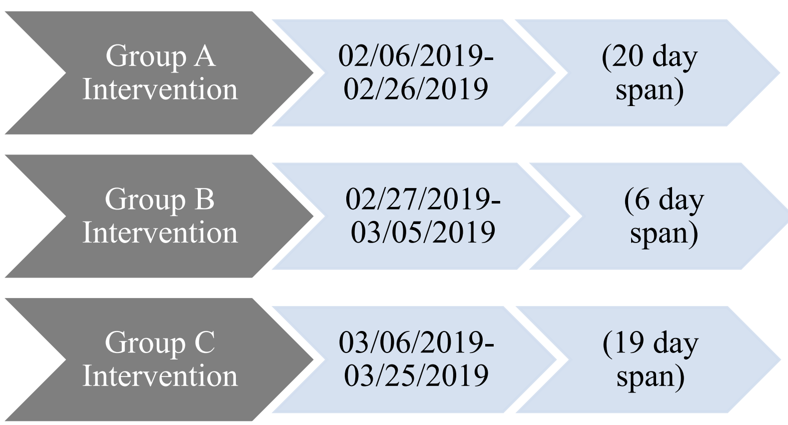
Likely the most significant limitation of the study stems from the environmental factors that impeded the coherency and consistency of the intervention. In total, the study was scheduled to occur over a total of 28 school days (five days baseline, five days of intervention per group, five days post-intervention at the conclusion of the final group's intervention phase, and at least three days for maintenance data collection). Due to unforeseen circumstances, the study lasted far longer than intended. A number of inclement weather days, field trips, holidays, and state and district testing affected the original timeline of the study. Thus, students received a five-lesson intervention that was designed to be taught across five consecutive school days across a drastically broader timeframe making it difficult for students to recall knowledge from previous intervention lessons and arrive with a focused mindset (e.g., classroom holiday parties and interruptions over the school's intercom system due to weather announcements caused delays in intervention treatment considering students' excitement levels drastically rose and attentiveness dramatically decreased). While the study began in late January, it was not feasible to complete until the end of the school year prior to a long serious of mandatory state and district assessments; hence, making the five days of post-intervention data collection after the final group had completed the intervention phase impossible to obtain. Please refer to Figure 4 for additional information pertaining to the timeline of the intervention study.

Outcomes were also affected by the time of day and physical location of the implementation of the intervention and data collection. Because the 19 participants originated from three different classroom teachers and the study occurred within a school setting with a rigorous schedule, the researcher was only permitted to teach the intervention lessons the last thirty minutes of the day. Not only did the participants appear physically tired, they often arrived at staggering times and with lethargic attitudes which did not allow for lessons to begin and conclude in a timely manner. The physical space used to teach the intervention and administer daily division probes varied. Strength and consistency in contextual classroom factors—such as classroom management, procedures, materials, and the ability to maintain student attention—are especially beneficial for students with EBD (Gunter, Coutinho, & Cade, 2002; Sutherland, Lewis-Palmer, Stichter, & Morgan, 2008). Unfortunately, this study was forced to be conducted in a variety of settings, often with other students working at tables next to the intervention group and/or causing distractions by entering and exiting the room. Procedures were difficult to consistently maintain, especially considering the intervention agent was maintaining her fulltime career as a special education teacher and was naturally required to work around the schedule of the students she had on her caseload as well.

Furthermore, the initial inclusion criteria outcome measure, the FastBridge aMath assessment, likely did not correlate as adequately with the selection of participants and study as a whole. Because the aMath assessment addresses a wide range of mathematical concepts, long division itself was not highly emphasized. Consequently, a more strongly correlated initial inclusionary screener should have been explored.

Finally, the daily outcome measure (long division probes) placed a limitation on the study as well. For example, many participants continued utilizing previously learned methods (such as the traditional or standard algorithm) during the intervention data collection phase which confounded the results when determining whether or not participants had successfully learned the SRSD partial quotients intervention. In addition, while the partial quotients method may have been more accurate, it was difficult to measure throughout the probes considering its novelty to the participants. In other words, because all but one participant had never seen nor heard of this new means of calculating long division, problems took longer to solve which became problematic as students only had seven minutes to complete each division probe. During baseline (and at times intervention phases), students chose to use faster, more familiar methods of solving for quotients which meant more problems were being answered; consequently, this offered more opportunities for participants to receive points on the probes, especially when they were scored on the premises of correct digits.

Figure 4. ***Timeline limitation***



Implications for Practice

The SRSD framework has been proven to be effective throughout a growing body of literature, particularly when reviewing its success with students with disabilities and language arts. (e.g., Sanders, 2018; Sanders, Ennis, and Losinski, 2018; Mason, Katie, Sukhram, & Kedem, 2006). Furthermore, due to its incorporation of both academic and behavioral teaching elements such as self-regulation skills, it lends itself naturally to the needs of students with characteristics of EBD. If the limitations within the current study are considered and catered to, SRSD can realistically and logically be implemented into a variety of educational settings including individual, small group, and whole class instructional opportunities.

Recommendations for Future Research

As exposed by both the review of previous literature and the results of the current study, it is incontestable that additional research must be conducted to assess the effectiveness of mathematical interventions designed to aid students with or at-risk for EBD in learning and accurately calculating the process of long division. More specifically, very few empirical studies have been conducted in association with mathematics, EBD, and the SRSD framework. Hence, the comprehensive recommendations for future research is fundamentally that additional studies must simply be designed and conducted. While the current study executed a multiple-baseline across participants design, it is recommended that both single-case and group experimental designs be empirically explored in order to specifically determine potential functional relationships between the SRSD framework and the learning of long division by students with characteristics of EBD. For instance, single-case educational research can serve as a promising foundation in which to foster larger sample experiments such as randomized control trials in which a wider EBD population can be represented (Sutherland et al., 2008).

More precisely, these future empirical studies must be cognizant of the environments and timeline in which are available to conduct quality research. For example, effectiveness of the current study was drastically impeded due to the inconsistencies in physical locations available within the school's setting and by the tangible days available to complete the study. Hence, a group design may have been more feasible as it may have offered potential to conduct the study in a more timely and efficient matter.

