Meeting the Needs of Students with Dyslexia and Dyscalculia

Bradley Witzel Winthrop University
Minnie Mize Winthrop University

Understanding dyslexia and dyscalculia is not only important to helping students achieve, it has also been recently legislated in one southeastern state. The purpose of the North Carolina House Bill 149 is to ensure that students identified with learning disabilities, including dyslexia and dyscalculia, receive the appropriate assessment and intervention services. In this paper, the authors explain learning characteristics of both dyslexia and dyscalculia and highlight four empirically-validated teaching strategies of increasing instructional intensity: (a) Task analysis; (b) Explicit instruction; (c) Multisensory instruction; and (d) Field-dependent approaches.

Devon worked hard in school and tried to complete his homework consistently. In class discussions, he always contributed with thoughtful comments and good ideas. However, when it came to reading, he struggled. His decoding was poor and his comprehension suffered. Mathematics wasn't much different. He struggled to catch onto calculation patterns and fluency strategies. Even when he felt he was successful completing a problem, his teacher would correct him, pointing out minute but important errors such as adding instead of multiplying or subtracting instead of adding. He thought that he was the dumbest 3rd grader in the school.

Devon is not alone. Many students in the U.S. struggle in reading and math. According to the most recent data from the National Assessment of Educational Progress (NAEP, 2015), percentages of 4th, 8th, and 12th grade students whose reading achievement is at or above proficient are 36%, 34%, and 37%, respectively. These scores highlight that a majority (more than 60%) of students are basic or below basic in reading. Likewise, the report in math shows that the percentages of 4th and 8th grade students at or above proficient of 4th- and 8th-grade students are only 40 and 33%, respectively. For 12th grade students, the scores are worse, with only 25% performing at or above proficient. Thus, a majority of students are also scoring basic or below basic in mathematics. This troubling amount of low achievement means that despite educators' best efforts, most students in the United States struggle in math and / or reading throughout their academic years.

To make matters worse, there has been an increase in the number of students identified as having dyslexia or dyscalculia in recent years. According to the University of Michigan (2017), it is estimated that between 70 and 80% of people with literacy concerns have dyslexia, which equates to about 5-10% of the population. Dyscalculia, although far less studied and understood, has similar rates of incidence.

Dyslexia is a specific language-related learning disability with difficulties ranging from single word decoding to spelling and writing (Fletcher, 2009; Lyon, Shaywitz, & Shaywitz, 2003) and is often characterized by deficits in decoding and phonological processing which impede comprehension. Dyslexia is often associated with students with average to above average cognitive abilities so teachers and parents are often surprised by the child's difficulties reading (Dickman et al., 2002*)*. Similarly, Dyscalculia is an umbrella term for intense difficulty or learning disability in mathematics that affects mathematics computation and numerical processing, typically in areas of number sense (Emerson & Babtie, 2010). Teachers and parents are typically surprised by a student's underachievement in mathematics when compared to her or his excellent performance with speaking, reading, or writing (Ribeiro, Tonoli, Ribeiro, & Santos, 2017).

Having dyslexia or dyscalculia means that students are resistant to general evidence-supported practices. There is certainly no cure and interventions must be targeted and focused specific to their needs.

Recent Legal Emphasis

Recent legislation has highlighted the need for better understanding of dyslexia and dyscalculia and how to teach students with such diagnoses. In July 2017, the North Carolina House voted 114-0 and Senate voted 47-0 in favor of North Carolina House Bill 149 (HB 149) requiring that North Carolina state education code include a definition of dyslexia and dyscalculia and the Department of Public Instruction provide teacher professional development specific to identification and intervention strategies for students with dyslexia and dyscalculia. Further, North Carolina school districts must review diagnostic and assessment tools to more effectively identify students with dyslexia and dyscalculia. The purpose is to ensure that all students identified with learning disabilities, including dyslexia and dyscalculia, receive the appropriate assessment and intervention services.

While HB 149 (2017) has a direct impact on public K-12 schools in North Carolina, it also has implications for all teacher preparatory programs that develop teachers who may work in North Carolina. Moreover, every teacher, within or outside of North Carolina, should understand the impact of dyslexia and dyscalculia on learning and develop an understanding of instructional strategies that have been shown to help such students achieve.

