

A Student With a Learning Disability and Multi-Step Equations With Fractions

Casey Hord*
Emily Ladrigan
University of Cincinnati

Rene L. Saldanha
New York University

The researchers conducted a microanalysis of two purposefully sampled sessions of a tutor working with a student with a learning disability (LD) engaging with multi-step equations with and without fractions. During the tutoring sessions, the student experienced quick, independent success on equations without fractions, but struggled considerably when fractions were embedded in the equations. When the tutor supported the student with gestures, verbal instruction, and managing his work on paper, the student was able to make some progress. The situation described in this study presents challenges for teachers regarding when to let students use a calculator for solving fraction computations versus when to teach fraction concepts as well as how to support a student with an LD who is struggling with possible anxiety while engaging with challenging mathematics.

Keywords: **Algebra, Equations, Fractions, Anxiety, Gestures**

Introduction

Policy Overview and Need for Research

In the United States, testing and curriculum requirements mandate that students with learning disabilities (LDs) have access to the general education curriculum and that these students are tested on this curriculum (Individuals with Disabilities Education Act, 2004; Every Student Succeeds, 2015). As these students progress to gatekeeper courses in secondary settings, they have opportunities to progress toward a variety of educational and occupational opportunities if they can advance through these courses (Achieve, 2015; Ysseldyke et al., 2004). Yet, students with LDs are likely to experience difficulties in mathematics and possibly more so with the challenging curriculum of high school mathematics courses (Andersson, 2008; Confrey et al., 2012). While there is substantial research on the teaching and learning of students with LDs in elementary settings, more research is needed on how students with LDs interact with secondary level content and what interventions are needed at this level (Foegen, 2008; Marita & Hord, 2017).

Review of Literature

Students with LDs, in the United States, are often assigned this label after not demonstrating progress in academics after receiving extensive support in small-group and individualized settings and after scoring above around 70 to 75 on an

*Please send correspondence to: Casey Hord, Ph.D., Department of Special Education, University of Cincinnati, Teachers College 600G, Cincinnati, OH 45221, USA, Phone: (513) 556-2481, Email: casey.hord@uc.edu.

intelligence test (Gresham & Vellutino, 2010). Despite these students' tendency to struggle with mathematics and schoolwork in general, they have demonstrated success in multiple research studies at the elementary level and in some studies at the secondary level (for reviews, see Hord & Xin, 2013; Marita & Hord, 2017). Teaching with visual aids, such as diagrams and use of manipulatives, is supported by research to be an effective instructional tool for these students at the elementary level (Hord & Xin, 2013). While these teaching tools are a good match for the demands of elementary curriculum, more research is needed to determine what supports are needed for the more complex curriculum these students will face in secondary settings (Foegen, 2008). For example, the diagramming of word problems (for review, see Hord & Xin, 2013) can support students' memory and processing as they think mathematically about additive and multiplicative word problems; yet, the supports students need as they engage with multi-step equations may be different due to the different demands of these problems.

In a few studies on students with LDs working with equations, the use of visuals does seem to impact these students; however, rather than diagrams of word problems (e.g., $\square \times \square = \square$ to represent factor × factor = product situations), it seems that other types of visual representations are effective in high school mathematics situations possibly due to the different structure of the problems (e.g., multiplicative word problems in elementary school and multi-step equations in high school) (Hord & Xin, 2013, Marita & Hord, 2017). For example, partitioning of multi-step equations into separate steps by drawing lines across parts of the work on the equations seems to help students with LDs split the work in the problems into manageable pieces and have more success in their work (Ives, 2008). In an exploratory study, the use of gestures (e.g., hand movements to draw attention to [or show the relationship between] problem elements) by both teachers and students seemed to support students with LDs on concepts such as reciprocals, distribution in equations, and problems involving the Pythagorean Theorem (Hord et al., 2016). Gestures can be used to support the working memory of students during learning processes (Alibali et al., 2013).