Finally, future research must be more cautious of outcome measures. For instance, future researchers must consider an alternate scoring approach to analyze the daily probes that considers a broader range of factors that potentially impact student performance. For instance, if a student does not know his multiplication facts, his ability to solve long division problems will likely be hindered regardless of which method (e.g., traditional or partial quotients) he is learning. Researchers should also consider the accuracy of the participant selection outcome measures. Specifically, the current study's participants were partially selected based upon the school's district-wide SAEBRs assessment to determine at-risk status for EBD. However, this assessment likely did not provide extensive enough data to determine this result.

Conclusion

Self-regulated strategy development applies a systematic, research-based approach to present academic and behavioral instruction to students of varying ages and backgrounds and across multiple content areas by emphasizing critical elements of successful teaching and learning such as modeling, scaffolding, and self-regulation (Case, Harris, & Graham, 1992). Despite minimal existing research linking SRSD to mathematics instruction, SRSD's success in other content areas implies a promising potential, particularly for students with EBD. While this study did not offer a concrete functional relationship between SRSD and the learning of long division skills with its participants, it denotes a convincing requirement for future research in order to address the mathematical needs of students with or at risk for EBD..

References

Albertoni, M. J. (2014). *Promoting engagement in math through interactive lessons* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses Global. (Order number 1584550). Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/1658783366?accountid=11789

Allday, R. A., Hinkson-Lee, K., Hudson, T., Neilsen-Gatti, S., Kleinke, A., & Russel, C. S. (2012). Training general educators to increase behavior-specific praise: Effects on students with EBD. *Behavioral Disorders, 37*(2), 87-98. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/1031151422?accountid=11789

Berch, D. B., & Mazzocco, M. M. M. (2007). Why is math so hard for some children? *The Nature and Origins of Mathematical Learning Difficulties and Disabilities.* Baltimore, MD, US: Paul H Brookes Publishing.

Brazel, J. (2014). *Developing elementary math skills through the instruction of differentiated mathematical strategies* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses Global. (Order number 1557235).

Cade, T., & Gunter, P. L. (2002). Teaching students with severe emotional or behavioral disorders to use a musical mnemonic technique to solve basic division calculations. *Behavioral Disorders*, 27(3), 208-214. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/619891820?accountid=11789

Case, L. P., Harris, K., & Graham, S. (1992). Improving the mathematical problem-solving skills of students with learning disabilities: Self-regulated strategy development. *The Journal of Special Education, 26*(1), 1-19. doi:10.117700224669202600101

Cassel, J. & Reid, R. (1996). Use of self-regulated strategy intervention to improve word problem-solving skills of students with mild disabilities. *Journal of Behavioral Education, 6*(2), 153-172. Retrieved from http://www.jstor.org/stable/41824117

Christ T. J. (2017). FastBridge Learning, Retrieved July 14, 2018, from https://www.fastbridge.org/

Common Core Standards Initiative. (2018). Grade 4: Number & Operations in Base Ten. Retrieved July 20, 2018, from http://www.corestandards.org/Math/Content/4/NBT/

Council for Exceptional Children. (2014). *Council for Exceptional Children Standards for Evidence-Based Practices in Special Education*. Arlington, VA: Council for Exceptional Children.

Cuenca-Carlino, Y., Freeman-Green, S., Stephenson, G. W., & Hauth, C. (2016). Self-regulated strategy development instruction for teaching multi-step equations to middle school students struggling in math. *The Journal of Special Education, 50*(2), 75-85. doi:10.1177/0022466915622021

Cuenca-Carlino, Y., Gozur, M., Jozwik, S., & Krissinger, E. (2018). The impact of self-regulated strategy development on the writing performance of English learners. *Reading & Writing Quarterly, 34*(3), 248-262. doi:http://dx.doi.org.er.lib.k-state.edu/10.1080/10573569.2017.1407977

Cuevas, G. J. (1975). *The Effects Of Precise Thinking Algorithmic Exercises And Cognitive Style On Fifth-grade Student's Ability To Perform The Division Algorithm (*Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses Global. (Order number 7604682).

Cullinan, D., Evans, C., Epstein, M.H., & Ryser, G. (2003). Characteristics of emotional disturbance of elementary school students. *Behavioral Disorders, 28*(2), 94-110.

Ennis, R. P. (2016). Using self-regulated strategy development to help high school students with EBD summarize informational text in social studies. *Education & Treatment of Children, 39*(4), 545-568. doi:http://dx.doi.org.er.lib.k-state.edu/10.1353/etc.2016.0024

Ennis, R. P., Jolivette, K., & Boden, L. J. (2013). STOP and DARE: Self-regulated strategy development for persuasive writing with elementary students with E/BD in a residential facility. *Education and Treatment of Children, 36*(3), 81-99. doi:http://dx.doi.org.er.lib.k-state.edu/10.1353/etc.2013.0026

Ezbicki, K. E. (2008). *The effects of a math-fact fluency intervention on the complex calculation and application performance of fourth grade student.* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global. (Order Number 3325323).

Fasko, S. N. (1994). *The effects of a peer tutoring program on math fact recall and generalization* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global. (Order number 9502507).

Flanagan, T. F., & DeBar, R. M. (2018). Trial-based functional analyses with a student identified with an emotional and behavioral disorder. *Behavioral Disorders, 43*(4), 423-435. doi:http://dx.doi.org.er.lib.k-state.edu/10.1177/0198742917719231

Forness, S. R., Freeman, S. F. N., Paparella, T., Kauffman, J. M., & Walker, H. M. (2012). Special education implications of point and cumulative prevalence for children with emotional or behavioral disorders. *Journal of Emotional and Behavioral Disorders, 20*(1), 4-18. doi:http://dx.doi.org.er.lib.k-state.edu/10.1177/1063426611401624

Fuchs, D., Fuchs, L. S., & Vaughn, S. (2014). What is intensive instruction and why is it important? *TEACHING Exceptional Children, 46*(4), 13-18. doi:10.1177/0040059914522966

Gunter, P. L., Coutinho, M. J., & Cade, T. (2002). Classroom factors linked with academic gains among students with emotional and behavioral problems. *Preventing School Failure, 46*(3), 126-32. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/62291249?accountid=11789