How Dyslexia and Dyscalculia Impact Learning

Dyslexia is one of the common forms of learning disabilities and is often used as a synonym to "difficulty in reading." Like Devon, who was described in the open vignette, students with dyslexia often struggle in decoding and fluency. The difficulties with decoding and fluency commonly result in poor reading comprehension. To decode a word, Devon needs to blend separate sounds to form the whole words: however, students with dyslexia easily mispronounce unfamiliar words compared to familiar words (Ellis, 2016). For example, Devon may be correct in sounding *grass* but might be struggling in pronouncing *grash*, which is an unfamiliar non-word. Proficient decoding skills are required to read a connected text fluently. As such, when struggling readers, like Devon, read a passage, they often mispronounce words, skip the words, and/or replace unfamiliar words with familiar words. For example, when given a 1-minute passage reading, Devon will read fewer words correctly and show more incorrectly read words (error words) than his peers without dyslexia. Decoding has a great impact on reading comprehension because it is a relatively lower-level reading skill, which is a pre-requisite to achieve reading comprehension.

Dyscalculia is sometimes looked at as a math version of dyslexia. In the open vignette, Devon struggled with recognizing the symbols of mathematics and had difficulties catching onto the patterns of computation. Difficulties memorizing rules and procedures are typical of students identified with dyscalculia (Ribeiro, Tonoli, Ribeiro, & Santos, 2017). As such, students with dyscalculia memorize small bits of information and inaccurately or erroneously generalize them to other areas of mathematics. For example, Devon may finally understand that the + symbol means to count on, such that for 5+3 means from five, count six, seven, eight. Excited about this understanding, a problem is then presented 5-3 so he says, "From five, six, seven, eight. That answer is eight." When corrected that 5-3 is a subtraction problem, Devon feels failure in not only understanding subtraction but believes that he misunderstood addition as well. Failure to understand the patterns and symbols in a math system will lead to several difficulties, from place value to computation to rational numbers (decimals, integers and fractions). In math, errors early lead to difficulties later (Witzel, 2016). For example, Devon's confusion with computation will impact his understanding and computation of fractions which will impact his ability to factor complex fractions and polynomials. Thus, it is important to screen for dyscalculia early and implement a focused intervention plan immediately.

Where to focus instruction

Dyslexia. Struggling readers, like Devon, need support for decoding unknown words especially multisyllabic words. For decoding, students must be familiar with basic rules such as dividing a word by syllables, and common prefixes as well as suffixes. Helpful tips are to teach the six syllable types (i.e., Closed, Vowel-Consonant-e (VCe), Open, Vowel-r (r-controlled), Consonant-le (C-le), and Vowel Team) and common prefixes and suffixes. Based on the knowledge, a strategy instruction such as DISSECT (Lenz & Hughes, 1990) can be applied: <u>D</u>iscover the Context - Isolate the prefix (**un**-fair-ness) - <u>S</u>eparate the suffix (un-fair-**ness**) - <u>S</u>ay the stem - <u>E</u>xamine the stem - <u>C</u>heck with someone - <u>T</u>ry the dictionary. As such, once students can separate the prefix (*un*-) and suffix (-*ness*), they can break the long words into parts (un-fair-ness). When teaching common prefixes and suffixes, teaching their meanings (*un*- and -*ness* mean "not" and "a form of noun") helps them grasp the semantics of the words.

When struggling readers, like Devon, come across familiar words even some multisyllabic words (e.g., straw-ber-ry, ham-burg-er), they will have no problem with decoding them as they already have heard and read the words a lot. To read fluently, one of the effective strategies for students with dyslexia is repeated reading (Chard, Vaughn, & Tyler, 2002; Kim, Bryant, Bryant, & Park, 2016). Repeated reading is simply having students read the same text more than once; some students might get bored with reading the same text over again so it is recommended to provide positive reinforcement (e.g., token economy) as they read repeatedly. Common mistakes with reading fluency include hesitations, repetitions, misidentifications, self-corrections, and omissions (Coulter, Shavin, & Gichuru, 2009).

Dyscalculia. A student with dyscalculia likely has difficulty understanding and memorizing processes. As such, it would be easy to rationalize why quick tricks and truncated strategies may work. However, an abundance of different rules, strategies, and tricks that work situationally may overload cognition leaving the student frustrated as to when to apply each one. For example, if Devon was having difficulty with dividing fractions, a teacher may feel compelled to teach invert and multiply, as in figure 1.

Figure 1

$\frac{6}{5} \div \frac{1}{5}$ would be "changed" to $\frac{6}{5} \times \frac{5}{1}$

The student is taught to invert and multiply.

