STRATEGIES FOR TEACHING MATHEMATICS TO HIGH SCHOOL STUDENTS WITH MILD DISABILITIES

by

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A Thesis

Submitted to the Faculty of Purdue University

In Partial Fulfillment of the Requirements for the degree of

Master of Science

School of Special Education at Purdue Fort Wayne

Fort Wayne, Indiana

May 2021

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This project is dedicated to my family and to the students and coworkers who have inspired me to pursue this path in special education.

Many thanks to my husband for all the delicious meals and support throughout this whole degree process.

Thanks to my three wonderful kids for your support and understanding.

ACKNOWLEDGMENTS

I would like to extend my thanks to Dr. Cousik for leading me through the development of this special project. I would like to thank Dr. Leatherman for her guidance and encouragement throughout the Masters program. Thank you to Dr. Cousik, Dr. Leatherman, and Dr. Cho for feedback on this project to ensure a quality finished product.

I want to thank the high school for their support during this process. I couldn't have done this without the support of the school principal and participation of the math and special education teachers who generously took time to respond to my survey.

Special thanks to my co-teacher for being flexible with co-teaching responsibilities this year, for your friendship, patience, and for listening when I needed it during our many hours together.

My classmates at PFW have also been a huge source of support throughout the program.

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ABSTRACT

Many high school math teachers are not trained for teaching students with mild disabilities. Math curriculum is not typically developed with the needs of students with mild disabilities in mind. Teachers may not be aware of the unique barriers for students with mild disabilities, and strategies to help them master mathematics. The purpose of this study was to identify research-based techniques used by general education and special education teachers for teaching math to high school students with mild disabilities. The study also investigated teachers' perceptions of and willingness to implement specific strategies to teach math skills to students with mild disabilities. Academic research articles were reviewed to identify strategies. A survey was taken by nine high school general education and five special education teachers who teach math. The results showed a reasonable degree of knowledge, experience, and positive perceptions of evidence-based strategies, especially co-teaching. There were significant differences between the responses of teachers with math teaching licenses compared to those with special education licenses. Based on the existing literature and the survey results, a handbook of resources was created for teachers of secondary math classes to support learning for students with mild disabilities.

CHAPTER 1. INTRODUCTION

Statement of the Problem

Math is a challenging subject for many students. A 2015 report of nationwide data by the National Education Assessment Program (NAEP) indicated only one-third of all eighth-grade students were achieving proficiency and only 4% of students with disabilities scored at a proficient level or above (Bouck, Park, Bouck, Alspaugh, & Spitzley, 2019; Satsangi, Hammer, & Bouck, 2019). For decades, the highest level of mathematics students with mild disabilities were required to master in the United States was Algebra I (Strickland, 2016). Now under the requirements of the Every Student Succeeds Act (ESSA) enacted in 2015 and the Individuals with Disabilities Education Act (IDEA) of 2004, most secondary students with disabilities are taking mathematics in general education classes and are expected to complete Algebra I, Algebra II, and Geometry in order to obtain a typical high school diploma (Marita & Hord, 2016). With this increased expectation, many students with mild disabilities need additional support to succeed in their high school math classes.

There are a variety of mild disabilities represented among American high school students, including Specific Learning Disabilities (SLD), Autism Spectrum Disorders (ASD), Attention Deficit Hyperactivity Disorder (ADHD), Intellectual Disabilities (ID), and Emotional Behavioral Disturbance (EBD). For the purpose of this thesis, all relevant disabilities will be referred to under the category of mild disabilities.

Significance of the Study

Many high school math teachers are not trained for teaching students with mild disabilities (Boyd & Bargerhuff, 2009; Grskovic & Trzcinka, 2011; Shoulders & Krei, 2016).

Math curriculum is not typically developed with the needs of students with mild disabilities in mind. While teachers may strive for all their students to master the material, they may not be aware of the unique barriers for students with mild disabilities, and strategies to help them master mathematics. This project was used to create a collection of resources for teachers of secondary math classes to support learning for students with mild disabilities. With the current need for remote learning models due to the COVID-19 pandemic, some of the strategies will be compatible with on-line learning.

In the course of the literature review, the researcher only found two resources for teachers that specifically discussed strategies for teaching math to secondary students with mild disabilities. The first book, *Understanding RTI in Mathematics: Proven Methods and Applications* (Gersten & Newman-Gonchar, 2011), is written about Response to Intervention in grades K-12, with several chapters about secondary students, mostly middle school. The second book, *Teaching Mathematics to Middle School Students with Learning Difficulties* (Montague & Jitendra, 2018), includes chapters on teaching problem-solving skills, visual representation, and self-regulation to middle school students.

There were many books about teaching math, including books about teaching secondary math. Some examples of these are *Mathematical Mindsets: Unleashing Students' Potential Through Creative Math, Inspiring Messages, and Innovative Teaching* (Boaler, 2016), *Taking Action: Implementing Effective Mathematics Teaching Practices in Grades 9 – 12 (*Boston, Dillon, Smith, & Miller, 2017), and *Teaching Secondary School Mathematics: Techniques and Enrichment* (Posamentier & Smith, 2020). In the beginning of their book, Posamentier and Smith (2020) discuss the varying needs of students, including those with disabilities, however once they start outlining teaching practices and lesson plans, they do not specifically mention how these apply to students with disabilities. Instead, their focus is on designing lessons that differentiate for learners at all abilities, including enrichment for gifted students. However, the researcher did not find any additional books that specifically addressed the needs of students with mild disabilities. Alternately, there were numerous books about teaching students with mild disabilities, but they were all geared toward elementary education, such as Blended Practices for Teaching Young Children in Inclusive Settings" (Grisham-Brown, Hemmeter, & Pretti-Frontczak, 2017). If desired, a teacher could read books that discuss both of those groups of students and look for cross-over in their recommendations in the hopes that such overlapping strategies would be effective for high school students with mild disabilities. Notwithstanding the amount of time and effort that would be required, since these resources are not designed for this population there is no evidence supporting their effectiveness with these students. In summary, high school math teachers have very few resources for strategies for teaching students with mild disabilities. With the prevalence of inclusion, such resources are sorely needed. This research is intended to start filling that gap.

Purpose of the Study

The purpose of this study was to identify techniques used by general education and special education teachers for teaching math to students with mild disabilities. The study also sought to investigate their perceptions of and willingness to implement specific strategies to teach math skills two students with mild disabilities. The desired outcome was to identify and compile a handbook for teachers that will help their students' mastery of high school mathematics.

Research Approach

This research used a qualitative format for collecting data and a quantitative format for summarizing and analyzing the data. A survey was given to both general education and special education teachers who teach math to students at one urban Midwestern high school (Appendix A). The total number of possible participants was eighteen. The survey questions were designed to understand teachers' knowledge of barriers faced by students with mild disabilities, strategies and tools they have used or are currently using to teach math skills to students with mild disabilities, their perceptions of other techniques to teach math, and their openness to trying different approaches to teach math skills. The questions were drawn from scholarly articles that described research in the area of teaching math skills to students with mild disabilities. Participants were recruited through an email request (Appendix B). The email clearly states that participation is optional. Permission was obtained from the school principal (Appendix C). Approval for the research was obtained from the Purdue Institutional Review Board (Appendix D).

Literature Review

There is a large volume of research about students with mild disabilities as defined by the Individuals with Disabilities Education Act (IDEA) of 2004. The goal of this literature review was to find research that addressed the ability of high school students with these disabilities to master the math that is required to earn a diploma in a state in the Midwest. There is much evidence that disabilities affect students' performance in math due to specific characteristics associated with them. Currently, most students with mild disabilities take inclusive high school math classes taught be general education teachers. These teachers generally have not been trained to teach students with special needs, so many are ill-equipped to meet these students' needs. This literature review is an attempt to locate specific research on ways teachers can support these students in learning high school math. The desired outcome of the research was to identify these strategies and compile them for use by high school math teachers. A detailed discussion of the literature can be found in Chapter 2.

The strategies found in the literature ranged from assistive technology, to cognitive strategies and graphic organizers. Although most of the literature focused on middle school students and was limited in scope, there were some potentially useful approaches that presumably would benefit high school students as well as middle school students. This information was developed into a special project of a compilation of resources presented in Chapter 5.

Research Questions

1. What knowledge do general education teachers have about the impacts of mild disabilities on student learning?
2. What strategies are teachers aware of, have used in the past, or are currently using to teach math skills for students with mild disabilities?
3. What do teachers think are some of the most effective strategies for teaching math skills to students with mild disabilities?

Definitions

Accommodations – "Changes in the way a student accesses learning without altering the actual standards a student is working to meet" (Bone & Bouck, 2018 p. 36).

Attention Deficit Hyperactivity Disorder (ADHD) – "Attention-deficit/hyperactivity disorder (ADHD) is one of the most common mental disorders affecting children. Symptoms of ADHD include inattention (not being able to keep focus), hyperactivity (excess movement that is not fitting to the setting) and impulsivity (hasty acts that occur in the moment without thought)" (American Psychological Association [APA], n.d.).

Assistive Technology (AT) – "Assistive technology device means any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of a child with a disability. The term does not include a medical device that is surgically implanted, or the replacement of such device." (IDEA, *Sec. 300.5* 2017).

Auditory Processing Disorder – "An auditory processing disorder interferes with an individual's ability to analyze or make sense of information taken in through the ears. This is different from problems involving hearing per se, such as deafness or being hard of hearing. Difficulties with auditory processing do not affect what is heard by the ear, but do affect how this information is interpreted, or processed by the brain" (APA, n.d.).

Autism Spectrum Disorder (ASD) – "Autism spectrum disorder (ASD) is a complex developmental condition that involves persistent challenges in social interaction, speech and nonverbal communication, and restricted/repetitive behaviors" (APA, n.d.).

Co-teaching – "In a co-taught class, general education and special education teachers work together to plan lessons, teach, monitor student progress, and manage the class" (Morin, 2020).

Emotional Behavioral Disturbance (EBD) or Emotional Disturbance (ED) or Severe Emotional Disturbance (SED) – "Emotional disturbance means a condition exhibiting one or more of the following characteristics over a long period of time and to a marked degree that adversely affects a 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 relationships with peers and teachers, (C) Inappropriate types of behavior or feelings under normal circumstances, (D) A general pervasive mood of unhappiness or depression, (E) A tendency to develop physical symptoms or fears associated with personal or school problems. Emotional disturbance includes schizophrenia. The term does not apply to children who are socially maladjusted, unless it is determined that they have an emotional disturbance" (IDEA, *Sec. 300.8 (c) (4)* 2017).

Enhanced anchored instruction (EAI) – A strategy using problem-based learning (PBL). EAI "immerses students in the context of the problem through a combination of video-based problems and real-world scenarios where students have the opportunity to take a hands-on approach to mathematics concepts" (Marita & Hord, 2017, p. 36).

Explicit Instruction – "Explicit instruction is a method of teacher-directed instruction that incorporates the following teaching functions: an advanced organizer, teacher demonstration, guided practice, independent practice, and curriculum-based assessment to provide data to drive instructional planning" (Strickland & Maccini, 2010 p. 39).

Graphic Organizers – "Graphic organizers, such as diagrams and charts, are visual representations that depict the relationship between facts or ideas within a learning task" (Strickland & Maccini, 2010 p. 43).

Intellectual Disability (ID) – “Intellectual disability means significantly subaverage general intellectual functioning, existing concurrently with deficits in adaptive behavior and manifested during the developmental period that adversely affects a child’s educational performance. The term ‘intellectual disability’ was formerly termed ‘mental retardation’” (IDEA, *Sec. 300.8 (c) (6)* 2018).

Mild Disabilities – For this special project, mild disabilities refer to mild emotional, learning, or intellectual disabilities. This includes specific learning disabilities (SLD), autism spectrum disorders (ASD), attention deficit hyperactivity disorder (ADHD), intellectual disabilities (ID), and emotional behavioral disturbance (EBD). See official definitions of each of these disabilities above.

Problem-based Learning (PBL) - “Problem-based learning is an instructional technique that allows students to learn through interaction with an open-ended problem scenario” (Marita & Hord, 2017, p. 36).

Response to Intervention (RtI) – “RtI is a multitiered system of support designed to provide early identification and intervention of struggling students” (Bouck, et al., 2019, p. 89).

Specific Learning Disorder (SLD or LD) – “Specific learning disorder (often referred to as learning disorder or learning disability) is a neurodevelopmental disorder that begins during school-age, although may not be recognized until adulthood. Learning disabilities refers to ongoing problems in one of three areas, reading, writing and math, which are foundational to one’s ability to learn.” This includes Dyslexia, Dysgraphia, Dyscalculia, and Auditory Processing Disorder (APA, n.d.).

Visual Processing Disorder – "A visual processing, or perceptual, disorder refers to a hindered ability to make sense of information taken in through the eyes. This is different from problems involving sight or sharpness of vision. Difficulties with visual processing affect how visual information is interpreted, or processed by the brain" (APA, n.d.).

Word Problems – "Mathematical problems that are expressed in words rather than using signs or symbols" (Sian, Shahrill, Yusof, Ling, & Roslan, 2016 p. 84).

CHAPTER 2. LITERATURE REVIEW

Introduction

This literature review summarized peer-reviewed scholarly articles from 2006 to 2019 published in the area of teaching math skills to students with mild disabilities. The articles pertain to strategies to improve mathematics learning by students with mild disabilities. This search was conducted to find evidence-based practices that high school math teachers could implement to improve outcomes for students with mild disabilities. The research was started using the Purdue Fort Wayne Helmke Library search engine. The researcher chose EBSCOhost databases Academic Search Complete, Education Full Text (H.W. Wilson), and ERIC. Later the researcher used Google Scholar for additional searches. The key terms that were entered included special education, mild disabilities, learning disabilities, autism, secondary, high school, math, and mathematics. As the researcher became aware of specific strategies that had been researched, some of those key terms were entered also. These included graphic organizer, calculator, and manipulatives. The researcher also read the reference section of the articles that were found and searched for some of those articles and authors. Initially the search was limited to articles less than 10 years old, but many of those referred to research that was performed earlier. As a result, the search was extended back to capture more primary sources.

How disabilities affect students' mastery of math

Students with mild disabilities exhibit a multitude of characteristics that make learning mathematics more difficult than it is for their non-disabled peers. They typically exhibit some combination of characteristics which impede their success in high school math. There is variability among students with mild disabilities, however there is overlap in the ways different disabilities manifest themselves in students. For example, students with visual processing disorders such as those with LD have difficulty understanding visual representations of math problems, such as graphs, tables, diagrams, and equations (Montague, Enders, & Dietz, 2011; Steele, 2006). Verbal directions or explanations are more difficult for students with auditory processing disorders such as those with ASD to understand, and written directions are a challenge for students with reading disabilities (Ives, 2007; Steele, 2006). Deficits in motor skills cause difficulty in taking notes, writing neatly, graphing problems, and using the keys on a calculator (Steele, 2006). Attention deficits result in trouble maintaining focus and persisting through multiple steps. Cognitive skills like conceptualizing, abstract reasoning, and generalizing are often weaker among students with mild disabilities (Marita & Hord; 2017, Steele, 2006).

Individual disabilities are defined above on pages 13 - 16. Most of the research is conducted on students with varying mild disabilities and does not specify which disability is associated with each characteristic. That is the reason I choose to use the overarching term of Mild Disabilities and list common problems that students with Mild Disabilities have in learning math skills.

These weaknesses cause difficulty following correct steps, making connections, and applying concepts to new problems (Steele, 2006). Deficits in working memory are also common, which means students have difficulty processing information, storing it, retrieving it, and integrating it with other information (Walsh & Hord, 2019). According to Montague, Enders, and Dietz (2011) students with LD are typically poor problem solvers and lack understanding of problem-solving processes, especially representing problems with diagrams and mathematical notation. They rarely recognize that a strategy is not working and adapt or replace it (Montague, Enders, & Dietz, 2011). Students with mild disabilities often lack prerequisite skills, take longer to develop strategies for solving problems, make more procedural mistakes, have trouble memorizing basic math facts, and have difficulty understanding mathematical relationships and operations (Rodgers & Weiss, 2019). These are all potential areas in which students with mild disabilities could benefit from specific strategies designed to help overcome barriers and increase their academic success.

Existing Research about Math Strategies

Instructional Strategies, Explicit Instruction and Cognitive Strategies

Not much research has been done to identify strategies that can help secondary students with mild disabilities overcome their math-specific challenges, and most of it has been with middle school students in grades 6 – 8. Research for grades 9 – 12 is relatively sparse (Bottge, Toland, Gassaway, Butler, Choo, Griffen, & Ma, 2015). This literature review summarizes findings that apply to any level of secondary students from 6th to 12th grade with the goal of identifying strategies that can be applied to high school math content.

According to Montague, Enders, and Dietz (2011), "Students with LD characteristically are poor problem solvers. They typically lack knowledge of problem-solving processes, particularly those necessary for representing problems and, therefore, need to be taught those processes explicitly and shown how to apply them when solving math word problems" (p. 263). An article by Marita and Hord (2016) summarized the results of twelve research studies published between 2006 and 2014 focused on secondary students with mild disabilities. Seven studies discussed the use of systematic instruction interventions, including an instructional sequence known as *Solve It!*. This method teaches students cognitive and metacognitive processes to help develop effective thinking processes. Cognitive processes are ways of thinking about a problem and metacognitive processes are ways of thinking about your thought processes. The processes used in this method are read, paraphrase, visualize, hypothesize, estimate, compute, and check (Marita and Hord, 2016, p. 31). The results of studies using *Solve It!* showed significant improvement in the performance of students at all ability levels. The students with mild disabilities in the experimental groups achieved scores higher than the average-achieving students in the control group. The students were also observed using more problem-solving strategies than the students in the control group.

The *Solve It!* method was cited as the basis for the *Understand and Solve!* strategy implemented in another research study and demonstrating similar results (Karabulut & Ozmen, 2019). In this study, the steps were modified, but the underlying goal of developing cognitive and metacognitive processes to aid in problem-solving was the same. In the modified version, the steps were read the problem and tell, underline the keywords, draw the schema of the problem, make a plan and solve the problem, and check. As a result of the intervention, the three subject students were not only able to solve the problems given in the study more successfully, but also were able to apply the problem-solving skills to other types of problems (Karabulut & Ozmen, 2019). Based on these results, the *Solve It!* method shows promise in applications with learning-disabled high school math students.

Another method discussed in Marita and Hord's 2016 article was concrete-representational-abstract (CRA). In this method, students were taught a math concept first with physical manipulatives, then with 2-dimensional representations of the concept such as drawings and graphic organizers, then with abstract symbolic representations of the concepts including algebraic formulas or equations. The studies found improved accuracy on problem-solving across all students and retention of the concepts after the initial instruction ended. Strickland and

Maccini (2011) described CRA as a graduated instructional sequence. One specific technique sometimes used in this method is the STAR strategy – "Search the word problem, Translate the words into a mathematical equation, Answer the problem, and Review the problem" (Maccini, Strickland, Gagnon, & Malmgren, 2008, p. 20). The researchers describe one benefit of graduated instruction as supporting the development of conceptual understanding.

In separate research conducted by Strickland (2016), five high school students were taught with a modified version of CRA called CRA integration (CRA-I). In this integrated approach, the concrete, representational, and abstract tools were applied simultaneously rather than sequentially. This modification was designed to enable teachers to more easily incorporate the methodology into the regular math curriculum without increasing teaching time as much as the sequential CRA method. This research demonstrated mastery of the math concepts taught within 13 sessions, but there were only five students. This integrated approach may be valuable but needs further research.

The next method discussed in Marita and Hord's article was developmental trajectory. In this strategy students were given progressively more complex problems and they were taught to think aloud and discuss their strategies with the teacher. If the student's approach was appropriate, they were encouraged to continue with the problem. If the student's approach was not productive, the teacher modeled how to solve the problem with an explicit demonstration of solving the problem along with a verbal description of the thought process used in solving it. The results of this method were positive as the students' success in problem-solving increased. This study was limited by its small size of three students and lack of a comparison group.

In a 2018 study, Duchaine, Jolivette, Fredrick, and Alberto looked at the practice of having high school students use response cards to check for understanding during lessons instead of hand raising. They described response cards as cards that are pre-printed or that students can write on and display to the teacher during a lesson. Teachers ask specific probing questions during the lesson to see how well students are understanding the content and if the teacher needs to reteach anything before proceeding. This study showed an increase in both engagement and academic performance among the three math students included (Duchaine, Jolivette, Fredrick, & Alberto, 2018).

Assistive Technology

Enhanced anchored instruction (EAI) is a strategy using problem-based learning (PBL) and discussed by Marita and Hord (2016). “EAI embeds basic skills instruction in authentic-like problems to strengthen students’ skills in both computation and problem solving” (Bottge, Grant, Stephens, & Rueda, 2010 p. 83). Two studies used a video scenario as an anchor to introduce a problem (Bottge, Grant, Stephens, & Rueda, 2010; Bottge, et al, 2015). Students searched the video for information important to solving the problem, then implemented multiple representations of the problem using media-based interactive tools and hands-on activities. This study resulted in middle school students completing a complex series of steps to solve problems including fractions, cost calculations, budgeting, making scale drawings, and geometric constructions. “One of the main advantages of EAI is its ability to directly immerse students in active problem contexts versus requiring students to decode text-based (word) problems. This is important because many students who have difficulty in math also difficulty in reading” (Bottge, Grant, Stephens, & Rueda, 2010 p. 84). The results showed gains in the skills taught, however the implementation of the teaching strategies in this study were complex and required significant planning and preparation on the part of the teachers and researchers.

In their summary, Strickland and Maccini (2011) included EAI under the category of technology. They defined technology as "…calculators, computer systems, and video that can help students learn and do mathematics" (p. 40). They include virtual manipulatives in this category and explain that technology can enable students to examine multiple representations of math concepts. It also allows students to perform computations or calculations that may be difficult and time-consuming more accurately and efficiently.

Manipulatives have been used for decades, particularly with students in primary grades. With the availability of technology, virtual manipulatives are becoming more widely available. Bouck, Satsangi, Doughty and Courtney conducted a study with three elementary students with Autism Spectrum Disorder (ASD) in which they compared the effectiveness of physical manipulatives to virtual manipulatives (2014). The results suggested that both types of manipulatives have significant potential as tools for teaching math to students with ASD. The students in this study expressed a preference for the virtual manipulatives, perhaps because they were easy to use, required less fine motor skills, included on-screen animations, and were visually engaging. The researchers also stated "…the virtual manipulatives allowed less room for error when completing intervention and the opportunity for self-directed correction of errors when solving problems" (p. 191).

A later study compared the effectiveness of concrete manipulatives versus virtual manipulatives with three high school students with LD (Satsangi, Bouck, Taber-Doughty, Bofferding, & Roberts, 2016). Both types of manipulatives improved the students' performance on algebra tasks, but one possible advantage of virtual manipulatives are their time efficiency because they are faster to set up and reset for the next task. Another possible advantage is the greater independence of students using virtual manipulatives because there are self-correcting constraints built into them. Each student preferred one type over the other and performed better with the one they preferred.

In separate research, Satsangi, Hammer, and Bouck (2019) investigated the use of video modeling to teach geometry word problems. Difficulty with word problems is one of students' most common frustrations in math classes. This makes sense when you consider what Satsangi, Hammer, & Bouck (2019) explain:

> Solving mathematical word problems is a complex procedure entailing multiple cognitive processes. To effectively solve word problems, students must first grasp the information presented within the problem, create a mental model of the problem with the information provided, and then determine a path toward solving for a solution based on the model selected. In addition, the role of working memory in the cognitive process for students when solving word problems is important to note, as each of these steps requires students to access pre-stored information including prior knowledge of content, select appropriate algorithms, and apply problem-solving processes in a variety of real world situations (p. 309).

In this study, three students with SLD were each given five word problems. They read the first problem out loud, then independently watched a video of lesson of a teacher modeling how to solve this type of problem. They were able to replay all or part of the video as many times as they wanted as they worked on the problems. The scores of all three students improved on an assessment after the video modeling compared to before (Satsangi, Hammer, & Bouck, 2019). This seems promising, however it needs more research due to its limited scope and the lack of a generalization phase.

Calculators are a common accommodation given in students' Individualized Education Programs (IEPs). However, not much empirical research has been conducted to provide concrete evidence of its efficacy (Bone & Bouck, 2016). Calculators come in many types with varying capabilities and higher-level math courses require the use of scientific or graphing calculators. Bone and Bouck did a study of eighth-grade students using a scientific calculator just for computation purposes. They found a decrease in calculation errors, however they noted that students must first understand how to use a calculator's functions and that the mere presence of a calculator does not replace the need for other interventions to help students master the conceptual math principals of secondary mathematics. They point out that in primary grades, the focus of math curriculum is developing fundamental skills such as math facts and basic operations, but at the secondary level the emphasis shifts to higher level mathematical understanding.

Furthermore, Steele proposes in her 2006 article that "…although graphing calculators are clearly useful resources for both teachers and students, the calculators frequently present challenges for students with learning problems" (p. 32). She proposed several methods for teaching students with mild disabilities to effectively use these powerful tools to improve their understanding and performance in secondary math classes. Her recommendations include Mnemonics, multisensory instruction, modeling, chunking, sample problems, student questions, realistic examples, and practice as means to improve students' calculator skills which would in turn result in better problem-solving skills in math classes.

Graphic Organizers and Diagrams

One visual representation intervention found in Marita and Hord's literature research involved teaching students how to draw effective diagrams of the information presented in math problems. The students in this study improved their problem-solving skills and their ability to apply the skills to real-world problems. This result reinforces previous evidence that visual strategies that help students organize their thoughts and reduce demands on their working memory.

Strickland and Maccini (2011) summarized existing research on teaching strategies for students with learning disabilities (LD). As evidence of the value of explicit instruction for these students, they cited earlier research showing the effectiveness of five intervention phases of cumulative practice, tiered feedback, feedback plus solution sequence instruction, review practice, and transfer training (p. 39). The most effective of these was transfer training, which is breaking a problem down into a series of steps, similar to performing a task analysis (p. 39). They presented this as one benefit of direct instruction, referencing the difficulty students with LD experience generalizing learned skills to new problems. The teacher presents the problem in smaller target skills first, and only presents the whole problem once the student is able to perform the target skills.

The use of diagrams and gestures was the subject of a study by Walsh and Hord (2019). Gestures were considered the use of the teacher's hands or objects to represent mathematical concepts or to draw attention to mathematical notation. Diagrams were any drawing or graphical representation on paper or on a graphing calculator used to organize information to support the student's thinking or problem-solving. This research found that students benefitted from the use of gestures and diagrams, especially on tasks where students had to rely heavily on working memory, such as a task with multiple steps that require information to be held in memory during the process. Some of the specific examples of gestures and diagrams were relatively simple and could be incorporated into a variety of lessons.

In a separate study, Van Garderen (2016) performed research that provided explicit instruction about creating diagrams to three students with LD. The author explains that there are two types of visual representations that students use when solving word problems: pictorial and schema. Pictorial images mainly show the visual appearance of objects described in the problem, while schema show the relationships among the objects. Van Garderen cites evidence that schema diagrams are more effective in problem-solving, and states that “Generally, students with LD use representation processes infrequently, if at all. Furthermore, the students showed considerable difficulty in transforming the linguistic and numerical information in a word problem into a representation” (p. 540). In the study, the students were taught two types of schema, a Line Diagram and a Part/Whole Diagram. After the intervention, the students went from almost never drawing a diagram to drawing one every time. Their ability to solve one-step and two-step problems significantly improved. An interesting finding in the study was that prior to the intervention, the students did not know what a diagram was or how one could be used to solve a problem (van Garderen, 2016).

Graphic organizers were discussed by Strickland and Maccini (2011). These are structured visual systems for students to work through problems and help students organize information in a logical order, reduce the load on working memory, and may help compensate for deficits in mathematical language. Using graphic organizers supports students in managing the steps required to complete multi-step problems. In a different study, Ives (2007)’s research demonstrated no advantage in solving systems of two equations, but showed a significant difference for the more complex task of solving systems of three equations. Strickland and Maccini (2011) proposed that graphic organizers can be developed and used for a variety of tasks, including solving quadratic equations which is a fundamental skill for Algebra.

A series of studies by Zollman (2009, 2012) examined the use of a graphic organizer known as four-corners-and-a-diamond to help students solve a variety of math problems. Although Zollman’s studies did not include students identified as having mild disabilities, they did demonstrate effectiveness for low-achieving students, which presents the possibility that his graphic organizer would help students with disabilities. Zollman states that "graphic organizers help students organize and then clarify their thoughts, infer solutions to problems, and communicate their thinking strategies" (Zollman, 2009, p. 4). In his 2012 research he describes one benefit of his graphic organizer explaining:

> The pictorial orientation allows students to record their ideas in *whatever* order they occur. If students first think of the unit for their final answer, then this is recorded in the fifth, bottom-right area. This idea (the unit), then, is not needed in the short-term memory because a reminder is recorded. If students first think of a possible procedure for their answer, this is recorded in the third, upper-right area. The *four-corners-and-a-diamond* graphic organizer allows, and even encouraged, students to use their problem-solving strategies in a no-hierarchical order. A student can work in one area of the organizer and later work a different area. (p. 52).

Since working memory is one of the known challenges of students with mild disabilities, it stands to reason that this would be useful for them. In one study of nine middle school teachers' classes, scores increased from a 27% average on the pre-test to a 70 % average on the post-test (Zollman, 2009, p. 8). In these studies, not only did students score higher on a post-test, but even if they didn't score higher they demonstrated more organized work and a better understanding of the mathematical concepts. Students' planning and use of appropriate models and diagrams improved and their explanations were better. In addition, the graphic organizer enabled the teachers to better identify the areas where students had difficulty. Zollman's explanations for this include that the graphic organizer allows students to organize their information and thoughts, while at the same time being able to work in a variety of different orders. It also allows them to pursue different ideas for solving the problem and make notes about things they will need to remember in a later step without having to hold it in their memory. His research shows that even the typically lowest performers who often don't even attempt problems did at least a portion of the work.