Harris, K. R., Graham, S., & Mason, L. H. (2003). *Self-regulated strategy development in the classroom: Part of a balanced approach to writing instruction for students with disabilities* Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/62165715?accountid=11789

Harris, K. R., Graham, S., Friedlander, B., & Laud, L. (2013). Bring powerful writing strategies into your classroom: Why and how. *The Reading Teacher, (66)*7, 538-542. doi:10.1002/TRTR.1156

Harris, K. R., Lane, K. L., Driscoll, S. A., Graham, S., Wilson, K., Sandmel, K., . . . Schatschneider, C. (2012). Tier 1, teacher-implemented self-regulated strategy development for students with and without behavioral challenges: A randomized controlled trial. *Elementary School Journal, 113*(2), 160-191. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/1314310688?accountid=11789

Hodge, J., Riccomini, P. J., & Buford, R., & Herbst, M. H. (2006). A review of instructional interventions in mathematics for students with emotional and behavioral disorders. *Behavioral Disorders, 31*(3), 297-311. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/62021056?accountid=11789

Hosp, M. K., Hosp, J. L., & Howell, K. W. (2007). *The ABCs of CBM*. New York, NY: Guilford.

http://www.math-aids.com/. (2009). Retrieved July 20, 2018, from http://www.math-aids.com/Division/

Hurts, K. (2008). Building cognitive support for the learning of long division skills using progressive schematization: Design and empirical validation. *Computers & Education*, *50*(4), 1141–1156. https://doi-org.er.lib.k-state.edu/10.1016/j.compedu.2006.11.008

Individuals with Disabilities Education Act, 20 U.S.C. § 300.8 (2004)

Individuals with Disabilities Education Act (2018). https://sites.ed.gov/idea/?src=policy-page

Irish, C. L. (2001). *The effects of peg- and keyword mnemonics and computer -assisted instruction on fluency and accuracy of basic multiplication facts in elementary students with learning and cognitive disabilities* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global. (Order No. 3028704).

Jackson, P.W. (1990). *Life in classrooms*. New York, NY: Teachers College Press.

Joyce, B., Weil, M., & Calhoun, E. (2015). *Models of Teaching*. 9thed. Boston, MA: Allyn and Bacon.

K-5MathTeachingResources.com (2018). Retrieved July 14, 2018, from https://www.k-5mathteachingresources.com/support-files/division-strategy-partial-quotients-ver.1.pdf

Kratzer, R. O. (1971). *A Comparison Of Initially Teaching Division Employing The Distributive And Greenwood Algorithm With The Aid Of A Manipulative Material* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global (Order number 7211464).

Losinski, M., Cuenca-Carlino, Y., Zablocki, M., & Teagarden, J. (2014). Examining the efficacy of self-regulated strategy development for students with emotional or behavioral disorders: A meta-analysis. *Behavioral Disorders, 40*(1), 52-67. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/1660315791?accountid=11789

Losinski, M. L., Ennis, R. P., Sanders, S. A., & Nelson, J. A. (2019). A Meta-Analysis Examining the Evidence-Base of Mathematical Interventions for Students With Emotional Disturbances. *The Journal of Special Education, (52)*4, 228-241.

Losinski, M., Ennis, R. P., & Shaw, A. (in review). Using self-regulated strategy development to teach addition and subtraction of fractions to students with or at-risk for emotional or behavioral disorders. *Behavioral Disorders.*

Mason, L. H., Katie, H. S., Sukhram, D. P., & Kedem, Y. (2006). TWA + PLANS strategies for expository reading and writing: Effects for nine fourth-grade students. *Exceptional Children, 73*(1), 69-89. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/201207948?accountid=11789

McDaniel, S. C., Lochman, J. E., Tomek, S., Powell, N., Irwin, A., & Kerr, S. (2018). Reducing risk for emotional and behavioral disorders in late elementary school: A comparison of two targeted interventions. *Behavioral Disorders, 43*(3), 370-382. doi:http://dx.doi.org.er.lib.k-state.edu/10.1177/0198742917747595

Menzies, H. M., & Lane, K. L. (2011). Using self-regulation strategies and functional assessment-based interventions to provide academic and behavioral support to students at risk within three-tiered models of prevention. *Preventing School Failure, 55*(4), 181-191. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/889925521?accountid=11789

National Assessment of Educational Progress (2018). The Nation's Report Card. National Center for Education Statistics. Retrieved from https://www.nationsreportcard.gov/math_2017?grade=4

National Mathematics Advisory Panel (2008). *The Final Report of the National Mathematical Advisory Panel*. U.S. Department of Education: Washington, DC

Peltier, C., & Vannest, K. J. (2018). The effects of schema-based instruction on the mathematical problem solving of students with emotional and behavioral disorders. *Behavioral Disorders, 43*(2), 277-289. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/2013521951?accountid=11789

Pierce, C. D., Nordness, P. D., Epstein, M. H., & Cullinan, D. (2016). Applied examples of screening students at risk of emotional and behavioral disabilities. *Intervention in School and Clinic, 52*(1), 6-11. doi:http://dx.doi.org.er.lib.k-state.edu/10.1177/1053451216630276

Rafferty, L. A., & Raimondi, S. L. (2009). Self-monitoring of attention versus self-monitoring of performance: Examining the differential effects among students with emotional disturbance engaged in independent math practice. *Journal of Behavioral Education, 18*(4), 279-299. doi:http://dx.doi.org.er.lib.k-state.edu/10.1007/s10864-009-9092-7

Ralston, N. C., Benner, G. J., Tsai, S., Riccomini, P. J., & Nelson, J. R. (2014). Mathematics instruction for students with emotional and behavioral disorders: A best-evidence synthesis. *Preventing School Failure, 58*(1), 1-16. doi:http://dx.doi.org.er.lib.k-state.edu/10.1080/1045988X.2012.726287

Reid, R., Gonzalez, J. E., Nordness, P. D., Trout, A., & Epstein, M. H. (2004). A meta-analysis of the academic status of students with Emotional/Behavioral disturbance. *Journal of Special Education, 38*(3), 130-143. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/62134098?accountid=11789

