Bringing Dyscalculia Awareness into the Mathematics Classroom

Honora Wall, Concordia University Chicago

Every mathematics teacher is familiar with students who just cannot seem to succeed, no matter how often they practice. They learn material on Monday, but forget the topic by Friday. No matter the direct instruction, game play, or small group intervention, they are consistently stumped by basic facts or problem-solving procedures. Place value, telling time, and handling money are a mystery to them. These children may have *dyscalculia*. Dyscalculia is a Specific Learning Disorder (SLD) related to learning and remembering mathematics. It is identified through neuropsychological evaluations, a score below the 30th percentile on standardized math tests, or when students with average intelligence perform mathematics two grade levels below their peers (Landerl, et al., 2004). Many educators have never heard of dyscalculia, and this needs to change. Dyscalculia awareness should be incorporated into mathematics teacher training programs.

Understanding SLD's is important for all educators, not just Special Education majors. More students than ever before are placed in general education classrooms staffed by teachers who do not understand their learning challenges (Conderman & Hedin, 2012). Currently, 70% of students with Specific Learning Disorders like dyscalculia, dyslexia, and dysgraphia are placed in general education classrooms, but many teachers feel unprepared, undertrained, and overwhelmed by their special education students (Conderman & Hedin, 2012). This is frustrating for teachers and students alike. Luckily, supporting students with dyscalculia is easy (although counter intuitive to many mathematics educators): properly addressing dyscalculia requires allowing the use of 1-100 charts, times tables lists, reference sheets, and calculators for students in all grades, and for all mathematics work.

A 2017 survey conducted by Horowitz, Rawe, and Whittaker found that 30% of general education teachers attribute failure in mathematics to a lack of student effort rather than to learning disabilities. Of course, it is hard for educators to understand the challenges of a disability that isn't fully understood by researchers. It is universally accepted that dyscalculia primarily affects the parietal lobe, where we store mathematics information in the brain. Many researchers, including Cherasaro, Reale, Haystead, and Marzano (2015), believe that dyscalculia deficiencies are due to coding issues that occur during mathematics instruction, specifically coding between Arabic numerals, written word form, and object representation (see Figure 1). Others feel there may be an underlying core issue in mathematics comprehension (Butterworth, et al., 2011). In either case, people with dyscalculia do not develop automaticity, have trouble subitizing, and use immature methods of problem solving compared to their peers. For example, one indicator of dyscalculia is a reliance on finger counting long after other students have progressed to more advanced algorithms for computing (Piazzi, et al., 2010). We know that students with dyscalculia have persistent mathematical deficits and are resistant to traditional instructional methods and common interventions (Piazzi, et al., 2010). We know that dyscalculia affects 10% of the population– about 5 million K-12 students in the United States— the same rate as dyslexia.

Figure 1
Coding and numerical cognition

Arabic digit	Word form	Object Representation
3	Three	O O O

The brain codes numeric information in three ways: The numeric symbol, the written and spoken word representing the amount, and a concrete, object-based representation of the amount. Researchers question whether dyscalculia stems from an underlying coding issue.
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Dyscalculia versus Low Numeracy

Dyscalculia is commonly misinterpreted as low numeracy. These issues share a similar presentation: poor mathematics performance. However, low numeracy is a temporary condition stemming from external issues, rather than a lifelong condition related to neurological or cognitive differences. While children with low numeracy struggle to perform operations, follow mathematical procedures, and learn basic arithmetic facts, they can permanently improve performance and retention through classroom interventions like extra practice (Geary, 2011). This happens because the mathematics-related deficits common to low numeracy are not related to cognitive deficits, working memory, or processing speed (Ashcraft & Kirk, 2001). Rather, they are attributed to poor instruction or insufficient early exposure to numbers and mathematical concepts (Geary, 2011). Children with low numeracy demonstrate problems with number sense and mathematical operations, but do not experience task-specific difficulties in telling time, learning place value, or forgetting information over time, the way those with dyscalculia do (Ashcraft & Kirk, 2001). By examining student performance in these key areas, teachers can better identify temporary issues versus foundational differences.

Dyscalculia in the Mathematics Classroom

It is crucial that general education educators have a better understanding of neurodiverse learners, whose needs are fundamentally different from the needs of other special education students. Special education theories commonly rely on Behaviorism, championed by Bandura, Skinner, and others. Behaviorism focuses on actions, studying the cause and effect of repeated behaviors, and recommending methods of altering inappropriate or unwanted behaviors (Lenjani, 2016). This approach has many beneficial applications but fails to address the inherent deficiencies of dyscalculia, namely, weakened retention of mathematics facts and a lack of recall of learned information. The most consistently observed signs of dyscalculia are impaired arithmetic fact retrieval and continuing to use inefficient strategies (i.e., counting from 1 every time, rather than counting on from a number) long after their typically developing peers have progressed to memory-based strategies (Price & Ansari, 2013). This slows students down and impedes their ability to focus on vocabulary (i.e., perimeter, area, and volume) or concepts (factoring quadratics or identifying asymptotes, for example). Allowing students to use calculators or reference a list of times tables can free up working memory and reduce cognitive load so they can get more out of a given lesson.

Students with dyscalculia benefit from support systems rather than repeated practice (Price & Ansari, 2013). For example, referring to notes that define perimeter and area, combined with using a calculator, allows students to demonstrate their understanding of adding around an object versus multiplying to cover the surface of an object, without the barrier of recalling basic facts. This is necessary because the parietal lobe loses facts and procedural information over time (Butterworth, et al., 2011). Helping students develop personalized notes is another useful support system. Students can learn how to tell their future self what the steps are, or what to look out for when solving a problem. Asking questions like, *Which part is confusing here– getting started, or knowing what to do next?*, during a review helps students develop metacognitive reflection and self-awareness as learners. Finally, offering extended time is useful for students who need to start at the beginning, every question, every time. It simply takes longer to answer a question when the work is not automatic– and dyscalculia blocks the development of automatic processes.

Looking forward, mathematics teacher educators can increase dyscalculia awareness in two ways: by discussing this SLD in all classes and by encouraging research on this topic. Today, the volume of published research on dyscalculia is only 10% that of its sister SLD, dyslexia. We must add to our knowledge of dyscalculia through both qualitative and quantitative research. Future studies could focus on differentiated classroom instruction for dyscalculia, improving mathematics abilities and confidence in those with dyscalculia, or the lived experiences of people with this learning disability at all stages of life. The author of this paper is currently studying the efficacy of test accommodations for students with dyscalculia. The mathematics learning disability *dyscalculia* should become common knowledge among mathematics teachers and mathematics teacher educators. This way, the mass of currently struggling people can become successful mathematics students in any classroom.

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