However, Devon didn't learn why the procedure works, and, therefore, might miss a step in this process or overgeneralize the strategy to other fractions operations as shown in figure 2.

Figure 2

$\frac{6}{5} - \frac{1}{5}$ would be "changed" to $\frac{6}{5} \times \frac{5}{1}$

The student overgeneralized the trick with division to other operations.

Instead, show math strategies that work progressively across a scope and sequence so that they can generalize appropriately to multiple math areas. In the example in figure 3, the student follows the process of multiplying fractions to dividing fractions per numerator and denominator.

Figure 3

$\frac{6}{5} \div \frac{1}{5} = \frac{6/1}{1} = 6$

The approach avoids tricks and progresses from what the student has already learned.

Once this approach is understood, allow the student to become proficient through practice. Do not try to force multiple approaches to solve a problem until the first approach has been mastered. It is important to provide time for practice with reasoning to make sense of the process. Once mastered, then the student is ready to attempt learning other mathematics approaches related to the first.

Strategies

For learning mathematics and reading, a number of empirically-validated practices are available. In increasing intensity, four are presented here: (a) Task analysis; (b) Explicit instruction; (c) Multisensory instruction, and (d) Field-dependent approaches.

Task analysis. Task analysis means to break a task down into small steps and sequentially prompt each step for students (Browder, Jimenez & Trela, 2011; Witzel & Riccomini, 2007). For a reading comprehension strategy, a task analysis may look like the following: (a) Before reading- Preview the text; (b) During reading- Identify unknown words and their meanings as well as the most important idea; and (c) After reading- Review what you learned (Klingner, Vaughn, Argüelles, Hughes, & Ahwee, 2004; Klingner, Vaughn, Schumm, 1998). For mathematics, a task analysis may be breaking down long division into a series of steps. Students should practice each step one or two at a time, rather than as the whole process at once. Practicing a stepwise process incrementally allows a student to succeed with minimal error.

Explicit instruction. The cornerstone of explicit instruction is gradual release from teacher knowledge to student knowledge. Typically, explicit instruction begins with an introduction to set the purpose of the lesson followed by teacher modeling with clear think alouds, high amounts of interactivity through guided practice, and an abundance of independent practice. Explicit instruction has a high effect size for students with disabilities and at-risk concerns in both reading (Gersten et al., 2008) and mathematics (Gersten et al., 2009).

Multisensory instruction. Teaching new content through multiple representations has long been supported for students with learning difficulties in reading and mathematics. From Orton-Gillingham to Slingerland to Wilson Reading, Multisensory Structured Language (MSL) approaches are highly popular when working with students with dyslexia for a reason. MSL programs incorporate task analysis and explicit instruction but include auditory, visual, and kinesthetic / tactile sensory input to increase engagement and aid memory of different components of literacy, from letter identification to phonological memory and processing (Birsh & Ghassemi, 2010). In mathematics, the equivalent to MSL is the concrete to representational to abstract sequence of instruction (CRA). In CRA, students learn mathematics through multiple representations, beginning with concrete manipulations followed by pictorial representations of those manipulations and ending with abstract practice (Witzel, 2016). In the earlier example of Devon, a lesson might start with showing subtraction using counter chips. Once Devon showed that he could perform the steps of subtraction while reasoning aloud each step, he would then have to do the same while drawing pictures of the counter chips. Finally, Devon would then be asked to complete similar subtraction problems using abstract notation with the same verbal reasoning. Similar to MSL, the increased sensory input increases engagement and aids memory.

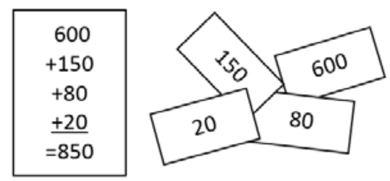
Field-dependent approaches. Field-dependent approaches rely on progressive scaffolding of fully worked examples to help guide a student through a process of understanding. Field-dependent learning relies on a teacher's task analysis and guidance of stepwise progressions to show how to complete a problem (Browder, Jimenez, & Trela, 2012). In mathematics, the steps would initially be presented for the students in a graphic organizer.

In the example in figure 4, Devon is presented with a graphic organizer showing a multiplication array of 25x 34.

Figure 4

X	20	5
30		
4		

The array and products are separated by cards.