Reid, R., Hagaman, J. L., & Graham, S. (2014). Using self-regulated strategy development for written expression with students with attention deficit hyperactivity disorder. *Learning Disabilities: A Contemporary Journal, 12*(1), 21-42. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/1651862926?accountid=11789

Ryan, J. B., Pierce, C. D., & Mooney, P. (2008). Evidence-based teaching strategies for students with EBD. *Beyond Behavior, 17*(3), 22-29. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/757171876?accountid=11789

Ryan, J. B., Reid, R., & Epstein, M. H. (2004). Peer-mediated intervention studies on academic achievement for students with EBD: A review. *Remedial and Special Education, 25*(6), 330-341. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/62119045?accountid=11789

Sailor, W. (2015). Advances in schoolwide inclusive school reform. *Remedial and Special Education, 36*(2), 94-99. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/1697501471?accountid=11789

Sanders, S. (2018). *An investigation of the effectiveness of TWA on reading comprehension of students with and at - risk for emotional and behavioral disorders* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global. (Order No. 10786451).

Sanders, S., Ennis, R. P., & Losinski, M. (2018). Effects of TWA on science text comprehension of students with emotional and behavior disorders in a special day school. *Education and Treatment of Children, 41*(4), 483-505. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/2155993595?accountid=11789

Scruggs, T. E., Mastropieri, M. A., Berkeley, S. L., & Marshak, L. (2010). Mnemonic strategies: Evidence-based practice and practice-based evidence. *Intervention in School and Clinic*, 46(2), 79-86. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/815957460?accountid=11789

Siegler, R. S., Duncan, G. J., Davis-Kean, P., Duckworth, K., Claessens, A., Engel, M., . . . Meichu, C. (2012). Early predictors of high school mathematics achievement. *Psychological Science, 23*(7), 691-697. doi:http://dx.doi.org.er.lib.k-state.edu/10.1177/0956797612440101

Sun, S., Pan, W., & Wang, L. L. (2010). A comprehensive review of effect size reporting and interpreting practices in academic journals in education and psychology. *Journal of Educational Psychology, 102*(4), 989-1004. doi:http://dx.doi.org.er.lib.k-state.edu/10.1037/a0019507

Sutherland, K. S., Lewis-Palmer, T., Stichter, J., & Morgan, P. L. (2008). Examining the influence of teacher behavior and classroom context on the behavioral and academic outcomes for students with emotional or behavioral disorders. *The Journal of Special*

Education, 41(4), 223-233. doi:http://dx.doi.org.er.lib.k-state.edu/10.1177/0022466907310372

Templeton, T. N., Neel, R. S., & Blood, E. (2008). Meta-analysis of math interventions for students with emotional and behavioral disorders. *Journal of Emotional and Behavioral Disorders, 16*(4), 226-239. doi:http://dx.doi.org.er.lib.k-state.edu/10.1177/1063426608321691

Trussell, R. P., Lewis, T. J., & Stichter, J. P. (2008). The impact of targeted classroom interventions and function-based behavior interventions on problem behaviors of students with Emotional/Behavioral disorders. *Behavioral Disorders, 33*(3), 153-166. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/742867698?accountid=11789

U.S. Department of Education, National Center for Education Statistics. (2018). *Digest of Education Statistics, 2016* (NCES 2017-094), Chapter 2.

Weeden, M., Wills, H. P., Kottwitz, E., & Kamps, D. (2016). The effects of a class-wide behavior intervention for students with emotional and behavioral disorders. *Behavioral Disorders, 42*(1), 285-293. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/1969008391?accountid=11789

What Works Clearinghouse. (2015). *Preview of Regression Discontinuity Design Standards*. Retrieved from https://ies.ed.gov/ncee/wwc/Docs/ReferenceResources/wwc_rdd_standards_122315.pdf

Wiley, A. L., Siperstein, G. N., Bountress, K. E., Forness, S. R., & Brigham, F. J. (2008). School context and the academic achievement of students with emotional disturbance. *Behavioral Disorders, 33*(4), 198-210. Retrieved from http://search.proquest.com.er.lib.k-state.edu/docview/742864327?accountid=11789

Wilhite, S., & Bullock, L. M. (2012). Effects of the WhyTry social skills program on students with emotional and/or behavioral problems in an alternative school. *Emotional & Behavioural Difficulties, 17*(2), 175-194. doi:http://dx.doi.org.er.lib.k-state.edu/10.1080/13632752.2012.675135

Wolf, M. M. (1978). Social validity: The case for subjective measurement or how applied behavior analysis is finding its heart. *Journal of Applied Behavior Analysis, 11*(2), 203-214.

Zientek, L. R., Yetkiner Ozel, Z. E, Ozel, S., & Allen, J. (2012). Reporting Confidence Intervals and Effect Sizes: Collecting the Evidence. *Career & Technical Education Research*, *37*(3), 277–295. https://doi-org.er.lib.k-state.edu/10.5328/cter37.3.277

Zisimopoulos, D. A. (2010). Enhancing multiplication performance in students with moderate intellectual disabilities using pegword mnemonics paired with a picture fading technique. *Journal of Behavioral Education,* 19(2), 117-133. doi: 10.1007/s10864-010-

Appendix A - Lesson Plan Checklists

Lesson 1

Introduce LSRA

Lesson Overview:
The purpose of the first LSRA lesson is to establish the necessary background knowledge students need, introduce and describe the strategy, gain student commitment to learning and using the strategy, and to set goals for subsequent lessons.

Student Objectives:
The student reviews necessary background knowledge.
The student commits to learning and using the strategy.

Materials:
LSRA mnemonic chart
Learning contract

Reviewing Background Knowledge

1. Say, "*Today we are going to begin learning a new strategy to help us when we are using long division.*" Brainstorm what students already know about division and review terms such as partial, dividend, divisor, quotient, and multiples.

Set the Context for Student Learning

1. Say, *"Now, I want to talk with you about why it's important to know how to solve long division problems."* Discuss why it is important to understand how to solve long division problems. Real life examples include times when we are equally sharing items with friends, budgeting, splitting a bill at a restaurant, etc.
2. Say, *"Solving long division problems can seem like a long and frustrating process. We have to be careful that we don't miss a single step if we want to find the correct answer.*

Today I am going to start teaching you a strategy that uses partial quotients to make solving long division problems easier to do."