Additionally, Sian et al (2016) conducted their own study with the four-corners-and-a-diamond graphic organizer and found that their students improved in their organization, planning, use of diagrams, and understanding the logic behind the problems. These are all skills that students with disabilities tend to do poorly with, however, this study did not include any students with mild disabilities either, so research including such students is greatly needed.

Current Educational Practices for Students with Mild Disabilities

One practice used successfully at the elementary level is response to intervention (RtI), however, the structure of education at the secondary level makes it harder to study and implement due to changing class periods and limited time (Bouck & Cosby, 2019). Bouck and Cosby propose three possible ways to implement RtI in secondary schools: small group pull-out instruction, an alternative math class, or an additional math class such as a math lab (Bouck & Cosby, 2019). Each of these delivery systems has significant drawbacks, such as tracking students by ability or interfering with their ability to earn the credits needed for graduation. Another issue is the lack of research on effective interventions that could be provided by any of these delivery systems. The results of the limited research that has been done on RtI for secondary math has not provided compelling evidence of the effectiveness. In one study, the results were not statistically significant, leading to the possible conclusion that "the Tier 2 math lab did not achieve the goal of RtI – to reduce the achievement gap between students" (Bouck, Park, Bouck, Alspaugh, & Spitzley, 2019).

Another practice that has become popular in recent years is co-teaching. Co-teaching describes teaching students in a general education classroom with two teachers, a general education teacher and a special education teacher. At the secondary level, the general education teacher is typically a specialist in the class content while the special education teacher is an expert on instructional practices adapted for students with learning disabilities. Research suggests students with disabilities benefit from specially designed instruction (SDI), which is instruction designed for the specific needs of an individual student. One supposed benefit of co-teaching is the delivery of SDI within the general education classroom, however that might not actually be taking place (Rodgers & Weiss, 2019). They contend "One reason SDI may not occur in secondary co-taught settings is likely because of concerns with instructional time. In co-taught classes, teachers are expected to teach not only the general curriculum informed by national and state standards, but also an 'IEP curriculum' (Kurz, 2011, p. 105) comprising students' IEP goals and instruction on needed prerequisite skills or knowledge" (Rodgers & Weiss, 2019, p. 278).

In the case of mathematics, there is generally a highly-qualified math teacher paired with a special education teacher. The special education teacher typically has received no prior training about the math content being taught, while the math teacher typically has had no prior training about teaching students with disabilities (Grskovic & Trzcinka, 2011). This can limit the depth of collaboration between the teachers. Also, high school math teachers are accustomed to teaching their classes alone, so it may be challenging to adjust to sharing teaching responsibilities. Sometimes co-teachers don't have their planning period at the same time, which creates a significant barrier to collaboration. Furthermore, in their pre-service preparation, math and special education teachers are exposed to different pedagogy. According to Boyd and Bargerhuff (2009), "mathematics education typically focuses on a student-centered learning which includes 'constructing' knowledge and understanding through exploration and tapping into students' background knowledge, special education methodology is more likely to emphasize task analysis and specific, measurable objectives, often appearing to target procedural rather than conceptual skills” (p. 58). In addition, co-teaching is not implemented consistently among various schools and classes, so conclusive evidence of its effectiveness is still lacking, but one potential benefit remains that it can be used in conjunction with any of the other teaching methods discussed in this literature review.

Challenges in Implementation of Strategies to Support Students with Mild Disabilities

Many general education teachers may not be aware of the specific ways in which students with disabilities’ learning is impacted. They also may be unaware of specific strategies that could alleviate these students’ problems. One challenge in the implementation of new teaching strategies is the complexity, planning and preparation required on the part of the teachers (Marita & Hord, 2016). One obstacle can occur when the co-teachers have different planning periods during the day. This makes communication and collaboration difficult and can prevent the relationship-building and in-depth conversations that are necessary for effective co-teaching. The lack of cross-training can also present a challenge, including the different terminology the two teachers are accustomed to, and discomfort with unfamiliar practices. In addition, teachers have many demands on them and are already pressed for time, especially during the COVID-19 pandemic.

Conclusion

There were similarities across the different research studies, including teaching students with learning disabilities how to organize information needed to solve mathematical problems and to reduce the load on the student’s working memory (Ives, 2007; Marita & Hord, 2016; Sian, 2016; Strickland & Maccini, 2011; Van Garderen, 2016; Walsh & Hord, 2019; Zollman, 2009, 2012). This was seen in the recommendations of graphic organizers and other diagrams (Ives, 2007; Marita & Hord, 2016; Sian, 2016; Strickland & Maccini, 2011; Van Garderen, 2016; Walsh & Hord, 2019; Zollman, 2009, 2012). Even in the CRA strategy, the written representation of the manipulatives was key in helping students make the transition from concrete manipulatives to symbolic abstract representations of the problems (Marita & Hord, 2016; Strickland, 2016; Strickland & Maccini, 2011). An emphasis on teaching students how to think problems through using cognitive and metacognitive strategies was also a common thread (Karabulut & Ozmen, 2019; Marita & Hord, 2016; Montague, Enders, & Dietz, 2011). The focus of these strategies was less on teaching the specific content skills, and more on the skills of problem-solving that could be generalized and applied to various types of problems. Taken together, there is promise that specific strategies can be implemented to help students with mild disabilities succeed in high school math courses.

Across the body of research, a common attribute was small sample sizes in the studies, as few as three students (Duchaine, Jolivette, Fredrick, & Alberto, 2018; Karabulut & Ozmen, 2019; Bouck, Satsangi, Doughty & Courtney, 2014; Karabulut & Ozmen, 2019; Satsangi, Bouck, Taber-Doughty, Bofferding, & Roberts, 2016; Satsangi, Hammer, & Bouck, 2019; van Garderen, 2016). The most common disability represented in the research was SLD, however students with ASD, ADHD, ED, and OHI (Bottge, Grant, Stephens, & Rueda, 2010; Bottge, Toland, Gassaway, Butler, Choo, Griffen, & Ma, 2015; Bouck, Satsangi, Doughty & Courtney, 2014; Duchaine, Jolivette, Fredrick, & Alberto, 2018; Ives, 2007; Satsangi, Hammer, & Bouck, 2019) were also included in some studies. Due to various participant selection processes along with the occurrence of comorbidities, a single study often included students with varying disabilities (Bottge, Grant, Stephens, & Rueda, 2010; Bottge, Toland, Gassaway, Butler, Choo, Griffen, & Ma, 2015; Ives, 2007; Satsangi, Hammer, & Bouck, 2019). There have not been many repeated studies of the same strategies. As in all research, repeated studies showing the same outcomes are necessary to validate the findings. Much of the research has been conducted by a small group of researchers in this area, including Bottge, Bouck, Satsangi, Strickland, and Zollman. Bouck is a prolific researcher who performs her research in local middle schools in her area. A greater number and diversity of researchers would add to the depth and breadth of the research. For example, Zollman has researched a single type of graphic organizer. While that has added validity to the effectiveness of that specific tool, there are many graphic organizers which could be investigated by additional researchers. Also, there have been few studies including students in high school grades (Bottge, Toland, Gassaway, Butler, Choo, Griffen, & Ma, 2015). There is a need for more research with high school students, using larger sample sizes, addressing a wider variety of disabilities, and with adequate control groups. In addition, there is little or no discussion of the practicality of implementing some of these strategies within the constraints of high school schedules and curriculum.

This research aimed to fill some of this gap and provide resources teachers can use to effectively support students with mild disabilities master high school mathematics. In an effort to fill this gap, the research addressed three questions.

Research Questions

- What knowledge do general education teachers have about the impacts of mild disabilities on student learning?
- What strategies are teachers aware of, have used in the past, or are currently using?
- What do teachers think are some of the most effective strategies for teaching math skills to students with mild disabilities?

CHAPTER 3. METHODOLOGY

Introduction

This research was conducted to meet some of the needs resulting from a gap in research on mathematics interventions for high school students with mild disabilities. Among the research on students with disabilities, there is very little that focuses on this area. High school math teachers and their students could benefit from more information on teaching strategies and interventions to help these students master the math standards that are required of them in Algebra 1, Algebra 2, and Geometry. In addition, with effective supports, more of these students may be able to advance to even higher-level math courses, such as Pre-calculus and Trigonometry. To compile a comprehensive list of evidence-based resources that math teachers can and will use, it is important to get their input. An anonymous survey is an effective way to gather input in a non-intrusive manner.

This research was conducted as part of the author's Masters of Science in Education with a Major in Special Education. In preparation for the research, permission to conduct the study was obtained from the university's IRB on November 11, 2020 (Appendix D). The researcher completed two online courses in the ethics of human research offered by Collaborative Institutional Training Initiative (CITI). The researcher took and passed the certification exams on January 1, 2020 and February 6, 2021, respectively (Appendix E). Initially, the researcher intended to discuss the research face-to-face with math and special education teachers to invite them to participate, however, due to safety concerns related to COVID-19, the recruitment process was modified to occur solely through email. Using a convenient sample method, the researcher sent the recruitment email to the school principal and requested to forward it with the study information to the teachers. To protect privacy and confidentiality of participants, the survey was administered through the Purdue University's Qualtrics platform.

Participants

The participants in the survey were nine general education and six special education teachers involved in teaching math to students at a Midwestern high school. According to the state's Department of Education website, the school has 102 full-time educators. The race/ethnicity data for educators at this school is White (86.3%), Black/African-American (7.8%), Hispanic (2.9%), and Multiracial (2.9%). The experience level categories are 0-2 years (9.8%), 3-5 years (14.7%), 6-10 years (17.6%), 11-15 years (17.6%), 16-20 years (15.7%), and 20 or more years (24.5%). Both general education and special education teachers who teach math were invited by email to answer a survey. The total number of possible respondents was eighteen. Demographic information about the respondents was not collected.

Setting

The research was conducted at a Midwestern high school serving students in grades 9-12. This school is one of five traditional high schools in an urban district and has a student population of 2087 according to the state's department of education data. The student body is 52.6% White, 17.5% Black/African American, 16.0% Hispanic, 8.3% Multiracial, 5.0 % Asian, and 0.5% Native American. Fifty percent of the students are economically disadvantaged, 4.2% are English Language Learners, and 15.9% are students with disabilities. The school currently has more than 300 special education students receiving mild interventions services.

Research Design

The project used a cross-sectional survey with both quantitative and qualitative questions. Both types of questions were included to keep the survey quick for respondents with the quantitative questions while providing opportunities for more thorough and flexible answers on a couple of key questions. Thirteen of the fifteen questions were quantitative. Six of those questions included an “other” option where teachers could include unique information that was not given in the checkbox options. The survey was delivered in a cross-sectional design in which a sample within a specific population of high school math and special education teachers were given the survey at a particular point in time (Creswell, 2015). This resulted in the collection of both quantitative and qualitative data which reflects the respondents’ familiarity, use, and perceptions of certain evidence-based practices. The purpose of the study was to identify needs of this population of teachers in order to produce a resource to help meet those needs.

Recruitment and Data Collection Procedures

Permission was obtained from the Purdue Institutional Review Board (Appendix D). The school’s principal also approved the study (Appendix C). An email was sent from the principal to general education and special education teachers who teach math (Appendix B). This email invited them to participate explain that it is completely voluntary. The recruitment email included a link to a Qualtrics survey (Appendix A). The survey included a series of questions presented as multiple choice, checkbox, and short answer questions. The questions collected information about the teachers’ experience with students with IEPs, their knowledge of the challenges of these students, their awareness of interventions, and their experience implementing interventions or specific strategies with these students. No identifying information was collected and the data was stored in a password-protected file only accessible by the investigator and the study supervisor. This data was compiled in a spreadsheet, analyzed, and used to prepare a handbook that can be distributed to teachers.

Data Analysis and Use

The Qualtrics survey consisted of fifteen questions, thirteen of which had predetermined options presented in multiple choice or checkbox formats. On the checkbox questions, respondents had the option of “other” where they could type in their own response. As a result, the data was primarily objective. The two remaining questions were a short answer format.

The first two questions asked respondents what type of teaching license they have and how many years they have been teaching math. The next two were scale questions and asked how much training teachers have had to work with students with disabilities and how prepared they felt about doing so. Questions 5 and 6 asked about how frequently they have had and whether they currently have students with IEPs in their classes. Questions 7 and 8 asked whether teachers had adapted strategies specifically for student with disabilities and what challenges they were aware of for these students. The following two questions provided a list of evidence-based practices and asked which ones teachers were aware of and have used in the past. Question 11 was a short answer question inquiring which past strategies teachers had found effective. The remaining questions were aimed at assessing teachers’ expectations and willingness to use any of the specific strategies listed. These were all checkbox questions except number 14, which was a short answer about teachers’ expectation of the success of these strategies.

Once the data was collected, it was exported from Qualtrics into an Excel workbook and the researcher analyzed it to look for patterns and trends. Most of the questions are objective “check all that apply” type of questions. The responses were summarized in graphs. This data was used to create a handbook that can be distributed to teachers.

Timeline

Survey respondents received the survey on Thursday, December 3 and had until the following Friday, December 11 to complete the survey. The results were compiled and summarized over the course of the next six weeks. Two weeks following that, Chapter 4 summarizing the results was completed. The timeline is included in Appendix F.

Special Project

There is evidence that the math performance of students with learning disabilities correlates to the effectiveness of their teachers. Effectiveness depends on teachers' understanding and implementation of research-based instructional techniques, and a focus on basic skills, conceptual understanding, and problem-solving (Myers, Wang, Brownell, & Gagnon, 2015). The special project is a handbook of reference materials for implementing evidence-based strategies for students with mild disabilities to master high school mathematics. For example, it contains graphic organizers and instructions and tips for implementing the strategies featured. The project was produced for the use of high school teachers who teach math. It is intended for both general education and special education teachers. More detail about what is be included can be found in Appendix H.

CHAPTER 4. RESULTS

Introduction

In recent years, students with mild disabilities have been included in general education settings more than ever before. These students are now required to take higher level math classes in high school, including Algebra 2 and Geometry (Marita & Hord, 2016). The purpose of this research was to identify research-based strategies to help these students master math. A literature review revealed a gap in the research with respect to measuring the effectiveness of strategies at the high school level specifically with students with mild disabilities. The study was designed to answer these research questions.

1. What knowledge do general education teachers have about the impacts of mild disabilities on student learning?
2. What strategies are teachers aware of, have used in the past, or are currently using to teach math skills for students with mild disabilities?
3. What do teachers think are some of the most effective strategies for teaching math skills to students with mild disabilities?

Based on the literature review and the research questions, a survey was developed and distributed to 18 general education and special education teachers who teach high school math at a Midwestern high school.

Teacher Backgrounds

Of the eighteen general education and special education teachers who received the survey, fifteen responded, a response rate of 83%. One question asked teachers which type of teaching license they had, a math license, a special education license, or both. Two teachers reported having both licenses. For the purposes of data analysis from this point on the teachers with both licenses were grouped in the Special Education category because they have received specialized training as part of that degree program. That resulted in nine teachers with only a math license and six teachers total holding a special education license. The results are shown in Chart 1.

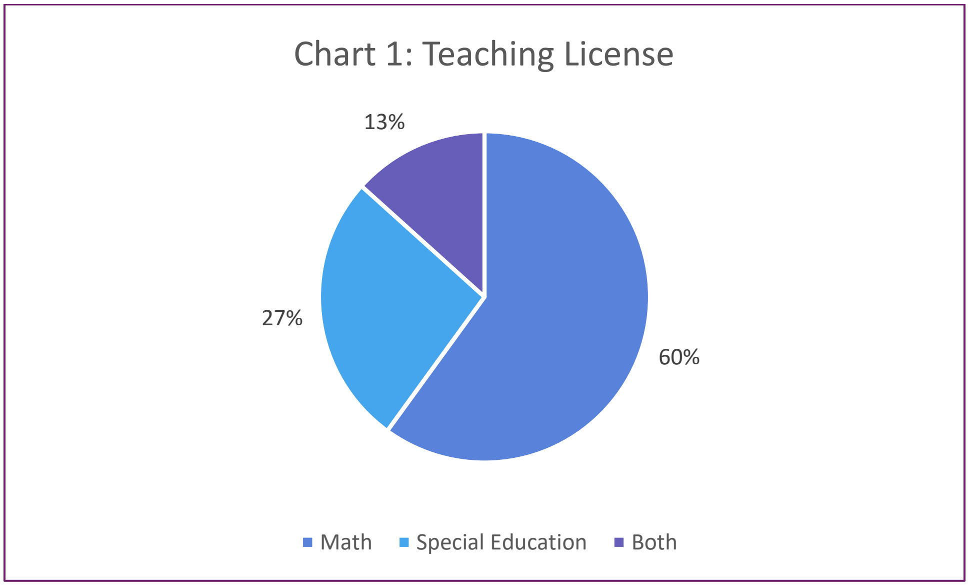


Chart 1: Teaching License Category

Teachers were then asked how many years they had been teaching high school math. There was an error in the survey question causing the overlap of two answer choices. Teachers were given the option of 3-5 and the option 5-10 years. Therefore, there is some uncertainty as to whether a teacher with five years of experience will be reflected in the 3-5 year category or the 5-10 year category of the data. One might presume that any teacher with five years would choose the category with the higher range to reflect their relatively higher level of experience. Two special education teachers reported having 1-2 years of experience and one math teacher reported 3-5 years. Six teachers have 5-10 years and five teachers have over 10 years. One teacher did not answer this question. After review of the data, there is no clear correlation between the years of experience with other responses like having more training or feeling more prepared. The responses are shown in Chart 2

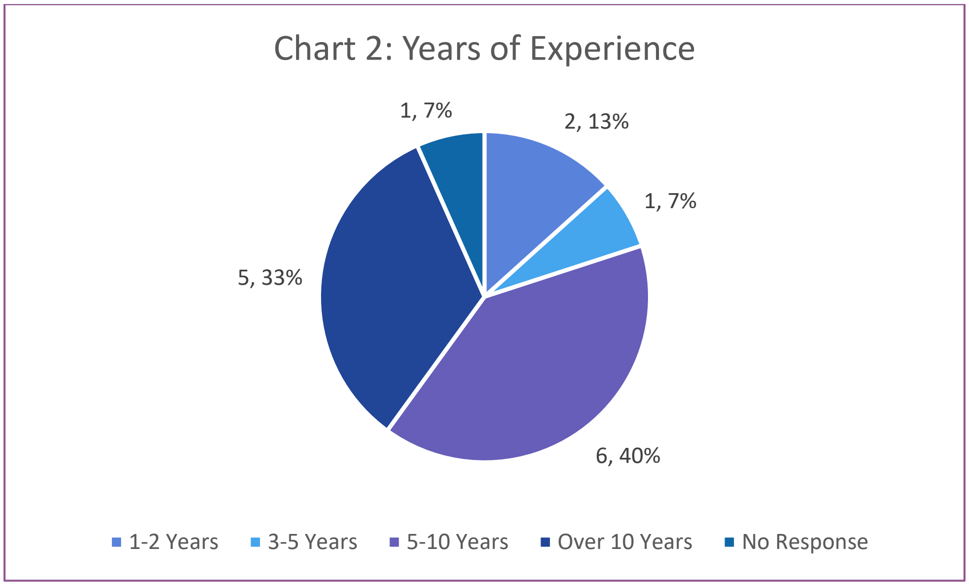


Chart 2: Years of Teaching Experience

Next teachers were asked how much specialized training they had received about teaching students with mild disabilities. The question was presented as a scale with choices of none, a little, a moderate amount, a lot, and extensive. Five teachers reported having extensive specialized training, all of whom hold special education licenses. The sixth special education teacher has only 1-2 years of experience and reported receiving a moderate amount of training. Four math teachers reported receiving a little training and the remaining 5 reported a moderate amount. All teachers reported having received at least some specialized training. The results are shown in Chart 3.

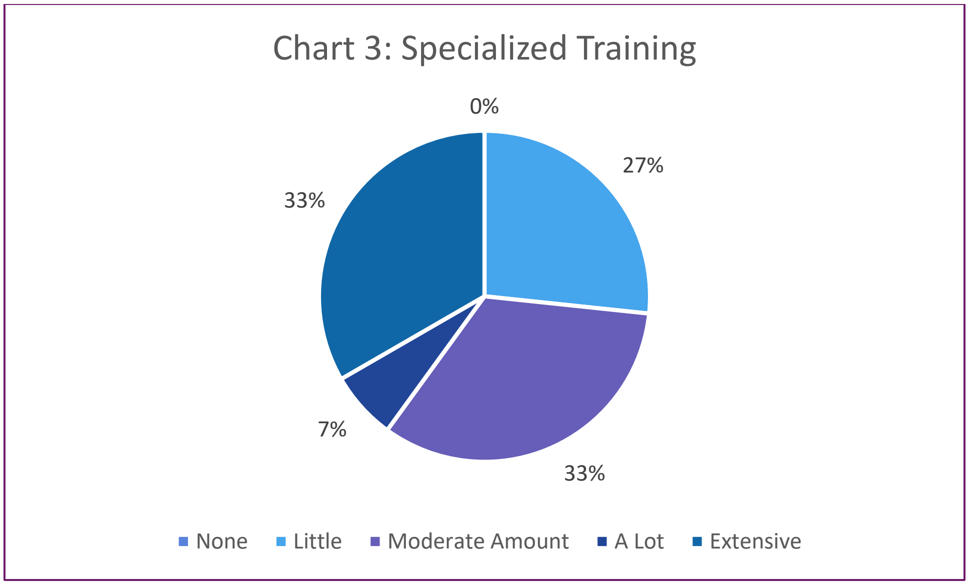


Chart 3: Specialized Training

The fourth question asked teachers how prepared they felt to teach students with IEPs. The question was given with a scale with the options of not at all, somewhat, neutral, very, and completely. None of the teachers reported feeling not at all prepared, nor completely prepared. Five said they feel somewhat prepared, four feel very prepared, and six feel neutral. The teachers who reported they felt very prepared all had special education licenses. The results are shown in Chart 4.

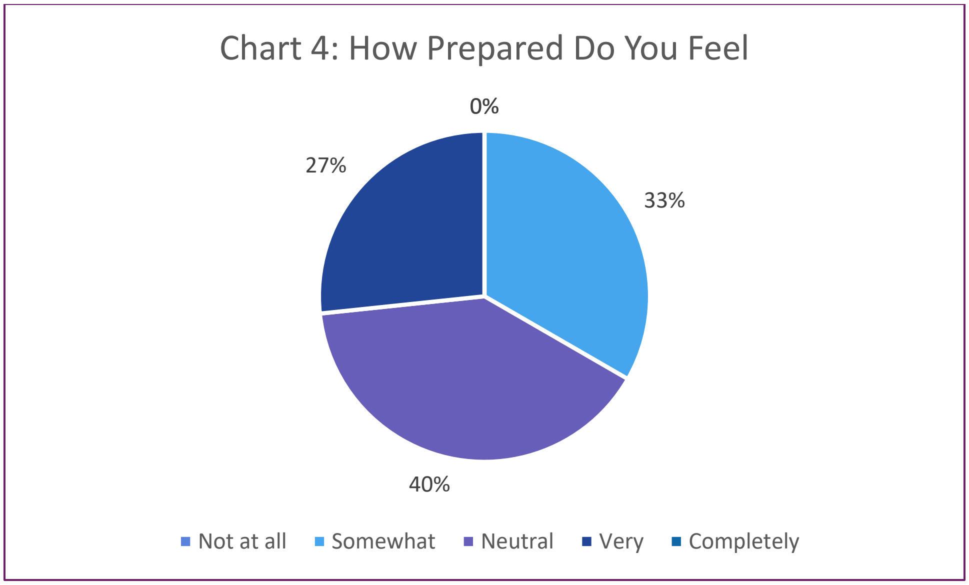


Chart 4: How Prepared Do You Feel

Question five focused on how often these teachers have students with IEPs in their classes. The options were never, rarely, occasionally, frequently, and always. One teacher did not answer this question. Thirteen teachers reported they always have students with IEPs and one teacher answered frequently. The results are in Chart 5.

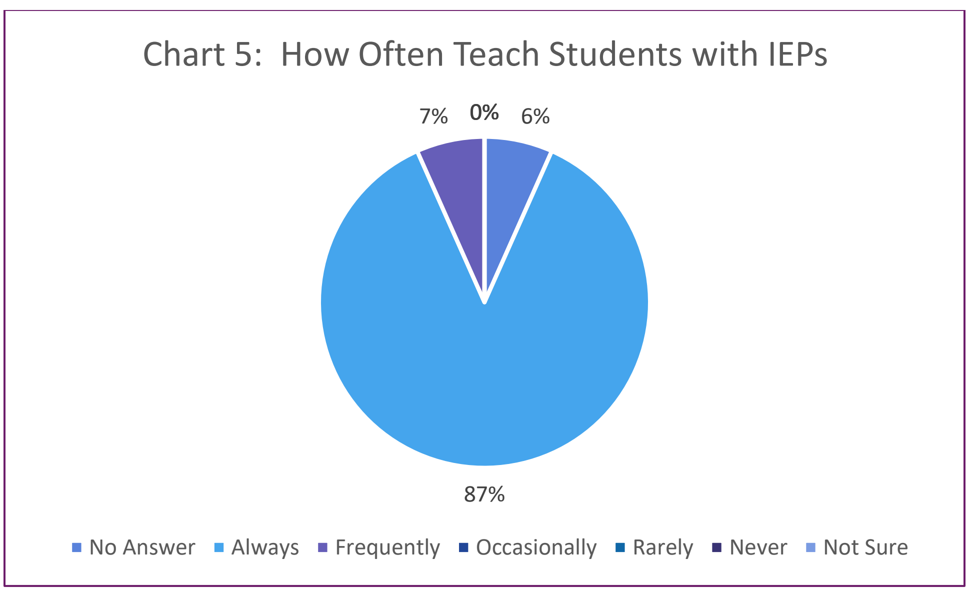


Chart 5: How Often Teach Students with IEPs

Teachers were then asked if they are currently teaching students with IEPs. All fifteen respondents responded yes. In other words, 100% of the teachers are currently teaching students with IEPs.

Question seven asked teachers if they have ever used specially designed instructional strategies to support students with mild disabilities. Thirteen teachers answered yes and two math teachers chose the option “Not sure what this means.” The results are shown in Chart 6.

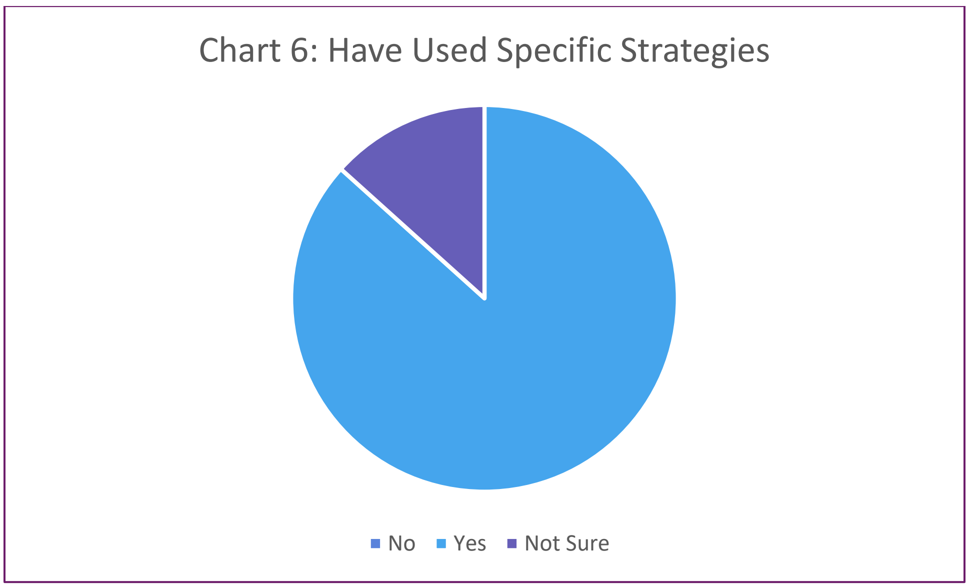
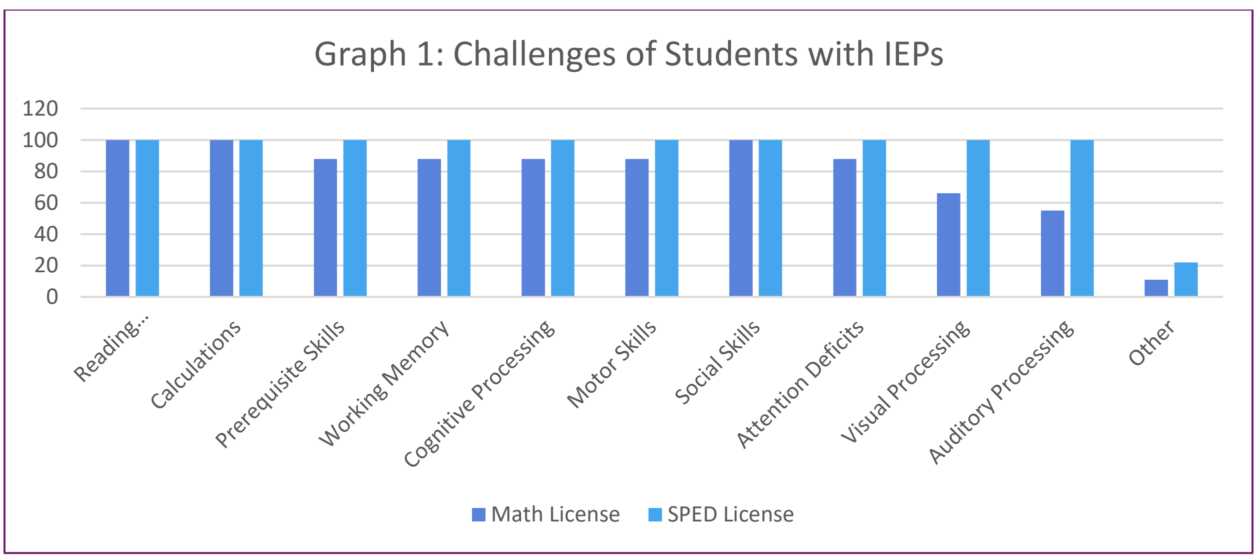


Chart 6: Have Used Specific Strategies

The type of license each teacher holds has a strong correlation to their responses. The teachers with special education licenses reported feeling better trained and more prepared. They also reported implementing specific strategies designed for students with mild disabilities. Surprisingly, years of experience did not correlate with training, feeling prepared, or using specific strategies.