While these findings do provide some information about how students with LDs may fare in high school mathematics courses, more research is needed to better explain this complex situation. In the high-pressure environment of these courses, where students' performance can impact future curriculum choices and occupational opportunities, it is reasonable to assume that students become anxious (see Hord et al., 2018; Ysseldyke et al., 2004). Students with LDs tend to have difficulties with anxiety in general and this anxiety can exacerbate difficulties that many of these students have with memory and processing (Ashcraft & Krause, 2007; Nelson & Harwood, 2011). For example, working memory (i.e., the processing, storing, and integration of information, Baddeley, 2003) is often an area of struggle for students with LDs and can be negatively affected by anxiety (Ashcraft & Krause, 2007; Swanson & Siegel, 2001).

Anxiety can produce a series of negative thoughts that can occupy students' attentional resources, therefore limiting the amount of attentional focus and working memory they have available to devote to solving the problem (e.g., more time spent on worrying about their work than focusing on what needs to be done to solve the problem) (Eysenck, Derakshan, Santos, & Calvo, 2007). Students are more likely to need to spend extra time on their work and, in some cases, make errors in their work when they are anxious (Eysenck et al., 2007). In situations where students are especially challenged by the material, both anxiety and working memory can both negatively affect students (Barrouillet, Bernardin, Portrat, Vergauwe, & Camos, 2007; Eysenck et al., 2007). These factors can create a difficult situation for students with LDs in which they are expected to engage with a challenging curriculum while possibly dealing with a high level of anxiety that can negatively impact their chances of thinking clearly and critically about mathematics (Confrey et al., 2012; Eysenck et al., 2007; Nelson & Harwood, 2011).

In situations in which they may struggle with working memory, students with LDs can benefit from offloading information (e.g., storing information in diagrams on paper so they do not have to remember all of the information in short-term memory; see Risko & Dunn, 2015) so they can then devote their attentional resources to thinking about how all of the pieces of information connect to find a solution for the problem (Keeler & Swanson, 2001). Special education researchers (e.g., van Garderen, 2007; Xin, Jitendra, & Deatline-Buchman, 2005) have utilized tables and diagrams for helping students offload and organize information on paper from multi-step word problems (at the middle school level) so they can then think critically about the information in the problem without the added stress of having to remember multiple components of information. These findings are encouraging and offer tools that may be utilized (possibly in somewhat different ways) in high school algebra settings.

Research Questions

More research is needed to build on preliminary findings (e.g., Hord et al., 2016, Ives, 2008) about how the needs of students with LDs can be met in secondary settings. It is important for researchers to explore how students with LDs can offload information, use and respond to gesturing, and manage complex information in high school settings as they face possible challenges with anxiety and working memory and a difficult curriculum (Confrey et al., 2012; Hord et al., 2018; Risko & Dunn, 2015; Swanson & Siegel, 2001). The research question in this study is as follows: What are the experiences of a student with a learning disability when working on multi-step equations and what are the possible supports a tutor can offer to meet his needs?

Method

Research Design

The researchers conducted a microanalysis of two purposefully sampled tutoring sessions with a student with a learning disability with a history of difficulties with math anxiety. We searched through a data set from a larger project for sessions of a student with some success with algebra, a label as a student with learning disability, and a history of math anxiety. We also looked for situations in which the mathematics problems had multiple steps and extra mathematics challenges (e.g., fractions embedded in multi-step equations) likely to create a situation in which the student would need to overcome potential difficulties with working memory and anxiety while facing challenging academics. Our intention was for the findings of this microanalysis to provide a foundation for larger-scale studies of students with LDs enrolled in high school mathematics courses.

Participant and Setting

The participant, Jerry, was a student with a learning disability. His special education teacher reported that Jerry had frequent difficulties with anxiety when doing mathematics, and he would sometimes get frustrated and stop working. This teacher also said that Jerry was strong as a critical thinker in mathematics, but struggled some with mathematics procedures. His general education, mathematics teacher said that Jerry sometimes got frustrated with his teachers when he did not do well on his schoolwork. She said he was sometimes relaxed in her class, but got nervous called upon to answer questions in class. She also reported that Jerry had strengths as a critical thinker and had a history of some success with algebra content. Jerry's tutor complimented his current level of success with algebra problems, but said that he appeared more anxious and really struggled with equations that had fractions embedded in the problems.