Develop the Strategy and Self-Regulation

1. Say, *"This strategy uses the phrase, 'Long division Seems Really Awesome.'" Long division Seems Really Awesome is an acronym. This means the beginning letters of each of the words in the phrase stands for a step of the strategy. This strategy has a total of four steps. To help us remember each step, we are going to use what is called a mnemonic device. A mnemonic device is a tool we use to help our brains remember something. The mnemonic for this strategy is Long division Seems Really Awesome (LSRA)."* Show students the chart with the mnemonic device and the long division steps. Say, *"See how the first letter in each word of the mnemonic device represents the letter in the acronym? That will help us remember the acronym!"* (Be sure to explain that for this strategy we will group the term "long division" as to not confuse students in thinking there is a separate step in the process represented by the letter d in division.)
2. Say, *"There are four steps to the LSRA strategy. You will use all four steps when you are solving long division problems. When you use the strategy, it will make the process of solving long division problems easier to remember."*
3. Be sure to emphasize the importance of using the strategy every time students solve long division problems.

Discuss the LSRA Steps

1. Put the LSRA acronym on the board or where students can see it, covering all of the steps except for the first. Say, *"The first is Long division = List easy multiples of the divisor. We need to identify the divisor and list some of its easier multiples like this:*

7x2=14

7x3=21 $\qquad 7\overline{)867}$

7x5=35

7x10=70

7x100=700

2. Uncover the second step. Say, *"The second step is Seems = Subtract from the dividend an easy multiple of the advisor."*

$$\begin{array}{r|} 7\overline{)\;867} \\ -\ \underline{700} \\ \\ \end{array}$$

3. Uncover the third step. Say, *"The next step is Really = Record the partial quotient to the right of the problem and repeat until the dividend is reduced to zero or the remainder is less than the divisor like this:*

7)867	
-700	100
167	
-70	10
97	
70	10
27	
21	3
6	

4. Uncover the last step. Say, *"The next step is Awesome = Add the partial quotients to answer the problem like this:*

123 r6	
7)867	
-700	100
167	+
-70	10
97	+
70	10
27	+
21	3
6	123

Obtaining Commitment

1. Say, *"I want you to try using the LSRA strategy because it can help you better understand how to solve long division problems. If you use these steps each time, it will*

make solving division problems easier and you will be confident that you have the right answer each time!"

2. Say, *"This strategy works, but it takes some commitment and work on your part. I promise to work with you and help you learn the strategy, but you also need to promise that you will try your best to learn the strategy and try hard every day we practice."*
3. Pass out the learning contract worksheets. Explain that this worksheet is going to represent their commitment as the student and your commitment as the teacher to ensure they learn the strategy.
4. Help the student fill out the contract. Be sure the goal the student chooses reflects them learning the strategy (e.g. "I will learn the LSRA strategy… I will use the LSRA strategy every time I solve a long division problem…")
5. After the learning strategies contract is filled out, both the student and teacher should sign it.

Memorization Practice

1. Ask students to tell you why it is important to use the LSRA strategy when working with long division problems.
2. Tell students it is important to practice each of the four steps, and eventually, they will have the steps memorized. Tell them at the end of each lesson, they will practice the strategy until they have it memorized.
3. Ask students if they remember the four letters in the acronym – **L**ist easy multiples of the divisor**, S**ubtract from the dividend an easy multiple of the divisor, **R**ecord the partial quotient to the right of the problem and repeat until the dividend is reduced to zero or the remainder is less than the divisor, **A**dd the partial quotients to answer the problem.
4. On a scratch piece of paper, have the students write out the acronym LSRA with a line next to each letter like the following:

    L_____

    S _____

    R _____

    A _____

5. Review the four steps orally. As each step is stated, have students check off the blank space next to the corresponding letter.
6. Stress again this strategy will help students when working with long division problems.

Wrap Up

Tell students they will need to come to the next class and write out the LSRA acronym and review the steps orally. End the session with a positive praise statement (e.g., “Great job remembering the steps to the strategy,” etc.).

Lesson 2

Model LSRA

Lesson Overview:

The purpose of the second LSRA lesson is to model the strategy. The teacher will model each step while talking aloud so that students understand the self-talk that occurs during the process. Self-regulation procedures will also be modeled by the teacher, including using the LSRA checklist and graph. Student self-statements will also be developed during the lesson.

Student Objectives:

The student will follow along as the teacher models the strategy.

The student will develop a list of self-statements to use with the LSRA strategy.

Materials:

Self-Monitoring Checklist

Mnemonic Chart

Learning Contract

Graphing Sheet

Self-Statements

Worksheet 1

Establish the Context for Student Learning

1. Ask students to recall the strategy that was discussed in Lesson 1 (LSRA). Review why it is important to be able to solve long division problems.
2. Ask students if they remember the mnemonic device that is used to remember the four letters in the acronym.
3. On a scratch piece of paper, have the students write out the acronym LSRA with a line next to each letter like the following:

   L _____

   S_____

   R _____

   A ______

4. Review the four steps orally. As each step is stated, have students check off the blank space next to the corresponding letter.

Develop the Strategy and Self-Regulation

1. Say, *"Today I am going to model how to use the* LSRA *strategy, but first, I want to show you some tools we are going to use to help us use the strategy every time we need to solve a long division problem."*
2. Show students the LSRA Self-Monitoring Checklist. Say, *"This is the* LSRA *checklist. As you can see, each step of the strategy is listed on the left. Across the top, you can see a column for each problem for which we are going to solve. For each problem, we are going to check off the strategy steps as we complete them so by the time we finish our ten problems today, our goal is to have checked off each step for each problem. Remember, if we use every step of the strategy each time, we are more likely to get the right answer!"*
3. Show students the LSRA Graphing Sheet. Say, *"This is the other tool we are going to use to help us keep track of how much we are using the strategy. Notice that there are four columns each split into ten boxes. We are going to fill up one column during each lesson. At the end of each lesson, we are going to graph the number of problems where we used all of the strategy's steps on one of the columns. We can use the checklist to keep track of that number."*

   NOTE: If desired, additional reinforcements can be used with the graphing sheet. For example, once students fill up all the columns on the page, they can earn reinforcement (e.g., free time, small edible/tangible item, special class privilege).

