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LDA Webinar

A Deep Dive into Dyscalculia

Dr. Anneke Schreuder,  
Founder of Dyscalculia Services and  
Dyscalculia Training Center

September 2021



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A 5<sup>th</sup> grade boy who loved sports 2

- ▶ Trouble with the fast math minute practice in 2<sup>nd</sup>
- ▶ Trouble with word problems
- ▶ Physically restless despite ADHD treatment
- ▶ Usually cheerful on the oppositional side in math
- ▶ Homework frustration
- ▶ Losing self esteem
- ▶ Almost switching schools

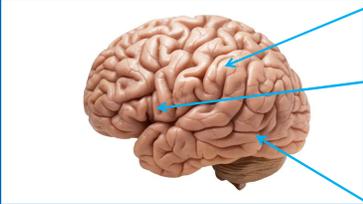


Could it be dyscalculia?

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3 main centers for math 3

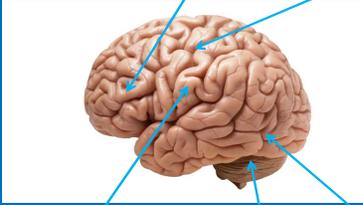


- Number Sense Center
- Verbal Centers
- Visual Centers

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Pre-frontal region executive function 4



- Pre-frontal region executive function
- Fine motor skills
- Various types of memory
- Visual spatial processing
- Rhythm

Temporal processing

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### Number Sense 5

The universal ability to represent and manipulate numerical magnitudes nonverbally on a spatially oriented mental number line

- ▶ Subitizing
- ▶ ANS Approximate Number Sense

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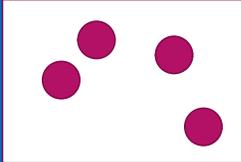
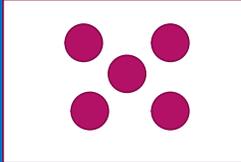
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### Number sense Center: Subitizing 6

The ability to instantaneously identify the number of items in a small set without counting

Perceptual: randomly placed dots

Conceptual: structured, dice and domino patterns, ten frames

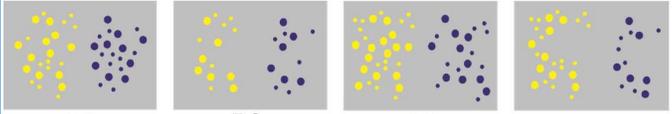
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### Number Sense Center: ANS Approximate Number Sense 7

The ability to estimate and compare larger quantities



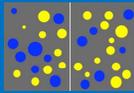


More Difficult ← ← → → Less Difficult

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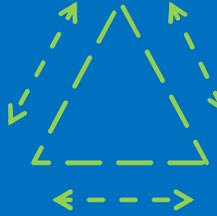
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### the 3 main centers for Math 8

**Number Sense Center**  
2 real objects, subitizing, estimating  
innate in humans and animals

**Verbal center**  
"two" number words, other math vocab



**Visual center**  
visual input  
2 the numeral, shapes and sizes

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## Dyslexia

- started to **talk** late
- difficulty with **blending** and **segmenting** sounds
- rhyme patterns** are hard
- reads **letter by letter** or **word by word** slowly
- forgets **sight words**
- copies **letters** out of order
- struggles with **grammar**
- forgets/loses info: **dates, names, addresses**

## Dyscalculia

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- started to **count** late
- difficulty with **composing** and **decomposing** numbers
- number patterns** are hard
- counts **tally marks** or **one by one** slowly
- forgets **math facts**
- copies **numbers** out of order
- struggles with **algorithms**
- forgets/loses info: **log ins, numbers, deadlines**

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## Low processing speed

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## Memory limitations

## Anxiety



## Attention issues

**Hyperactivity**  
**Inattention**  
 Distraction  
 Forgetfulness  
 Disorganization  
 Distractibility

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## Dyscalculia in adults the numbers

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- ▶ Mental math is difficult, any math makes you nervous
- ▶ Can't estimate, has no clue if an answer is OK or really far off
- ▶ Calculating a tip is tricky even on your phone
- ▶ Need to ask to repeat a phone number several times
- ▶ Copy the digits of a larger number out of order
- ▶ Poor memory for numbers, like dates and deadlines



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## Dyscalculia in adults money and shopping

