How to Identify, Screen, and Support Students with Dyscalculia

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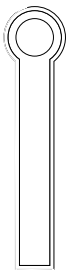

Dyscalculia– A Lesser-Known Learning Disability

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Dyscalculia– A Lesser-Known Learning

Many of us are familiar with dyslexia, a learning disability that impacts a person's language skills, including reading and writing. However, fewer people have heard of dyscalculia, a math learning disability that affects one's ability to understand and work with numbers.

We're providing educators, parents, and caregivers with resources to better understand what dyscalculia is, identify common signs, access screening tools, and support students diagnosed with this learning disability.

Dyscalculia Statistics

Dyscalculia can be found in classrooms throughout the world yet, it's not nearly as well-known as dyslexia.

- **Research says between 3 to 7 percent of students worldwide may have dyscalculia.**
- **105 million+ students globally—over 3 million in the United States—have this math learning disability.**

Sources:

The Diagnosis and Treatment of Dyscalculia

Pilot Data From Third to Ninth Grade for a Large-Scale Online Dyscalculia Screener

What is Dyscalculia?

Students with dyscalculia have difficulty understanding and manipulating numbers, estimating quantities, and performing mental math without writing things down. However, not everyone with dyscalculia will struggle in all areas of math.

Unlike math anxiety, which is a worry or fear about performing math calculations, people with dyscalculia have difficulty acquiring number-related skills. An estimated 7 percent of the world's population (around 1 in 15 children, adolescents, and adults)[1] struggle with math due to dyscalculia. It's a lifelong math learning disability that can impact a student's academic career, future employment, and self-esteem. It's listed as a disability under both the Individuals with Disabilities Education Act (IDEA) and the Americans with Disabilities Act (ADA).

1 (Butterworth, 2003; Haberstroh & Schulte-Korne, 2019; Menon et al., 2021; Price & Ansari, 2013; Ustun, 2021).

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Dyscalculia– A Lesser-Known Learning

While teachers or caregivers often discover evidence of dyscalculia when children begin to learn about numbers and basic mathematical concepts, dyscalculia persists over time regardless of IQ or education level. It also affects individuals of all ages and is not gender specific.

Inside the Classroom	Outside the Classroom
Difficulty completing assignments	Difficulty using analog clocks and maps
Confusing order of operations	Unable to estimate remaining time or distance left
Struggling to apply concepts, rules, formulas, and/or sequence	Inability to guess remaining volume of containers for storing liquid/solids
Inability to use mental math during lessons or on homework assignments/tests	Challenges with estimating sale prices, calculating tips, an/or making change

Individuals with dyscalculia may have problems with:

- **Number sense (understanding the meaning and relationships of numbers)**
- **Memorizing math facts**
- **Performing math calculations**
- **Reasoning mathematically**
- **Solving math problems**

The longer dyscalculia goes unrecognized, the harder it is for children to get the instructional supports needed and get on grade level. When students lag behind their classmates in math, have difficulty following procedures, and are slow in problem-solving it can also lead to math anxiety and avoidance of math-related tasks when taking more advanced math courses during school.

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How Does Dyscalculia Impact Student Learning?

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How Does Dyscalculia Impact Student Learning?

Students with dyscalculia may not experience difficulty with all areas of math. Instead, they might encounter challenges in a specific area.

These areas include:

- **Number Sense**: Students with dyscalculia have difficulty understanding and recognizing numbers and counting and using number patterns. They may struggle with estimating quantities and solving math problems that involve basic number concepts.
- **Memorization of Arithmetic Facts:** For students with dyscalculia, memorizing math facts, such as multiplication tables, could pose greater challenges. They may forget recently learned facts and count on their fingers to solve math problems.
- **Accurate and Fluent Calculation:** Students with dyscalculia generally take longer to solve math problems and make more errors. They often rely on inefficient counting strategies and struggle with accuracy, especially when working through multi-step problems.
- **Accurate Mathematical Reasoning**: Students with dyscalculia have difficulty judging quantities and manipulating numbers. They may struggle to understand abstract mathematical representations and have trouble comparing numbers or identifying number sequences.

In addition to these specific math difficulties, students with dyscalculia may also face challenges with general reasoning that affect their math abilities.