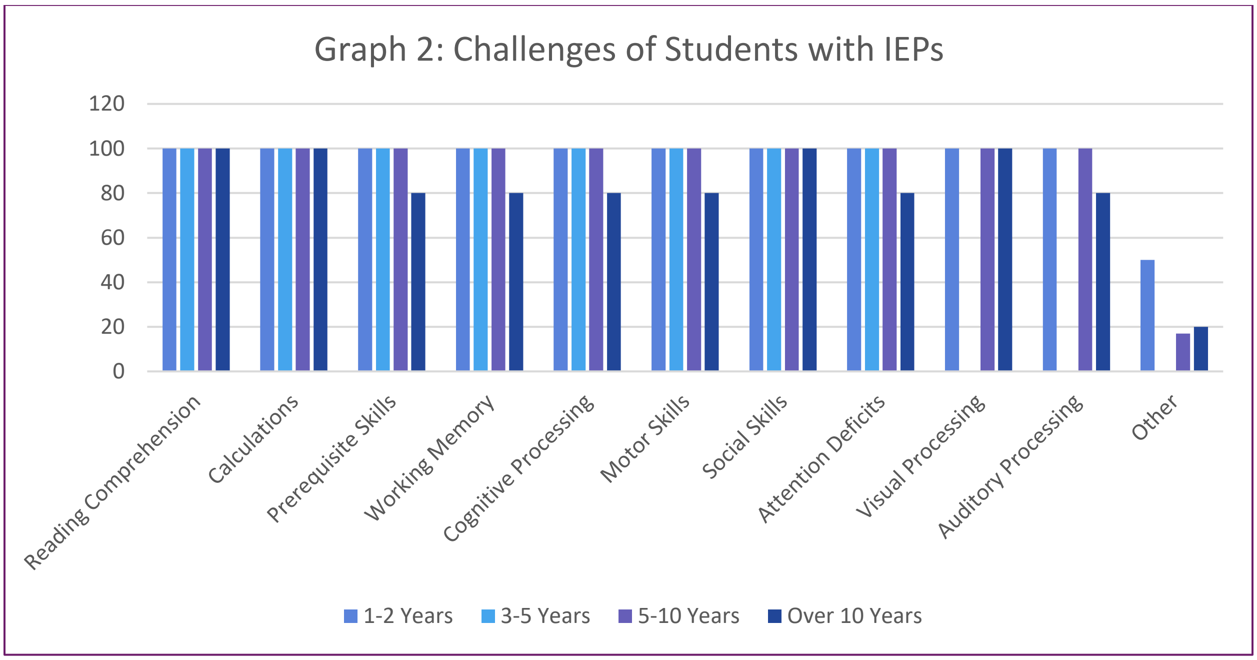
Awareness of Challenges of Students with Mild Disabilities

Next the survey proceeded to ask about the teachers' awareness of the unique challenges faced by students with mild disabilities. All teachers were aware of challenges with reading comprehension, calculations, lack of prerequisite skills, and social skills. Eleven of the fifteen teachers were aware of every challenge listed. The least known challenge was auditory processing, with four teachers reporting they were not aware of this issue. Three teachers were not aware of visual processing issues. One teacher was not familiar with motor skill issues in addition to auditory processing. One teacher was not aware of challenges related to prerequisite skills, working memory, cognitive processing, or attention deficits. This teacher also reported only receiving a little special education training. All of the teachers who reported not being aware of all of the challenges listed were math teachers who had been teaching at least five years. Two special education teachers and one math teacher listed additional challenges, including seizures, emotional issues, lying, stealing, non-compliance, avoidance, and attention. Graph 1 shows the percentage of teachers with each type of license who were familiar with the special challenges of students with mild disabilities.



Graph 1: Challenges of Students with IEPs by teaching licenses

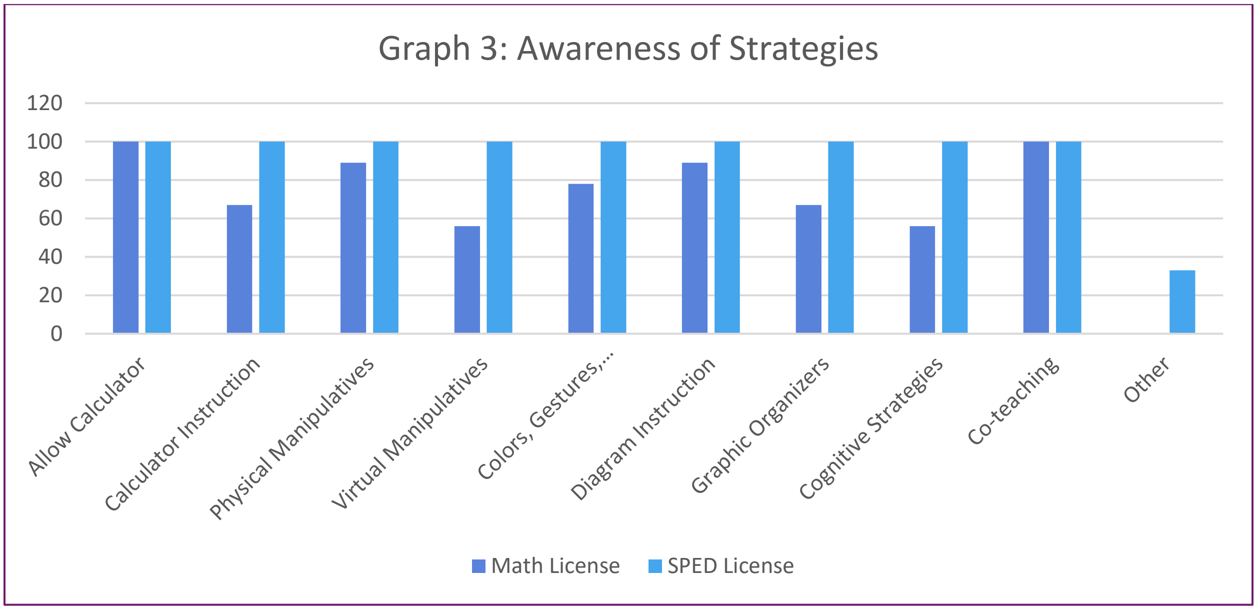
Graph 2 shows the percentage of teachers broken down by years of experience who were familiar with the special challenges of students with mild disabilities. Of the five teachers who have more than 10 years of experience, two were unaware of some of the challenges. Each was unaware of different challenges so it is unclear if there was an underlying cause of this, such as different training provided to teachers 10 or more years ago compared to more recently. Among teachers with 3-5 years of experience, two teachers were not aware of all challenges, but they were both lacking knowledge of the same two challenges, visual and auditory processing.



Graph 2: Challenges of Students with IEPs by years of experience

Awareness of Strategies

All the teachers who have special education licenses, including the two teachers who have both licenses, were aware of every strategy. Two of the special education teachers cited additional strategies including direct teaching of just IEP students separately and teaching reasoning skills. All teachers were familiar with the strategies of providing calculators and co-teaching. All six teachers with special education licenses and two math only teachers knew about all nine strategies. That represents 100% of special education teachers compared to 22% of math teachers. Both of the math teachers who knew all strategies had been teaching for 5-10 years. Every other strategy was already known by at least eleven of the fifteen teachers, or 73%. The least known strategies, both at 73%, were virtual manipulatives and teaching cognitive or metacognitive strategies to students.

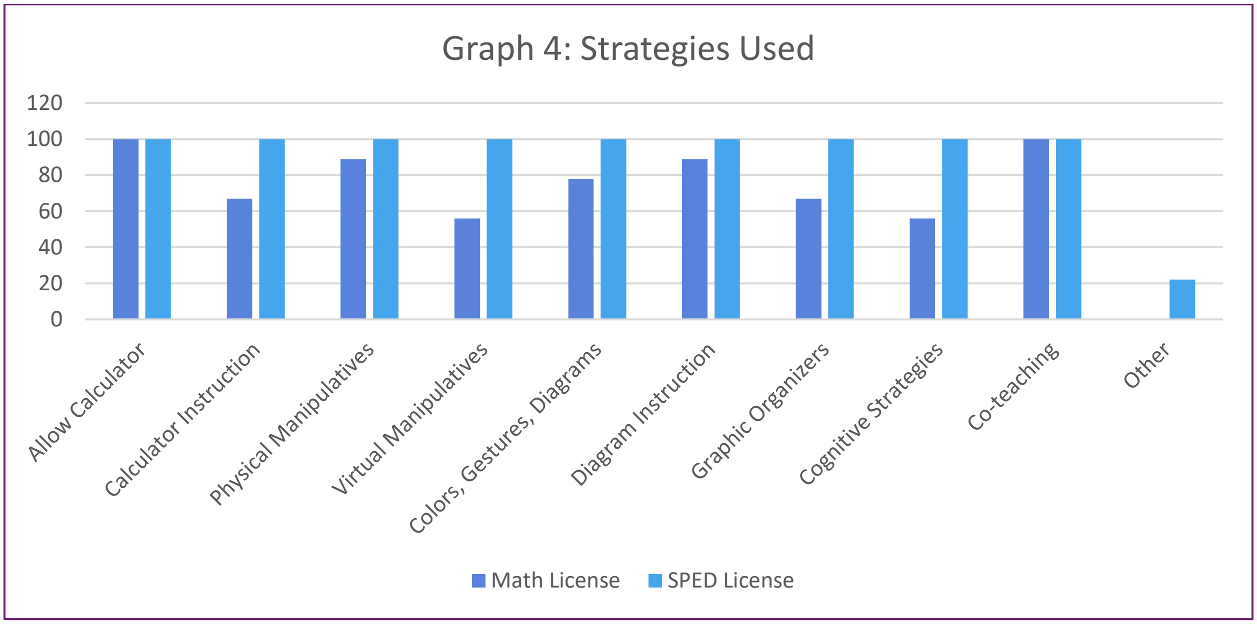


Graph 3: Awareness of Strategies

Overall, teachers were aware of most of the challenges faced by students with disabilities, especially reading comprehension, calculations, lack of prerequisite skills, and social skills. Most were aware of every challenge listed. The least known challenges were auditory processing and visual processing issues. All special education teachers were familiar with every strategy given, and math teachers were all familiar with calculator and co-teaching.

Strategies Used in the Past

Next, the teachers were asked which of the strategies they had used in the past to support students with mild disabilities. All teachers report that they have used allowing calculators and co-teaching. Fourteen teachers have used physical manipulatives and direct instruction on drawing effective diagrams. Thirteen teachers have used colors, gestures, or diagrams. Twelve teachers have provided direct instruction on how to use a calculator and have used graphic organizers. Eleven teachers report teaching cognitive or metacognitive strategies and using virtual manipulatives. All special education teachers reported that they have used all of these strategies. Two special education teachers listed other strategies they have used including direct teaching of students with IEPs in the special education setting and teaching reasoning skills. These results are shown in Graph 4.



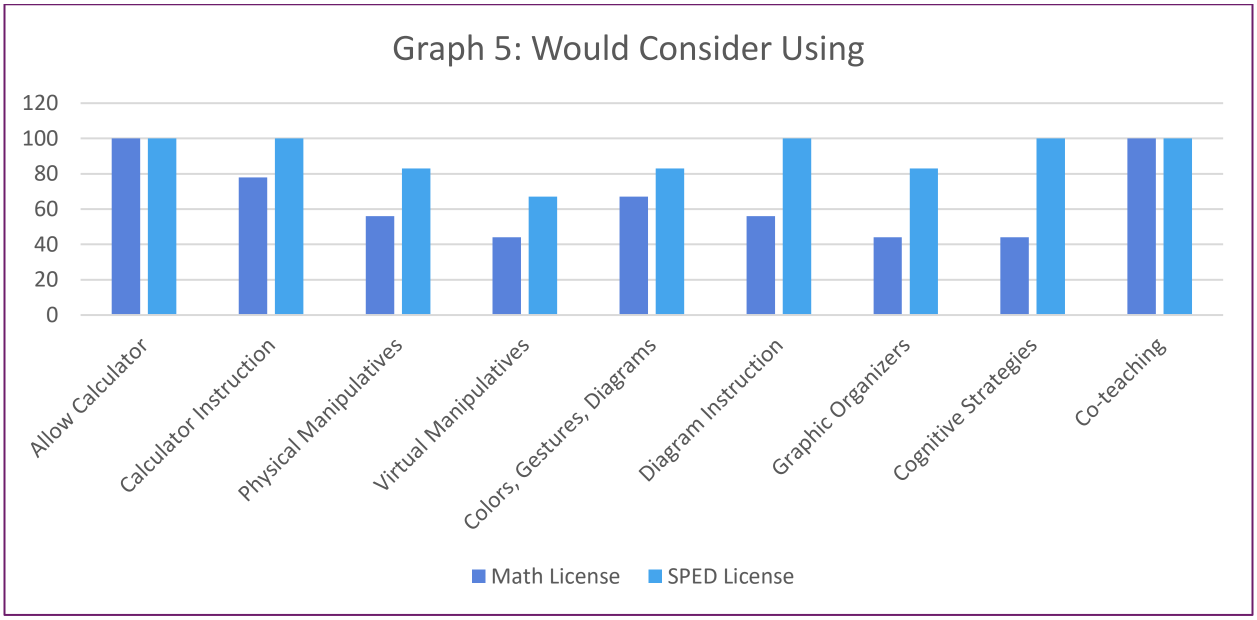
Graph 4: Strategies Used

Effectiveness of Past Strategies

The survey asked teachers to indicate which strategies have been effective for them in the past. The strategy chosen by the most teachers was co-teaching, which was chosen by four teachers. Their reasons included being able to break students apart into groups, give students more targeted help, and have a second teacher available to monitor students during instruction and help with notes and organization. According to one teacher, "Co-teaching is especially helpful as students can get focused help." Four additional teachers cited small group or one-on-one instruction, which are methods that would be more feasible with a co-teacher. One of them linked this with having a co-teacher, stating "My co teacher and I break the kids up into small groups to reteach topics to get a better understanding." Three teachers referred to note-taking support and one cited allowing students to use their notes. One mentioned "writing out step by step instructions to get through a complex problem (helps them not to forget any steps)" Two teachers listed manipulatives and two others responded with peer group work. Color coding, gestures, graphs, and calculators were each cited once. One teacher cited calculators as ineffective, arguing that when students use calculators they "do not develop the number sense needed for math."

Strategies Teachers Would Consider Using

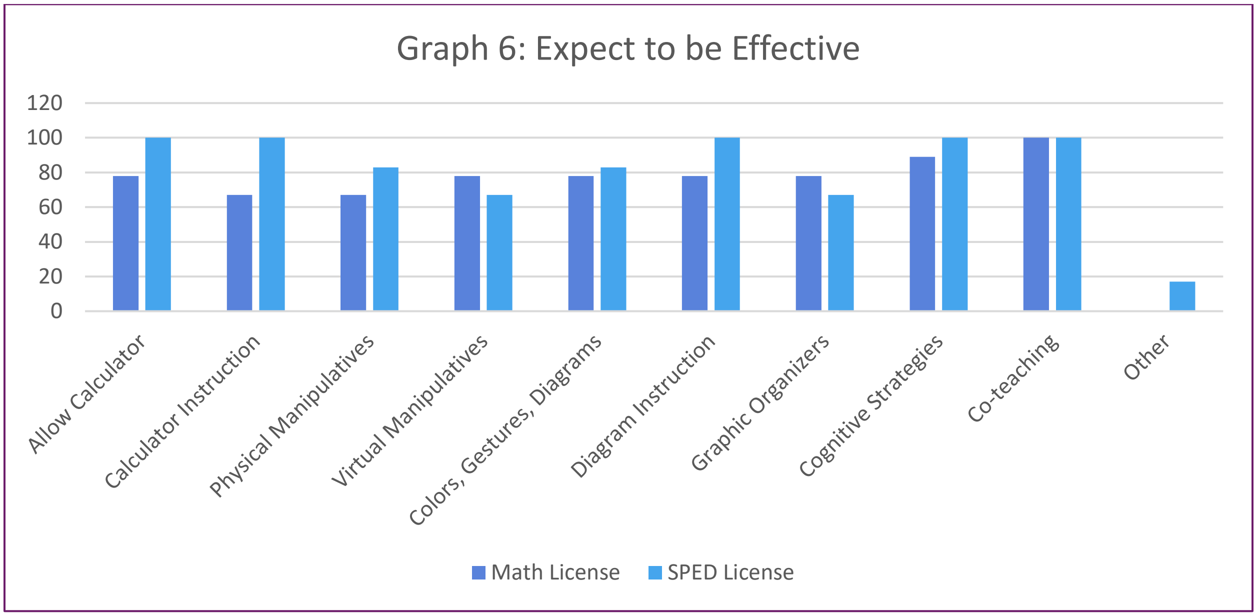
When asked which strategies they would consider using, the number of positive answers went down overall. All teachers were in favor of using calculators and co-teaching, but the other strategies had less interest. The data also showed a higher willingness among the special education teachers than the math teachers. All special education teachers would use direct instruction on how to use a calculator and draw effective diagrams. Among the math teachers, seven of nine and five of nine selected those options respectively. Special education teachers were the least interested in virtual manipulatives, while math teachers were least interested in virtual manipulatives, graphic organizers, and cognitive strategies. The result for this question are shown in Graph 5.



Graph 5: Would Consider Using

Expected Effectiveness of Strategies

When asked which strategies teachers would expect to be effective for improving academic performance, four teachers with special education licenses and two teachers with only math licenses said all strategies would be effective. All special education teachers agreed that allowing a calculator, providing direct instruction on using a calculator, direct instruction on drawing effective diagrams, teaching cognitive or metacognitive strategies, and co-teaching would all be effective. Only four of the six special education teachers had confidence that virtual manipulatives and graphic organizers would work. One special education teacher added the strategy of small group instruction, which is shown as “other.” Overall, teachers reported the lowest expectations for physical and virtual manipulatives and graphic organizers. The teachers unanimously believed co-teaching would be effective. The results are shown in Graph 6.



Graph 6: Expect to be Effective

In the qualitative response section, teachers were asked "In what ways would you expect these strategies to benefit students with IEPs?" Teachers reported various ways in which students benefited from the strategies. One teacher said it helped both students with and without disabilities. She stated "I use these with IEP students and students without IEP's." The various benefits that they listed included increased student engagement, attention, understanding, on-task behavior, increased self-esteem and confidence. Here are their responses in their own words:

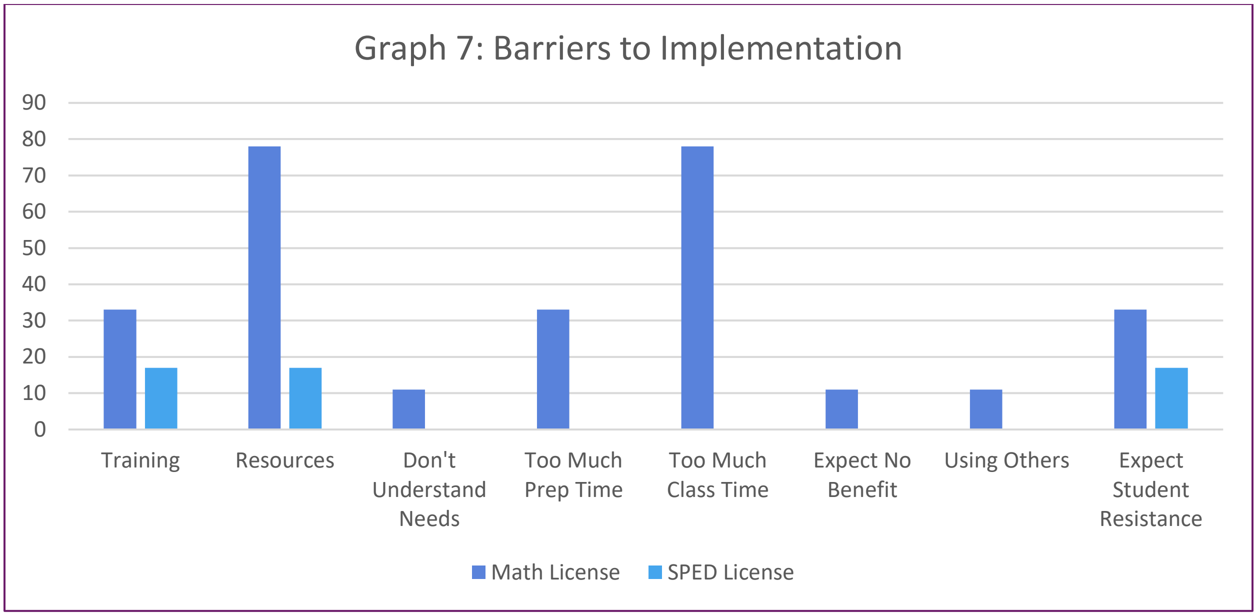
- "Assuming sufficient time was allowed for implementing these strategies I expect that student growth on formal assessments would increase student engagement and on-task behaviors would increase and student discipline issues would decrease."
- "I would think these strategies would increase understanding."

- “Calculator to help with the speed. Different manipulatives to increase the level of mastery or help build understanding.”
- “It makes it more tangible for kids. Gives them a more concrete structure on how to solve problems.”
- “This would give them the ability to work on things and have accommodations to help them.”
- “It helps them organize their thoughts and material in a way they can come back to revisit again.”
- “A lot of the students need written reminders of the steps of the order of operations.”
- “These make them feel more comfortable to have a calculator or a second teacher to help answer questions.”
- “They would have more of a sense of accomplishment? And then do better in classroom settings?”
- “They provide extra support for the students who are struggling.”
- “I use these with IEP students and students without IEP's.”
- “I’ve seen them work.”

When it comes to strategies, all teachers have used calculators and co-teaching. Every teacher agreed that co-teaching is an effective approach for students with mild disabilities. The least chosen strategies were cognitive and metacognitive strategies and virtual manipulatives. Overall, special education teachers were more receptive to using all strategies and were also more optimistic about their effectiveness.

Barriers to Implementation

Teachers reported few obstacles to implementing the given strategies. The biggest barrier, cited by seven teachers, was the belief that the strategies would take too much time during class. Five teachers reported they don't have enough training and four teachers said they expected students with IEPs to be resistant to the strategies. Only three teachers thought it would take too much prep time. Barriers listed only once were not understanding the needs of students with IEPs, not believing the strategies would benefit the students, and already using other strategies the teacher believes are effective. Three potential barriers that were not chosen by any teachers were not knowing what any of the strategies are, not believing it is the teacher's responsibility to provide these for students with IEPs, and not believing that students with IEPs will be successful in class no matter what the teacher does. Only four teachers, all of whom had special education licenses, did not select any barriers. These four teachers spanned the whole range of years of experience, but all reported receiving a moderate amount or a great deal of training. The other two special education teachers reported only three barriers compared to the eight barriers reported by math teachers. The one special education teacher who felt they lacked training and resources had only been teaching 1-2 years. The other special education teacher had 5-10 years of experience and thought students would be resistant to the strategies. In fact, all teachers who expected students to be resistant had at least 5 years of experience. The results are shown in Graph 7.



Graph 7: Barriers to Implementation

Summary of Results

Prior to reviewing the data, I expected the survey results to show that few of the math teachers feel prepared to teach students with mild disabilities. I anticipated most would say they were familiar with accommodations such as extra time, read-aloud, and calculators, but have little knowledge of the specific challenges of students with disabilities, which are the reasons behind those accommodations. Furthermore, I expected most math teachers to state that they were unaware of specific research-based strategies that can be used to support students with IEPs, and that they were not very open to trying new strategies. My expectations were based on my personal experience working with high school math teachers for the past seven years. In my experience, most are well-intentioned, but lack extensive preparation and tools necessary to meet the specialized needs of learners with mild disabilities. Some existing research confirmed that many high school teachers report feeling unprepared for teaching students with mild (Boyd & Bargerhuff, 2009, Grskovic & Trzcinka, 2011, Shoulders & Krei, 2016). Also, little research has been done to identify strategies that can help high school students with disabilities overcome their math-specific challenges (Bottge, Toland, Gassaway, Butler, Choo, Griffen, & Ma, 2015).

I expected the special education teachers to be fully aware of all accommodations and the challenges faced by students with mild disabilities. However, I didn't expect most of them to know about many research-based strategies. My past observations led me to believe that few, if any, teachers have the time or motivation to look for research about this topic due to already heavy workloads. For the same reasons, I also didn't expect any of them to incorporate any new strategies unless they are simple to access and use. I have a bias based on working directly with students with IEPs and not seeing many strategies being implemented specifically for those students. This bias was reinforced in research by Marita and Hord (2016) describing how the complexity, planning, and preparation required of teacher to implement new teaching strategies is a challenge.

Upon analysis, the data showed that teachers reported more knowledge of and experience with the strategies listed in the survey than the researcher had expected. The special education teachers reported full knowledge of every challenge and strategy listed and offered additional ones. Math teachers reported less thorough knowledge than the special education teachers, but still a significant amount. Upon reflection, the researcher hypothesizes the math teachers learned the strategies for use with all math students, not specifically with students with mild disabilities. Special education teachers may have learned more of this information from working with various math teachers and other special education teachers in addition to what they learned during their degree programs.

The most striking trend in the results was the difference between teachers with special education licenses and those with math licenses. There was a consistent difference in the responses between these two groups, resulting in the highest correlation of this characteristic with response data. Special education teachers reported more knowledge about strategies, more experience using them, more receptiveness to using them, higher expected effectiveness, and fewer perceived barriers. They were also more likely to reference additional strategies that could be used. Other teacher background characteristics, such as years of experience, did not appear to have a consistent correlation with their responses to the other questions.

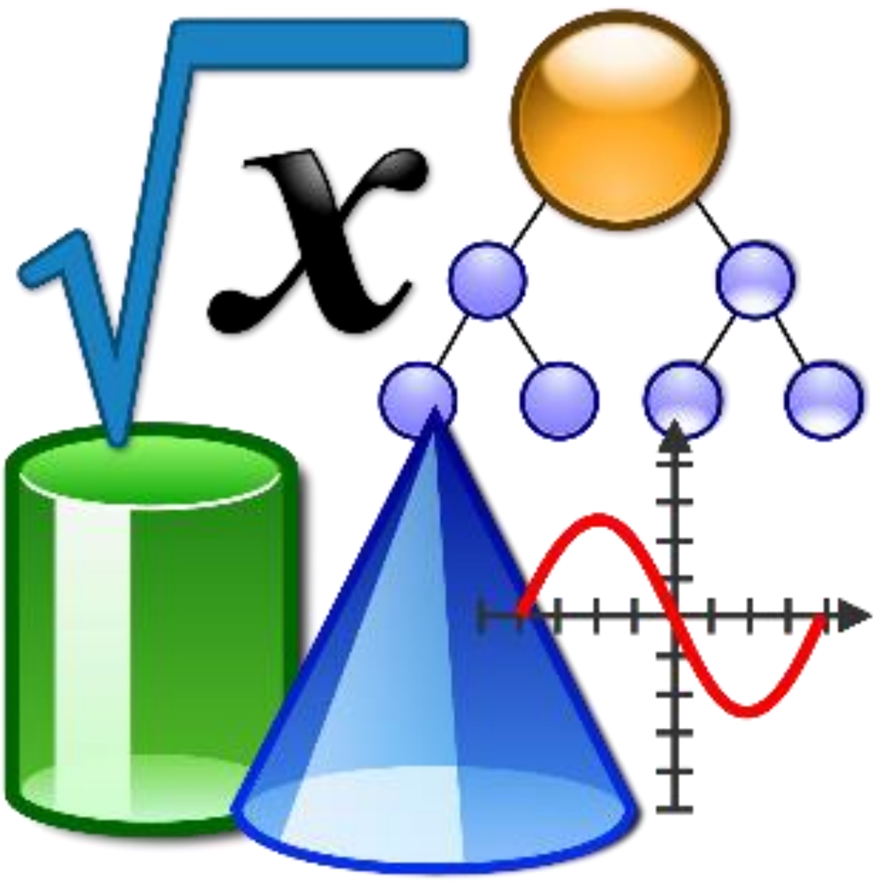
Another notable finding was the universal support of co-teaching as a strategy. Use of a calculator was a close second, but there were two math teachers who reported they would not want to implement this. This result is not a surprise, given that there is an ongoing debate in the math teaching community over whether this reduces students' proficiency and math sense (Latterell, 2005).

Interestingly, teachers reported a high level of awareness of strategies and experience with them, but somewhat less willingness to use them in the future. The category of expectations of effectiveness showed the highest similarity between the two groups of teachers. Strategies teachers would consider using received the least positive responses of the questions about specific strategies, even lower than expected effectiveness. One might speculate this is due to barriers to implementation, but teachers did not report many barriers. This discrepancy would be interesting to investigate further.

Overall, the results appear to support the value a special education teacher can bring to high school math classes. Over half of the teachers reported lack of resources as a barrier. This finding supports the need for a convenient handbook of tools and strategies. Given that the biggest concern teachers reported was the class time needed for these strategies, the concern about class time was taken into consideration when developing the handbook.