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- ▶ Can't estimate total of grocery shopping cart
- ▶ Can't check the change
- ▶ Unable to balance your checkbook
- ▶ Doesn't understand percent in a sale
- ▶ Doesn't know how to compare deals with installments or monthly payments (cell phone)
- ▶ Understanding credit card debt
- ▶ Choosing any long-term finance planning, savings, mortgage
- ▶ May get in trouble with the law



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### Dyscalculia in adults sequencing 13

- ▶ Can't remember order of steps in a sequence like for cooking a recipe
- ▶ Missing important dates and deadlines
- ▶ Forget monthly car, credit card, or utilities payments or pay the wrong amount
- ▶ Planning in general is difficult
- ▶ Struggle to keep score in games and whose turn it is
- ▶ Patterns are difficult, number patterns even more
- ▶ Dislike strategy games
- ▶ Can't remember or follow dance steps

[dyscalculiaservices.com](http://dyscalculiaservices.com)

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### Dyscalculia in adults time and direction 14

- ▶ Still sometimes confused with left and right
- ▶ Any time sensitive planning is difficult
- ▶ Mistakes reading an analogue clock
- ▶ Difficulty estimating driving time
- ▶ Doesn't know what time to leave, often late
- ▶ Poor sense of direction, gets lost easily
- ▶ Dislike mazes and games requiring visual planning

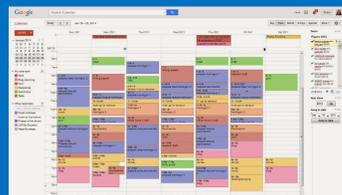


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### Dyscalculia in adults visual spatial issues 15

- ▶ Doesn't easily read or recall time schedules
- ▶ Mix up calculation where location matters: 3/4 or was it 4/3 ?
- ▶ Difficulty reading graphs, maps, and spreadsheets
- ▶ Recognizing shapes and geometry is difficult
- ▶ Dislike board games and visual puzzles mazes, Where's Wally?



[dyscalculiaservices.com](http://dyscalculiaservices.com)

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### DSM-V Specific Learning disorder 16

▶ a neurodevelopmental disorder of **biological origin** manifesting in learning difficulty and problems in acquiring **academic skills markedly below age level** and manifested in the **early school years**, lasting for **at least 6 months**, not attributed to intellectual disabilities, developmental disorders, or neurological or motor disorders

- ▶ Specify if:
  - ▶ 315.00 with impairment in reading
  - ▶ 315.1 with impairment in mathematics
  - ▶ 315.2 with impairment in written expression
- ▶ Specify current severity: Mild / Moderate / Severe

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## TESTING

- 01 Dyscalculia Screener developed by Dr Butterworth, Dyscalculia Assessment, Diagnostic Interview, online Math and Dyscalculia Screening Test, ZAREKI
- 02 WISC, WIAT, Woodcock-Johnson, Key-Math, WRAT, BAS-III, GLOSS, TEN (Test of Early Numeracy), online Math and Dyscalculia Screening Test, MARS
- 03 SAT (Stanford Ability Test), IOWA test, statewide testing, MAP test, ERB (Educational Research Bureau) test, Numeracy Screener, regular classroom testing tied to the curriculum

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### Early screening in KG – 1<sup>st</sup> grade, 5 min

- ▶ **Numeracy Screener, free** 18
  - ▶ 2 activities: comparing dots, comparing numbers
  - ▶ Numerical Cognition Laboratory, Canada
- ▶ **Early Numeracy Indicators, free**
  - ▶ 4 activities: comparing numbers, missing number, read numbers, mixed
  - ▶ Research Institute on Progress Monitoring (RIPM)
- ▶ **TEN Test of Early Numeracy**
  - ▶ 4 activities: comparing numbers, missing numbers, read numbers, counting
  - ▶ Aimsweb
- ▶ **Kindergarten Math CBM for fluency**
  - ▶ Fuchs Research Group, Vanderbilt University

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## Screening and Assessment options

- ▶ [DyscalculiaScreener.org](https://dyscalculiascreener.org)
  - ▶ Checklist
  - ▶ Grade specific screeners
  - ▶ Access to detailed online testing

<https://dyscalculiascreener.org>

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## Assessing Mathematical Understanding AMU

EducationNorthwest.org  
Portland Oregon

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### Suspected Math LD in KG

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- ▶ late with learning the counting words in order, or rattles of 1-10 all together like one big word
- ▶ can't count back
- ▶ no one-to-one correspondence
- ▶ does not recognize the dice patterns
- ▶ only sorts by color, not by size, shape, length, or quantity
- ▶ difficulty sequencing even everyday events
- ▶ can't complete an ABAB pattern
- ▶ avoids visual puzzles