The tutoring sessions we analyzed for this project were recorded at a suburban high school in the United States. The tutor worked on algebra problems provided by Jerry's special education teacher as supplemental instruction for Jerry. The tutor in this study, Emma, was an undergraduate, special education major. Emma met with Jerry in a one-on-one setting separate from his classroom.

Data Collection and Analysis

The tutor video recorded each session using a document camera to capture the details of her work and her student's work on paper. The researchers transcribed and analyzed two purposefully sampled tutoring sessions with Jerry. Then, the first author organized the data in a table with columns for time of session, transcript, video stills of key moments (e.g., gesturing, writing on paper, etc.), and subjective comments and codes. The first phase of analyzing the transcripts consisted of open coding (Strauss & Corbin, 1998). During the second phase of analysis, we used open codes as a basis for establishing a priori codes which we used to code the data set. Then, the researchers placed the coded data into patches and looked for emerging themes in these patches (Brantlinger, Jimenez, Klingner, Pugach, & Richardson, 2005).

After the first author compiled a description of emerging themes, the second and third authors examined the data tables and conversed with the first author about his conclusions to verify interpretive validity (Maxwell, 1992). For triangulation and also to check interpretive validity, the authors consulted with an external auditor, a local teacher, to evaluate the inferences and conclusion we made about our data set regarding our coding and our themes (Brantlinger et al., 2005). In the next section, we describe the findings that were agreed upon by the research team and the external auditor.

Results

The researchers noticed a pattern with Jerry's work where he quickly and easily solved multi-step equations that did not have fractions embedded in them, yet he experienced significant difficulty when there were fractions in the equations. Jerry quickly solved equations such as 9g + 12 = 84. Equations, such as $\frac{x-4}{6} = \frac{5}{4}$, created lots of mathematics difficulties, and potentially significant anxiety for Jerry. Even when Emma wrote easier equations off to the side to give Jerry a better chance of seeing what he needed to do (e.g., writing $\frac{x-4}{6} = 1$, after he struggled with $\frac{x-4}{6} = \frac{5}{4}$,), he still struggled to solve these problems. Interestingly, Jerry seemed to struggle with algebraic procedures when fractions were involved in the problems (not just with fraction computations). We offer examples of situations in which Jerry may have been simply struggling because of missing knowledge of fractions, or possibly this was part of the issue, but he was also having difficulty thinking clearly because of his anxiety.

We also noticed patterns in Emma's teaching in which she routinely used gestures to draw attention to key information on the paper (e.g., pointing to similar equations that were already solved to help him think about an equation on which he was struggling) as well as frequently offloading of information on paper. To offload (or simply just present a more appropriate problem visually off to the side), Emma would often write similarly structured equations on paper and record Jerry's progress as they spoke about the problems. This way, Jerry had better opportunities to see how problems had similar algebraic structure when he was getting confused by fractions. This practice of keeping Jerry's work on paper well-organized and documented as he was struggling, may have allowed Jerry to focus all of his attention on thinking critically about the problems rather than having to divert any attentional resources to short-term memory. We will demonstrate how his approach (along with Emma's gestures) may have alleviated some the anxiety- and working memory-related difficulties he might have experienced without Emma's help.

In the first example, we demonstrate a situation in which (directly after easily solving 4n + 5 – n = 13 and 8x – 12 = 4x + 24) Jerry struggled with $x - \frac{4}{5} = \frac{1}{2}$. After Jerry did not know how to get started, Emma wrote an easier equation above the original equation to help Jerry think about the algebra he would need to use.