Model the LSRA Steps

1. Model the whole problem-solving process using the steps from LSRA. Be sure to use self-statements and to think aloud during the entire process so that students can hear examples of what they should be thinking.
   Give each student a copy of Worksheet #1. Say, *"I have ten problems here on my worksheet. I need to solve all of these problems. Using the LSRA strategy will help me know how to solve the problems. What is the first thing I should do? Well, the first letter of the acronym is L – that means I need to List easy multiples of the divisor."*

   6x2=12

   6x3=18 $\qquad 6\overline{)921}$

   6x5=30

   6x10=60

   6x100=600

Say, *"So, since the divisor is 6, we list out several simple multiples of the number six."*

Uncover the second step. Say, *"The second letter is S which stands for Subtract from the dividend an easy multiple of the divisor. During this step I can subtract 600 from 900.*

6x2=12	
6x3=18	6 ⟌ 921
6x5=30	-600
6x10=60	321
6x100=600	

"Ok time to move on to the next step. "The next letter is R which stands for Record the partial quotient to the right of the problem and repeat until the dividend is reduced to zero or the remainder is less than the divisor.

6x2=12		
6x3=18	6 ⟌ 921	
6x5=30	-600	100
6x10=60	321	
6x50=300	-300	50
6x100=600	21	
	-18	3
	3	

Uncover the last step. Say, *"The next letter is A, which stands for Add the partial quotients to answer the problem.*

6x2=12	153 r.3	
6x3=18	6 ⟌ 921	
6x5=30	-600	100

6x10=60	321	+
6x50=300	-300	50
6x100=600	21	+
	-18	3
	3	153

"So, my answer is 153 r.4. I did it! I can check off the last step on my checklist!"

2. Complete the other nine problems, modeling the steps, possible self-statements, and thinking aloud.

Reinforce Performance

1. Review the LSRA checklist. Count how many times you used all four of the LSRA steps.
2. Say, *"Wow I used the* LSRA *steps for all ten problems! The strategy really helped me solve the problems I was working with."*
3. Get out the LSRA graphing sheet. Say, *"Since I used the strategy for all ten problems, I get to color in all 10 sections in the column! I did a great job using the strategy today."*

Develop Self-Statements

1. Give each student a blank copy of the self-statements sheet. Explain that this worksheet will be used to write down some statements students can tell themselves as they use LSRA. If students get frustrated or stuck, they can use their self-statements sheet to help them use the LSRA strategy and get back on track.
2. Explain to students that you are going to brainstorm statements they can tell themselves before they start, while they work, and when checking their work. Have students record at least two things for each section. Some examples are listed below:

Before Starting: I will use my checklist to make sure I don't miss a step. If I forget a step, I can look at my checklist.

While I Work: This might be taking a while, but I will get faster the more I practice. After I complete a step, I need to check it off.

To Check my Work: Are all the steps checked off?

I did a great job using all my steps!

Memorization Practice

3. Ask students to tell you why it is important to use the LSRA strategy when solving long division problems (e.g. it will help students do better in math, it will make it easier when working with long division problems, etc.).
4. Reinforce that it is important for students to practice each of the four steps. Remind them that at the end of each lesson, they will practice the strategy until they have it memorized.
5. Ask students if they remember the mnemonic device to remember the four letters in the acronym LSRA.
6. On a scratch piece of paper, have the students write out the acronym LSRA with a line next to each letter like the following:

   L _____

   S _____

   R _____

   A ______
7. Review the four steps orally. As each step is stated, have students check off the blank space next to the corresponding letter.
8. Stress again this strategy will help students when working with long division problems.
9. If needed, update or review learning contracts.

Wrap Up

Tell students they will need to come to the next class and write out the LSRA acronym and review the steps orally. End the session with a positive praise statement (e.g., "Great job remembering the steps to the strategy," etc.).

Lesson 3

Collaborative Practice

Lesson Overview:

The purpose of the third LSRA lesson is to allow students to collaboratively practice the strategy. The teacher will facilitate collaborative problem solving with students, providing assistance when required. Self-regulation procedures will be used by students, including using the LSRA checklist, cue cards, self-statements, and graph.

Student Objectives:

The student will collaboratively practice the LSRA strategy with the teacher and peers.

The student will utilize self-regulation strategies.

Materials:

Cue Cards

Self-Monitoring Checklist

Mnemonic Chart

Graphing Sheet

Self-Statements

Graphic Organizer

Worksheet 2

Establish the Context for Student Learning

1. Ask students to recall the mnemonic device that is used to remember the four letters in the acronym LSRA.
2. On a scratch piece of paper, have students write out the acronym LSRA with a line next to each letter like the following:

    L _____

    S _____

    R _____

    A _____

3. Review the four steps orally. As each step is stated, have students check off the blank space next to the corresponding letter.
4. Have students explain how the strategy can help them when working with long division problems.