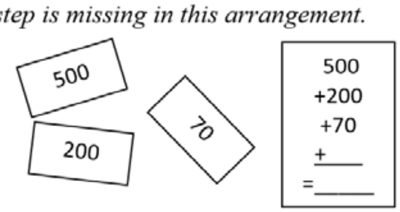


Devon places the cards in the array and explains the process to the teacher. Next, the teacher would present all of the steps to the student except one. Devon would arrange the premade steps and identify the missing step requiring him to compute one of the facts in the array, further developing his independent with the task.

Figure 5

X	50	7
10		
4		

One step is missing in this arrangement.



The faded supports continue until he can independently complete the work. A benefit for the student is that errors are minimized and learning occurs incrementally to support memory.

Assessment

Federal law encourages Multi-Tiered System of Supports (MTSS), originally called Response to Intervention, be considered to accurately identify students with learning disabilities (Gersten et al., 2008; 2009). In a MTSS approach, multiple levels of assessment and interventions are conducted so that students with academic difficulties are identified quickly and instructional interventions delivered quickly. A MTSS approach ensures that students are assessed for specific needs and interventions are focused directly on these needs. In some cases, the intervention delivery is enough to curb the student's performance so that special education identification is avoided.

Catching dyslexia and dyscalculia early is important to addressing areas of academic need and providing an alternative approach to instruction than might already be happening in the classroom. While both dyslexia and dyscalculia are associated with deficits in working memory and attention, there are specific elements for each domain that should be assessed. For dyslexia, typical areas of assessment include:

- Phonological awareness
- Phonological and language-base memory
- Fluent letter identification
- Receptive vocabulary
- Decoding of real and nonsense words
- Oral reading fluency
- Spelling
- Writing (The International Dyslexia Association [IDA], 2017, https://dyslexiaida.org/dyslexia-assessment-what-is-it-and-how-can-it-help/)

Based on these areas of literacy needs, focused interventions must be planned to address each component. While MTSS has been implemented frequently in reading, its use has been less pervasive in mathematics. Early numeracy assessments are needed to catch potential issues with mathematics learning. For dyscalculia and other mathematics difficulties, typical areas of assessment include:

- Numeral naming
- Number magnitude comparisons
- Number seriation
- Arithmetic fact retrieval
- Problem solving
- Visio-spatial processing (Clarke, Gersten, Dimino, & Rolfhus, 2012; Price & Ansari, 2013)

Interventions specific to these areas have proven to help improve students' growth in not only these areas (Geary, Hoard, Nugent, & Bailey, 2013) but may also predict later mathematics achievement (Price, Mazzocco, & Ansari, 2013).

Summation

Educators must be apprised of the needs of students who struggle with literacy and mathematics. Without awareness, concerns may not lead to targeted instructional changes. Accommodations and modifications will help improve access, but employing assessment-informed empirically-validated approaches has the highest potential to improve both reading and math achievement. Having legislative support for students with dyslexia and dyscalculia is a good thing. Employing empirically-validated assessments and strategies is even better. Teachers and teacher candidates alike must learn how to assess and instruct students with dyslexia and dyscalculia.

References

Birsh, J. R., & Ghassemi, C. (2010, March). *Are multisensory instruction and science based reading research (SBRR) in tune?* Presentation at the New York Branch of the International Dyslexia Association Conference, New York, NY.

Browder, D. M., Jimenez, B. A., & Trela, K. (2012). Grade-aligned math instruction for secondary students with moderate intellectual disability. *Education and Training in Autism and Developmental Disabilities, 47*(3), 373–388.

Chard, D., Vaughn, S., & Tyler, B. J. (2002). A synthesis of research on effective interventions for building reading fluency with elementary students with learning disabilities. *Journal of Learning Disabilities, 35*, 386–406. doi:10.1177/00222194020350050101

Clarke, B., Gersten, R., Dimino, J., & Rolfhus, E. (2012). *Assessing student proficiency in early number sense.* Longmont, CO: Sopris West.

Coulter, G., Shavin, K., & Gichuru, M. (2009). Oral reading fluency: Accuracy of assessing errors and classification of readers using a 1-min timed reading sample. *Preventing School Failure, 54*(1), 71–76.

Dickman, G. E., Lyon, G. R., Shaywitz, S., Shaywitz, B., Fletcher, J., Ellis, E., & Henry, M. (2002). *Definition consensus project*. Alexandria, VA: International Dyslexia Association. Retrieved from https://dyslexiaida.org/definition-consensus-project/.