> Tutor: Hypothetically, if this was the problem (writes x -1 = 2), what would you do first?
> Student: (adds one to both sides by writing +1 below -1 and again below 2)
> T: You would add one to both sides, right?
> S: Yeah.
> T: We can just pretend that this is number is just one (POINTING to the four-fifths), right. What are we going to do if this (POINTING to the four-fifths) is one and this is two (POINTING to the one-half) (see row 1 of Table 1)?
> S: (He tried to multiply both sides of the equation by five.)
> T: What would happen if you did times five?
> S: Multiply these… Uh… (stops working to let Emma help him).
> T: The first thing I would have to tell you is, if you tried to multiply everything by five, you would have to multiply that x by five too. I see what you were trying to do; you were trying to make the fraction go away, but we're not going to make the fraction go away like that. We're just going to have to move it. How would you move it

to the other side?

S: I don't know.

While Jerry's conceptual understanding of the mathematics may have been a hindrance in this situation, it is also possible that Jerry was overly concerned about the fraction in the equation. He may have seen the five as a denominator and was trying to multiply the equation by five to eliminate the fractions. He did not follow the plan of action he followed on other problems for which he would try to eliminate the number on the side of the term with variable (e.g., subtract 12 from both sides in the equation, 9g + 12 = 84). His possible anxiety of fractions seemed to affect his decision-making with this problem. Emma realized he was having trouble and began providing more explicit instruction to keep him moving forward.

T: Just like we did with x minus one equals two, you said plus one, plus one, right?

S: Sure

T: Yeah! We're just going to treat this the same way you would a whole number. We're going to add four-fifths to both sides (writing plus four-fifths below negative four-fifths and again below one-half).

T: Because this (POINTING to the -1 in x – 1 = 2) is like negative four-fifths plus four-fifths. So, what does that equal?

S: Zero

T: Yeah, we've gotten rid of this (crossing out negative four-fifths and plus four-fifths); now, we just sort of have to grapple with this one-half plus four-fifths.

At this point, Jerry seemed to be following Emma's teaching regarding eliminating negative four-fifths. Once the process moved towards fractions though, Jerry began to struggle again. Due to these struggles, Emma decided to take a break from the algebra in the problem and teach some missing fraction knowledge to Jerry. Some would argue that Emma should simply give a calculator to Jerry to solve the fraction portion of the problem. While this argument has merit, Emma's decision to teach some missing foundational skills also is reasonable. Teachers are often faced with difficult decision such as these when students are missing key basic skills. Emma continued provided more visual scaffolds off the side.

S: Five over five, which is one. Not because you don't add denominators...

T: You don't add denominators, but you need… Let me write this out a little bit more.

(writes fractions off to the side, see row 2 of Table 1)

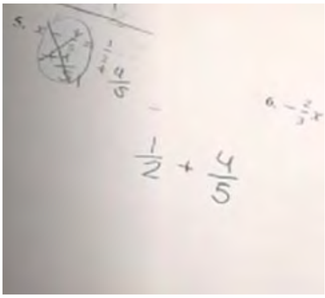
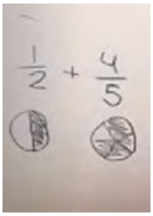
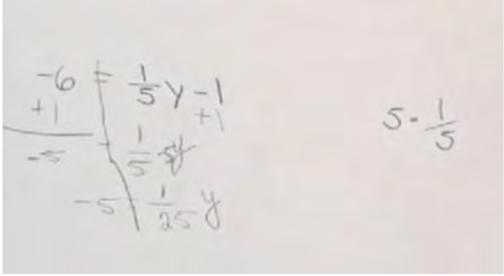
I think you're thinking about multiplication right now. And, I know fractions are a little tricky. If we're adding it, how might it be different than multiplying it?

S: You add up these two (POINTING to both denominators).

T: Do you add denominators? Do you remember?

S: No

Table 1. ***Teacher and Student Use of Pencil and Paper***

Emma's use of pointing as a gesture to help the student see information about which she was questioning him.	
Emma wrote a fraction computation off to the side to separate that information from the rest of the equation.	
Emma's drawing/representation of one-half and four-fifths.	
Jerry's work on an equation with fractions.	