Support the Strategy and Self-Regulation

1. Give each student a copy of the LSRA cue cards. Say, *"These are called cue cards. They have the steps for the* LSRA *strategy and an example of what you need to do for each step. You can use these if you get stuck on a step."*
2. Tell students to get out their self-statements sheet. Say, *"Remember, our self-statement sheets are here to help us use the strategy. If you start having trouble with a step, check your self-statement sheet for help."*
3. Give students a copy of the LSRA checklist and have them get out their graphing sheets. Say, *"We are going to set a goal to use all of the LSRA steps on every problem today. We can use the checklist to make sure we are following the strategy. At the end of the lesson we can graph the number of problems we used the strategy with to see if we've met our goal."*
4. Give each student a copy of Worksheet #2 and the LSRA graphic organizer. Tell students that today they will be working on the problems as a group using the LSRA strategy. Emphasize that you will be able to help them anytime they need it.
5. Say, *"Today as you work on problems, you can use the graphic organizer to help organize your thoughts and remember to complete all steps of our strategy."*
6. *Show students the first problem.* Say, "*What is the first step in our strategy?"* Facilitate student discussion – they should identify the first step L – List easy multiples of the divisor. After students complete the first step, make sure they check it off on their checklist.
7. Collaboratively identify and complete the second step: S – Subtract from the dividend an easy multiple of the divisor. Show students how the graphic organizer has a place to write in this step of the problem. Check off the step on the checklist.
8. Collaboratively identify and complete the third step: R – Record the partial quotient to the right of the problem and repeat until the dividend is reduced to zero or the remainder is less than the divisor. Check off the step on the checklist.
9. Collaboratively identify and complete the fourth step: A – Add the partial quotients to answer the problem. Have students check their work and check off the step on the checklist.
10. Once the first problem is completed, have students look at their checklists. Say, *"Great job everyone! We used every step on the checklist. When we use the* LSRA *strategy, it helps us reach the correct answer. We should keep using the strategy and our checklists on the next nine problems. If using the graphic organizer was helpful, you can erase your responses and use it for the next long division problem."*
11. Complete the other nine problems, facilitating student collaboration. Be sure to emphasize the use of self-statements, cue cards, graphic organizer, and self-monitoring checklist as students work through the problems.

Reinforce Performance

12. Review the LSRA checklist. Students count how many times they used all four of the LSRA steps.
13. Say, *"Wow we used the* LSRA *steps for all ten problems! The strategy really helped us solve the problems we were working with."*
14. Get out the LSRA graphing sheet. Say, *"Since we used the strategy for all ten problems, we get to color in all of the sections in our columns! We did a great job using the strategy today."*

Add to Self-Statements Sheet

1. As students have had the opportunity to use the strategy, have them look at their self-statements sheet and add any self-statements they would find helpful. Think about steps students may have struggled with and if there are any self-statements that might be helpful at that particular step. Encourage students to add at least one or two statements.

Memorization Practice

2. Ask students to tell you why it is important to use the LSRA strategy when solving long division problems (e.g. it will help students do better in math, it will make it easier when working with long division problems, etc.).
3. Ask students to recall the mnemonic device to remember the four letters in the acronym – LSRA.
4. On a scratch piece of paper, have the students write out the acronym LSRA with a line next to each letter like the following:

   L _____

   S _____

   R _____

   A ______
5. Review the four steps orally. As each step is stated, have students check off the blank space next to the corresponding letter.
6. Stress again this strategy will help students when working with long division.
7. If needed, update or review learning contracts.

Wrap Up

Tell students they will need to come to the next class and write out the LSRA acronym and review the steps orally. End the session with a positive praise statement (e.g., “Great job remembering the steps to the strategy,” etc.).

Lesson 4

Peer Practice

Lesson Overview:

The purpose of the fourth LSRA lesson is to allow students to work in pairs to practice the strategy. The teacher will monitor student work to determine if additional individual instruction is needed. Self-regulation procedures will be used by students, including using the LSRA checklist, cue cards, self-statements, and graph. By the end of this lesson, students should be able to long division problems with minimal help from the teacher. This lesson should be repeated as many times as necessary for students to achieve this standard.

Student Objectives:

The student will work with a partner to practice the LSRA strategy.
The student will utilize self-regulation strategies.

Materials:

Cue Cards
Worksheet 3
Self-Monitoring Checklist
Mnemonic Chart
Graphing Sheet
Graphic Organizer (optional)
Learning Contract (optional)
Self-Statements (optional)

Establish the Context for Student Learning

8. Ask students to recall the mnemonic device that is used to remember the four letters in the acronym LSRA.
9. On a scratch piece of paper, have the students write out the acronym LSRA with a line next to each letter like the following:

   L _____

S _____

R _____

A _____

10. Review the four steps orally. As each step is stated, have students check off the blank space next to the corresponding letter.
11. Have students explain how the strategy can help them when working with long division problems.

Support the Strategy and Self-Regulation

1. Tell students to get out their self-statements sheets and mnemonic charts (students can also use cue cards but consider using a subtler prompt as we seek to fade supports in lesson 5). Remind students that these are materials they can use if they are having trouble with a step or are feeling frustrated.
2. Give students a copy of the LSRA checklist and have them get out their graphing sheets. Say, *"We are going to set a goal to use all of the LSRA steps on every problem today. We can use the checklist to make sure we are following the strategy. At the end of the lesson we can graph the number of problems we used the strategy with to see if we've met our goal."* If needed, give students a copy of the graphic organizer to guide them through solving problems.
3. Give each student a copy of Worksheet #3. Tell students that today they will be using the LSRA strategy with a partner. Emphasize that you will be there to assist them as much as they need.

    NOTE: Teacher discretion should be used when determining which students work with whom. For example, students may also work individually or in a small group if the teacher feels this is a better fit.

4. Say, *"I want you to work on the first problem with your partner. You should take turns going through each step. Don't forget to check off the step on your checklist after completing it. When you finish the first problem, please raise your hand and let me know."*
5. Monitor students' use of the strategy on the first problem, providing assistance as needed. When students finish the first problem, check to see if they used all of the strategy steps and if they got the correct answer.
    1. If students got the correct answer and used the strategy steps correctly, instruct students to complete the remainder of the worksheet using the strategy. Remind them to take turns (either take turns with each step or each problem) and to use the LSRA strategy, checking off each step on their worksheet. Continue to monitor student work and provide assistance if needed.
    2. If students got the incorrect answer or are not using the strategy steps correctly, provide corrective feedback. Then have students try the second problem and check in with you again. Continue this process until students are able to use the strategy to get the correct answer.

Reinforce Performance

6. Once students have completed the worksheet, review the LSRA checklist. Count how many times they used all four of the LSRA steps.
7. Say, *"Wow you used the* LSRA *steps for all ten problems! The strategy really helped you solve the long division problems you were working with."*
8. Get out the LSRA graphing sheet. Say, *"Since you used the strategy for all ten problems, you get to color in all 10 sections in our columns! You did a great job using the strategy today."*

Add to Self-Statements Sheet

1. If needed, add to self-statements sheets. (This may not be necessary if students are comfortable with the strategy.)

Memorization Practice

2. Ask students to tell you why it is important to use the LSRA strategy when solving long division problems (e.g. it will help students do better in math, it will make it easier when working with division problems, etc.).
3. Ask students to recall the mnemonic device used to remember the four letters in the acronym.
4. On a scratch piece of paper, have the students write out the acronym LSRA with a line next to each letter like the following:

    L _____

    S _____

    R _____

    A _____

5. Review the steps orally. As each step is stated, have students check off the blank space next to the corresponding letter.
6. Stress again this strategy will help students when working with long division problems.
7. If needed, update or review learning contracts.