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### Math LD in 1<sup>st</sup> grade

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- ▶ keeps counting all instead of counting on
- ▶ miscounts quantities above 10
- ▶ difficulty knowing which number is larger
- ▶ perceives written numbers as a scribble or a sign, not something that indicates a quantity
- ▶ can't remember addition and subtraction facts
- ▶ difficult to know the operation in a word problem
- ▶ doesn't know left and right yet

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## Math LD in 2<sup>nd</sup> – 3<sup>rd</sup> grade

25 

- ▶ keeps counting by one on fingers, slow
- ▶ can't remember addition and subtraction facts
- ▶ difficult to know the operation win a word problem
- ▶ doesn't like analogue clocks
- ▶ seems to know it one day, forgets it the next




Dyscalculiaservices.com The Photo

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## Math LD in 4<sup>rd</sup> – 5<sup>th</sup> grade

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- ▶ keeps counting
- ▶ adding seems the default mode
- ▶ can't remember multiplication facts
- ▶ number lines and place value operations are hard
- ▶ struggles with long division
- ▶ fractions and decimals are confusing
- ▶ no proportional thinking
- ▶ frustration and anxiety

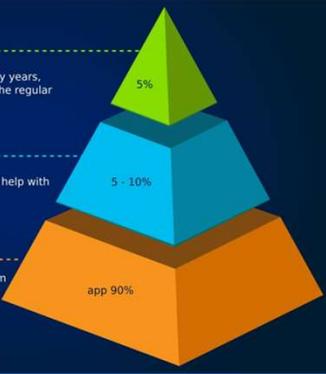


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## Three intervention levels

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- Tier 3**  
Specialized tutoring done by Dyscalculia Specialists, one on one, working on gaps that may go back many years, objective is not homework help or keeping up with the regular curriculum but re-mediation of the Dyscalculia
- Tier 2**  
Tutoring typically done by special ed teachers, objective is to boost knowledge, re-teach topics and help with homework and to keep up with the curriculum
- Tier 1**  
Classroom instruction following the regular curriculum

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## Golden rules

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Working one-on-one	Work in the student's pace	Start at a very comfortable level
Use real life examples, tools, and models	Never drill something that is not deeply understood	Make repeated practice fun with games
Cycle back regularly	The cycle is estimate, calculate, check	Provide immediate and positive feedback
Never say anything the student can say	Work on self confidence, show their progress	Reinforce the process and hard work

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Establish the link between 3 centers 29



Draw, show, and tell **simultaneously**:

- ▶ Real life quantity
- ▶ Number words/definitions
- ▶ Written numerals, math signs, formulas

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Write the question: **There are 15 children, 9 need to go home, how many can stay?**

15 - 9

is it Part1-Part2-Total, Change, or Difference?

Draw the question:

Total	Change +/-	Larger number
P1 P2	Start End	Smaller d ?

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Draw on number path

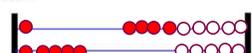
Rekenrek start



My answer is:

It makes sense because:

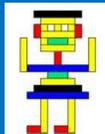
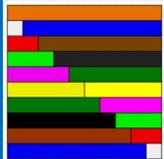
Rekenrek end



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Cuisenaire rods



10-bonds

4+3

8+5

9-2

13-7

5 + 8 = 13  
13 - 8 = 5

8 x 3 = 24  
4 x 6 = 24  
6 x 4 = 24

3 x 2 = 6

2 x 3 = 6

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Strategies 32

- ▶ help with calculations you don't know the answer for yet
- ▶ are used to reach an answer in steps
- ▶ use known skills and expand on them
- ▶ need to be taught explicitly
  - ▶ doubles, doubles and one
  - ▶ split numbers and recombine
- ▶ know which strategies your student can apply: MARS at MathStrategy.org

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*Math Assessment Reasoning & Strategy*  
Mathstrategy.org



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**Resources for parents** 34

- ▶ Understood.org
- ▶ MomsTeachMath.com
- ▶ Online dyscalculia programs:
  - ▶ The Number Race
  - ▶ The Number Catcher

[thenumberrace.com](http://thenumberrace.com) and [thenumbercatcher.com](http://thenumbercatcher.com)

- ▶ Meister Cody [www.meistercody.com/](http://www.meistercody.com/)
- ▶ Calcularis [dybuster.com/en/calcularis/](http://dybuster.com/en/calcularis/)