At this point, Jerry was still struggling with the fractions, possibly due to missing understanding of fractions and/or algebra, his anxiety, or a combination of these factors. Emma supported his thinking by showing him the easier equation (that did not have fractions) and using that knowledge he had with algebra to give him a boost with the equation with fractions. However, he did not know how to compute one-half plus four-fifths, and possibly more importantly, he did not know what to do algebraically with the equation with fractions. It seemed like that, in the face of fractions, he was not able to apply what he knew about algebra as he did in equations without fractions. For example, if he did not know how to add fractions, it makes sense that he would not know the answer to four-fifths plus one-half, but one might assume that he would have known those numbers were what he needed to add. In response to Jerry's struggles, Emma began drawing a representation of the concept to support his thinking.

T: I like to make a picture just to sort of give myself a frame of reference (Emma draws a pie chart representation of the fractions; see row 3 of Table 1).

If you add these together, do you think it will be more or less than one?

S: More

Emma and Jerry continued their discussion and it was apparent that he knew that the answer would be a number greater than one, but he did not know how to find common denominators. Emma eventually helped him find the answer of 13/10. Based on Jerry's difficulties with fractions, it is understandable that he experienced challenges with these problems and likely experience anxiety in these situations.

On another problem, $-6 = \frac{1}{5}y - 1$, Jerry seemed to make errors with algebraic thinking when the problem had fractions in it. A logical approach would be to add 1 to both sides to get $-5 = \frac{1}{5}y$ .Then, divide -5 by $\frac{1}{5}$ to get -25 as the answer. Jerry correctly completed the first step and had $-5 = \frac{1}{5}y$ on paper. At that point, he wrote $-5 = \frac{1}{25}y$ (see row 4 of Table 1). At this point, he seemed to be too pre-occupied with the fractions to simply apply the algebraic knowledge he had to solve the problem as he did in equations without fractions. Also, he forgot to multiply the left side of the equation by five, and he made a mistake while multiplying five times one fifth. Emma decided to go along with his approach and it seems reasonable, considering how much he wanted to eliminate fractions as soon as possible due to his potential anxiety with them. She helped him multiply one fifth by five to eventually get one which took a considerable amount of time as she explained the process of how to solve that computation.

It is understandable that he would struggle with fraction computation if that was a weakness for him, but it was (in some ways) surprising that Jerry struggled so much with the algebra in this problem that was structurally similar to problems he easily solved. Once Emma and Jerry got the right side of the equation correct, she then focused on how he forgot to multiply the left side of the equation by 5.

T: This side's (POINTING to the right side) completely right, but we forgot to do the same stuff over here. We multiplied one-fifth by five (POINTING to the right side). We have to do the same thing on the other side right?

S: We'll do the same thing, right? (makes a mistake by trying multiply by one-fifth)

T: Negative five times…Did we multiply by one-fifth, or by five?
S: By five, negative five times five.
T: Yeah!
S: Negative times a positive so it's negative
T: I can tell you've been reviewing those negative rules. (pause) positive or negative?
S: (writes -25 as his answer)
T: Awesome

In both of these cases (despite easily solving many multi-step equations without fractions), Jerry made mistakes with fractions and the algebra he needed to do. With a calculator, one might assume that the fraction computations would not have been an issue. Regardless, it is important that to consider why Jerry struggled with algebraic reasoning on problems with fractions that were structurally similar to problems he easily solved that did not contain fractions.

Discussion

The work of Emma and Jerry on multi-step equations with fractions demonstrates a situation in which a student may have been struggling with working memory, anxiety, and challenging mathematics simultaneously. Jerry appeared to become anxious when presented with fractions in the equations. He had trouble processing the information these problems despite having consistent and quick success with problems of a similar structure without fractions. Anxiety may have led to difficulties with working memory, critical thinking, and the mathematics tasks at hand (Ashcraft & Krause, 2007; Eysenck et al., 2007). Being in a situation in which the mathematics expected involved foundational skills (e.g., fraction computations) that Jerry was yet to develop, and in the context of a gatekeeper mathematics course, could have made Jerry nervous. With policies in place that have led to secondary mathematics courses being gatekeeper courses, it is understandable that some students would feel anxiety about the consequences they may face if they do not pass these courses (Ysseldyke et al., 2004).