CHAPTER 5. HANDBOOK

Teaching Mathematics to High School Students with Mild Disabilities



By Kim Kamler

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Introduction

What is the Issue?

Math can be a difficult subject for many students. The National Education Assessment Program (NAEP) produced a report of nationwide data in 2015 that indicated only one-third of all eighth-grade students were achieving proficiency, and only 4% of students with disabilities were demonstrating proficiency (Bouck, Park, Bouck, Alspaugh, & Spitzley, 2019; Satsangi, Hammer, & Bouck, 2019). For decades, the highest level of mathematics students with mild disabilities were required to master in the United States was Algebra I (Strickland, 2016). Under the current requirements of the Every Student Succeeds Act (ESSA) enacted in 2015 and the Individuals with Disabilities Education Act (IDEA) of 2004, most secondary students with disabilities are taking mathematics in general education classes and are expected to complete Algebra I, Algebra II, and Geometry in order to obtain a typical high school diploma (Marita & Hord, 2016). Students with mild disabilities may require additional support from their teachers in order to meet this increased expectation and succeed in their high school math classes.

There is an assortment of mild disabilities represented among American high school students, including:

- **Specific Learning Disabilities (SLD)**
- **Autism Spectrum Disorders (ASD)**
- **Attention Deficit Hyperactivity Disorder (ADHD)**
- **Intellectual Disabilities (ID)**
- **Emotional Behavioral Disturbance (EBD)**

For the purpose of this handbook, all relevant disabilities will be referred to as mild disabilities.

Why is it an Issue?

Many high school math teachers find themselves teaching students with mild disabilities without enough training or support for teaching those students (Boyd & Bargerhuff, 2009, Grskovic & Trzcinka, 2011, Shoulders & Krei, 2016). Math curriculum is not typically developed with the needs of students with mild disabilities in mind. While teachers may do their best in trying to help all of their students master the material, not all of them may be aware of the unique challenges for those students with mild disabilities, or the strategies to better assist them. This handbook is a collection of resources for teachers of secondary math classes to support learning for students with mild disabilities. With the current need for remote learning models due to the COVID-19 pandemic, some of the strategies are compatible with on-line learning.

I developed this handbook as my Masters in Education special project. In the course of my literature review, I only found two resources that specifically discussed strategies for helping high school students with mild disabilities in their math classes. The first book, *Understanding RTI in Mathematics: Proven Methods and Applications* (Gersten & Newman-Gonchar, 2011), is about Response to Intervention in grades K-12, has several chapters about secondary students, mostly middle school. The second book, *Teaching Mathematics to Middle School Students with Learning Difficulties* (Montague & Jitendra, 2018), includes chapters on teaching problem-solving skills, visual representation, and self-regulation to middle school students.

High school math teachers have few available resources with strategies for teaching students with mild disabilities. With the rise and prevalence of inclusion, such resources are sorely needed. This handbook is intended to start filling that gap. The handbook describes strategies that are evidence-based and supported by scholarly research. This establishes their effectiveness, which may increase teachers' interest in implementing them.

Characteristics of Learners with Mild Disabilities

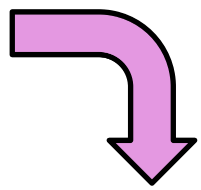
How is this a problem?

Students with mild disabilities exhibit a multitude of characteristics that make learning math more difficult than it is for their non-disabled peers. There is lots of variability among students with mild disabilities, but there is some overlap in the ways different disabilities manifest themselves in students. Some common challenges include:

- **Difficulty understanding visual representations of math problems, such as graphs, tables, diagrams, and equations (Montague, Enders, & Dietz, 2011; Steele, 2006).**
- **Verbal directions or explanations are more difficult for students with auditory processing disorders such as those with ASD to understand (Ives, 2007; Steele, 2006).**
- **Reading and understanding written directions (Ives, 2007; Steele, 2006).**
- **Difficulty taking notes, writing neatly, graphing problems, and using the keys on a calculator due to poor motor skills (Steele, 2006).**
- **Trouble maintaining focus and persisting through multiple steps (Marita & Hord, 2017; Steele, 2006).**
- **Weaker cognitive skills like conceptualizing, abstract reasoning, and generalizing (Marita & Hord, 2017; Steele, 2006).**
- **Difficulty following correct steps, making connections, and applying concepts to new problems (Steele, 2006).**
- **Deficits in working memory, which means they may have difficulty processing, storing, retrieving, and integrating information (Walsh & Hord, 2019).**
- **Poor problem-solving and understanding of problem-solving processes, especially representing problems with diagrams and mathematical notation (Montague, Enders, & Dietz, 2011).**
- **Trouble recognizing that a strategy is not working and adapting or replacing it (Montague, Enders, & Dietz, 2011).**
- **Lack of prerequisite skills (Rodgers & Weiss, 2019).**

- **Difficulty understanding mathematical relationships and operations (Rodgers & Weiss, 2019).**

All of these are potential areas in which students with mild disabilities could benefit from specific strategies designed to help overcome barriers and increase their academic success.



Evidence-Based Strategies

Graphic Organizers

Several studies used graphic organizers to help students visualize concepts and make connections among ideas. They can help students organize their thoughts and the processes of problem-solving. There are a variety of specific tools available. These are some examples.

Alan Zollman used a graphic organizer known as “Four Corners and a Diamond.” (Zollman, 2009) This tool can easily be created by any student from just a piece of paper by following these steps:

1. Fold the paper in half in either direction.
2. Fold the paper in half again, in the other direction.
3. At the corner where both folded edges come together, fold the corner down.
4. Unfold.

Figure 1 shows this process.

Once the organizer is created, certain information is written in each area that was created. The areas and where they are located follow. They are not numbered because they do not need to be completed in this order.

- What do you need to find (center)?
- What do you already know (top left)?
- Brainstorm ways to solve this problem (top right).
- Try it here (bottom left).
- Explanations and/or what did you learn (bottom right)?

See Figure 2 to see what this looks like.

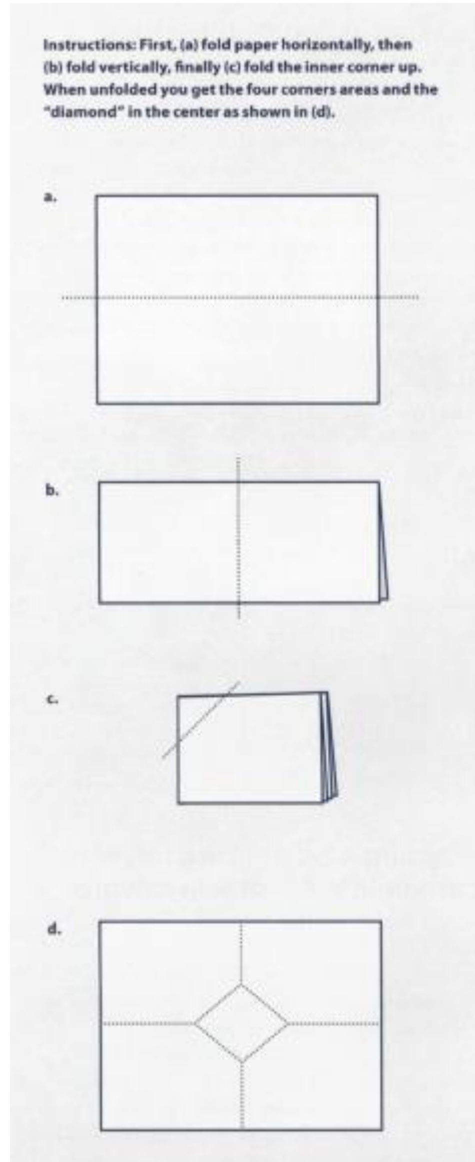


Figure 1: How to make a Four Corners and a Diamond graphic organizer (Zollman, 2009, p. 6)

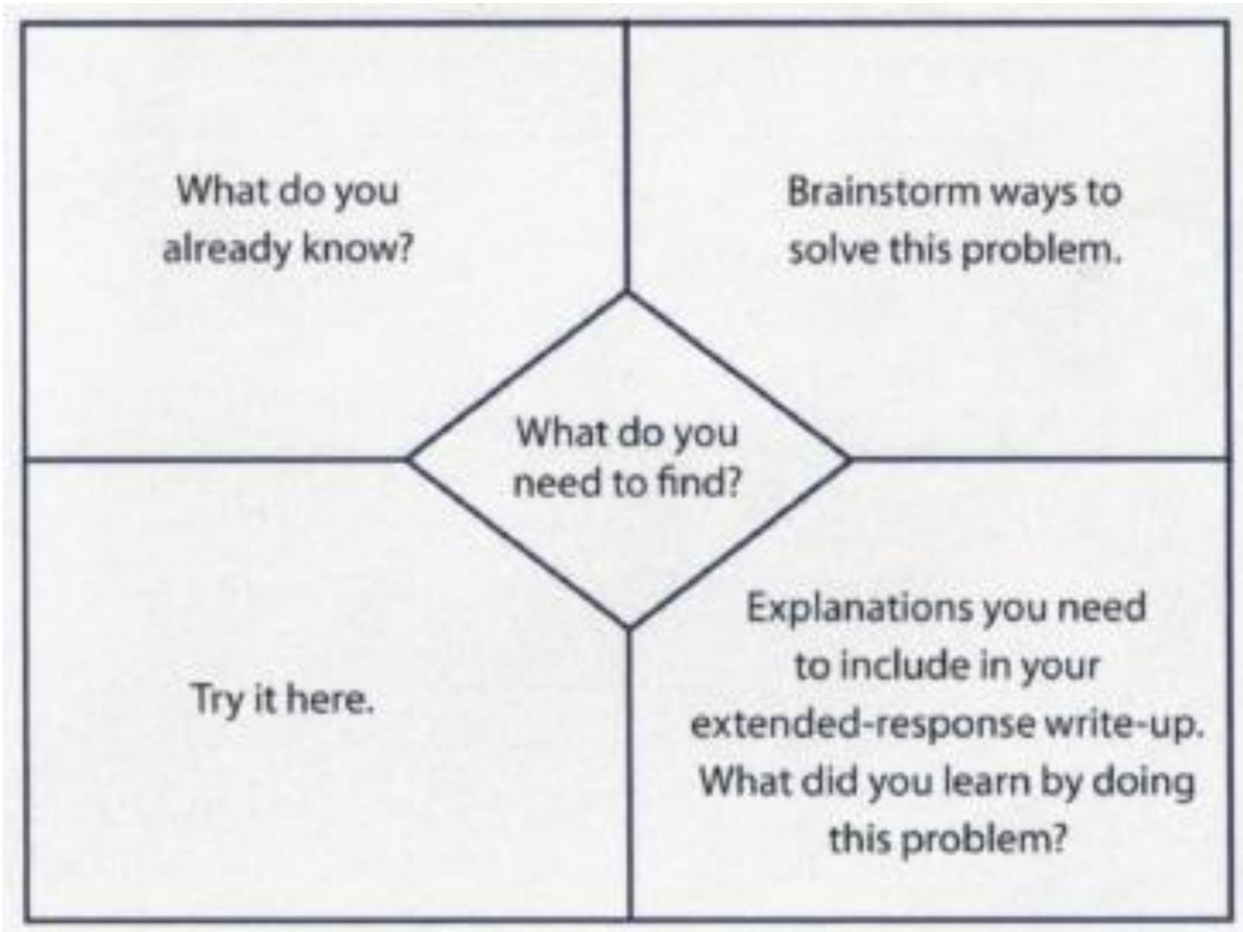


Figure 2: Four Corners and a Diamond graphic organizer (Zollman, 2009 p. 5)

In his research, Zollman found that students performed better when they used the Four Corners and a Diamond graphic organizer (2009, 2012). Since students with IEPs often have difficulty with organization and memory, it makes sense that any tool that helps them organize and remember the details of a math problem could help them solve the problem more successfully. In other words, a variety of graphic organizers could be helpful. This next example was used by Ives and Hoy (2003) for solving systems of equations with three variables. Since this organizer is just six rectangles labeled at the top of each column with 3, 2, and 1, it could easily be made from a piece of copy paper. The following figures show the sequence of steps completed on the organizer. Steps were performed starting at the top left corner and proceeding clockwise.

1. ***Create the graphic organizer by folding or drawing lines on paper to make a 2 by 3 grid of rectangles. See Figure 3 below.***

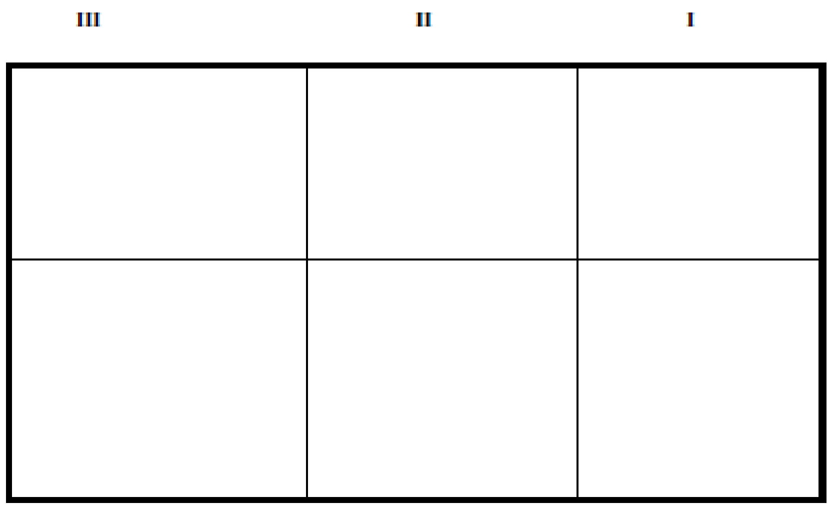


Figure 3: Blank graphic organizer for solving systems of equations with 3 variables. (Ives & Hoy, 2003, p. 44)

2. ***Write the system of 3 equations in the top left box as shown in Figure 4.***

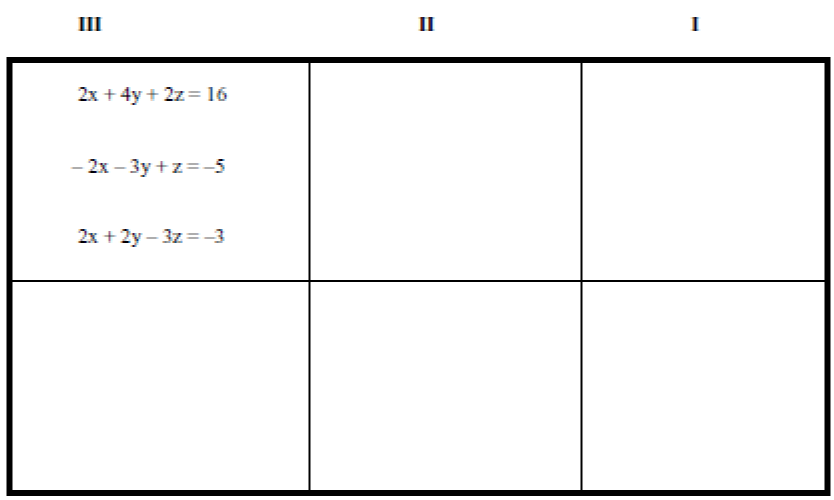


Figure 4: Graphic organizer with a system of equations with 3 variables (Ives & Hoy, 2003, p. 45)

3. *Use elimination to find 2 equations with 2 variables. Write these in the top middle box as shown in Figure 5.*

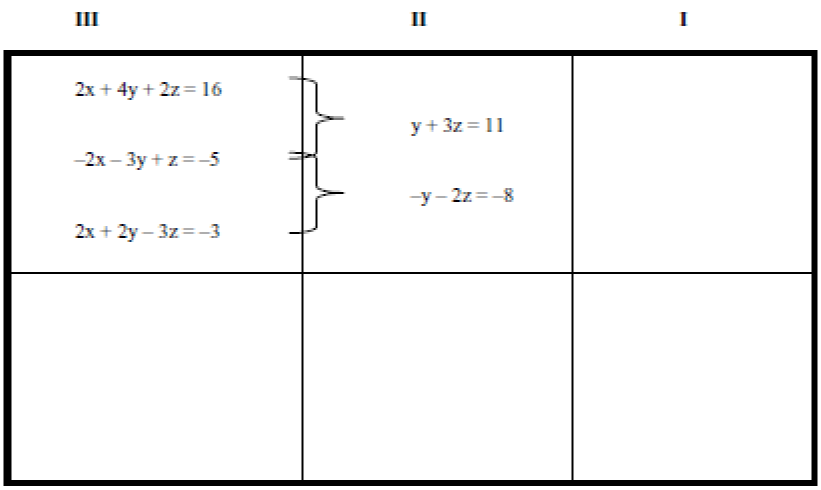


Figure 5: Graphic organizer after the first elimination. (Ives & Hoy, 2003, p. 46)

4. *Use elimination or substitution to solve for 1 variable as seen in Figure 6.*

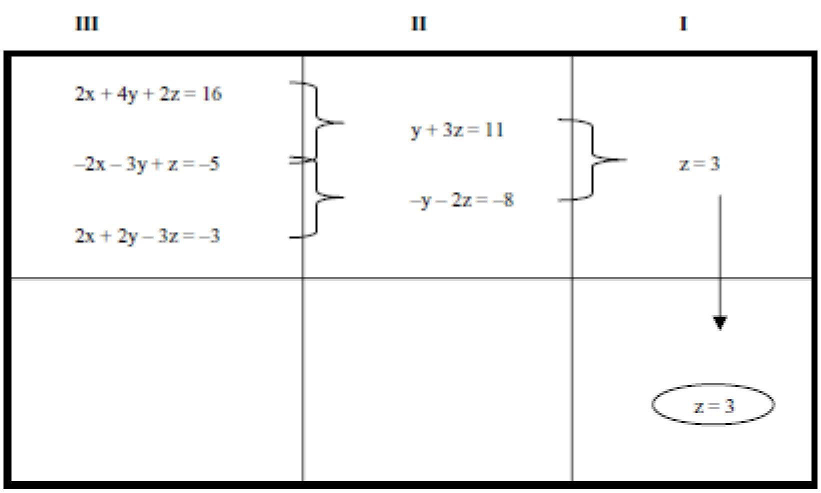


Figure 6: Graphic organizer after the first variable has been found. (Ives & Hoy, 2003, p. 47)

5. *Plug the value for the solved variable back into one of the 2 equations in the top middle box and find the 2nd variable. Write it in the bottom middle box. Plug both of the found values into one of the 3 equations in the top left box and solve for the 3rd value. Write the answer in the lower left box. Now you have solved for all 3 variables as seen in Figure 7.*

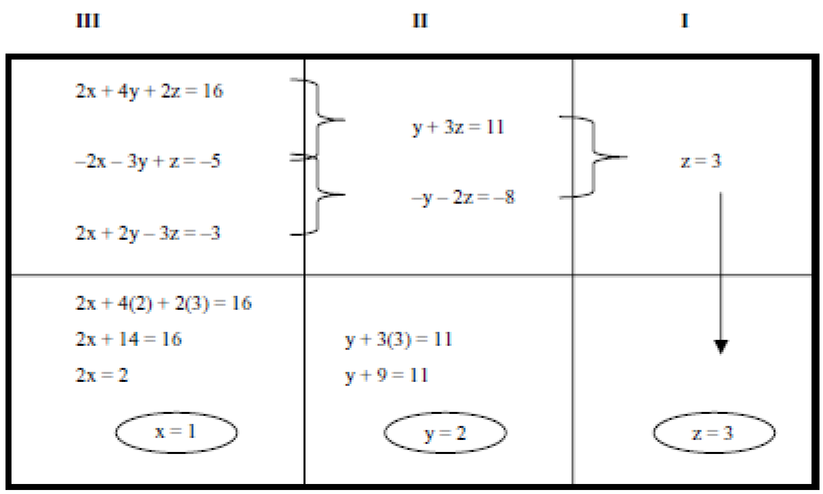


Figure 7: Graphic organizer after all 3 variables have been found. (Ives & Hoy, 2003, p. 47)

The 3rd example was used by Strickland and Maccini (2015) for solving quadratic equations and is shown in Figure 8.

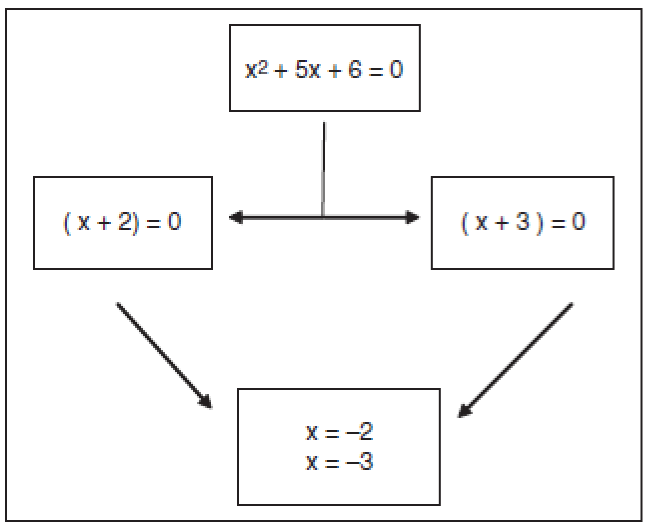


Figure 8: Example of a graphic organizer for factoring a quadratic expression (Strickland & Maccini, 2015, p. 44)

These are just some graphic organizers that appeared in the literature review. There are many other options for graphic organizers that can be found online at sites such as Understood.org or even with a Google search for “math graphic organizers.” Teachers and students could even create their own to match the types of problems and the challenges of specific students.

Diagrams

Other studies used diagrams to help students visualize concepts and make connections among ideas. One definition of a diagram is “a representation that you draw to show the parts of a math problem and how they belong together” (van Garderen, 2007, p. 544). Diagrams can help students organize their thoughts and the processes of problem-solving but do require instruction first. In van Garderen’s research, “Each instructional phase incorporated principles of explicit instruction, such as teacher modeling and demonstration, questioning, guided and independent practice, rehearsal, reinforcement, and feedback” (van Garderen, 2007, p. 544). The researchers taught the students

> (a) a definition of what a diagram is,
>
> (b) reasons to use a diagram for solving word problems,
>
> (c) general rules to use when generating a diagram,
>
> (d) what symbols and graphic codes are and how to use them to represent things or people,
>
> (e) how to use a symbol such as a question mark to indicate what is unknown, and
>
> (f) two diagram types that can be generated and when to use then for different word problems (p. 544).

In addition, van Garderen incorporated the cognitive strategy of VR-PCC discussed later, and with other techniques such as backward chaining (van Garderen, 2007). Figures 9 and10 are examples of the math diagrams from this research.

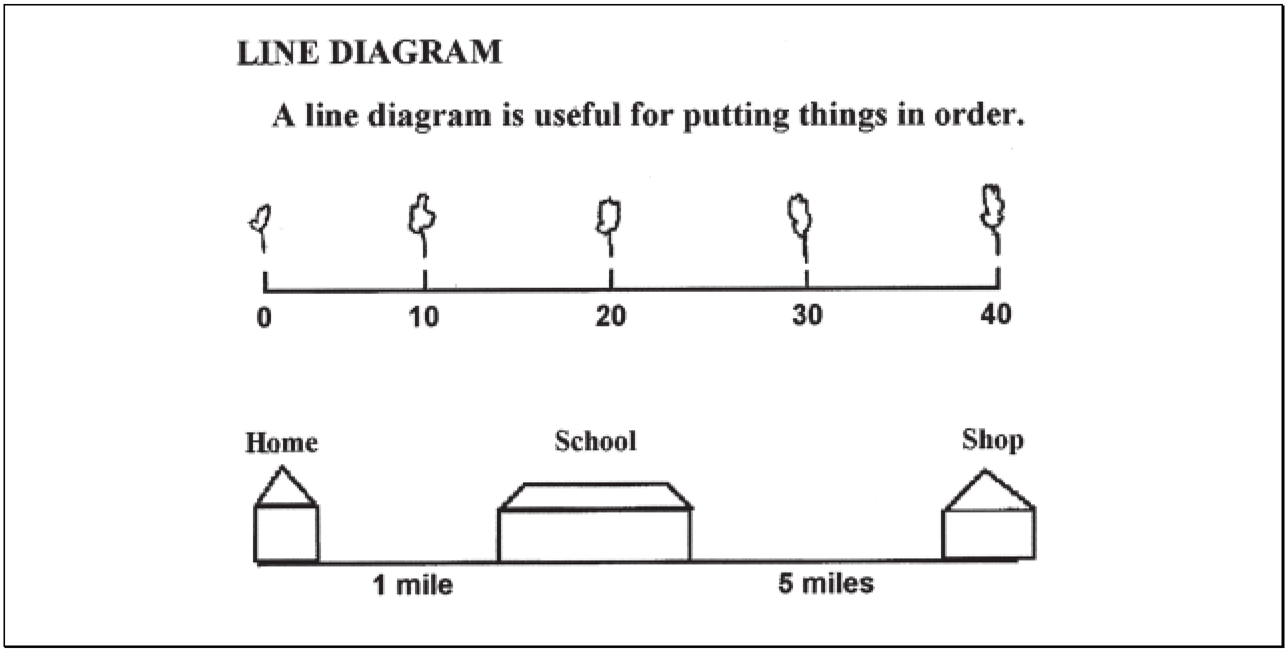


Figure 9: Example of a line diagram (van Garderen, 2007, p. 545)

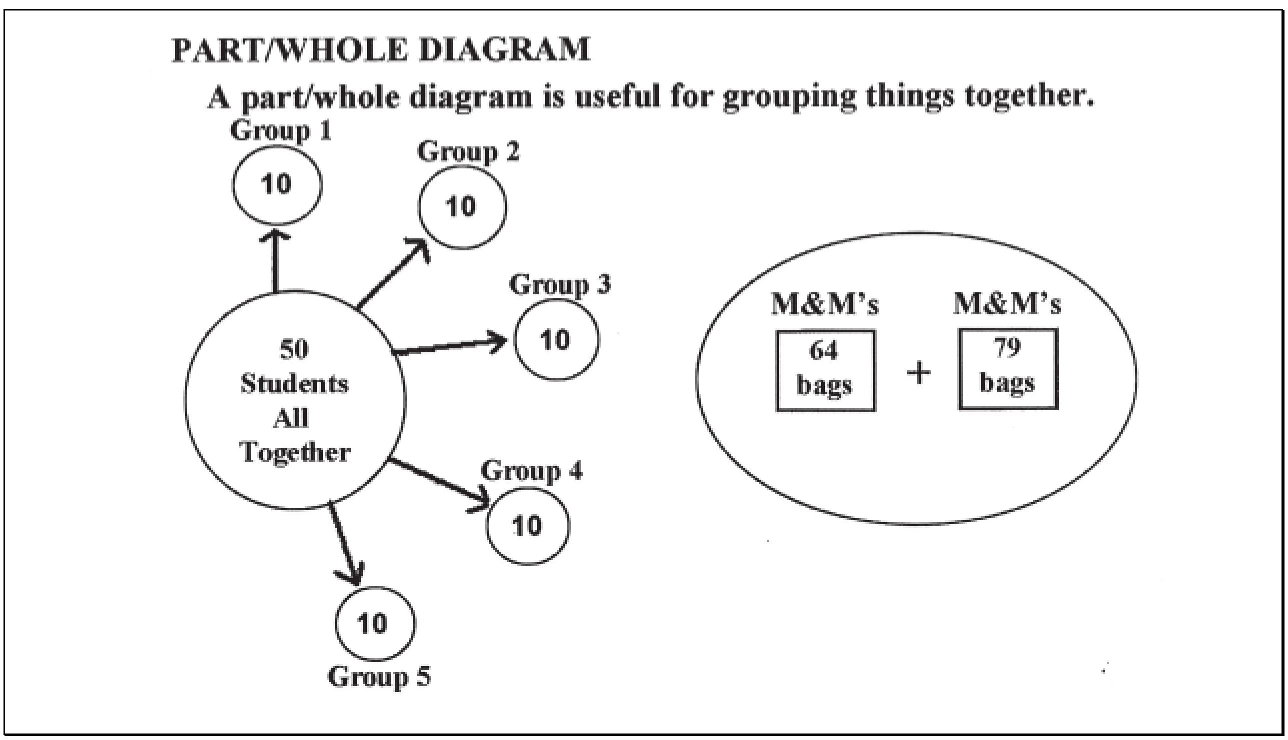


Figure 10: Example of a part/whole diagram (van Garderen, 2007, p. 545)

In van Garderen's study, students learned to use diagrams with one-step and two-step computational problems and were able to generalize to other types of problems. Carcoba Falomir (2019) included examples of several different types of diagrams, shown in Figure 11.