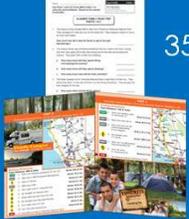


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**Resources for Adults** 35

- ▶ **Real life math for adults**
- ▶ Practical Practice Math:  
actual situations with math questions  
2 binders from Remedica
- ▶ BBC SkillsWise Maths for adults  
[www.bbc.co.uk/teach/skillswise/maths/zfdymfr](http://www.bbc.co.uk/teach/skillswise/maths/zfdymfr)  
video transcripts, factsheets, worksheets with clear examples
- ▶ AdultDyscalculia.com, online Math in Real Life coming soon
- ▶ **Catch up Math for adults**
- ▶ GED many free and commercial resources to practice
- ▶ KhanAcademy.org, SchoolYourself.org, Mathigon.org, MathsBot.com
- ▶ In person tutoring



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**Take home** 36

- ▶ Dyscalculia is as common as dyslexia but far less known and diagnosed inconsistently
- ▶ Early screening and testing is important to prevent anxiety and get the best results
- ▶ Specialized tutoring can help students bring their ability in math to acceptable levels

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# Questions and Answers

Do deficits in visual spatial skills contribute to dyscalculia?

Yes, they are certainly related. Research done by Giannis Karagiannakis and Anna Baccaglini list it as one of the four domains in dyscalculia: Core Number, Memory, Reasoning, and Visual-Spatial. Visual spatial skills are part and parcel of dyscalculia, for many math question the location of the numerical information is important: our number system is based on place value and many students with dyscalculia struggle with that; compare  $\frac{3}{4}$  and  $\frac{4}{3}$ ; on a number line the negative numbers are on the left side, the positive on the right side (which may be a confusion in itself), and obviously shapes and sizes are directly related to visual spatial skills, so geometry is rally difficult for them

What are assistive technology options for individuals with Dyscalculia?

The understood.org organization lists the various categories of assisted technology that help with trouble with math; calculators, math notation tools, graph paper, graphing tools, drawing tools and equation solving tools, virtual manipulatives, graphic organizers, and text to speech tools if necessary. There is so much and in your app store you probably find an abundance of them. The proof of the pudding is in the eating: what works for one student might not help others

Are there colleges that specialize in helping students with dyscalculia

A good source of information is the K&W guide to colleges for students with learning disabilities. You can also look at the group of “Colleges that change Lives” CTCL.org. Always read the latest on the college website and get in touch with the admission dpt. to make sure it fits the specific needs of your student. Not all colleges have a math requirement.

## Are there subtypes of dyscalculia?

Yes, dyscalculia does not present itself equally in all people, there are different grades of severity and since our brains are developing over time that is another discriminating factor. People with dyscalculia may experience different symptoms based on differences in the structure and function of their brains and how much they practiced with mathematics already. The core type or most pure type of dyscalculia is seen in people who lack number sense and as a result struggle severely with subitizing and comparing quantities, and as they can't sequence numbers, they do not develop an internal number line. Making the connection between an actual quantity (say 8 pencils), the number word, and the numerical notation (the numeral 8) is hard for them. These issues spill over to all topics in math and they need the most intensive and ongoing intervention.

Some people mainly struggle mostly with memorizing and retrieving numerical facts, procedures, formulas, or math vocabulary. Mental math is extremely hard for them and multi-step questions are cumbersome. They may struggle for instance with learning the process of the long division. When you do not memorize math facts like the multiplication tables, working out partial multiplication facts does not only take time but also consumes a lot of your working memory leaving less mental space and energy to think about what you need to do with the numbers in a question.

Reasoning is another key component in doing math and some people struggle mainly with that aspect. They may not grasp the connection between operations like addition and subtraction being each other's inverse. They often struggle with figuring out what operation to choose with the numbers in a word problem and with using logic.

Then there are people whose issues are predominantly centered around visual spatial issues, we talked about that before

These domains/subtypes of dyscalculia may occur separately or in combination, so there are many individual differences

## Sources for manipulatives

There are many providers of manipulatives, a search for Ants on a Log, Cuisenaire rods, rekenreks, stacking Base Ten Blocks, dual number lines or number tracks, and fraction pieces etc. will give you many options. Go for simple tools that can be used with any curriculum. I also use a variety of beads, counters, egg cartons, and Tangrams.