Due to these circumstances (and the tendency for students with LDs to experience anxiety in a variety of settings), teachers will need to prepare to address potentially high levels of anxiety from students like Jerry (Nelson & Harwood, 2011). His decision-making processes seemed to be negatively impacted by the presence of fractions in equations. Anxiety can limit students' ability to focus on key concepts and think critically in the challenging academic situations (Eysenck et al., 2007) and this seemed to be the case when Jerry struggled to use his algebraic reasoning he used successfully on problems without fractions. Working memory is also likely to be impacted in situations in which students are expected to solve problems that are unfamiliar or difficult for them, have multiple steps, or create anxiety for the students (Barrouillet et al., 2007; Eysenck et al., 2007; Swanson & Beebe-Frankenberger, 2004). Teachers may need be prepared to help students offload information on paper (or even present more accessible equations with similar structure) so they can devote attentional resources to thinking critically and supplement their verbal instruction with gestures to minimize students' difficulties with working memory (Hord et al., 2016; Risko & Dunn, 2015).

When working with students like Jerry, teachers also need to be prepared to make difficult decisions about when to provide a calculator for students. Undoubtedly, Jerry needed help with fractions. But, he also needed extra help with algebra and working toward more complex mathematics to support his growth as learner in an environment in which he will need to succeed in gate-keeper mathematics courses to access future educational and occupational opportunities (see Achieve, 2015). In short, Jerry needs to understand fractions, but passing algebra courses are what will lead to better opportunities for Jerry in the short-term (e.g., access to college and jobs that require a high school diploma) (Ysseldyke et al., 2004).

Special education researchers need to continue to investigate how students with LDs experience challenges and success in the context of high school, gatekeeper courses. Jerry's possible difficulties with anxiety demonstrate a need for researchers to search for links between anxiety and how well students with LDs can focus on key information in equations and think critically in the face of challenging mathematics. Special education researchers also need to search for ways to teach students how to support their own working memory with effective use of pencil and paper to offload information as they think through multi-step problems. Interventions for students with LDs also need to be studied so that teachers can utilize techniques, such as gestures and ways of offloading information on paper, so these students will be supported and empowered to succeed in high school mathematics courses.

References

Achieve. (2015). *ELA, math, and science course requirements across states* [data file]. http://www.achieve.org/publications/ela-math-and-science-course-requirements-across-states

Alibali, M. W., Young, A. G., Crooks, N. M., Yeo, A., Wolfgram, M. S., Ledesma, I. M., Nathan, M. J., Breckinridge Church, R., & Knuth, E. J. (2013). Students learn more when their teacher has learned to gesture effectively. *Gesture, 13,* 210–233. https://doi.org/10.1075/gest.13.2.05ali

Andersson, U. (2008). Mathematical competencies in children with different types of learning difficulties. *Journal of Educational Psychology, 100,* 48–66. https://doi.org/10.1037/0022-0663.100.1.48

Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math anxiety. *Psychonomic Bulletin & Review, 14,* 243–248. https://doi.org/10.3758/BF03194059

Baddeley, A. D. (2003). Working memory and language: An overview. *Journal of Communication Disorders, 36,* 189–208. https://doi.org/10.1016/S0021-9924(03)00019-4

Barrouillet, P., Bernardin, S., Portrat, S., Vergauwe, E., & Camos, V. (2007). Time and cognitive load in working memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33,* 570–585. https://doi.org/10.1037/0278-7393.33.3.570

Brantlinger, E., Jimenez, R., Klinger, J., Pugach, M, & Richardson, V. (2005). Qualitative studies in special education. *Exceptional Children, 71,* 195–207. https://doi.org/10.1177/001440290507100205

Confrey, J., Nguyen, K. H. Lee, K., Panorkou, N., Corley, A. K., & Maloney, A. P. (2012). *Turn-on Common Core Math: Learning Trajectories for the Common Core State Standards for Mathematics.* http://www.turnonccmath.net

Every Student Succeeds Act, Pub. L. No. 114–95, Stat. 1177 (2015).