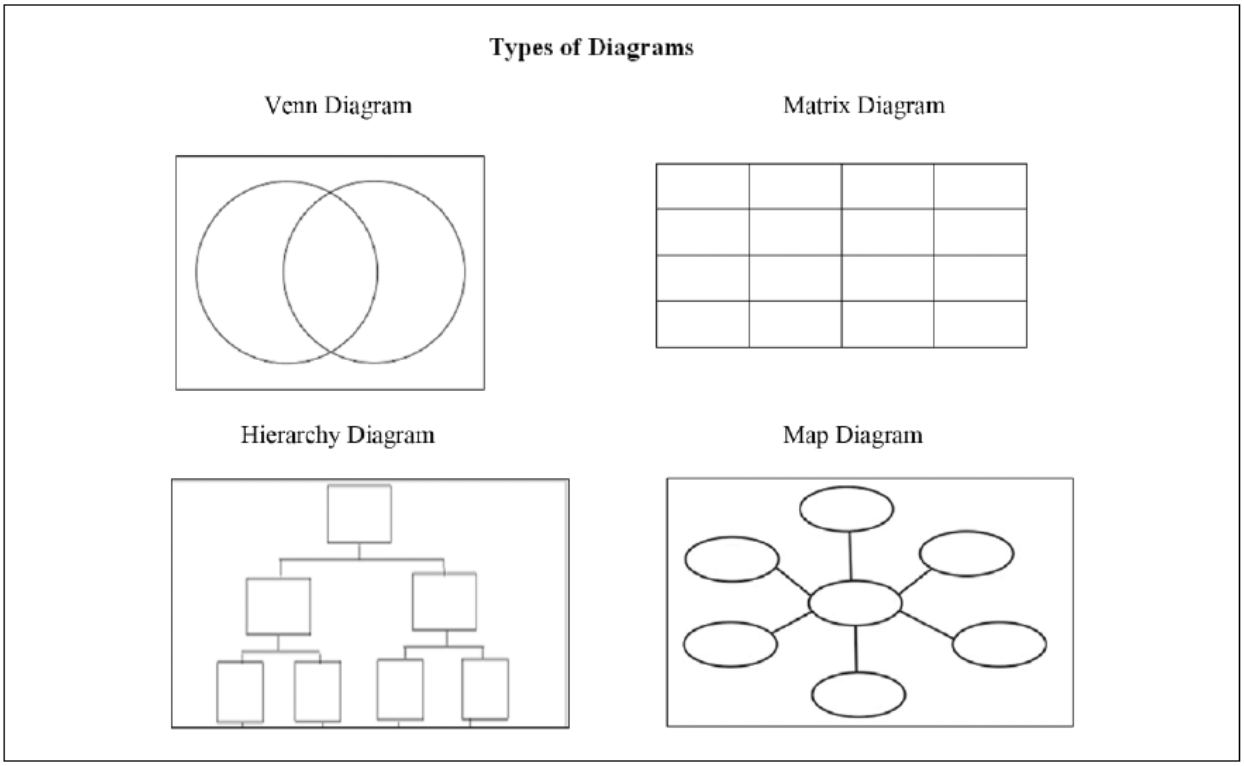


Figure 11: Types of diagrams for solving word problems. (Carcoba Falomir, 2019, p. 214)

Regardless of the type of diagram, students need to learn the steps to drawing one. Figure 12 shows the step-by-step process Carcoba Falomir (2019) created for students to follow to use a matrix diagram for algebraic word problems.

Table 1. Steps to Create a Diagram to Effectively Solve Algebraic Word Problems.

Step	Description
1	Carefully read the algebraic word problem
2	Underline the relevant information stated in the word problem
3	Determine what the word problem is asking you to do
4	Choose the formula to find the missing variable
5	Determine how many variables the formula contains
6	Define your variables (e.g., t = time, d = distance)
7	Create a matrix with as many columns as variables (including the missing variable)
8	Write the formula at the top of the matrix, placing each variable in a different column
9	Determine how many equations you can build with the information in the problem (e.g., you have the information of 2 different people)
10	Create the rows in your matrix depending on the different equations you will build
11	Start completing your matrix with the known variables stated in the word problem
12	Solve the formula for the problem
13	Write the solution of your formula in the missing variable column in terms of the other variables
14	Solve the equations according to your problem

Figure 12: Steps for creating effective diagrams for word problems. (Carcoba Falomir, 2019, p. 215)

The following figure shows an example of how the above process could be used. In this case it is used to solve a word problem related to distance and time.

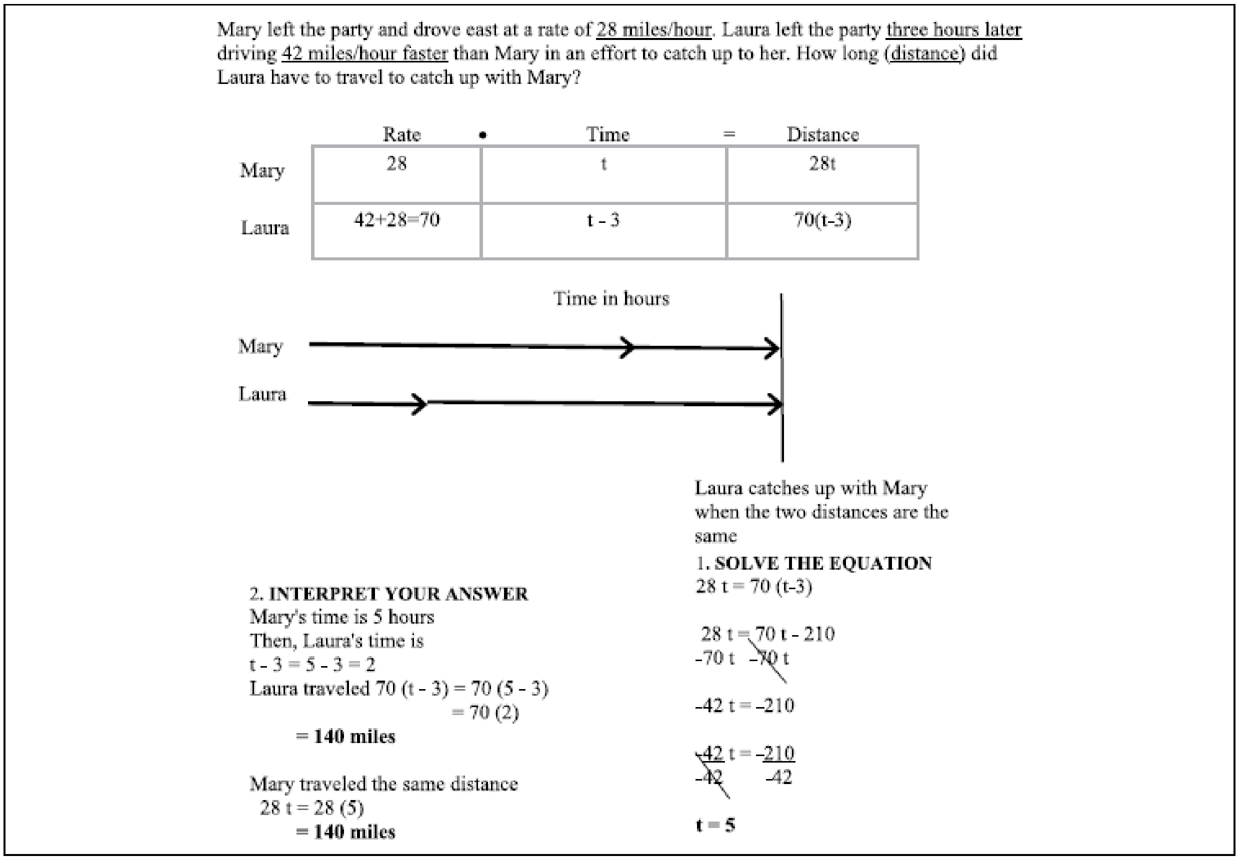


Figure 13: Example of a matrix diagram in use. (Carcoba Falomir, 2019, p. 215)

These are just a few examples of diagrams and clearly the course content would dictate what diagrams would be most suitable, but the research shows this is an important skill for students with mild disabilities (van Garderen, 2016; Walsh & Hord, 2019).

Teaching Cognitive and Metacognitive Skills

Cognitive skills are generally considered to be ways of thinking and metacognitive skills are ways of thinking about your thinking. Both of these can be useful in working with students with mild disabilities. Myers, Wang, Brownell, and Gagnon (2015) categorized cognitive or metacognitive approaches as those featuring a reasoning strategy, think-aloud, self-monitoring, or mnemonic device. According to Maccini, Strickland, Gagnon, and Malmgren (2008),

> "Common elements of effective strategies for students with LD are
>
> (a) a memory device, such as a first-letter mnemonic to aid in remembering the problem-solving steps;
>
> (b) familiar words or phrases that begin with an action verb (e.g. "*Read* the problem") to prompt students to use the strategy; and
>
> (c) sequenced steps to help students remember and recall the process (p. 7)."

Cognitive and metacognitive strategies can be used in conjunction with any of the other tools discussed. One of the cognitive strategies in the research literature was the STAR Strategy, which includes the steps of searching the problem, translating information into an equation, answering the problem, and reviewing the answer and the problem. These are represented using STAR as a mnemonic device, and a more detailed outline is shown below in Figure 14.

STAR Strategy

1. S earch the word problem
   a. Read the problem carefully.
   b. Ask yourself questions: “What facts do I know?” and “What do I need to find out?”
   c. Write down facts.
2. T ranslate the words into a mathematical equation.
   a. Choose a variable.
   b. Identify the operation(s).
   c. Represent the problem with Algebra Lab Gear (concrete). Draw a picture of the representation (semi-concrete). Write an algebraic equation (abstract).
3. A nswer the problem.
   a. Using Algebra Lab Gear (concrete)
   b. Using picture representation (semi-concrete)
   c. Apply rule for integers (abstract)
4. R eview the problem.
   a. Reread the problem.
   b. Ask question, “Does the answer make sense? Why?”
   c. Check answer.

Figure 14: Steps of the STAR strategy. (Maccini, Strickland, Gagnon, & Malmgren, 2008, p. 20)

SOLVE IT!

Several research studies cited the effectiveness of the *Solve It!* strategy or a modification of it (Karabulut & Ozmen, 2019; Marita & Hord, 2016; Montague, Enders, & Dietz, 2011). The results of studies using *Solve It!* showed significant improvement in the performance of students at all ability levels. The students with mild disabilities in the experimental groups scored higher than the average-achieving students in the control group. The students were also observed using more problem-solving strategies than the students in the control group. In reference to the *Solve It!* process, Myers, Wang, Brownell, and Gagnon (2015) stated "The goal of the intervention is that students will be able to use cognitive processes and metacognitive strategies (i.e., reading, paraphrasing, visualizing, hypothesizing, estimating the accuracy of their responses, computing and checking their work during the problem-solving process) taught through think alouds to independently solve mathematical problems" (p. 212). This strategy could be applied to many different types of math problems. A more detailed outline of the process is shown in Figure 15 below.

READ (for understanding)

Say: Read the problem. If I don't understand it, read it again.

Ask: Have I read and understood the problem?

Check: For understanding as I solve the problem.

PARAPHRASE (your own words)

Say: Underline the important information. Put the problem in my own words.

Ask: Have I underlined the important information? What is the question? What am I looking for?

Check: That the information goes with the question.

VISUALIZE (a picture or diagram)

Say: Make a drawing or a diagram. Show the relationships among the problem parts.

Ask: Does the picture fit the problem? Did I show the relationships?

Check: The picture against the problem information.

HYPOTHESIZE (a plan to solve the problem)

Say: Decide how many steps and operations are needed. Write the operation symbols (+, -, x, and /).

Ask: If I … , what will I get? If I … , then what do I need to do next? How many steps are needed?

Check: That the plan makes sense.

ESTIMATE (predict the answer)

Say: Round the numbers, do the problem in my head, and write the estimate.

Ask: Did I round up and down? Did I write the estimate?

Check: That I use the important information.

COMPUTE (do the arithmetic)

Say: Do the operations in the right order.

Ask: How does my answer compare with my estimate? Does my answer make sense? Are the decimals or money signs in the right places?

Check: That all the operations were done in the right order.

CHECK (make sure everything is right)

Say: Check the plan to make sure it is right. Check the computations.

Ask: Have I checked every step? Have I checked the computation? Is my answer right?

Check: That everything is right. If not, go back. Ask for help if I need it.

Figure 15: Steps of the *Solve It!* strategy (Montague, Enders, & Dietz, 2011, p. 264)

Carcoba Falomir (2019) describes a “think-aloud” metacognitive strategy to use in conjunction with diagrams. This one has just four steps, summarized by the mnemonic FOPS.

1. **Find the problem**
2. **Organize information using the diagram**
3. **Plan to solve the problem**
4. **Solve the problem**

The author recommends teaching this to students through direct instruction and in conjunction with diagramming.

SAY:	READ the problem for understanding.
ASK:	“Do I understand the problem?” If not, reread the problem.
CHECK:	For understanding as I solve the problem.
SAY:	VISUALIZE the problem.
STEP 1:	*DRAW: Ask:* “What type of diagram should I draw?”
	Draw a diagram of what I know and a symbol for what I do not know.
	Check I have drawn the diagram correctly.
STEP 2:	*ARRANGE: Ask:* “ Does my diagram show how the parts of the problem are related?”
	Re-Arrange the diagram if needed.
	Check that my diagram matches what the problem is asking.
SAY:	PLAN how I am going to solve the problem.
ASK:	“What operations and how many steps are needed to solve the problem?”
CHECK:	Using my diagram, that my plan makes sense.
SAY:	COMPUTE the answer.
ASK:	“Have I correctly computed the answer?”
CHECK:	That all the operations were done in the right order.
SAY:	CHECK the answer.
ASK:	“Does my answer make sense?”
CHECK:	That everything is right. If not, go back. Then ask for help if I need it.

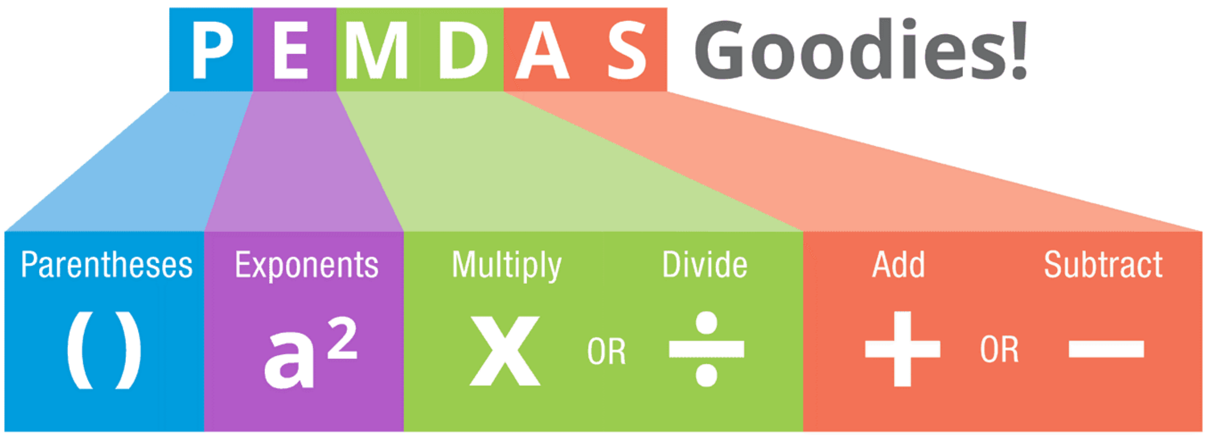
Figure 16: RV-PCC Strategy (van Garderen, 2007, p. 546)

The following figure shows how it could be used with the word problem about distance and time shown on page 17.

Four-step Strategy (FOPS)	Math	Self-explanation
F- Find the problem		**First**, I realized this is a distance, time, and rate problem because it involves Laura's time and speed information in terms of Mary's time and speed information. Additionally, the problem asks for the distance when Laura catches up Mary.
O- Organize information using the diagram	Mary's time = t Laura's time = t-3	**Second**, I represented the information using a time variable (t). Laura's time in terms of Mary's. Laura left the party 3 hours after Mary
	Mary's r = 28m/hr Laura's r = 28 + 42 = 70m/hr	**Then**, I identified Mary's speed rate information and Laura's speed rate information (42 miles faster than Mary)
P- Plan to solve the problem	**d = r*t** Mary's d = 28t Laura's d = 70(t-3)	**Third**, I wrote the formula for distance (rate times time). Mary catches up Mary when their distances are equal.
S- Solve the problem	Both distances are the same **28t = 70(t-3)** Solve the equation 28t = 70t – 210 28t – 70 t = 70 t -70 t – 210 -42t = -210 -42t/-42 = -210/-42 **t=5** Mary's d = 28t = 28 (5) **d = 140m** Laura's d = 70 (5-3) = 70 (2) **d = 140m**	**Last**, I solved the equation. I needed to leave the variable t by itself (both sides minus 70t, both sides divided by negative 42). Once I had t, I realized I was not done solving the problem, I had to figure out the time for Mary, and Mary's distance. **At the end**, I checked Laura's distance to verify that both distances were the same.

Figure 17: Example of FOPS think aloud strategy. (Carcoba Falomir, 2019, p. 215)

A variety of cognitive and metacognitive strategies have been found to be helpful for students with mild disabilities (Karabulut & Ozmen, 2019; Marita & Hord, 2017; Montague, Enders & Dietz, 2011). One consideration in utilizing these is that they need to be explicitly taught. "Students with LD characteristically are poor problem solvers. They typically lack knowledge of problem-solving processes, particularly those necessary for representing problems and, therefore, need to be taught those processes explicitly and shown how to apply them when solving math word problems" (Montague, Enders & Dietz, 2011, p. 263).



One of the best-known mnemonic devices in math is PEMDAS, used for the order of operations in algebra.

Calculator Instruction and Use

In the math teaching profession, there is ongoing debate about whether students should be allowed to use calculators. This excerpt from *Math Wars: a guide for parents and teachers*, by Latterell, (2005) summarizes that debate.

> Let me say a little more about calculator use and the de-emphasis of basic arithmetic. The NCTM-oriented side will argue that we should use a calculator for the same reasons that nobody would plow their fields using horses in place of a tractor. It is no longer important to learn how to plow a field using horses. But, the traditional-oriented side will give a different analogy. They will argue that, when one is out walking for exercise, one is unlikely to accept the offer of a ride. If one is walking for exercise, it makes no sense to accept the efficiency of a car ride. The efficiency and availability of cars is not the point when walking for exercise. Mathematicians will argue that whether a calculator is efficient and available is immaterial to whether a student should use a calculator. When students study mathematics, they are doing so for the mental exercise (p. 28).

Latterell explains that mathematicians don't just care about mental exercise. Some believe if students learn certain skills and procedures without calculators, they may develop a better understanding of math foundations. They argue that "Calculators do have a place in mathematics education, and mathematicians certainly make use of calculators and computers. However, there remains a good portion of mathematics that mathematicians want students to do without calculators" (Latterell, 2005, p. 28).

Despite the debate, calculators are a common accommodation given in students' Individualized Education Programs (IEPs). Calculators come in many types with varying capabilities and higher-level math courses require the use of scientific or graphing calculators. To benefit from having calculators, students must first understand how to use a calculator's functions and just having a calculator does not replace the need for other interventions to help students master the conceptual math principals of math (Bone & Bouck, 2016). In primary grades, the focus of math curriculum is developing fundamental skills such as math facts and basic operations, but at the secondary level the emphasis shifts to higher level mathematical understanding (Bone & Bouck, 2016).

Furthermore, Steele proposes in her 2006 article that "…although graphing calculators are clearly useful resources for both teachers and students, the calculators frequently present challenges for students with learning problems" (p. 32). She proposed several methods for teaching students with mild disabilities to effectively use these powerful tools to improve their understanding and performance in secondary math classes. She recommends the following ways to improve students' calculator skills to produce better problem-solving:

- **Mnemonics**
- **Multisensory instruction**
- **Modeling**
- **Chunking**
- **Sample problems**
- **Student questions**
- **Realistic examples**
- **Practice**

Many high school students with mild disabilities do not recall basic math facts or procedures. This memory gap can interfere with their mastery of the more conceptual math content because their focus and energy is spent on still trying to perform more basic processes. With their attention focused on basic math they can't learn the concept at hand. For example, when learning about similar triangles, students can spend so much time and energy on algebraic processes in solving proportions that they miss the overarching principles of similarity. Using calculators for the prior skills allows students to pay more attention to the new concept of similarity. Calculators can free up mental resources to use toward mastery of the conceptual skills rather than algebraic or computational skills.

There are many good calculators available, including the Texas Instruments scientific and graphing calculators. One barrier for students is cost, since a good graphing calculator can easily cost $100 or more. One source of free online calculators is Desmos.com, which offers both scientific and graphing calculators.

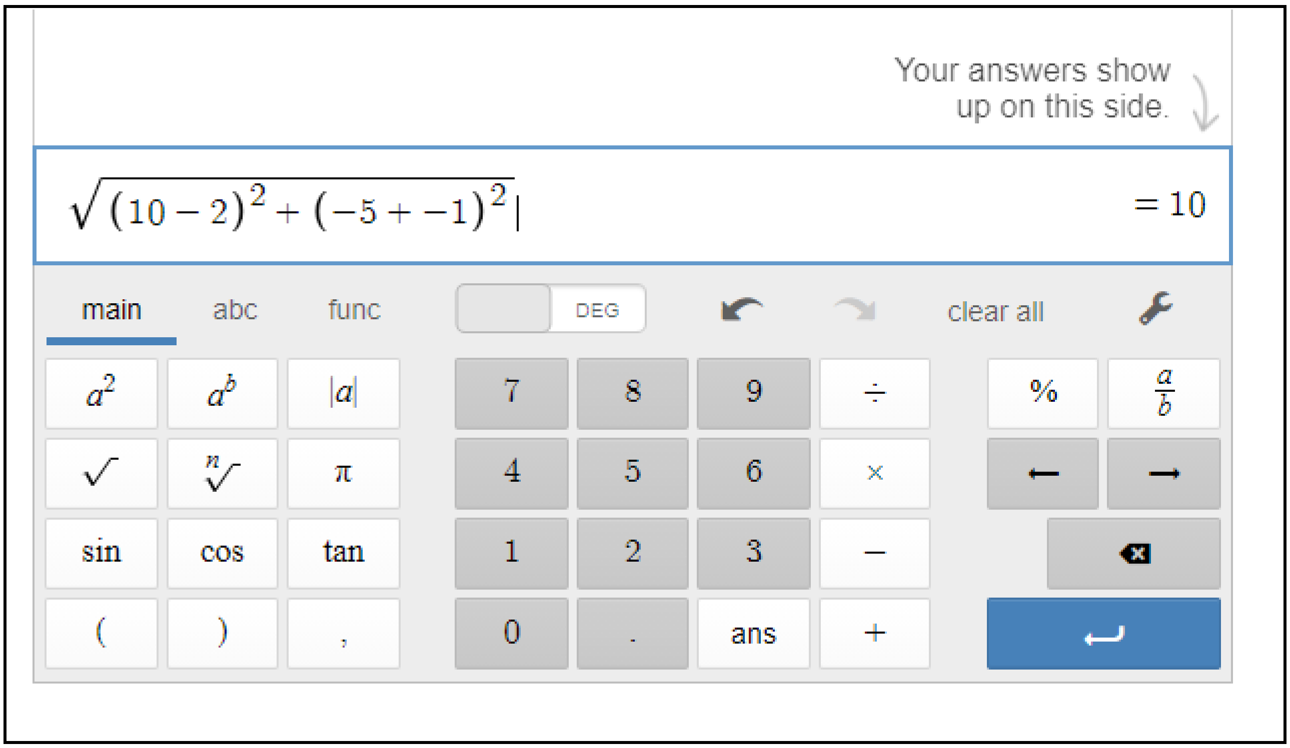


Figure 18: Desmos Scientific Calculator showing a distance formula problem https://learn.desmos.com/.

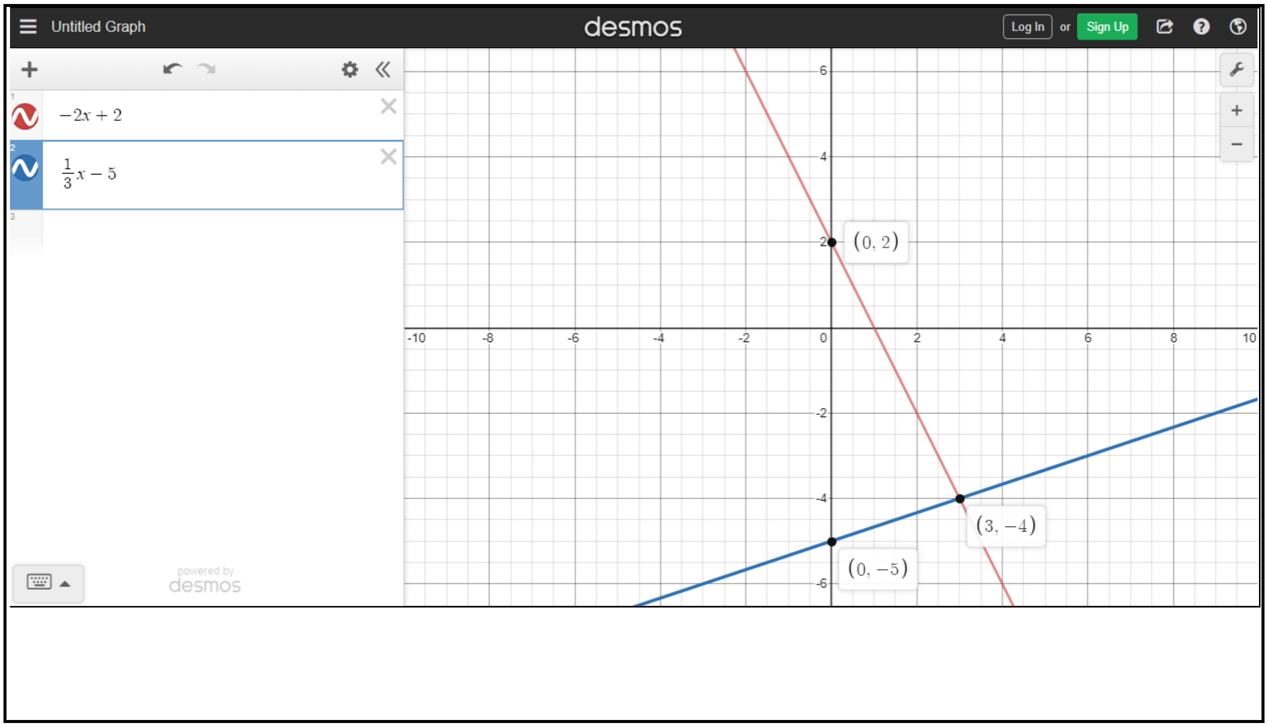


Figure 19: Desmos Graphing Calculator showing a system of 2 equations

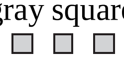
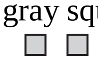
These calculators can help compensate for students' difficulties with calculations, fractions, and even order of operations to some extent. Desmos online calculators prepopulate end parenthesis, which helps prevent one common mistake students make when entering equations. Desmos offers tutorials on its calculators at https://learn.desmos.com/.

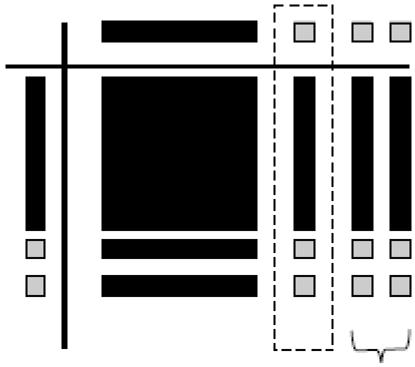
Physical and Virtual Manipulatives

Manipulatives have been used for decades, particularly with students in primary grades. Some examples include base 10 blocks, fraction strips, GeoSolids, balance scales, and algebra tiles. They can be used alone or in conjunction with other teaching strategies. One way to use manipulatives is as part of a process known as Concrete-Representational-Abstract (CRA) or Concrete-Semi-concrete-Abstract (CSA). As a result of their research, Maccini, Strickland, Gagnon, and Malmgren (2008) developed one very thorough lesson plan incorporating the STAR cognitive strategy with CSA. The lesson is on multiplying binomials from word problems. The first problem they used was:

> Jill's house is being renovated and her bedroom will be enlarged. Currently, her room is shaped like a square. After the renovation, the length of Jill's bedroom will be 3 feet longer and the width will be 2 feet longer. Write an expression to represent the new dimensions of Jill's bedroom and the polynomial expression for the area of Jill's new bedroom. (p. 8).

The teacher begins modeling the STAR process.

1. Search the word problem.
    a. They locate the current dimensions and increase for the length and width of the room.
2. Translate the problem with manipulatives.
    a. Use a long black tile to represent the current length of Jill's bedroom.
        i. 
    b. Use 3 gray squares to represent the 3 feet being added to the length.
        i. 
    c. Since the bedroom is square, use a long black square for the width of the room.
        i. 
    d. Use 2 gray squares for the 2 feet being added to the width.
        i. 
    e. Put the manipulatives together for the whole length.
        i. 
    f. Put the manipulatives together for the whole width.
        i. 
    g. Use the tiles to represent multiplication of the length x width.



3. Answer the problem
    a. Write this as a polynomial. The large square tile represents the x^2 term, the long black tiles represent the x term, and the small gray squares represent the constant term, resulting in $x^2 + 5x + 6$
4. Review the problem
    a. Read the problem again and review the answer, checking that it makes sense.

The sample lesson plan proceeds to show how to do increasingly complex problems using the same procedure, including multiplying binomials where constants are subtracted because a dimension is being decreased. It also provides a guide for remediation and extension using the manipulatives.

Once students understand the process using manipulatives, the teacher does another problem in which instead of using manipulatives, they <u>draw</u> a picture of the manipulatives as they would be arranged while solving the problem. This the semi-concrete phase of CSA.

The final step of CSA is abstract, where math symbols are used to represent the problem. In the example problem above, the dimensions of Jill's bedroom would be shown as a length of (x + 3) and a width of (x + 2). Those would be multiplied together as (x + 3)(x + 2) and result in the answer of $x^2 + 5x + 6$, which is the same answered obtained with the previous two methods of concrete and semi-concrete.

This was a simplified summary of the lesson plan. The entire plan can be found in their paper *Accessing the General Education Math Curriculum for Secondary students with HID*, published in the April 2008 edition of Focus on Exceptional Children.

Figure 20 below shows another example of the use of manipulatives with the CSA strategy.