These challenges could include:

- **Working Memory:** Dyscalculia can impact a students' working memory, or their ability to hold and manipulate information. People with dyscalculia may have trouble remembering the steps in a math problem or have difficulty accessing numerical information quickly.
- **Attention**: Students with dyscalculia may struggle to focus their attention on math tasks and may be easily distracted. This can appear more often when they are asked to solve multi-step problems or when they haven't fully automated certain math skills.
- **Processing Speed**: Students with dyscalculia often take longer to process and respond to math problems compared to their classmates. They may need more time to retrieve information or complete calculations accurately.
- **Phonological Processing**: Dyscalculia can affect a student's ability to recognize and manipulate sounds in language, which is important for understanding and processing math problems that are spoken rather than written. Difficulties in phonological processing can hinder a student's ability to work with numbers and solve arithmetic problems.

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How Does Dyscalculia Impact Student Learning?

- **Spatial Skills**: Dyscalculia can impact a student's spatial skills, including their ability to understand shapes, sizes, positions, and directions. Students need spatial skills to solve geometry problems and to visualize mathematical concepts.

- **Logical/Non-Verbal Reasoning**: Students with dyscalculia may have difficulty problem-solving and forming concepts without relying on language. Students must develop logical reasoning and non-verbal reasoning skills to identify patterns, understand problem constraints, and find solutions.

Individuals' math abilities can vary, ranging from severe and long-lasting difficulties to temporary struggles that can improve with targeted interventions and practice.

How Can Poor Math Skills Affect Students Later On?

Poor math skills can negatively impact a student's academic future. It can limit their access to advanced math classes critical for STEM jobs and other career paths and increase their chances of dropping out of school. Later in life, innumeracy can contribute to financial problems, higher stress levels, other career paths, and an increased risk of mental health issues.

To be successful in advanced math topics, students must build a strong mathematical foundation while they are in early grades. By the end of second or third grade, students should understand basic operations such as addition, subtraction, and multiplication. If they're unable to master these skills, it becomes even more challenging for them to grasp advanced math concepts in middle and high school.

Often, teachers in upper elementary and middle school seek help for students who are falling significantly behind in math. Unfortunately, students who go undiagnosed with a learning disability such as dyscalculia may not receive additional support when they need it, leading to years of lost potential assistance.

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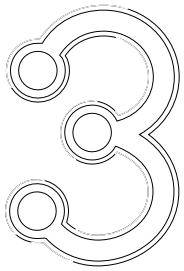

Screening For Dyscalculia

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Screening For Dyscalculia

To bring awareness to dyscalculia and address these challenges, educators can help students improve their math skills, bridge learning gaps, and boost their academic and future career success.

Research shows that identifying dyscalculia is critical to helping students get the support they need for math success. By using screeners, or quick assessments, educators can "shortlist" students who might need further evaluation to determine if they qualify for a dyscalculia diagnosis.

A good screener can identify children at risk who may require further testing and possibly a formal diagnosis of dyscalculia. However, screeners are not comprehensive evaluations and should not be used to make a definitive dyscalculia diagnosis. Screeners as well as observational information should be collected in a short survey, decreasing the chances that indicators are overlooked and also providing additional information if a formal evaluation is undertaken.

By identifying potential difficulties early on, screeners can help educators start the diagnostic process and make instructional decisions, regardless of the assessment outcome. Screeners, as well as observational information, should be accessible and easy to use for educators and caregivers.

A good dyscalculia screener should also:

- **Reflect the complexity of mathematics through a multi-proficiency assessment, and allow educators to collect the maximum amount of information in the minimum amount of time.**
- **Indicate where the potential for dyscalculia exists and kickstart the diagnostic process to formally identify individuals with the Specific Learning Disability-Math, Dyscalculia.**
- **Be based on foundational math skills that are predictive of later math achievement.**
- **Inform the instructional decision-making process, regardless of the outcome of a diagnostic process.**
- **Be easily accessible and useable by those that wish to learn more about why a student is struggling with math and how to best address the issue.**

How and Why TouchMath's Dyscalculia Screener (DySc) Tool Works

We applied the latest research when we designed the TouchMath **Dyscalculia Screener (DySc)** in order to identify difficulties in the specific areas of math that can indicate a risk of dyscalculia. The DySc is available for use with students and consists of a questionnaire for students, a survey for educators/caregivers, and a report that provides actionable suggestions for next steps and evidence-based interventions.