Wrap Up

Tell students during the next class they will be quizzed on the LSRA strategy. End the session with a positive praise statement (e.g., "Great job remembering the steps to the strategy," etc.).

Lesson 5

Fading Supports to Independence

Lesson Overview:

The purpose of the fifth LSRA lesson is to fade out supports, such as the checklist, self-instruction sheet, and cue cards, and to encourage students to use the strategy independently. The fading out of supports and move towards independence may take several days. For example, a student may start by fading out the self-instruction sheet on the first day, the checklist and cue cards on the second, and complete the worksheet independently on the third. Teachers should make these decisions based on individual student needs. Procedures for fading supports and promoting independence are provided in the lesson which could happen over multiple days. By the end of this lesson, students should be able to solve long division problems without support materials. **This lesson should be repeated as many times as necessary for students to achieve this standard.**

Student Objectives:

The student will independently solve problems using the LSRA strategy.

The student will utilize self-regulation strategies.

Materials:

LSRA Quiz

Worksheet 4

Graphing Sheet

Learning Contract

Establish the Context for Student Learning

1. Give students the LSRA quiz. This quiz could be completed orally or be given as a written assignment.
2. Have students explain how the strategy can help them when working with long division problems.

Support the Strategy and Self-Regulation

1. Tell students you are going to show them how to use the LSRA strategy without support materials.
2. Write out the acronym LSRA vertically with a line next to each letter.
3. Remind students they can think self-statements in their head if they get stuck on a problem or if they get frustrated.
4. Give each student a copy of Worksheet #4.
5. Monitor students' use of the strategy, providing assistance as needed.

Reinforce Performance

6. Once students have completed the worksheet, review their checklists. Count how many times they used all of the LSRA steps.
7. Fill out the LSRA graphing sheet.

Learning Strategies Contract (Note: this part of the lesson should not be completed until students can independently solve problems without support materials.)

1. Review the goals they set and ask students if they feel like they've met their goals.
2. Brainstorm times students can use the strategy.
3. Fill out the bottom half of the learning strategies contract, listing some of the places identified by students as a time to use the strategy.

Wrap Up

Praise!

Appendix B - Lesson Materials

Learning Strategies Contract

STRATEGY_________________________________

Student: ____ **Date:** __________________

Teacher: _______________________________________

Targeted Completion Date: ______________________

Goal: ____

____

____

____

How to meet my goal: ____

____

____

____

____

Signatures:

Student: ___________________________________

Teacher: ___________________________________

________________________________ **has successfully completed instruction in the** _____________________________ **Strategy and agrees to use it in** ________________

____

____

Date: ________________________

Student: ______________________________________

Teacher: ______________________________________

Strategy Cue Cards

L – List easy multiples of the divisor

Step 1

7⟌867

7x2=14
7x3=21
7x5=35
7x10=70
7x100=700

S– Subtract from the dividend an easy multiple of the divisor

Step 2

7⟌867
-700

R – Record the partial quotient to the right of the problem and repeat until the dividend is reduced to zero or the remainder is less than the divisor

Step 3

7⟌867	
-700	100
167	
-70	10
97	
-70	10
27	
-21	3
4	

A – Add the partial quotients to answer the problem

Step 4

123 r4	
7⟌867	
-700	100
167	+
-70	10
97	+
-70	10
27	+
-21	3
4	123

My Self Statements

Before starting:

While I work:

To check my work:

Mnemonic Chart

LONG DIVISION **S**EEMS **R**EALLY **A**WESOME

L = **L**ist easy multiples of the divisor

S = **S**ubtract from the dividend an easy multiple of the divisor

R = **R**ecord the partial quotient to the right of the problem and repeat until the dividend is reduced to zero or the remainder is less than the divisor

A = **A**dd the partial quotients to answer the problem

LSRA Checklist

	Problem 1	Problem 2	Problem 3	Problem 4	Problem 5	Problem 6	Problem 7	Problem 8	Problem 9	Problem 10
L - List easy multiples of the divisor										
S - Subtract from the dividend an easy multiple of the divisor										
R - Record the partial quotient to the right of the problem and repeat until the dividend is reduced to zero or the remainder is less than the divisor										
A - Add the partial quotients to answer the problem										

LSRA Self-Graphing Sheet

Directions: Color in one box each time you complete a problem using all steps of the self-monitoring LSRA strategy.

10	10	10	10
9	9	9	9
8	8	8	8
7	7	7	7
6	6	6	6
5	5	5	5
4	4	4	4
3	3	3	3
2	2	2	2
1	1	1	1
Worksheet 1	**Worksheet 2**	**Worksheet 3**	**Worksheet 4**

LSRA Quiz

Name: ______________________________

Long division Seems Really Awesome

Write down the steps to the strategy below:

L ____

S ____

R ____

A ____

Sample Worksheet
(Worksheet 1)

1) $921 \div 6=$

2) $623 \div 5=$

3) $1,892 \div 2=$

4) $6,588 \div 6=$

5) $3,742 \div 3=$

6) $4,103 \div 8=$

7) $883 \div 4=$

8) $943 \div 5=$

9) $5,176 \div 9=$

10) $6,453 \div 3=$

CIRP

	I do not agree					I agree
The math intervention was fair.	1	2	3	4	5	6
I think the math teacher was too tough on me.	1	2	3	4	5	6
The math intervention caused problems with my friends.	1	2	3	4	5	6
There are better ways to help me be a good at math than the math intervention.	1	2	3	4	5	6
The math intervention was a good one to use with other students.	1	2	3	4	5	6
I liked the math intervention LSRA.	1	2	3	4	5	6
I think that math intervention helped me do better in school.	1	2	3	4	5	6