Learning Disabilities in Mathematics (Dyscalculia)

What is Dyscalculia?

Dyscalculia is a specific math learning disability, that affects the way students understand number-related concepts and hinders their mathematical computation ability. Approximately 5-8% of students in elementary school have dyscalculia which is the same prevalence rate for dyslexia (Geary, 2004). Students who have dyscalculia are also at an increased risk of developing deficits in reading or writing.

Life-long impact

Although math learning disabilities are typically diagnosed throughout elementary and middle school, the associated problems have been reported to persist into later life. For example, an individual with a mathematical learning disability is more likely to develop low self-esteem, set low expectations, have fewer friends, and get in trouble with the law (National Centre for Learning Disabilities, 2014). Additionally, dyscalculia has been described as an "economic issue, as adults with poor arithmetic skills suffer a major disadvantage in the job market" (Kaufmann & Aster, 2012, p. 767).

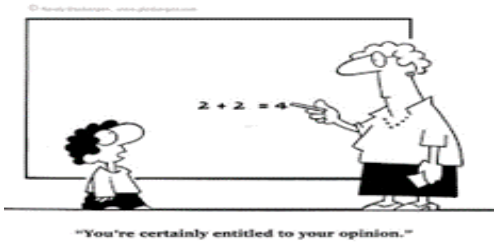
Underlying Cognitive Mechanisms

It is believed that students with dyscalculia experience deficits in the central executive or working memory systems of language or visuospatial areas. These deficiencies can, therefore, negatively impact an individual's conceptual or procedural competencies in mathematics (Geary, 2004). For example, the automatization rate of arithmetic skills in children with dyscalculia is much slower than in children without the disability.

There are three subtypes of dyscalculia: procedural, semantic memory, and visuospatial subtype. Each of these subtypes will manifest themselves differently. For example, a student with the procedural subtype will show frequent mistakes in following procedures and have trouble understanding multi-step concepts. In contrast, individuals with the semantic memory subtype, can have trouble retrieving mathematical facts or retrieve information with high error rates. Furthermore, students who have difficulty spatially representing or interpreting mathematical relationships, display characteristics of the visuospatial subtype (See Table 1, Geary, 2004 for more detail about each subtype).

Comorbidities

Up to 60% of students with dyscalculia have an impaired working memory, visuospatial skills, or attention deficit hyperactivity disorder. Moreover, children and adolescents with dyscalculia often have emotional distress because of their decreased academic achievements in school. It has been demonstrated that these emotions can lead to a negative mathematics attitude, mathematics anxiety, and even school phobia (Kaufmann & Aster, 2012). Desoete (2008) also reported that 97% of students in her study experienced a comorbidity alongside their dyscalculia. For example, the participants had motor difficulties, oppositional defiant disorder, or depression symptoms.



Early signs and Diagnostic Criteria

Children with dyscalculia can exhibit average literacy skills, but experience challenges with counting and reading numbers sequentially. Students can also have computational difficulties because of a poor long-term memory. Time management and understanding directions can be tough for a child with dyscalculia as well (National Center for Learning Disabilities, 2017). Although the early signs associated with dyscalculia are important for educators to consider, it does not necessarily guarantee the student has a math learning disability.

According to Cunningham (2016), there are four main assessments that are used to diagnose dyscalculia. These include: Wechsler Individual Achievement Test, Kaufman Test of Education Achievement, Woodcock-Johnson IV Test of Achievement and KeyMath3. To be diagnosed with a math learning disability, students must score between the 10th and 15th percentile on these standardized tests and have experienced math difficulties for at least six months (Cunningham, 2016). Using curricular assessments and standardized tests do provide insights into mathematical performance, but they should not be used in isolation may not provide a full picture of the mathematical deficits (Kaufmann & Aster, 2012).

Preventative Instructional Strategies

Gersten, Chard, Jayanthi, Baker, Morphy and Flojo (2009) found the following strategies to be effective when teaching students with math learning disabilities.

Explicit Instruction. Effective techniques for explicit instruction ranged from providing students with a step-by-step plan for solving specific math problems to visual representations (Gersten et al., 2009, p. 1228). The authors concluded that visual representations improved student performance, but a greater effect was shown when used in combination with other instructional components. Furthermore, when specific visual representations were provided, students learned more than from less specific visuals (p. 1229).

Student Verbalization. Student verbalizations of their thinking or of explicit instructions has been shown to be an effective teaching method (Gersten et al., 2009). These findings suggest that it is important to teach students how to use their oral language skills to enhance their learning (p. 1230).

Feedback. Providing ongoing feedback to students on their effort as opposed to their abilities was shown to have the greatest impact on performance (Gersten et al., 2009, p. 1231)

Sample #1 and #2 demonstrate how dyscalculia can affect a student's understanding of place value. The student is exhibiting a conceptual error as determined by the Diagnosis, Prescription and Remediation model.

Sample #1

Express the following number words as numbers:

1. **fifty seven**
   507
2. **six hundred forty two**
   60042
3. **seven hundred fifty thousand fifty eight**
   7005000058

Sample #2

Write the correct answer below each question:

1. **Which is larger? 13 or 31?**
   They are equal
2. **Which is larger? 41 or 39?**
   39

Error Pattern Intervention

Educators should consider utilizing the Mathematics Improvement Plan and the Data analysis sheet if students should require additional support. These resources will allow educators to develop and implement effective assessments to evaluate students' abilities (Sherman, Richardson & Yard, 2009). Moreover, a three-stage model can be used to accurately identify and address a student's mathematical needs. The first stage of the model is called *Diagnosis*, because educators identify the error a child is making. *Prescription* is the second stage, because educators brainstorm a list of manipulatives which can strengthen a child's skills, to minimize the occurrence of the error. The final stage is *Remediation*, because educators develop activities that incorporate the prescribed resources (Sherman, Richardson & Yard, 2009).

References

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