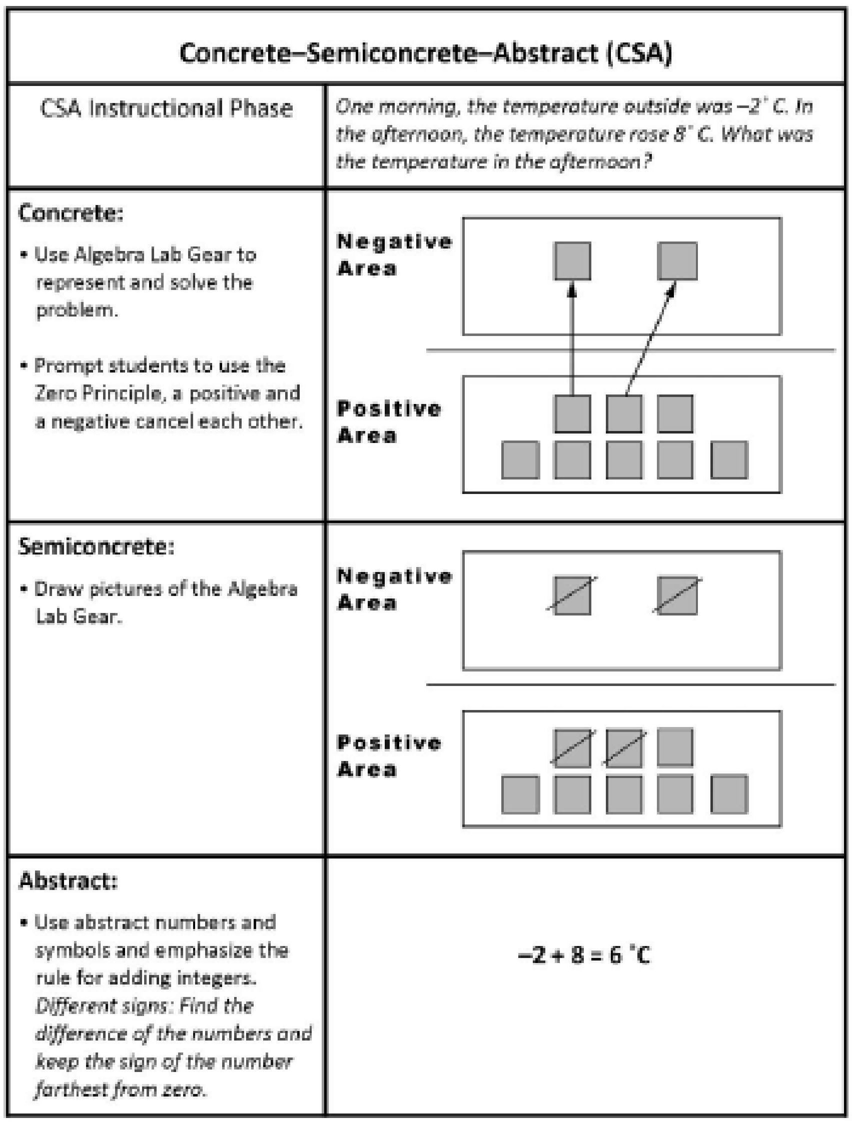


Figure 20: Concrete-representational-abstract strategy, or CRA (Strickland & Maccini, 2015. p. 41)

With the availability of technology, virtual manipulatives are becoming more widely available. The results of one study suggested that both types of manipulatives have significant potential as tools for teaching math to elementary students with ASD (Bouck, Satsangi, Doughty & Courtney, 2014). The students in this study expressed a preference for the virtual manipulatives, perhaps because they were easy to use, required less fine motor skills, included on-screen animations, and were visually engaging. The researchers also stated "…the virtual manipulatives allowed less room for error when completing intervention and the opportunity for self-directed correction of errors when solving problems" (Bouck, Satsangi, Doughty, & Courtney, 2014, p. 191).

A later study compared the effectiveness of concrete manipulatives versus virtual manipulatives with three high school students with LD (Satsangi, Bouck, Taber-Doughty, Bofferding, & Roberts, 2016). Both types of manipulatives improved the students' performance on algebra tasks, but one possible advantage of virtual manipulatives are their time efficiency because they are faster to set up and reset for the next task. Another possible advantage is the greater independence of students using virtual manipulatives because there are self-correcting constraints built into them. Each student preferred one type over the other and performed better with the one they preferred.

The availability of virtual manipulatives is constantly changing. As of this writing, there are several good online sources for free virtual manipulatives. Two sites that have good materials for high school geometry and algebra are Geogebra (https://www.geogebra.org/) and NCTM's Illuminations (https://illuminations.nctm.org/Search.aspx?view=search&type=ac) by the National Council of Teachers of Mathematics (NCTM). Geogebra has hundreds of animations and manipulatives for geometry concepts. The following 3 figures are examples.

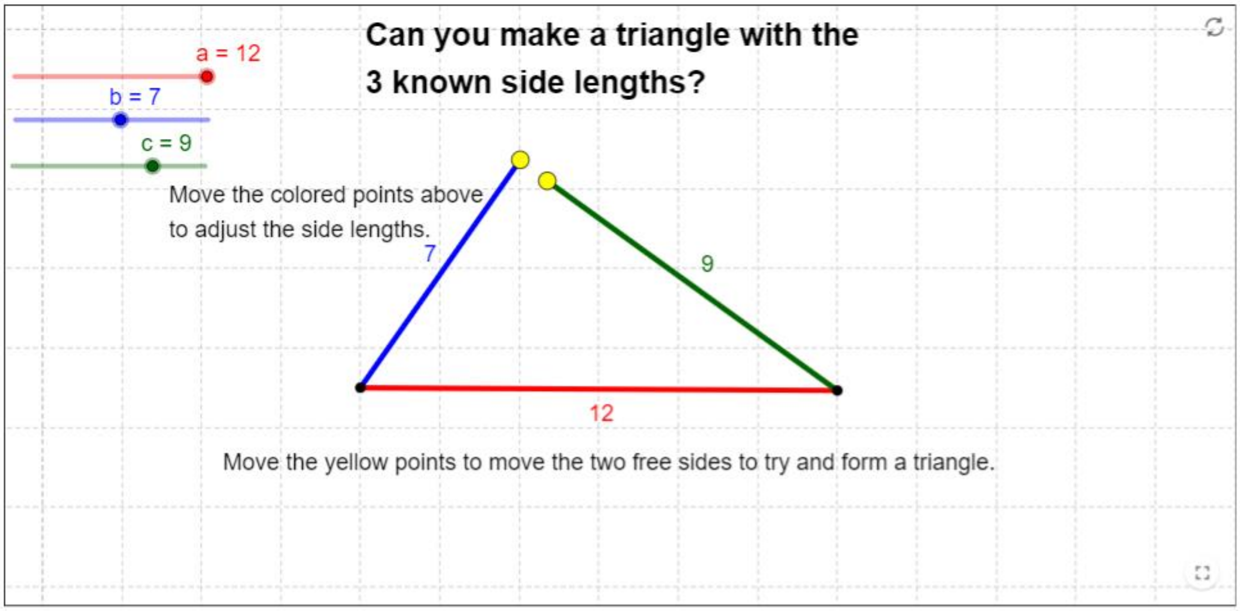


Figure 21: Triangle Inequality Theorem https://www.geogebra.org/m/FAhtKpR5

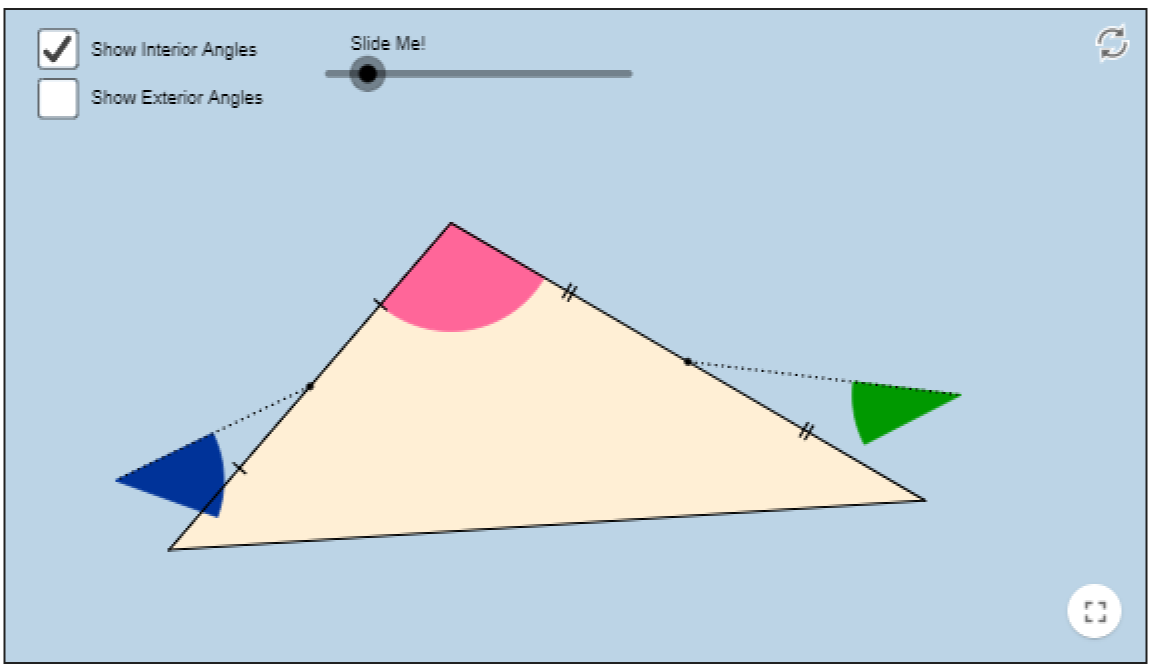


Figure 22: Triangle Sum Theorem and Exterior Angle Theorem
https://www.geogebra.org/m/FAhtKpR5

Exterior Angles of a Pentagon

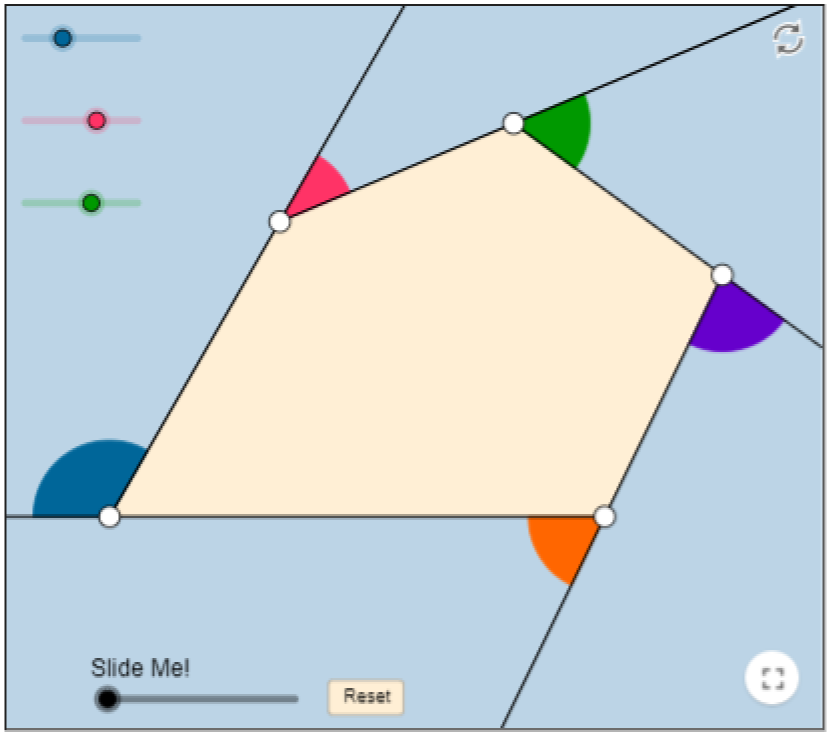


Figure 23: Exterior Angles of Polygons https://www.geogebra.org/m/pPhgGMse

The National Council of Teachers of Mathematics (NCTM) has a website called Illuminations with manipulatives for various grades and content, including algebra, geometry, and trigonometry. Examples of two common algebra manipulatives are shown below in Figures 24 and 25.

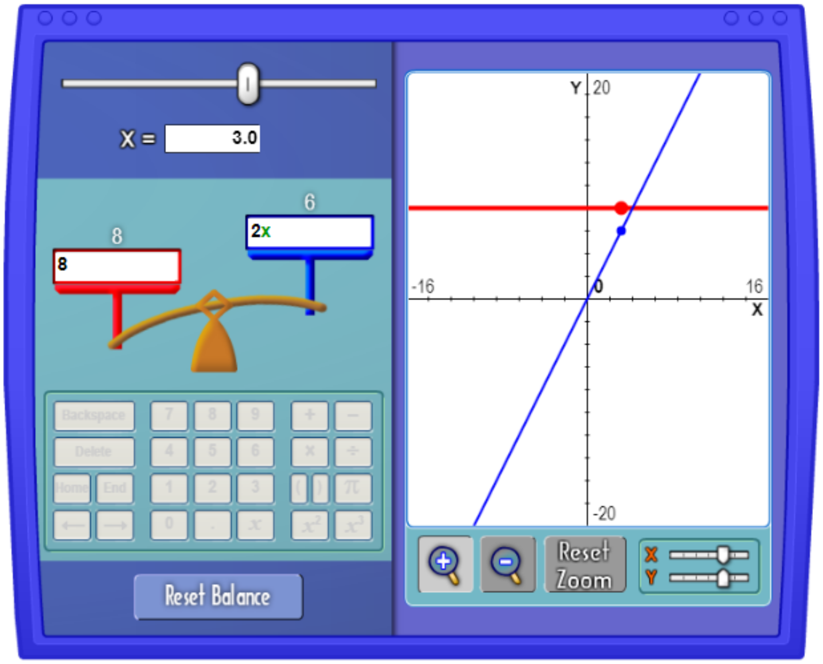


Figure 24: Pan Balance - Expressions https://www.nctm.org/Classroom-Resources/Illuminations/Interactives/Pan-Balance----Expressions/

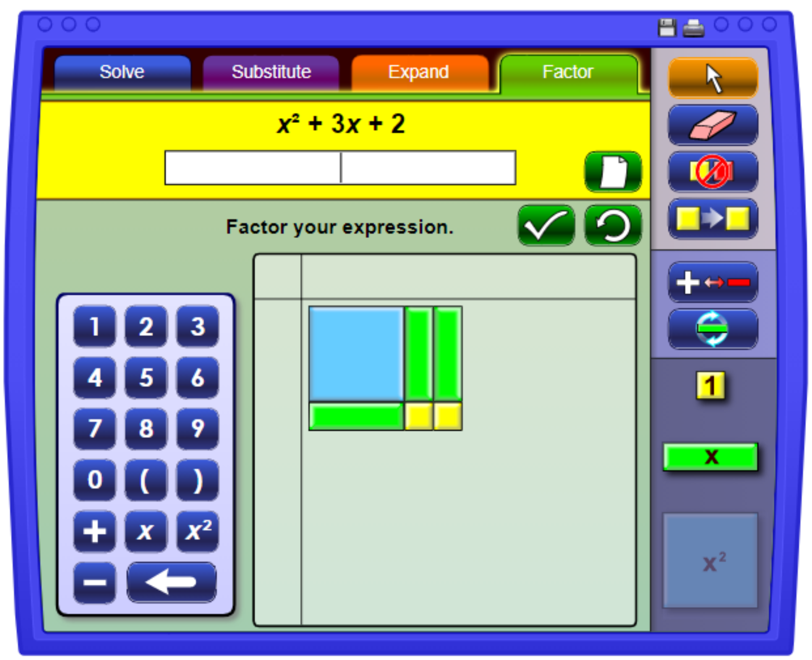


Figure 25: Algebra tiles https://www.nctm.org/Classroom-Resources/Illuminations/Interactives/Algebra-Tiles/

Virtual manipulatives have some benefits for remote learning, since the ones included here are free and can be accessed from students' computers from home. In addition to using them during direct instruction, teachers can link them on their schools' Learning Management System pages so students can use them to explore concepts further at school or at home.

Co-Teaching

Co-teaching is becoming more common in high school math classes. Magiera, Smith, Zigmond, and Gebauer (2005) conducted observations of co-teaching in math classes at ten high schools. Based on their observations, they made some recommendations for co-teachers to perform together more effectively. One important tool co-teachers need is a common planning time so they can discuss the curriculum, the needs of specific students, and create a plan together. Co-teachers need to work together over a period of at least two years to develop the teamwork necessary. The teachers should utilize varying small group instruction practices, and the special education teacher should actively teach math content. Both teachers should be presented as equals in the teaching environment, each having their own desk in the classroom and their names included on the classroom door, the boards, and all class materials such as tests and assignments. Throughout the next six pages, some visuals and summaries of the common co-teaching models are included (Teaching for Tolerance, n.d.).

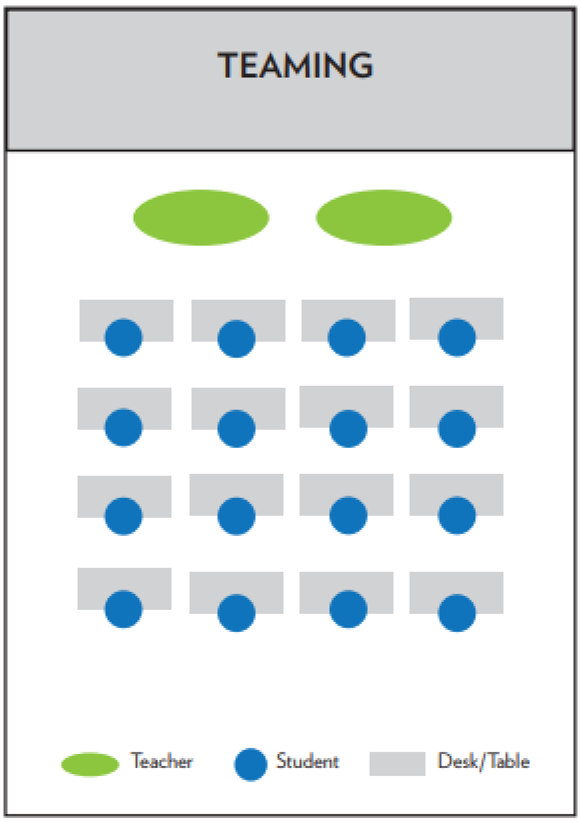


Figure 26: Team Teaching (Teaching for Tolerance, n.d.)

Team Teaching

Co-teachers are both delivering instruction to the whole class together.

Co-teachers are interacting with each other in a conversational manner during instruction.

Requires more planning, collaboration, and trust between teachers.

Best used when all students are working on the same thing or at the same level.

Provides less opportunity for individual student assistance.

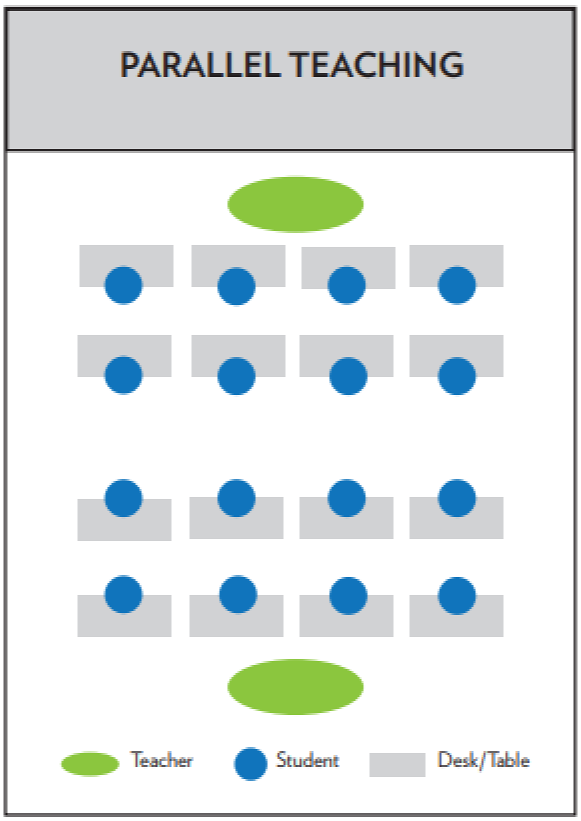


Figure 27: Parallel Teaching
(Teaching for Tolerance, n.d.)

Parallel Teaching

Class is divided into two groups and one teacher delivers instruction to each group simultaneously.

Useful when smaller teacher to student ratio is desired.

Allows content to be delivered in 2 different ways.

Separation into groups should be carefully planned.

Best when all students are working on the same content but at different levels.

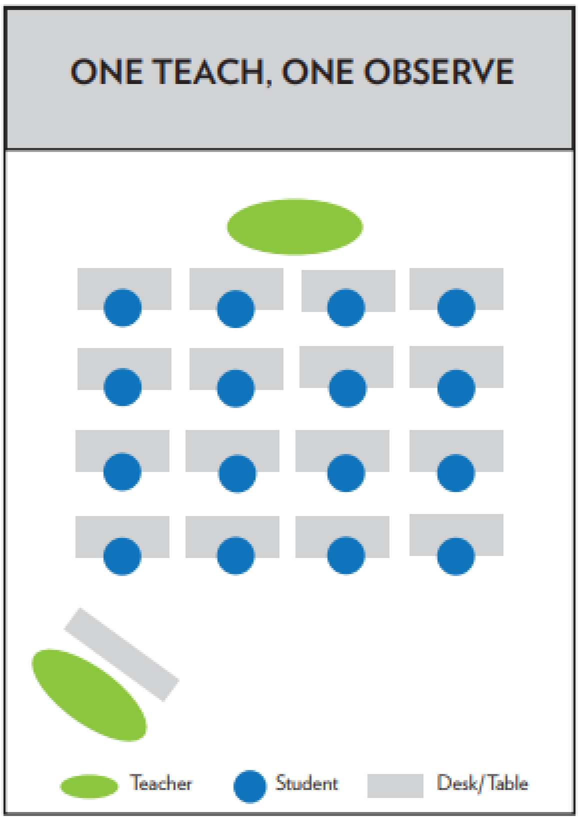


Figure 28: One Teach, One Observe (Teaching for Tolerance, n.d.)

One Teach, One Observe

Co-teachers plan in advance what observations they want to make and what data to collect.

One teacher provides instruction while the other teacher observes the students.

Observing teacher collects the data as planned.

Opportunity to evaluate the lesson and provide feedback for the teacher leading it.

Useful for gathering information about how individual students respond and learn.

Observing teacher does not help students during the lesson.

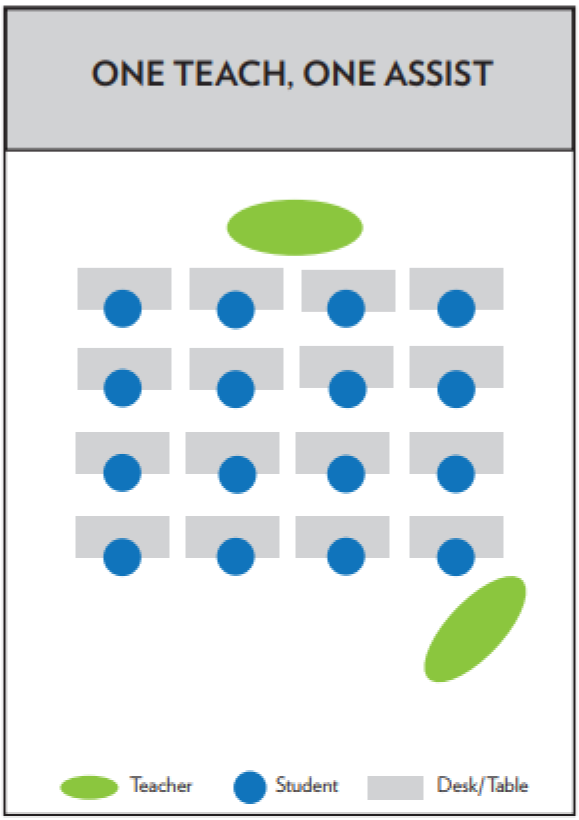


Figure 29: One Teach, One Assist (Teaching for Tolerance, n.d.)

One Teach, One Assist

One teacher leads the lesson while the other circulates around the room.

Circulating teacher assists individual students while instructing teacher continues with the lesson.

Works well when students are all working on mastery of the same content, but gaps have been identified in certain students.

May be distracting to some students during class.

Tends to be overused form of co-teaching because it is the easiest to adopt.

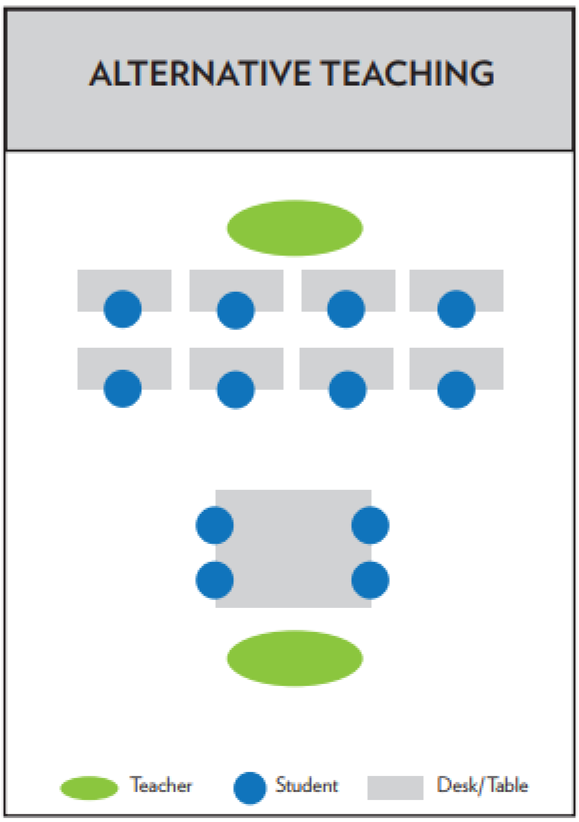


Figure 30: Alternative Teaching (Teaching for Tolerance, n.d.)

Alternative Teaching

One teacher delivers instruction to a large group of students, while the other teacher delivers instruction to a smaller group.

Each teacher delivers the same lesson, but at different levels or in a different way.

Useful when mastery will look different for different students.

Requires planning and teaching 2 lessons.

Allows differentiation within the classroom.

Purpose and make-up of small groups vary.

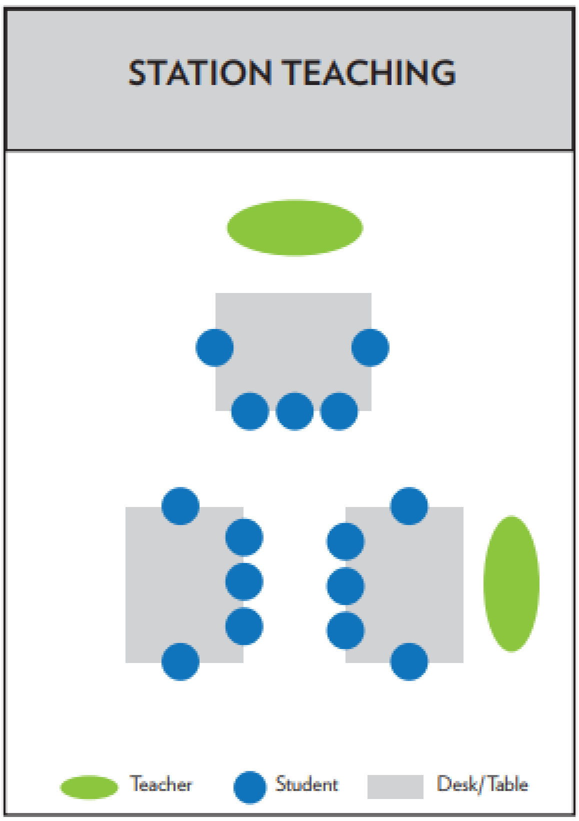


Figure 31: Station Teaching (Teaching for Tolerance, n.d.)

Station Teaching

Content is divided into 3 sections and students are assigned to 3 groups.

Each section of content is presented at a separate station.

Each teacher leads 1 station. The 3rd station provides independent practice. Students rotate among the stations.

Useful when the lesson contains smaller skills or topics.

Students can be grouped various ways to meet individual needs.

Teachers can't collaborate during stations.

Conclusion

Math teachers may already be familiar with many of these strategies, since they can be useful for any students, not just those with mild disabilities. However, it would be useful to view some of these through the specific lens of students with IEPs because they may have a greater need to learn and use these tools. Non-disabled students may be adept at using a variety of strategies or even creating their own, but students with mild disabilities tend to need more direct instruction on such practices. In one study, the researchers were surprised to find that eighth-grade students with learning disabilities did not know what diagrams were or how to create them at the beginning of the study. After being taught how to create and use diagrams, the students' performance on one and two-step problems improved and the students generalized the skills to other problems study (van Garderen, 2007). These tools can help such students reduce procedural errors and mistakes due to memory issues. Having information organized in a neat and orderly way can help students with memory challenges store and retrieve information more easily on the page so they don't have to rely as much on their memory. These students could benefit from the intentional instruction of such techniques.

Resources

For more information, see these resources:

<u>Background Research</u>

Bouck, E. C., Park, J., Bouck, M. K., Alspaugh, J., & Spitzley, S. (2019). Exploration of a middle school Tier 2 math lab on student performance. *Preventing School Failure: Alternative Education for Children and Youth, 63*(1), 89-95.

Boyd, B, & Bargerhuff, M. E. (2009). Mathematics education and special education: Searching for common ground and the implications for teacher education. *Mathematics Teacher Education and Development, 11*, 54-67.

Gersten, R. M., & Newman-Gonchar, R. (2011). *Understanding RTI in mathematics: Proven methods and applications*. Baltimore, MD: Paul H. Brookes.

Grskovic, J. A., & Trzcinka, S. M. (2011). Essential standards for preparing secondary content teachers to effectively teach students with mild disabilities in included settings. *American Secondary Education, 39*(2), 94-106.