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DySc Tool (continued)

The DySc tool includes 16 to 39 age-appropriate questions in four categories aimed to identify dyscalculia traits without asking math questions that may be too advanced for a student's age. The screener can be used to assess three distinct age groups, ages 3–4 years, 5–7 years (pre-kindergarten to second grade), and ages 8 years and above, including adults.

These include questions in the following domains:

- **Number Sense:** Students are asked to identify the quantity of dots and provide the corresponding number quickly and accurately in a series of problems. This helps us understand their ability to recognize and understand numerical quantities.
- **Memorizing Arithmetic Facts:** The DySc assesses how well students can memorize and use basic arithmetic facts. They are given a series of addition, subtraction, and multiplication problems to solve. The problems start with single-digit numbers and progress to more complex calculations.
- **Accurate and Fluent Calculations:** Being able to make accurate and quick calculations is essential to mastering mathematics and is an area of struggle for those with dyscalculia. In the DySc, students solve addition, subtraction, multiplication, and division problems. The difficulty level of each problem increases gradually, with the division problems being the most challenging.
- **Reasoning and Problem Solving:** Mathematical reasoning requires understanding concepts and applying them to solve different types of problems. In the DySc, students tackle problems that require them to solve for missing numbers and make number pattern predictions.

Scoring the DySc: Analyzing the Results

The DySc screener reports raw scores and a dyscalculia risk score. The DySc report provides an overview of the student's performance, including the specific tasks or assessments used and their scores.

The digital version of the DySc automatically scores each student's assessment. If educators or guardians decide to use the print version, they must carefully add up the points and input the point value manually where they can generate a report.

By analyzing students' scores, educators can determine whether a student might be at risk for dyscalculia.

- **A score of 0–12 indicates definite markers for dyscalculia, and further evaluation and interventions are recommended.**
- **A score of 13–52 suggests some indicators are present, and it is recommended to screen again at a later date while implementing immediate interventions.**
- **A score of 53–78 means there are no indicators of dyscalculia risk, but since the student is still struggling, interventions can be helpful.**

These scores help educators determine critical next steps, based on what the screener reveals about a student's specific math difficulties.

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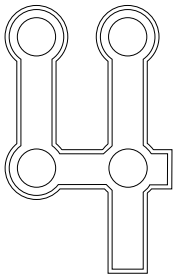

Supporting Students With Dyscalculia:
Evidence-Based Tools and Strategies

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Supporting Students With Dyscalculia: Evidence-Based Tools and Strategies

Research supports early screening and applying evidence-based interventions as effective for helping students with dyscalculia achieve age-appropriate math levels (Bailey et al., 2020; Dennis et al., 2016; Kuhl et al., 2021). Matching math interventions to specific content areas of math increases the intervention's effectiveness by personalizing it to that child (Chodura et al., 2015; Haberstroh & Schulte-Korne, 2019; Nelson et al., 2022).

We have identified four key intervention areas that caregivers and educators can use to help students. These interventions are not all-inclusive, but can help parents and educators address the specific areas of math where students with dyscalculia struggle .

These interventions include:

1. **Child/student supports that impact the ability to learn math:**
   - **Math anxiety interventions**
   - **Self-efficacy interventions**
   - **Working memory interventions**
   - **Attention span interventions**

2. **Mathematics interventions:**
   - **Number sense**
   - **Memorization of arithmetic facts**
   - **Whole numbers computation that is accurate and fluent**
   - **Accurate mathematical reasoning**

3. **Instructional strategy interventions:**
   - **Multisensory delivery of information and engaging the student**
   - **Systematic, explicit instruction**
   - **Extensive rehearsals or repeated experiences**
   - **Use of the concrete–representational–abstract framework**

4. **Learning strategy interventions:**
   - **Taking time to review**
   - **Use of templates and graphic organizers**
   - **Writing down the steps before solving a problem**
   - **Use of schemas and frameworks to solve problems**

Child/Student Supports That Impact the Ability to Learn Math

The following interventions can help students overcome math anxiety, and improve self-efficacy, working memory, and their attention span.