## Does it run in families?

Thank you for asking, I should have mentioned that. Yes, absolutely, dyscalculia runs in families, just like dyslexia does. It is not always the same severity though and when you know it runs in your family you can take action and do a screening and/or assessment at a young age and start tutoring before the student has failing grades or develops math anxiety

## Is there overlap between dyslexia and dyscalculia?

Yes, there is certainly overlap, or comorbidity between the two. They both draw partly on similar mental abilities such as visual discrimination, sequencing and attention to name a few, but there are also differences: where dyslexia is rooted in limitations in phonological awareness, people with dyscalculia have limited number sense

## Is there a place to find good tutors who understand dyscalculia?

There is no nationwide source of Dyscalculia Tutors, you can contact your local LDA chapter or contact Dr. Schreuder for options relevant to you.

## Is specialized tutoring something the child will need throughout their schooling?

The aim of the specialized tutoring is to teach the student strategies to be able to cope with math eventually. It depends on when tutoring is started and which math gaps are present at that time, in combination with other parameters such as Number Sense, verbal and visual spatial abilities, information processing, memory, and attention if students keep needing tutoring, later-on it may be at a lower frequency

## Is affordable testing available?

You can contact your local LDA chapter for help with this. Some colleges offer reduced price assessments. Online assessments are less expensive, and can provide useful information, but when unsupervised can't be used to request accommodations or modifications. They help to decide about in-depth testing.

## What is the best curriculum for Dyscalculia?

There is no best curriculum, it all depends on the needs and abilities of a student. A curriculum for Dyscalculia should be research based and researched to be effective. Important is a structured, sequential, multisensory approach, with built-in spiral reviews, and RTI. Although not specifically for dyscalculia Number Worlds is a classroom program, that can also be used for small groups. A few fully scripted intervention programs are on the next slide for example Pirate Math. The Meadow Center at UT-Texas has several intervention modules with entry tests and RTI. There is a book series "Life of Fred" based on stories; some people may prefer Touch Math that starts with numerals with dots based on counting by one for 1-5 and on two for 6-10 and is later using just rote memory a lot. The Stern Math method can be used for students with combined limitations.

# Fully scripted intervention programs 41

## Number Rockets

1st gr.

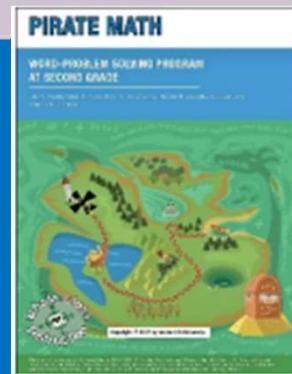
- 40 min.,
- 3 lessons/wk.,  
21 wks,
- small group



## Pirate Math

2nd gr.

- $\frac{3}{4}$  hr.,
- 2 lessons/wk.,  
17 wks,
- whole  
class/small  
group

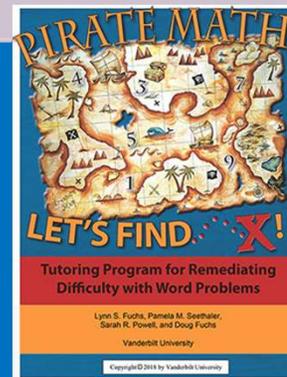


## Pirate Math

**Let's find X!**

3rd gr.

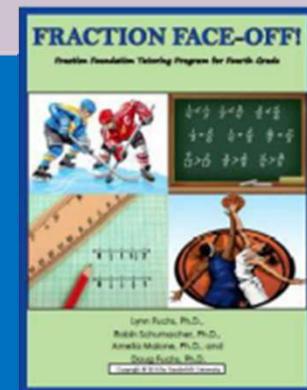
- $\frac{1}{2}$  hr.,
- 3 lessons/wk.,
- 16 wks,
- small group



## Fraction Face-Off!

4th gr.

- $\frac{1}{2}$  hr.,
- 3 lessons/wk.,
- 12 wks,  
whole  
class/small  
group



# Further reading about dyscalculia

Here are two books that are also used in our online dyscalculia tutor course <http://www.DyscalculiaTrainingCenter.org>

- **Understanding Dyscalculia and Numeracy Difficulties** by Patricia Babbie and Jane Emerson is a clear, easy to read guide for parents, teachers, and other professionals with many examples from their decades long experience in assessing and tutoring students with dyscalculia ISBN 978-1-84905-390-7
- **Dyscalculia From Science to Education** by Brian Butterworth goes in depth about the background of number sense, the development of arithmetic, explains the issues in the brain of people with dyscalculia and highlights the consequences this brings in society, in school, and at home. It provides information about assessments and intervention ISBN 978-1-138-68861-2