Ellis, A. W. (2016). *Reading, writing, and dyslexia: a cognitive analysis* (Classic edition). London, UK: Routledge, Taylor & Francis Group.

Emerson, J., & Babtie, P. (2010). *The dyscalculia assessment*. New York, NY: Continuum International.

Fletcher, J. M. (2009). Dyslexia: The evolution of a scientific concept. *Journal of the International Neuropsychological Society, 15*(4), 501-508.

Geary, D. C., Hoard, M. K., Nugent, L., & Bailey, D. H. (2013). Adolescents' functional numeracy is predicted by their school entry number system knowledge. *PloS One, 8*(1), e54651. doi:10.1371/journal.pone.0054651

Gersten, R., Compton, D., Connor, C. M., Dimino, J., Santoro, L., Linan-Thompson, S., & Tilly, W. D. (2008). *Assisting students struggling with reading: Response to Intervention and multi-tier intervention for reading in the primary grades. A practice guide.* (NCEE 2009-4045). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://ies.ed.gov/ncee/wwc/ publications/practiceguides/.

Gersten, R., Beckmann, S., Clarke, B., Foegen, A., Marsh, L., Star, J. R., & Witzel, B. (2009). *Assisting students struggling with mathematics: Response to Intervention (RtI) for elementary and middle schools* (NCEE 2009-4060). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://ies.ed.gov/ncee/wwc/publications/practiceguides/.

House Bill 149, SL 2017-127. H149v4. § 127.01-127.05 (2017). Retrieved from https://www.ncleg.net/Sessions/2017/Bills/House/PDF/H149v4.pdf.

Kim, M., Bryant, D. P., Bryant, B. R., & Park, Y. (2017). A synthesis of interventions for improving oral reading fluency of elementary students with learning disabilities. *Preventing School Failure, 61*(2), 116–125.

Klingner, J. K., Vaughn, S., Argüelles, M. E., Hughes, M. T., & Ahwee, S. (2004). Collaborative strategic reading: "Real world" lessons from classroom teachers. *Remedial and Special Education, 25,* 291–302. doi:10.1177/07419325040250050301

Klingner, J. K., Vaughn, S., Schumm, J. (1998). Collaborative strategic reading during social studies in heterogeneous fourth-grade classrooms. *Elementary School Journal, 99,* 3–22. doi:10.1086/461914

Lenz, B. K., & Hughes, C. (1990). A word identification strategy for adolescents with learning disabilities. *Journal of Learning Disabilities, 23*(3), 149–158.

Lyon, G. R., Shaywitz, S. E., & Shaywitz, B. A. (2003). A Definition of Dyslexia. *Annals of Dyslexia*, *53*, 1–14.

National Assessment of Educational Progress. (2015). *Reading and mathematics assessments*. Retrieved from https://www.nationsreportcard.gov/reading_math_2015/#?grade=4.

Price, G. R. & Ansari, D. (2013) Dyscalculia: Characteristics, causes, and treatments. *Numeracy, 6*(1), Article 2. Retrieved from: http://scholarcommons.usf.edu/numeracy/vol6/iss1/art2.

Price, G. R., Mazzocco, M. M. & Ansari, D. (2013). Why mental arithmetic counts: brain activation during single digit arithmetic predicts high-school math scores. *The Journal of Neuroscience*, 33(1), 156 –163.

Ribeiro, F. S., Tonoli, M. C., Ribeiro, D. P. d. S. A., & Santos, F. H. D. (2017). Numeracy deficits scrutinized: Evidences of primary developmental dyscalculia. *Psychology & Neuroscience*, *10*(2), 189-200.

The International Dyslexia Association [IDA] (2017). Dyslexia assessment: What is it and how can it help? Retrieved from https://dyslexiaida.org/dyslexia-assessment-what-is-it-and-how-can-it-help/

University of Michigan. (2017). Dyslexia help starts here. Frequently asked questions. Retrieved from http://dyslexiahelp.umich.edu/answers/faq.

Witzel, B. S. (2016). *Bridging the arithmetic to algebra gap*. Alexandria, VA: Council for Exceptional Children.

Witzel, B., & Riccomini, P. J. (2007). OPTIMIZE your math curriculum to meet the learning needs of students. *Preventing School Failure*, *52*(1), 13–18.

Brad Witzel is a professor and program director of the M.Ed. in Special Education Intervention and researches instruction and interventions for students who struggle in P-12 mathematics.

Minnie Mize is an assistant professor in Special Education and researches interventions for struggling readers.