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion, 7,* 336–353. https://doi.org/10.1037/1528-3542.7.2.336

Foegen, A. (2008). Algebra progress monitoring and interventions for students with LD. *Learning Disability Quarterly, 31,* 65–78. https://doi.org/10.2307/20528818

Gresham, F. M., & Vellutino, F. R. (2010). What is the role of intelligence in the identification of specific LD? Issues and clarifications. *Learning Disabilities Research & Practice, 25,* 194–206. https://doi.org/10.1111/j.1540-5826.2010.00317.x

Hord, C., Marita, S., Ayaz, S., Tomaro, T., Gordon, K., Tunningley, J., & Haskins, S. (2018). Diverse needs of students with learning disabilities: A case study of tutoring two students in algebra. *Journal of Research in Special Educational Needs, 18,* 25–35. https://doi.org/10.1111/1471-3802.12415

Hord, C., Marita, S., Walsh, J. B., Tomaro, T. M., Gordon, K., & Saldanha, R. L. (2016). Teacher and student use of gesture and access to secondary mathematics for students with learning disabilities: An exploratory study. *Learning Disabilities: A Contemporary Journal, 14,* 189–206.

Hord, C., & Xin, Y. P. (2013). Intervention research for helping elementary school students with math learning disabilities understand and solve word problems from 1996-2009. *Learning Disabilities: A Multidisciplinary Journal, 19,* 3–17. https://doi.org/10.18666/LDMJ-2013-V19-I1-4789

Individuals With Disabilities Education Improvement Act of 2004, Pub. L. No. 108–446 (2004).

Ives, B. (2008). Graphic organizers applied to secondary algebra instruction for students with learning disorders. *Learning Disabilities Research & Practice, 22,* 110–118. https://doi.org/10.1111/j.1540-5826.2007.00235.x

Keeler, M. L., & Swanson, H. L. (2001). Does strategy knowledge influence working memory in children with mathematical disabilities? *Journal of Learning Disabilities, 34,* 418–434. https://doi.org/10.1177/002221940103400504

Marita, S., & Hord, C. (2017). Review of mathematics interventions for secondary students with learning disabilities. *Learning Disability Quarterly, 40,* 29–40. https://doi.org/10.1177/0731948716657495

Maxwell, J. A. (1992). Understanding and validity in qualitative research. *Harvard Educational Review, 62,* 279–300. https://doi.org/10.17763/haer.62.3.8323320856251826

Nelson, J. M., & Harwood, H. (2011). Learning disabilities and anxiety: A meta-analysis. *Journal of Learning Disabilities, 44,* 107–110. https://doi.org/10.1177/0022219409359939

Risko, E. F., & Dunn, T. L. (2015). Storing information in-the-world: Metacognition and cognitive offloading in a short-term memory task. *Consciousness and Cognition, 36,* 1–74. https://doi.org/10.1016/j.concog.2015.05.014

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques for developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage.

Swanson, H. L., & Beebe-Frankenberger, M. (2004). The relationship between working memory and mathematical problem solving in children at risk and not at risk for serious math difficulties. *Journal of Educational Psychology, 96,* 471–491. https://doi.org/10.1037/0022-0663.96.3.471

Swanson, H. L., & Siegel, L. (2001). Learning disabilities as a working memory deficit. *Issues in Special Education, 7,* 1–48.

van Garderen, D. (2007). Teaching students with LD to use diagrams to solve mathematical word problems. *Journal of Learning Disabilities, 40,* 540–553. https://doi.org/10.1177/00222194070400060501

Xin, Y. P., Jitendra, A, & Deatline-Buchman, A. (2005). Effects of mathematical word problem solving instruction on middle school students with learning problems. *The Journal of Special Education, 39,* 181–192. https://doi.org/10.1177/00224669050390030501

Ysseldyke, J., Nelson, R., Christenson, S., Johnson, D. R., Dennison, A., Triezenberg, H., . . . Hawes, M. (2004). What we know and need to know about the consequences of high-stakes testing for students with disabilities. *Exceptional Children, 71,* 75–95. https://doi.org/10.1177/001440290407100105