Ives, B. (2007). Graphic organizers applied to secondary algebra instruction for students with learning disorders. *Learning Disabilities Research & Practice*, *22(2)*, 110-118. doi:10.1111/j.1540-5826.2007.00235

Marita, S., & Hord, C. (2016). Review of mathematics interventions for secondary students with learning disabilities. *Learning Disability Quarterly*, *40*(1), 29–40. doi:10.1177/0731948716657495

Montague, M., Enders, C., & Dietz, S. (2011). Effects of cognitive strategy instruction on math problem solving of middle school students with learning disabilities. *Learning Disability Quarterly, 34*(4), 262-272. doi:10.1177/0731948711421762

Rodgers, W. J., & Weiss, M. P. (2019). Specially Designed Instruction in secondary co-taught mathematics courses. *Teaching Exceptional Children, 51*(4), 276–285. doi: 10.1177/0040059919826546

Satsangi, R., Hammer, R., & Evmenova, A. S. (2018). Teaching multistep equations with virtual manipulatives to secondary students with learning disabilities. *Learning Disabilities Research & Practice, 33*(2), 99-111. doi:10.1111/ldrp.12166

Shoulders, T. L., & Krei, M. S. (2016). Rural secondary educators' perceptions of their efficacy in the inclusive classroom. *Rural Special Education Quarterly*, 35(1), 23-30. doi:10.1177/875687051603500104

Steele, M. M. (2006). Graphing Calculators: Teaching suggestions for students with learning problems. *TechTrends*, *50*(6), 32–35. doi:10.1007/s11528-006-7616-8

Strickland, T. K. (2016). Using the CRA-I strategy to develop conceptual and procedural knowledge of quadratic expressions. *Teaching Exceptional Children*, *49*(2), 115–125. doi:10.1177/0040059916673353

Evidence-Based Strategies

Graphic Organizers

Ives, B., & Hoy, C. (2003). Graphic organizers applied to higher-level secondary mathematics. *Learning Disabilities Research & Practice, 18(1)*, 36-51.

Strickland, T. K., & Maccini, P. (2010). Strategies for teaching algebra to students with learning disabilities: making research to practice connections. *Intervention in School and Clinic,* 46(1), 38–45.doi:10.1177/1053451210369519

Zollman, A. (2009). Students Use Graphic Organizers to Improve Mathematical Problem-Solving Communications. *Middle School Journal, 41*(2), 4-12. doi:10.1080/00940771.2009.11461707

Zollman, A. (2012). Write is right: Using graphic organizers to improve student mathematical problem solving. *Investigations in Mathematics Learning, 4*(3), 50-60. doi:10.1080/24727466.2012.11790316

Diagrams

Carcoba Falomir, G. A. (2019). Diagramming and algebraic word problem solving for secondary students with learning disabilities. Intervention in School and Clinic, 54(4), 212–218. https://doi.org/10.1177/1053451218782422

van Garderen, D. (2007). Teaching students with LD to use diagrams to solve mathematical word problems. *Journal of Learning Disabilities,* 40(6), 540–553. doi: 0.1177/00222194070400060501

Walsh, J. B., & Hord, C. (2019). Using gestures and diagrams to support students with learning disabilities enrolled in Algebra II. *Learning Disabilities: A Contemporary Journal*, *17*(1), 59–75.

Teaching Cognitive and Metacognitive Strategies

Carcoba Falomir, G. A. (2019). Diagramming and algebraic word problem solving for secondary students with learning disabilities. Intervention in School and Clinic, 54(4), 212–218. https://doi.org/10.1177/1053451218782422

Karabulut, A., & Özmen, E. R. (2019). Effect of "Understand and Solve" strategy instruction on mathematical problem solving of students with mild intellectual disabilities. *International Electronic Journal of Elementary Education*, *11*(2), 77–90. doi:10.26822/iejee.2018245314

Maccini, P., Strickland, T., Gagnon, J. C., & Malmgren, K. W. (2008). Accessing the general education math curriculum for secondary students with high incidence disabilities. *Focus on Exceptional Children*, *40*(8), 1-32.

Marita, S., & Hord, C. (2016). Review of mathematics interventions for secondary students with learning disabilities. *Learning Disability Quarterly*, *40*(1), 29–40. doi:10.1177/0731948716657495

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Physical and Virtual Manipulatives

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Strickland, T. K. (2016). Using the CRA-I strategy to develop conceptual and procedural knowledge of quadratic expressions. *Teaching Exceptional Children*, *49*(2), 115–125. doi:10.1177/0040059916673353

Co-Teaching

Magiera, K., Smith, C., Zigmond, N., & Gebauer, K. (2005). Benefits of co-teaching in secondary mathematics classes. *Teaching exceptional children*, *37*(3), 20-24.

Teaching for Tolerance (n.d.). Seamless Teaching: 6 co-teaching models for the inclusion classroom. Retrieved February 07, 2021, from https://www.learningforjustice.org/sites/default/files/general/Seamless%20Teaching%20Handout.pdf

CHAPTER 6. CONCLUSION

The purpose of this study was to investigate teachers' knowledge of evidence-based strategies for teaching high school math to students with mild disabilities. The research was based on three questions. What knowledge do general education teachers have about the impacts of mild disabilities on student learning? What strategies are teachers aware of, have used in the past, or are currently using to teach math skills for students with mild disabilities? What do teachers think are some of the most effective strategies for teaching math skills to students with mild disabilities?

First, a literature review was conducted to identify strategies that have been researched for use with this group of students. The literature review revealed a gap in research of specific strategies with high school students. A variety of strategies were identified and used to develop a survey, which was sent to 18 high school math and special education teachers who teach math. Fifteen of the 18 teachers responded to the survey. This is a response rate of 83%, unusually high for this type of study. Only one request was made for participation and most responses were received within 48 hours. Once possible explanation for the high response rate is that it was given during the COVID-19 pandemic during a week in which students were all learning remotely. This gave teachers more flexibility with their time that week. The literature and the survey results were used as a starting point for developing a handbook of resources for high school teachers to support students with mild disabilities with learning math.

Math teachers may already be aware of many of the strategies in the literature, since they can also be useful for students of all abilities. However, students with IEPs may have a greater need to learn and use these tools. While non-disabled students may be adept at using a variety of strategies or even creating their own, students with mild disabilities tend to need more direct instruction on such practices. In one study, the researchers were surprised to find that eighth-grade students with learning disabilities did not know what diagrams were or how to create them at the beginning of the study. After being taught how to create and use diagrams, the students' performance on one- and two-step problems improved and the students generalized the skills to other types of problems study (van Garderen, 2007). Appropriate tools can help students with mild disabilities reduce procedural errors and mistakes due to memory issues. Having information organized in a neat and orderly way can help students with memory challenges store and retrieve information more easily on the page so they don't have to rely as much on their memory. These students could benefit from the intentional instruction of such techniques.

Another issue, as pointed out in the limitations section, is that scholarly, published articles are not accessible to teachers, who are the actual users of effective teaching strategies. Teachers do not have access to free research articles unless they are enrolled in higher education institutions, which include access to scholarly articles in their cost. Freely available sources lack information about whether they are validated by research and/or recommended practices or not. Some organizations provide useful information only for a short time, and many resources are expensive. They cannot be freely downloaded and printed by teachers. This is a huge gap that must be addressed. According to Gullion, J. S., and Tilton, A. (2020) in their book, *Researching With: A Decolonizing Approach to Community-Based Action Research*, research findings must be freely available to the participants that may actually use them in their work or lives.

Survey Results

The survey collected some general information about the teachers' license, years of experience, and training. It then provided a list of specific strategies and asked teachers if they were familiar with them, had used the strategies, found them effective, and would use them in the future. It also provided predetermined choices of challenges faced by students with mild disabilities and barriers that might prevent teachers from implementing listed strategies. Several of the questions allowed teachers to type in additional methods, student challenges, and barriers to implementation.

The resulting data showed a notable difference between teachers with special education licenses and those with math licenses. Although special education teachers consistently reported more knowledge and use of evidence-based strategies for high school math, math teachers reported a high level also. Overall, teachers reported extensive knowledge, experience, and willingness to implement these research-based strategies.

The student challenges teachers were least familiar with were visual and auditory processing. Unfortunately, the literature review did not find any research related to those particular issues with respect to high school math. Therefore, more research is needed in this area. Another notable finding of the survey was the universal support of co-teaching as a strategy. Use of a calculator was a close second, but there were two math teachers who reported they would not want to implement this. This result is not a surprise, given that there is an ongoing debate in the math teaching community over whether calculator use reduces students' proficiency and math sense.

Over half of the teachers reported lack of resources as a barrier. This finding supports the need for a convenient handbook of tools and strategies. The biggest concern teachers reported was the class time needed for these strategies as also reported in other studies (Marita & Hord, 2016), so the handbook was developed with this in mind.

Limitations of the Research

One limitation of the survey is the small sample size. The teachers surveyed were also all teachers at one school in a Midwestern school, so the diversity of their past experiences was probably fairly narrow. One reason for this sample of participants was convenience, given the time limits of the project. A larger study including more teachers and in more diverse school settings would provide a broader view of the challenges of teaching math to high school students with mild disabilities. Also, a larger pool of respondents may reveal more correlations among background characteristics of teachers and their responses to other questions. For example, the existing survey results did not find a significant relationship between years of experience and knowledge of strategies, but a larger sample might find a relationship. Additionally, the only source of data was the survey, due to constraints of time and restrictions induced by the COVID-19 pandemic. Broader conclusions could have been drawn by sourcing additional data sets such as interviews and observations, to achieve data triangulation. The strategies included in the survey were limited to those found in the literature review. As a result, the study findings cannot be generalized for all teachers, although some of the findings may be parallel with similar research on this topic. With more time to spend on literature review, more strategies might be found.

Strengths and Limitations of the Handbook

One of the strengths of the handbook is that it includes strategies that have been researched with students with various mild disabilities and have shown promise. Since most teachers don't have the time or desire to read research studies about different methods, this handbook is a more practical and efficient way for them to access the information. Also, the handbook presents strategies from many studies in a single resource, for time-saving access to a variety of tools.

Another strength of the handbook is that it was developed by a teacher with real classroom experience teaching math to this group of students. While the researcher hasn't tried all of the strategies described here, they have used several of them successfully with their own students and have seen students' confidence and pride increase once they are taught to use tools that help them solve math problems correctly on their own.

One weakness of the handbook is that while research evidence for many strategies was included, a few other research-based strategies were not. For example, Enhanced Anchored Instruction (EAI) is not included in the handbook because the video resources, such as *The New Adventures of Jasper Woodbury*, Learning and Technology Center at Vanderbilt University, 1997 and Grand Pentathlon (Bottge, Grant, Stephens, & Rueda, 2010; Bottge, et al, 2015), used by the researchers could not be located at the time the handbook was developed. The websites cited are no longer active, so these resources may no longer be available. Also, when they were available, they had to be purchased.

Some of the virtual manipulatives used in the research aren't readily available any more either. One example is the National Library of Virtual Manipulatives (NLVM, nlvm.usu.edu) referenced by some studies, which used to offer free online manipulatives to anyone. The website had a large and varied collection of manipulatives organized by course content and grade level. Currently, the collection is not compatible with Google Chrome and is only available with a paid subscription. While there are still a variety of virtual manipulatives still available, it took a lot of time and persistence to find useful ones that are available to teachers at no cost.

The virtual manipulatives included in the handbook haven't been used in scholarly research, and therefore point to a need for further research in the area of math manipulatives for secondary levels. At this time, one can only assume they would be similarly effective to the few used in previous studies.

Suggestions for Future Research

There were many gaps in the previous research that were beyond the scope of this research. One is the small sample sizes in the existing research. Another is the limited variety of specific strategies and tools that have been studied. For example, there are many different graphic organizers and manipulatives that were not included in any of the prior research. In addition, the specific tools that have been researched were mostly tested with middle school students. Research with high school students may yield different results due to the increased complexity and variety of math concepts taught in high school.

One suggestion would be to conduct studies with a larger group of students. Another would be to repeat past research but specifically with high school students to see how well the findings transfer to this different age group and content. Yet another would be to conduct some research comparing various versions of specific strategies, such as comparing the effectiveness of different types of graphic organizers for the same content within one study. This could help identify specific characteristics of graphic organizers that help students. Alternatively, a comparison could be made using the same tool with different content. For example, researchers could investigate whether the same graphic organizer is equally effective with solving linear equations, inequalities, absolute values, quadratics, and systems of equations. This type of research could identify certain tools that lend themselves to different content or types of problems. An additional aspect of research could be to have teachers try several different tools and rate them for the ease of incorporating them into the classroom. This could be invaluable because even the best strategies will not help students if teachers do not adopt them.

Even co-teaching, which received the most positive responses, needs additional research. Despite the positive expectations the teachers expressed toward co-teaching, research showing conclusive evidence of its efficacy is lacking (Magiera, & Zigmond, 2005). There are many resources about how to implement co-teaching and lots of anecdotal evidence, but not compelling data proving that it improves the outcomes of students.

This study only begins to address the gap in research related to math instruction of students with mild disabilities at the high school level. Much more research is needed to fill this gap. One finding from this survey was that teachers reported a lower willingness to use strategies than they reported expecting them to be successful. It would be interesting to investigate the reason for this discrepancy. This discrepancy may indicate there are barriers that are unrecognized or unreported by teachers. A comparison between teachers' answers to such questions and observations of their practices in their classrooms may yield useful information on developing the professional development, coaching, and resources needed to bridge this divide. Easier access to the most current research may be one step toward helping teachers implement new strategies that would benefit students. Teachers need free and easy access to the most recent research, as proposed by Gullion and Tilton in *Researching With: a Decolonizing Approach to Community-Based Action Research* (2020). An even better solution would be to provide the key findings from current research in easily accessible, understandable, and actionable formats without waiting for teachers to seek it out or require them to wade through lengthy research reports. As we know, time is a limited resource for all teachers.

Another interesting finding of this study was the notable difference in responses between teachers with math licenses and special education licenses. The type of teacher license merits some investigation to determine the cause of this difference and whether teacher training should be altered to present information about tools for students with mild disabilities to teachers of all content areas. Additionally, more research could be conducted on effective ways to leverage the expertise of special education teachers in high school general education math classes.

Ultimately, additional research could benefit both students and teachers if it can identify specific tools and strategies that are not only effective to high school math students, but also easy for teachers to find and implement. This could result in positive outcomes not only for teachers and students, but for society at large by enabling students to learn to their greatest potential and enter adulthood with both competence and confidence in math skills and concepts.

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APPENDIX A. SURVEY

Math Teaching Strategies Survey

Please respond to all questions and submit your answers by 2/12/2021. All responses are anonymous and will be stored in a secure password-protected file. The data will be used only for my graduate research study. Thank you for your help with this!

1. What is your teaching license? Check all that apply.

__ Mathematics
__ Special Education
__ Other:

2. How long have you been teaching mathematics?

__ 1 - 2 years

__ 3-5 years

__ 5 - 10 years

__ over 10 years

3. How much specialized training in Special Education have you received, either as part of your degree or as part of Professional Learning?

None 1 2 3 4 5 Extensive

Grskovic, J. A., & Trzcinka, S. M. (2011). Essential standards for preparing secondary content teachers to effectively teach students with mild disabilities in included settings. *American Secondary Education*, 94-106.

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4. How prepared do you feel to meet the educational needs of Special Education students?

Not at all 1 2 3 4 5 Completely

Grskovic, J. A., & Trzcinka, S. M. (2011). Essential standards for preparing secondary content teachers to effectively teach students with mild disabilities in included settings. *American Secondary Education*, 94-106.

Shoulders, T. L., & Krei, M. S. (2016). Rural secondary educators' perceptions of their efficacy in the inclusive classroom. *Rural Special Education Quarterly*, 35(1), 23-30.

5. How often have you had students with IEPs in your classes in the past?

__ Always
__ Frequently
__ Occasionally
__ Rarely
__ Never
__ Unsure

McLeskey, J., Landers, E., Williamson, P., & Hoppey, D. (2012). Are we moving toward educating students with disabilities in less restrictive settings? *The Journal of Special Education*, *46*(3), 131-140.

6. Do you currently have students with IEPs in your classes?

__ Yes
__ No
__ Unsure

McLeskey, J., Landers, E., Williamson, P., & Hoppey, D. (2012). Are we moving toward educating students with disabilities in less restrictive settings? *The Journal of Special Education*, *46*(3), 131-140.

7. Have you ever used teaching strategies specifically designed to support students with IEPs?

__ Yes
__ No
__ Not sure what this means.

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Walsh, J. B., & Hord, C. (2019). Using gestures and diagrams to support students with learning disabilities enrolled in Algebra II. *Learning Disabilities: A Contemporary Journal*, *17*(1), 59–75.

8. Before receiving this survey, which specific challenges were you aware of that students with IEPs may experience? Check all that apply.

__ reading comprehension
__ calculations such as basic math facts
__ lack of prerequisite skills
__ working memory such as processing, storing, and retrieving information
__ cognitive processing such as conceptualizing, abstract reasoning, and generalizing
__ motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator
__ social skills
__ attention deficits
__ visual processing disorders
__ auditory processing disorders
__ Other: ____

Rodgers, W. J., & Weiss, M. P. (2019). Specially Designed Instruction in secondary co-taught mathematics courses. *TEACHING Exceptional Children*, *51*(4), 276–285. doi: 10.1177/0040059919826546

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Walsh, J. B., & Hord, C. (2019). Using gestures and diagrams to support students with learning disabilities enrolled in Algebra II. *Learning Disabilities: A Contemporary Journal*, *17*(1), 59–75.

9. Before receiving this survey, which of these specific teaching strategies were you aware of? Check all that apply.

__ Allowing or providing calculators at all times
__ Direct instruction on how to use a calculator
__ Using physical manipulatives
__ Using virtual manipulatives
__ Using colors, gestures, or diagrams
__ Direct instruction on drawing effective diagrams
__ Using graphic organizers for math
__ Teaching cognitive or metacognitive strategies
__ Co-teaching
__ Other: ____

Ives, B. (2007). Graphic Organizers Applied to Secondary Algebra Instruction for Students with Learning Disorders. Learning Disabilities Research & Practice, 22(2), 110-118. doi:10.1111/j.1540-5826.2007.00235.x

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Rodgers, W. J., & Weiss, M. P. (2019). Specially Designed Instruction in secondary co-taught mathematics courses. *TEACHING Exceptional Children*, *51*(4), 276–285. doi: 10.1177/0040059919826546

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Steele, M. M. (2006). Teaching suggestions for students with learning problems. *TechTrends*, *50*(6), 32–35. doi: 10.1007/s11528-006-7616-8

Strickland, T. K. (2016). Using the CRA-I strategy to develop conceptual and procedural knowledge of quadratic expressions. *TEACHING Exceptional Children*, *49*(2), 115–125. doi: 10.1177/0040059916673353

Walsh, J. B., & Hord, C. (2019). Using gestures and diagrams to support students with learning disabilities enrolled in Algebra II. *Learning Disabilities: A Contemporary Journal*, *17*(1), 59–75.

10. Which of these specific teaching strategies have you used to support students with IEPs? Check all that apply.

__ Allowing or providing calculators at all times
__ Direct instruction on how to use a calculator
__ Using physical manipulatives
__ Using virtual manipulatives
__ Using colors, gestures, or diagrams
__ Direct instruction on drawing effective diagrams
__ Using graphic organizers for math
__ Teaching cognitive or metacognitive strategies
__ Co-teaching
__ Other: ____

Ives, B. (2007). Graphic Organizers Applied to Secondary Algebra Instruction for Students with Learning Disorders. Learning Disabilities Research & Practice, 22(2), 110-118. doi:10.1111/j.1540-5826.2007.00235.x

Karabulut, A., & Özmen, E. R. (2019). Effect of "Understand and Solve" strategy instruction on mathematical problem solving of students with mild intellectual disabilities. *International Electronic Journal of Elementary Education*, *11*(2), 77–90. doi: 10.26822/iejee.2018245314

Marita, S., & Hord, C. (2016). Review of mathematics interventions for secondary students with learning disabilities. *Learning Disability Quarterly*, *40*(1), 29–40. doi: 10.1177/0731948716657495

Rodgers, W. J., & Weiss, M. P. (2019). Specially Designed Instruction in secondary co-taught mathematics courses. *TEACHING Exceptional Children*, *51*(4), 276–285. doi: 10.1177/0040059919826546

Satsangi, R., Bouck, E. C., Taber-Doughty, T., Bofferding, L., & Roberts, C. A. (2016). Comparing the effectiveness of virtual and concrete manipulatives to teach algebra to secondary students with learning disabilities. *Learning Disability Quarterly*, *39*(4), 240–253. doi: 10.1177/0731948716649754

Steele, M. M. (2006). Teaching suggestions for students with learning problems. *TechTrends*, *50*(6), 32–35. doi: 10.1007/s11528-006-7616-8

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Walsh, J. B., & Hord, C. (2019). Using gestures and diagrams to support students with learning disabilities enrolled in Algebra II. *Learning Disabilities: A Contemporary Journal*, *17*(1), 59–75.

11. Which strategies, either listed here or other ones, have been successful when you have used them. Please describe what you did and what effects you saw among the students.

Ives, B. (2007). Graphic Organizers Applied to Secondary Algebra Instruction for Students with Learning Disorders. Learning Disabilities Research & Practice, 22(2), 110-118. doi:10.1111/j.1540-5826.2007.00235.x

Karabulut, A., & Özmen, E. R. (2019). Effect of "Understand and Solve" strategy instruction on mathematical problem solving of students with mild intellectual disabilities. *International Electronic Journal of Elementary Education*, *11*(2), 77–90. doi: 10.26822/iejee.2018245314

Marita, S., & Hord, C. (2016). Review of mathematics interventions for secondary students with learning disabilities. *Learning Disability Quarterly*, *40*(1), 29–40. doi: 10.1177/0731948716657495

Rodgers, W. J., & Weiss, M. P. (2019). Specially Designed Instruction in secondary co-taught mathematics courses. *TEACHING Exceptional Children*, *51*(4), 276–285. doi: 10.1177/0040059919826546

Satsangi, R., Bouck, E. C., Taber-Doughty, T., Bofferding, L., & Roberts, C. A. (2016). Comparing the effectiveness of virtual and concrete manipulatives to teach algebra to secondary students with learning disabilities. *Learning Disability Quarterly*, *39*(4), 240–253. doi: 10.1177/0731948716649754

Steele, M. M. (2006). Teaching suggestions for students with learning problems. *TechTrends*, *50*(6), 32–35. doi: 10.1007/s11528-006-7616-8

Strickland, T. K. (2016). Using the CRA-I strategy to develop conceptual and procedural knowledge of quadratic expressions. *TEACHING Exceptional Children*, *49*(2), 115–125. doi: 10.1177/0040059916673353

Walsh, J. B., & Hord, C. (2019). Using gestures and diagrams to support students with learning disabilities enrolled in Algebra II. *Learning Disabilities: A Contemporary Journal*, *17*(1), 59–75.

12. If given sufficient resources and training, which of these strategies would you consider implementing to support students with IEPs? Check all that apply.

__ Allowing or providing calculators at all times
__ Direct instruction on how to use a calculator
__ Using physical manipulatives
__ Using virtual manipulatives
__ Using colors, gestures, or diagrams
__ Direct instruction on drawing effective diagrams
__ Using graphic organizers for math
__ Teaching cognitive or metacognitive strategies

__ Co-teaching
__ Other: ____

Ives, B. (2007). Graphic Organizers Applied to Secondary Algebra Instruction for Students with Learning Disorders. Learning Disabilities Research & Practice, 22(2), 110-118. doi:10.1111/j.1540-5826.2007.00235.x

Karabulut, A., & Özmen, E. R. (2019). Effect of "Understand and Solve" strategy instruction on mathematical problem solving of students with mild intellectual disabilities. *International Electronic Journal of Elementary Education*, *11*(2), 77–90. doi: 10.26822/iejee.2018245314

Marita, S., & Hord, C. (2016). Review of mathematics interventions for secondary students with learning disabilities. *Learning Disability Quarterly*, *40*(1), 29–40. doi: 10.1177/0731948716657495

Rodgers, W. J., & Weiss, M. P. (2019). Specially Designed Instruction in secondary co-taught mathematics courses. *TEACHING Exceptional Children*, *51*(4), 276–285. doi: 10.1177/0040059919826546

Satsangi, R., Bouck, E. C., Taber-Doughty, T., Bofferding, L., & Roberts, C. A. (2016). Comparing the effectiveness of virtual and concrete manipulatives to teach algebra to secondary students with learning disabilities. *Learning Disability Quarterly*, *39*(4), 240–253. doi: 10.1177/0731948716649754

Steele, M. M. (2006). Teaching suggestions for students with learning problems. *TechTrends*, *50*(6), 32–35. doi: 10.1007/s11528-006-7616-8

Strickland, T. K. (2016). Using the CRA-I strategy to develop conceptual and procedural knowledge of quadratic expressions. *TEACHING Exceptional Children*, *49*(2), 115–125. doi: 10.1177/0040059916673353

Walsh, J. B., & Hord, C. (2019). Using gestures and diagrams to support students with learning disabilities enrolled in Algebra II. *Learning Disabilities: A Contemporary Journal*, *17*(1), 59–75.

13. Which of these strategies would you expect to be effective for increasing academic performance of students with IEPs? Check all that apply.

__ Allowing or providing calculators at all times
__ Direct instruction on how to use a calculator
__ Using physical manipulatives
__ Using virtual manipulatives
__ Using colors, gestures, or diagrams
__ Direct instruction on drawing effective diagrams
__ Using graphic organizers for math
__ Teaching cognitive or metacognitive strategies
__ Co-teaching
__ Other: ____

Ives, B. (2007). Graphic Organizers Applied to Secondary Algebra Instruction for Students with Learning Disorders. Learning Disabilities Research & Practice, 22(2), 110-118. doi:10.1111/j.1540-5826.2007.00235.x

Karabulut, A., & Özmen, E. R. (2019). Effect of "Understand and Solve" strategy instruction on mathematical problem solving of students with mild intellectual disabilities. *International Electronic Journal of Elementary Education*, *11*(2), 77–90. doi: 10.26822/iejee.2018245314

Marita, S., & Hord, C. (2016). Review of mathematics interventions for secondary students with learning disabilities. *Learning Disability Quarterly*, *40*(1), 29–40. doi: 10.1177/0731948716657495

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Steele, M. M. (2006). Teaching suggestions for students with learning problems. *TechTrends*, *50*(6), 32–35. doi: 10.1007/s11528-006-7616-8

Strickland, T. K. (2016). Using the CRA-I strategy to develop conceptual and procedural knowledge of quadratic expressions. *TEACHING Exceptional Children*, *49*(2), 115–125. doi: 10.1177/0040059916673353

Walsh, J. B., & Hord, C. (2019). Using gestures and diagrams to support students with learning disabilities enrolled in Algebra II. *Learning Disabilities: A Contemporary Journal*, *17*(1), 59–75.

14. In what ways would you expect these strategies to benefit students with IEPs?

Ives, B. (2007). Graphic Organizers Applied to Secondary Algebra Instruction for Students with Learning Disorders. Learning Disabilities Research & Practice, 22(2), 110-118. doi:10.1111/j.1540-5826.2007.00235.x

Karabulut, A., & Özmen, E. R. (2019). Effect of "Understand and Solve" strategy instruction on mathematical problem solving of students with mild intellectual disabilities. *International Electronic Journal of Elementary Education*, *11*(2), 77–90. doi: 10.26822/iejee.2018245314

Marita, S., & Hord, C. (2016). Review of mathematics interventions for secondary students with learning disabilities. *Learning Disability Quarterly*, *40*(1), 29–40. doi: 10.1177/0731948716657495

Rodgers, W. J., & Weiss, M. P. (2019). Specially Designed Instruction in secondary co-taught mathematics courses. *TEACHING Exceptional Children*, *51*(4), 276–285. doi: 10.1177/0040059919826546

Satsangi, R., Bouck, E. C., Taber-Doughty, T., Bofferding, L., & Roberts, C. A. (2016). Comparing the effectiveness of virtual and concrete manipulatives to teach algebra to secondary students with learning disabilities. *Learning Disability Quarterly*, *39*(4), 240–253. doi: 10.1177/0731948716649754

Steele, M. M. (2006). Teaching suggestions for students with learning problems. *TechTrends*, *50*(6), 32–35. doi: 10.1007/s11528-006-7616-8

Strickland, T. K. (2016). Using the CRA-I strategy to develop conceptual and procedural knowledge of quadratic expressions. *TEACHING Exceptional Children*, *49*(2), 115–125. doi: 10.1177/0040059916673353

Walsh, J. B., & Hord, C. (2019). Using gestures and diagrams to support students with learning disabilities enrolled in Algebra II. *Learning Disabilities: A Contemporary Journal*, *17*(1), 59–75.

15. What barriers have prevented or might prevent you from trying any of these strategies in the future? Check all that apply.

__ I don't know what any of these strategies are
__ I don't have enough training
__ I don't have the materials or resources
__ I don't understand the needs of students with IEPs
__ They would take too much preparation or time on my part
__ They would take too much time during class
__ I don't think students with IEPs would benefit from these strategies
__ I don't think it's my responsibility to provide these for students with IEPs
__ I don't think students with IEPs will succeed in my classes no matter what I do
__ I'm already using other strategies that are effective
__ I think students with IEPs will be resistant to these strategies
__ Other: ____

Grskovic, J. A., & Trzcinka, S. M. (2011). Essential standards for preparing secondary content teachers to effectively teach students with mild disabilities in included settings. *American Secondary Education*, 94-106.

Marita, S., & Hord, C. (2016). Review of mathematics interventions for secondary students with learning disabilities. *Learning Disability Quarterly*, *40*(1), 29–40. doi: 10.1177/0731948716657495

Shoulders, T. L., & Krei, M. S. (2016). Rural secondary educators' perceptions of their efficacy in the inclusive classroom. *Rural Special Education Quarterly*, 35(1), 23-30.