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Math Anxiety Interventions

Many students experience math anxiety, which can significantly impact their academic performance and confidence. Fortunately, there are a number of interventions that can help to reduce math anxiety (Jordan et al., 2013). By helping students break down complex problems and encourage positive self-talk, educators can help boost confidence and reduce anxiety. They can also incorporate math games and puzzles into lessons to help make learning more fun. If a student is experiencing severe math anxiety, it may be helpful to refer them to a professional counselor who can provide additional support and guidance.

Self-Efficacy Interventions

High self-efficacy—a student's belief that they have done well in the past and can accomplish new tasks—contributes to their engagement with the math task (Bandura, 2012). High self-efficacy can impact how much effort students will put into the lesson and how long they will tolerate frustration when faced with difficulty. Educators can help boost self-efficacy by practicing "errorless learning," and sharing anxiety-reducing techniques—such as deep breathing—in high-stress testing situations. Gamifying math can also help students gain confidence in a lower-risk, non-competitive setting that provides immediate feedback on their successes.

Working Memory Interventions

Students with dyscalculia commonly have problems with their working memory, or their ability to temporarily store and manipulate information such as the retrieval of math facts. Improving working memory can have a significant impact on academic performance. By presenting information in chunks and breaking multi-step tasks into subsets, educators can help students memorize and retrieve information more easily. Students also benefit if they are given longer wait times in which to process new information and have opportunities to reach automaticity with basic facts.

Attention Span Interventions

Children with shorter attention spans may struggle to stay focused in math class or complete assignments. (For children who have been diagnosed with ADHD, educators and caregivers should consult experts.) Educators can use visual aids to make math more engaging and incorporate bursts of physical activity into lessons, to help students improve their focus and concentration. Clear instructions and positive reinforcement can also help motivate students and keep them on task.

Mathematics Interventions

Here are a few of the mathematics-specific interventions in each of the four domains—number sense, memorization of math facts, whole numbers computation, and mathematical reasoning— that can help students boost competency in these areas.

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Number Sense

Some instructional interventions that have shown success in improving number sense include *(Fyfe, 2019):*

- Games that require counting and recognizing that one number is larger than another, such as Chutes and Ladder or the TouchMath Connect 1 app. This intervention helps students attach a numerical symbol to a quantity and reinforces addition and subtraction skills.
- Using manipulatives and visual aids or the concrete-representational-abstract framework to understand the connection between the physical object and its abstract symbol.

> *Using the TouchMath technique has been shown to be effective in teaching math facts. It is a multisensory approach, combining visual, auditory, and tactile actions as the student places dots or object pictures on the concrete object, drawing, or the abstract numeral. This simultaneously allows the child to connect the concrete, semi-concrete, and abstract version of the numeral. As the child reaches mastery in number recognition, the dots are removed. Dice, counters, TouchMath numerals, texture cards, etc. can all be used to support this strategy (Yikmis, 2016.)*

- Having students draw the physical item or represent it with dots, squares, etc. before attaching the appropriate symbol to the drawing. *Using the TouchMath Build It, Draw It, Write It (BiDiWi) sheet is an effective instructional strategy.*

Memorization of Arithmetic Facts

- Set aside regular practice time each day to help a student build fluency, using flashcards, practicing mental math, or playing math games that focus on arithmetic skills such as dominoes.
- Focus on one set of facts at a time to avoid overwhelming the student by asking them to memorize all arithmetic facts at once. Instead, focus on one operation at a time, such as addition or subtraction, and gradually add more sets as they achieve mastery.
- Conduct non-competitive quick sprints or math fluency tests to help students memorize math to increase students' accuracy and then speed. It is important that the student beat their own time or number correct, and it not be a competitive exercise at this point.

Whole Numbers Computation that is Accurate and Fluent

Instructional interventions that have shown success in improving math computation include:

- Timed trials or practices with paper and pencil where students only compete against themselves to improve accuracy and speed.

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- Computer games that enable practice for memorization and fluency.
- Using a mind map or mathematical modeling to assist students in conceptual understanding *(Powell, Fuchs, et al., 2009).*
- Word problem-solving that asks students to break own problems into smaller steps (*Fuchs, Fuchs, et al. 2012).*

Accurate Mathematical Reasoning

Accurate mathematical reasoning refers to the process of using logical and precise methods to arrive at correct solutions to mathematical problems. Students need to master accurate mathematical reasoning to achieve success in many academic and professional fields. It requires building a combination of knowledge, skills, and attention to detail.