APPENDIX B. RECRUITMENT EMAIL

Dear Teachers,

I am in the process of earning my Masters of Science in Education with a Major in Special Education at Purdue University Fort Wayne. As part of this program, I am conducting a special research project on strategies to help students with mild disabilities learn high school math. I would appreciate your participation in a survey I have developed to gather more information on the awareness and implementation of such strategies.

The survey is in Purdue Qualtrix and can be accessed with this link. If you would like to participate in the research, please do your best to submit your responses by December 11, 2020 so I can tabulate and analyze the data for my project. You will not have to provide any personal information and your answers will be confidential. The data will be stored in a Google Sheet that is only accessible to me and will not collect your email address. At the completion of the project, the survey responses will be deleted. Your participation and survey responses will contribute to the body of knowledge in the area of improving math skills in students with mild disabilities. The survey has been approved by Principal [redacted].

You have the right to not participate in the research. If you decide not to participate or complete the survey, this will have no consequences whatsoever for you or your employment status.

Thank you in advance for your time and participation in this survey. If you have any questions, you can email me at [redacted] or call or text me [redacted]. You can also contact my professor, Dr. Rama Cousik, at cousikr@pfw.edu or (260)481-6003.

Thank you,

Kim Kamler
Special Education Teacher
[redacted] High School

APPENDIX C. PRINCIPAL APPROVAL

[redacted]

Date: **November 4, 2020**
Re: Letter of Cooperation For [redacted] ***High School***

Dear Dr. Cousik,

This letter confirms that that I, as an authorized representative of [redacted] High School, allow Kimberly Kamler access to conduct study related activities at the listed site(s), as discussed with the Principal Investigator and briefly outlined below, and which may commence when she provides documentation of IRB approval for the proposed project.

- **Study Title:** Strategies For Teaching Mathematics To High School Students With Mild Disabilities
- **Study Activities Occurring at this Site:** A survey will be distributed by email to math and special education teachers.
- **Site(s) Support:** [redacted] High School Principal will have access to email addresses of all math and special education teachers. [redacted] High School will also provide the researcher access to a computer and an organization email address from which to send the recruitment email and survey link to the school principal. The researcher will be authorized to view and analyze survey results using this computer. The data will be stored in a password protected file on Purdue FW One Drive.
- **Anticipated End Date:** The survey responses are expected to be completed by March 30, 2021 and the entire study is expected to be completed by May 15, 2021.

I understand that any activities involving compliance with Health Insurance Portability and Accountability Act (HIPAA), Family Educational Rights and Privacy Act (FERPA), or other applicable regulations at this site must be addressed prior to granting permission to the Purdue University researcher to collect or receive data from the site. I am authorized to make this determination on my organization's behalf.

We understand that [redacted] High Schools participation will only take place during the study's active IRB approval period. All study related activities must cease if IRB approval expires or is suspended. If we have any concerns related to this project, we will contact the Principal Investigator who can provide the information about the IRB approval. For concerns regarding IRB policy or human subject welfare, we may also contact the Purdue University IRB at irb@purdue.edu [www.irb.purdue.edu].

[redacted] November 4, 202 [redacted]

Signature *Date Signed*

[redacted]

APPENDIX D. IRB APPROVAL

IRB-2020-1376 - Initial: 1. COVID-19 EXEMPTION MEMO

KK

This Memo is Generated From the Purdue University Human Research Protection Program System, Cayuse IRB.

*****THIS LETTER IS BEING ISSUED DURING THE FACE TO FACE RESTRICTION ON HUMAN SUBJECTS RESEARCH STUDIES RELATED TO COVID-19. THIS DOCUMENT SERVES AS PROTOCOL APPROVAL FROM THE HRPP/IRB, BUT DOES NOT PERMIT FACE TO FACE RESEARCH UNTIL AN APPROVED UNIVERSITY COVID-19 RESEARCH SPACE SOP PERMITS RESEARCH OPERATIONS. ******

Date: November 11, 2020
PI: RAMA COUSIK
Re: Initial - IRB-2020-1376
STRATEGIES FOR TEACHING MATHEMATICS TO HIGH SCHOOL STUDENTS WITH MILD DISABILITIES

The Purdue University Human Research Protection Program (HRPP) has determined that the research project identified above qualifies as exempt from IRB review, under federal human subjects research regulations 45 CFR 46.104. The Category for this Exemption is listed below . Protocols exempted by the Purdue HRPP do not require regular renewal. However, the administrative check-in date is November 10, 2023. The IRB must be notified when this study is closed. If a study closure request has not been initiated by this date, the HRPP will request study status update for the record.

Specific notes related to your study are found below.
Decision: Exempt
Category: Category 2.(i). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording).
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects.

Findings: N/A
Research Notes: Researcher should use her Purdue Fort Wayne email address when recruiting participants. This is because she is conducting the study on behalf of Purdue and to help minimize the perception of being coerced since she is associated with [redacted] High School.

Any modifications to the approved study must be submitted for review through Cayuse IRB. All approval letters and study documents are located within the Study Details in Cayuse IRB.

What are your responsibilities now, as you move forward with your research?

Document Retention: The PI is responsible for keeping all regulated documents, including IRB correspondence such as this letter, approved study documents, and signed consent forms for at least three (3) years following protocol closure for audit purposes. Documents regulated by HIPAA, such as Release Authorizations, must be maintained for six (6) years.

Site Permission: If your research is conducted at locations outside of Purdue University (such as schools, hospitals, or businesses), you must obtain written permission from all sites to recruit, consent, study, or observe participants. Generally, such permission comes in the form of a letter from the school superintendent, director, or manager. You must maintain a copy of this permission with study records.

Training: All researchers collecting or analyzing data from this study must renew training in human subjects research via the CITI Program (www.citiprogram.org) every 4 years. New personnel must complete training and be added to the protocol before beginning research with human participants or their data.

Modifications: Change to any aspect of this protocol or research personnel must be approved by the IRB before implementation, except when necessary to eliminate apparent immediate hazards to subjects or others. In such situations, the IRB should still be notified immediately.

Unanticipated Problems/Adverse Events: Unanticipated problems involving risks to subjects or others, serious adverse events, and
noncompliance with the approved protocol must be reported to the IRB immediately through an incident report. When in doubt, consult with the HRPP/IRB.

Monitoring: The HRPP reminds researchers that this study is subject to monitoring at any time by Purdue's HRPP staff, Institutional Review Board, Research Quality Assurance unit, or authorized external entities. Timely cooperation with monitoring procedures is an expectation of IRB approval.

Change of Institutions: If the PI leaves Purdue, the study must be closed or the PI must be replaced on the study or transferred to a new IRB. Studies without a Purdue University PI will be closed.

Other Approvals: This Purdue IRB approval covers only regulations related to human subjects research protections (e.g. 45 CFR 46). This determination does not constitute approval from any other Purdue campus departments, research sites, or outside agencies. The Principal Investigator and all researchers are required to affirm that the research meets all applicable local/state/ federal laws and university policies that may apply.

If you have questions about this determination or your responsibilities when conducting human subjects research on this project or any other, please do not hesitate to contact Purdue's HRPP at irb@purdue.edu or 765-494-5942. We are here to help!

Sincerely,

Purdue University Human Research Protection Program/ Institutional Review Board

APPENDIX E. CITI TRAINING CERTIFICATES

CITI PROGRAM

Completion Date 01-Jan-2020
Expiration Date 31-Dec-2023
Record ID 34684413

This is to certify that:

Kim Kamler

Has completed the following CITI Program course:

Human Research (Curriculum Group)
Group 2.Social Behavioral Research Investigators and Key Personnel (Course Learner Group)
1 – Basic Course (Stage)

Under requirements set by:

Purdue University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w709af116-6602-47ec-9879-af7304e54b9a-34684413

CITI PROGRAM

Completion Date 06-Feb-2021
Expiration Date 05-Feb-2026
Record ID 34684414

This is to certify that:

Kim Kamler

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Responsible Conduct of Research
(Curriculum Group)
Responsible Conduct of Research (RCR) Training - Faculty, Postdoctoral, and Graduate Students
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Purdue University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wbefbaea8-88aa-471a-a792-031f7f8bd1ff-34684414

APPENDIX F. SURVEY TIMELINE

October 5, 2020   Obtain permission from [redacted] High School Principal

October 22, 2020   Survey questions and recruitment email finalized

December 3, 2020   Recruitment email and survey sent to math and special education teachers

December 11, 2020   Survey responses due back from participants

January 31, 2021   Survey responses compiled, analyzed, summarized

March 13, 2021   Chapter 4 Results completed

APPENDIX G. SPECIAL PROJECT TIMELINE

September

Refine and Finalize Topic

Complete Rationale for Topic

Search, Read, and Summarize Articles

Write IRB Proposal

Recruitment Letter

Timeline for Special Project Completion

October

Submit IRB Proposal

Search, Read, and Summarize Articles

Support Letter from Principal

Assessment Needs Survey

Literature Review

Methodology

November

Methodology

Completion of Chapter 1 – Introduction

December

Completion of Chapter 2 – Literature Review

Completion of Chapter 3 – Methodology

January

Revise Chapters 1 – 3

Design of Project and Final Product

February

Completion of Chapter 4 – Results

Completion of Chapter 6 - Conclusion

Design of Project and Final Product

March

Completion of Chapter 5 – Handbook

PowerPoint Slides

April

Completion of Special Project

APPENDIX H. SPECIAL PROJECT TABLE OF CONTENTS

Section 1: Introduction

Section 2: Characteristics of Learners with Mild Disabilities

Section 3: Evidence-Based Strategies

- Graphic Organizers
- Diagrams
- Teaching Cognitive and Metacognitive Skills
- Calculator Instruction and Use
- Physical and Virtual Manipulatives
- Co-teaching

Section 4: Conclusion

Section 5: Resources

APPENDIX I. RAW DATA

	Wor	RecordedDate	Q1	Q2	Q23_1	Q24_1	Q5	Q6	Q7	Q8	Q8_11_TEXT	Q10	Q10_10_TEXT
2	Part	Recorded Date	What is your teaching license? Check all that apply.	How long have you been teaching mathematics?	How much specialized training in Special Education have you received, either as part of your degree or as part of Professional Learning? - 1	How prepared do you feel to meet the educational needs of Special Education students? - 1	How often have you had students with IEPs in your classes in the past?	Do you currently have students with IEPs in your classes?	Have you ever used teaching strategies specifically designed to support students with IEPs?	Before receiving this survey, which specific challenges were you aware of students with IEPs may experience? Check all that apply. - Selected Choice	Before receiving this survey, which specific challenges were you aware of that students with IEPs may experience? Check all that apply. - other - Text	Before receiving this survey, which of these specific teaching strategies were you aware of? Check all that apply. - Selected Choice	Before receiving this survey, which of these specific teaching strategies were you aware of? Check all that apply. - Other - Text
3	P02	12/3/2020 9:04	Mathematics	5 - 10 years	A little	Somewhat prepared	Always	Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits,visual processing disorders,auditory processing disorders		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching	
4	P03	12/3/2020 9:05	Special Education	5 - 10 years	A great deal	Somewhat prepared	Always	Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits,visual processing disorders,auditory processing disorders		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or	
5	P04	12/3/2020 9:08	Mathematics	5 - 10 years	A moderate amount	Neutral	Always	Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Direct instruction on drawing effective diagrams,Co-teaching	
6	P05	12/3/2020 9:08	Mathematics	5 - 10 years	A lot	Somewhat prepared	Always	Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Teaching cognitive or metacognitive strategies,Co-teaching	

1	Wor	RecordedDate	Q1	Q2	Q23_1	Q24_1	Q5	Q6	Q7	Q8	Q8_11_TEXT	Q10	Q10_10_TEXT
2	Part	Recorded Date	What is your teaching license? Check all that apply.	How long have you been teaching mathematics?	How much specialized training in Special Education have you received, either as part of your degree or as part of Professional Learning? - 1	How prepared do you feel to meet the educational needs of Special Education students? - 1	How often have you had students with IEPs in your classes in the past?	Do you currently have students with IEPs in your classes?	Have you ever used teaching strategies specifically designed to support students with IEPs?	Before receiving this survey, which specific challenges were you aware of students with IEPs may experience? Check all that apply. - Selected Choice	Before receiving this survey, which specific challenges were you aware of that students with IEPs may experience? Check all that apply. - other - Text	Before receiving this survey, which of these specific teaching strategies were you aware of? Check all that apply. - Selected Choice	Before receiving this survey, which of these specific teaching strategies were you aware of? Check all that apply. - Other - Text
7	P06	12/3/2020 9:10	Special Education	1 - 2 years	A moderate amount	Neutral	Always	Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits,visual processing disorders,auditory processing disorders		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching	
8	P07	12/3/2020 9:10	Mathematics	3 - 5 years	A little	Somewhat prepared		Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits		Allowing or providing calculators at all times,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching	
9	P08	12/3/2020 9:11	Mathematics, Special Education	5 - 10 years	A great deal	Very prepared	Always	Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits,visual processing disorders,auditory processing disorders		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching	
10	P09	12/3/2020 9:16	Mathematics	Over 10 years	A moderate amount	Somewhat prepared	Always	Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,social skills,attention deficits,visual processing disorders		Allowing or providing calculators at all times,Using physical manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching	

	Wor	RecordedDate	Q1	Q2	Q23_1	Q24_1	Q5	Q6	Q7	Q8	Q8_11_TEXT	Q10	Q10_10_TEXT
2	Part	Recorded Date	What is your teaching license? Check all that apply.	How long have you been teaching mathematics?	How much specialized training in Special Education have you received, either as part of your degree or as part of Professional Learning? - 1	How prepared do you feel to meet the educational needs of Special Education students? - 1	How often have you had students with IEPs in your classes in the past?	Do you currently have students with IEPs in your classes?	Have you ever used teaching strategies specifically designed to support students with IEPs?	Before receiving this survey, which specific challenges were you aware of students with IEPs may experience? Check all that apply. - Selected Choice	Before receiving this survey, which specific challenges were you aware of that students with IEPs may experience? Check all that apply. - other - Text	Before receiving this survey, which of these specific teaching strategies were you aware of? Check all that apply. - Selected Choice	Before receiving this survey, which of these specific teaching strategies were you aware of? Check all that apply. - Other - Text
11	P10	12/3/2020 9:28	Mathematics	Over 10 years	A little	Neutral	Frequently	Yes	Yes	reading comprehension,calculations such as basic math facts,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,visual processing disorders,auditory processing disorders		Allowing or providing calculators at all times,Using physical manipulatives,Direct instruction on drawing effective diagrams,Co-teaching	
12	P11	12/3/2020 9:36	Mathematics	5 - 10 years	A moderate amount	Neutral	Always	Yes	Not sure what this means	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits,visual processing disorders,auditory processing disorders		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching	
13	P12	12/3/2020 9:50	Special Education	5 - 10 years	A great deal	Very prepared	Always	Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits,visual processing disorders,auditory processing disorders,other	emotional issues; physical aggression; lying; stealing	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching,Other	direct teaching of just IEP students; teaching reasoning skills

1	Wor	RecordedDate	Q1	Q2	Q23_1	Q24_1	Q5	Q6	Q7	Q8	Q8_11_TEXT	Q10	Q10_10_TEXT
2	Part	Recorded Date	What is your teaching license? Check all that apply.	How long have you been teaching mathematics?	How much specialized training in Special Education have you received, either as part of your degree or as part of Professional Learning? - 1	How prepared do you feel to meet the educational needs of Special Education students? - 1	How often have you had students with IEPs in your classes in the past?	Do you currently have students with IEPs in your classes?	Have you ever used teaching strategies specifically designed to support students with IEPs?	Before receiving this survey, which specific challenges were you aware of students with IEPs may experience? Check all that apply. - Selected Choice	Before receiving this survey, which specific challenges were you aware of that students with IEPs may experience? Check all that apply. - other - Text	Before receiving this survey, which of these specific teaching strategies were you aware of? Check all that apply. - Selected Choice	Before receiving this survey, which of these specific teaching strategies were you aware of? Check all that apply. - Other - Text
14	P13	12/3/2020 11:36	Mathematics	Over 10 years	A moderate amount	Neutral	Always	Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits,visual processing disorders,auditory processing disorders,other	seizures - I've had a surprising number of students who suffer from mild to moderate seizures	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Co-teaching	
15	P14	12/3/2020 12:14	Special Education		A great deal	Very prepared	Always	Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits,visual processing disorders,auditory processing disorders,other	non-compliance, avoidance, attention	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching,Other	extended time, tests read aloud
16	P15	12/4/2020 7:03	Mathematics	Over 10 years	A little	Neutral	Always	Yes	Not sure what this means	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits,visual processing disorders,auditory processing disorders		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Co-teaching	

1	Wor	RecordedDate	Q1	Q2	Q23_1	Q24_1	Q5	Q6	Q7	Q8	Q8_11_TEXT	Q10	Q10_10_TEXT
2	Part	Recorded Date	What is your teaching license? Check all that apply.	How long have you been teaching mathematics?	How much specialized training in Special Education have you received, either as part of your degree or as part of Professional Learning? - 1	How prepared do you feel to meet the educational needs of Special Education students? - 1	How often have you had students with IEPs in your classes in the past?	Do you currently have students with IEPs in your classes?	Have you ever used teaching strategies specifically designed to support students with IEPs?	Before receiving this survey, which specific challenges were you aware of students with IEPs may experience? Check all that apply. - Selected Choice	Before receiving this survey, which specific challenges were you aware of that students with IEPs may experience? Check all that apply. - other - Text	Before receiving this survey, which of these specific teaching strategies were you aware of? Check all that apply. - Selected Choice	Before receiving this survey, which of these specific teaching strategies were you aware of? Check all that apply. - Other - Text
17	P16	12/4/2020 13:57	Mathematics, Special Education,Other	Over 10 years	A great deal	Very prepared	Always	Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits,visual processing disorders,auditory processing disorders		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching	

	Wor Part	Q12 Which of these specific teaching strategies have you used to support students with IEPs? Check all that apply. - Selected Choice	Q12_10_TEXT Which of these specific teaching strategies have you used to support students with IEPs? Check all that apply. - Other - Text	Q14 Which strategies, either listed here or other ones, have been successful when you have used them. Please describe what you did and what effects you saw among the students.	Q15 If given sufficient resources and training, which of these strategies would you consider implementing to support students with IEPs? Check all that apply. - Selected Choice	Q15_10_TEXT If given sufficient resources and training, which of these strategies would you consider implementing to support students with IEPs? Check all that apply. - Other - Text	Q17 Which of these strategies would you expect to be effective for increasing academic performance of students with IEPs? Check that apply. - Selected Choice	Q17_10_TEXT Which of these strategies would you expect to be effective for increasing academic performance of students with IEPs? Check all that apply. - Other - Text	Q19 In what ways would you expect these strategies to benefit students with IEPs?	Q20 What barriers have prevented or might prevent you from trying any of these strategies in the future? Check all that apply. - Selected Choice	Q20_12_TEXT What barriers have prevented or might prevent you from trying any of these strategies in the future? Check all that apply. - Other - Text
1 2											
3	P02	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching					Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-			I don't have the materials or resources,They would take too much preparation or time on my part,They would take too much time during class	
4	P03	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Direct instruction on drawing effective diagrams,Teaching cognitive or metacognitive strategies,Co-teaching			Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Direct instruction on drawing effective diagrams,Co-teaching		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Direct instruction on drawing effective diagrams,Teaching cognitive or metacognitive strategies,Co-			I don't have enough training,I don't have the materials or resources	
5	P04	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Direct instruction on drawing effective diagrams,Co-teaching		Allowing the use of a calculator, small group testing, frequent redirection, group work.	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-		Calculator to help with the speed, different manipulatives to increase the level of mastery or help build understanding, etc etc	I don't have enough training,I don't have the materials or resources,They would take too much time during class	
6	P05	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Co-teaching		manipulatives, co teaching. Co-teaching is especially helpful as students can get focused help. Calculator use does NOT help, as the students do not develop the number sense needed for math.	Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching,Other	Placing kids in a math class of appropriate level instead of passing them on like we do now.	Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching			They would take too much time during class,I don't think students with IEPs would benefit from these strategies,I'm already using other strategies that are effective,I think students with IEPs will be resistant to	

1	Wor	Q12	Q12_10_TEXT	Q14	Q15	Q15_10_TEXT	Q17	Q17_10_TEXT	Q19	Q20	Q20_12_TEXT
2	Part	Which of these specific teaching strategies have you used to support students with IEPs? Check all that apply. - Selected Choice	Which of these specific teaching strategies have you used to support students with IEPs? Check all that apply. - Other - Text	Which strategies, either listed here or other ones, have been successful when you have used them. Please describe what you did and what effects you saw among the students.	If given sufficient resources and training, which of these strategies would you consider implementing to support students with IEPs? Check all that apply. - Selected Choice	If given sufficient resources and training, which of these strategies would you consider implementing to support students with IEPs? Check all that apply. - Other - Text	Which of these strategies would you expect to be effective for increasing academic performance of students with IEPs? Check that apply. - Selected Choice	Which of these strategies would you expect to be effective for increasing academic performance of students with IEPs? Check all that apply. - Other - Text	In what ways would you expect these strategies to benefit students with IEPs?	What barriers have prevented or might prevent you from trying any of these strategies in the future? Check all that apply. - Selected Choice	What barriers have prevented or might prevent you from trying any of these strategies in the future? Check all that apply. - Other - Text
7	P06	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching			Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-		This would give them the ability to work on things and have accommodations to help them.	Other	I feel like these are all appropriate to use.
8	P07	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		parallel teaching grouping kids on levels	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		Ive seen them work	They would take too much time during class	
9	P08	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		I use co teaching every day. My co teacher and I break the kids up into small groups to reteach topics to get a better understanding.	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-		these make them feel more comfortable to have a calculator or a second teacher to help answer questions	I think students with IEPs will be resistant to these strategies	
10	P09	Allowing or providing calculators at all times,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Co-teaching		Using graphic organizers during note taking. It helped students organize their notes in a way they can come back to if they forget the concept	Using physical manipulatives,Using virtual manipulatives,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		Allowing or providing calculators at all times,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Co-teaching		It helps them organize their thoughts and material in a way they can come back to revisit again	I don't have the materials or resources	

	Wor	Q12	Q12_10_TEXT	Q14	Q15	Q15_10_TEXT	Q17	Q17_10_TEXT	Q19	Q20	Q20_12_TEXT
2	Part	Which of these specific teaching strategies have you used to support students with IEPs? Check all that apply. - Selected Choice	Which of these specific teaching strategies have you used to support students with IEPs? Check all that apply. - Other - Text	Which strategies, either listed here or other ones, have been successful when you have used them. Please describe what you did and what effects you saw among the students.	If given sufficient resources and training, which of these strategies would you consider implementing to support students with IEPs? Check all that apply. - Selected Choice	If given sufficient resources and training, which of these strategies would you consider implementing to support students with IEPs? Check all that apply. - Other - Text	Which of these strategies would you expect to be effective for increasing academic performance of students with IEPs? Check that apply. - Selected Choice	Which of these strategies would you expect to be effective for increasing academic performance of students with IEPs? Check all that apply. - Other - Text	In what ways would you expect these strategies to benefit students with IEPs?	What barriers have prevented or might prevent you from trying any of these strategies in the future? Check all that apply. - Selected Choice	What barriers have prevented or might prevent you from trying any of these strategies in the future? Check all that apply. - Other - Text
11	P10	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		Having co-tacher. Someone to help watch the students during instruction time. Help students with nots and organization	Using virtual manipulatives,Co-teaching		Allowing or providing calculators at all times,Using virtual manipulatives,Teaching cognitive or metacognitive strategies,Co-teaching			I don't have enough training,I don't have the materials or resources,They would take too much time during	
12	P11	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using colors, gestures, or diagrams,Teaching cognitive or metacognitive strategies,Co-teaching			Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		they would have more of a sense of accomplishment? and then do better in classroom settings?	I don't have the materials or resources,They would take too much preparation or time on my part,They would take too much time during class,I think students with IEPs will be resistant to those strategies	
13	P12	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		using manipulatives is very helpful for basic math skills; graphs are helpful for kids to 'see' how things are affected by another variable; sitting and working one on one; writing out step by step instructions to get through a complex problem (helps them not to forget any steps); allowed to use "formula" sheets so they don't have to remember the exact formula	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching,Other	pulling for small group instruction	it makes it more tangible for kids; gives them a more concrete structure on how to solve problems;		

1	Wor	RecordedDate	Q1	Q2	Q23_1	Q24_1	Q5	Q6	Q7	Q8	Q8_11_TEXT	Q10	Q10_10_TEXT
2	Part	Recorded Date	What is your teaching license? Check all that apply.	How long have you been teaching mathematics?	How much specialized training in Special Education have you received, either as part of your degree or as part of Professional Learning? - 1	How prepared do you feel to meet the educational needs of Special Education students? - 1	How often have you had students with IEPs in your classes in the past?	Do you currently have students with IEPs in your classes?	Have you ever used teaching strategies specifically designed to support students with IEPs?	Before receiving this survey, which specific challenges were you aware of students with IEPs may experience? Check all that apply. - Selected Choice	Before receiving this survey, which specific challenges were you aware of that students with IEPs may experience? Check all that apply. - other - Text	Before receiving this survey, which of these specific teaching strategies were you aware of? Check all that apply. - Selected Choice	Before receiving this survey, which of these specific teaching strategies were you aware of? Check all that apply. - Other - Text
14	P13	12/3/2020 11:36	Mathematics	Over 10 years	A moderate amount	Neutral	Always	Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits,visual processing disorders,auditory processing disorders,other	seizures - I've had a surprising number of students who suffer from mild to moderate seizures	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Co-teaching	
15	P14	12/3/2020 12:14	Special Education		A great deal	Very prepared	Always	Yes	Yes	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits,visual processing disorders,auditory processing disorders,other	non-compliance, avoidance, attention	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching,Other	extended time, tests read aloud
16	P15	12/4/2020 7:03	Mathematics	Over 10 years	A little	Neutral	Always	Yes	Not sure what this means	reading comprehension,calculations such as basic math facts,lack of prerequisite skills,working memory such as processing, storing, and retrieving information,cognitive processing such as conceptualizing, abstract reasoning, and generalizing,motor skills such as taking notes, writing neatly, graphing problems, using the keys on a calculator,social skills,attention deficits,visual processing disorders,auditory processing disorders		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Co-teaching	

1	Wor	Q12	Q12_10_TEXT	Q14	Q15	Q15_10_TEXT	Q17	Q17_10_TEXT	Q19	Q20	Q20_12_TEXT
2	Part	Which of these specific teaching strategies have you used to support students with IEPs? Check all that apply. - Selected Choice	Which of these specific teaching strategies have you used to support students with IEPs? Check all that apply. - Other - Text	Which strategies, either listed here or other ones, have been successful when you have used them. Please describe what you did and what effects you saw among the students.	If given sufficient resources and training, which of these strategies would you consider implementing to support students with IEPs? Check all that apply. - Selected Choice	If given sufficient resources and training, which of these strategies would you consider implementing to support students with IEPs? Check all that apply. - Other - Text	Which of these strategies would you expect to be effective for increasing academic performance of students with IEPs? Check that apply. - Selected Choice	Which of these strategies would you expect to be effective for increasing academic performance of students with IEPs? Check all that apply. - Other - Text	In what ways would you expect these strategies to benefit students with IEPs?	What barriers have prevented or might prevent you from trying any of these strategies in the future? Check all that apply. - Selected Choice	What barriers have prevented or might prevent you from trying any of these strategies in the future? Check all that apply. - Other - Text
17	P16	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		Peer work. Students don't feel as intimidated when working with peers sometimes as they do with adults.	Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-teaching		Allowing or providing calculators at all times,Direct instruction on how to use a calculator,Using physical manipulatives,Using virtual manipulatives,Using colors, gestures, or diagrams,Direct instruction on drawing effective diagrams,Using graphic organizers for math,Teaching cognitive or metacognitive strategies,Co-		They provide extra support for the students who are struggling. I use these with IEP students and students without IEP's		

VITA

Kim Kamler

Experience

[redacted] High School [redacted] 2019 - present

Special Education Teacher

Manage case load of special education students, organize and facilitate meetings, collaborate with parents, students, administrators, counselors, and general education teachers with respect to SPED students. Co-teach geometry with general education teacher. Create and deliver lessons and assessments.

- Build relationships with students, parents, administrators, counselors, teachers and paraprofessionals.
- Monitor testing, ensure test security, and provide accommodations such as reading aloud, small group setting, and extra time.
- Coach parents and students through the use of technology resources such as PowerSchool and Zoom.
- Write IEP goals in consultation with the case conference committee.
- Monitor and communicate progress toward IEP goals.

[redacted] High School [redacted] 2013 - 2019

Special Education Paraprofessional

Supervised Strategic Instruction, during which I monitored, directed, and enforced appropriate behavior and retaught subject matter from academic classes. Plugged into general education classes. Collaborated with Special Education and general education teachers with respect to SPED students.

- Worked with students in grades 10 – 12, specializing in math and science classes, including Algebra I, Algebra II, Geometry, Pre-calculus, Trigonometry, Finite Math, Business Math, Integrated Chemistry and Physics, and Economics.
- Built relationships with students, monitored their grades and behavior, and contributed input to their Teachers of Record with regard to the students' needs and accommodations.
- Scheduled students, staff members, and rooms for testing during semester finals.
- Monitored testing throughout the semester, ensured test security, and provided accommodations such as reading aloud, small group setting, and extra time.

Education

MSED Degree in Special Education – Mild Intervention	Purdue University Fort Wayne	Fort Wayne, IN
B.S. Environmental Studies	Michigan State University	East Lansing, MI