Key elements include:

- **Understanding mathematical concepts**
- **Using appropriate mathematical methods**
- **Checking for errors**
- **Communicating results**

For example, playing logic games, such as Sudoku and crossword puzzles, helps students develop their logical reasoning skills by improving their ability to analyze relationships and make connections between different pieces of information.

Instructional Strategy Interventions

As educators aim to improve students' math skills in the four targeted domains, they can use research-supported instructional strategies including:

- Multisensory interventions that aim to increase motivation and boost conceptual knowledge gain *(APA, 2022; Mahmud, 2020).* This could include dance or choral response, which is not only engaging and provides for practice but also is known to help the brain retrieve facts *(Doi, 2018).* It also includes the use of presenting visual, auditory, and tactile input concurrently as is used in TouchMath materials *(Abdou, 2020; 81Taneja, 2019; Urton et al., 2022; Vinson, 2004; Waters & Boon, 2011; Wisniewski, 2002).*
- Systematic explicit instruction focused on basic arithmetic competencies. Explicit instruction includes a review of prerequisite skills, checking for understanding, direct instruction, guided practice, and independent practice.

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Instructional Strategy Interventions (continued)

- **Concrete-Representational-Abstract** *(Bouck et al., 2018; Jacobsen, 2020; Mahmud, 2020; Mononen, 2014)* strategies use manipulatives and visual representations for problem-solving and practice so that students can connect abstract symbols and numerals to their numerical values through a fading technique. The use of color is encouraged as it adds an extra element of being engaging to any age student.

> *The use of dice, Touch Numerals, etc. allows student to directly connect the concrete and the abstract. Using cereal, beads, tiles, and chips also enables a tactile technique for engaging the students and explore the math concept or demonstrating their understanding of it (Cihak & Faust, 2008; Yikmis, 2016; Ellingsen & Clinton, 2017; Fletcher, 2010; Kot et al., 2018; Taneja, 2019).*

Learning Strategy Interventions

When a student has dyscalculia, there will usually be areas of mathematics they will permanently struggle with, and there are strategies they can use to overcome these challenges. Educators can teach students the following learning strategies as they attempt to master various math concepts and skills.

Students should be encouraged to:

- Take time to review work, deliberately slow down and read a problem twice, and ask themselves if the answer is logical.
- Use templates and graphic organizers such as Frayer charts and TouchMath BiDiWi templates.
- Solve a problem and then use the inverse operation to check their own work to decrease mistakes as an additional way to check or solve a problem.
- No matter what intervention is used, educators and caregivers should support the student first in order to prevent further math anxiety or disengagement with a task that they find difficult.

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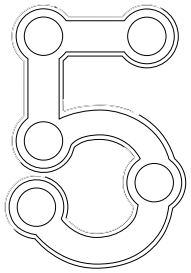

Equip Teachers to Help All Students
Achieve Math Mastery

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Equip Teachers to Help All Students Achieve Math Mastery

Dyscalculia is a learning disability that affects a person's ability to understand and work with numbers. By understanding what dyscalculia is and how to recognize it, educators can more quickly identify students who may have this learning disability.

TouchMath's research-backed and no-cost Dyscalculia Screener (DySc) helps caregivers and educators more accurately determine whether students experiencing difficulty with math and show evidence of dyscalculia. Additionally, the screener pinpoints the math content areas in which students need extra help, ensuring they get appropriate math interventions as they wait for a learning diagnosis.

The child supports, math interventions and instruction, and learning strategies describe a few of the ways in which caregivers and educators can support a student's math journey, whether or not they have a formal diagnosis.

TouchMath can help you navigate dyscalculia and provide more information and tools to help your students succeed. For nearly 50 years, we've been proud to serve as the go-to learning solution for educators around the world. Our multi-sensory approach to mathematics meets students where they are in their math journey and helps them develop new concrete, representational, and abstract skills.

To learn more about supporting learners with dyscalculia, visit touchmath.com/dyscalculia-101.

Read the full white paper for the underlying research summarized above:

The Transformative Potential of Early Screening for Dyscalculia, The Discounted Specific Learning Disability

by Dr. Sandra Elliott and Sam Wertheim, Doctoral Candidate.

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