BREAKING BARRIERS IN MATH LEARNING

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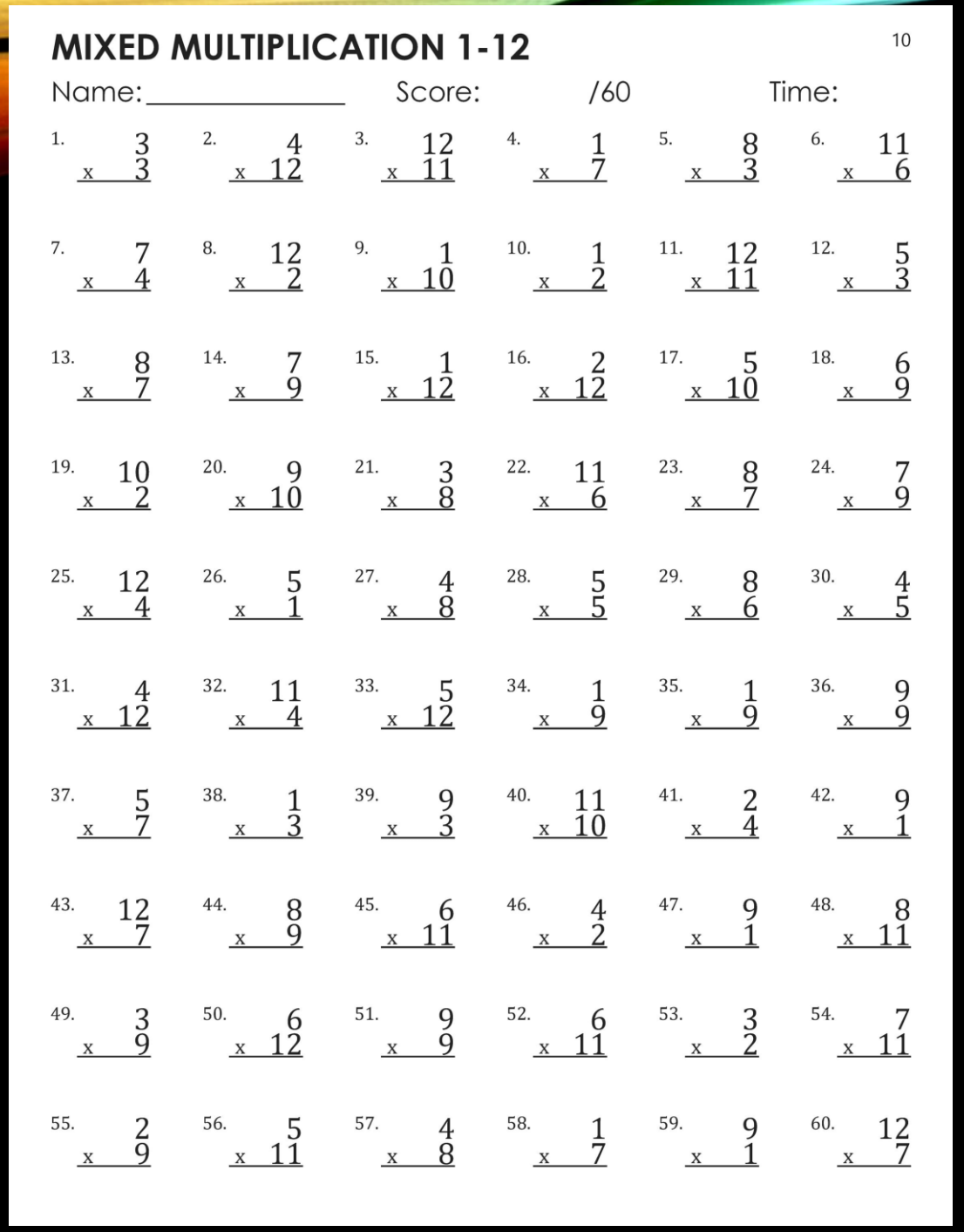
OBJECTIVES

- Define math anxiety and describe its cognitive, emotional, and behavioral components.
- Distinguish between math anxiety and learning disabilities such as dyscalculia.
- Modify an existing math lesson to reduce cognitive load and anxiety.

POP QUIZ!



MIXED MULTIPLICATION 1-12

10

Name:_____ Score: /60 Time:

1. 3 x 3	2. 4 x 12	3. 12 x 11	4. 1 x 7	5. 8 x 3	6. 11 x 6
7. 7 x 4	8. 12 x 2	9. 1 x 10	10. 1 x 2	11. 12 x 11	12. 5 x 3
13. 8 x 7	14. 7 x 9	15. 1 x 12	16. 2 x 12	17. 5 x 10	18. 6 x 9
19. 10 x 2	20. 9 x 10	21. 3 x 8	22. 11 x 6	23. 8 x 7	24. 7 x 9
25. 12 x 4	26. 5 x 1	27. 4 x 8	28. 5 x 5	29. 8 x 6	30. 4 x 5
31. 4 x 12	32. 11 x 4	33. 5 x 12	34. 1 x 9	35. 1 x 9	36. 9 x 9
37. 5 x 7	38. 1 x 3	39. 9 x 3	40. 11 x 10	41. 2 x 4	42. 9 x 1
43. 12 x 7	44. 8 x 9	45. 6 x 11	46. 4 x 2	47. 9 x 1	48. 8 x 11
49. 3 x 9	50. 6 x 12	51. 9 x 9	52. 6 x 11	53. 3 x 2	54. 7 x 11
55. 2 x 9	56. 5 x 11	57. 4 x 8	58. 1 x 7	59. 9 x 1	60. 12 x 7

https://nebusresearch.wordpress.com/2017/10/29/reading-the-comics-october-2017-mathematics-anxiety-edition/

MATH ANXIETY

ANXIETY

- Most common mental disorder-30%
- “Anticipation of a future concern and is more associated with muscle tension and avoidance behavior”
- Different types:
  - Generalized anxiety disorder
  - Panic disorder with or without agoraphobia
  - Specific phobias
  - Agoraphobia
  - Social Anxiety Disorder
  - Separation anxiety disorder
  - Selective Mutism

ANXIETY

- Women have a higher prevalence of all anxiety disorders compared to men
- Median age of onset of anxiety disorders is 11 years old
  - Separation anxiety can start as young as 7 years old

- 3 levels
  - Mild
  - Moderate
  - Severe

MATH ANXIETY

- "Math anxiety has been defined as feelings of apprehension and increased physiological reactivity when individuals deal with math, such as when they have to manipulate numbers, solve mathematical problems, or when they are exposed to an evaluative situation connected to math"
- Affects 20-30% of students
- Math anxiety relates to the fear and pain network in the brain
- Math anxious students avoid jobs with lots of math, science, technology, engineering

MANIFESTATIONS

Physical

Tremors

Sweating

Rapid heartbeat

Fever

Difficulty breathing

Behavioral

Avoidance

Worrying

Believe that something frightening will happen soon

Cognitive

Fear of the inability to overcome problems

Memory blocking

Concentration Difficulties

MATH ANXIETY

- Teachers can influence beliefs and achievements of their students and abilities
- Parents can also pass down math anxiety
- Mathematics anxiety rating scale
  - Shorter version Revised Mathematics Anxiety rating scale

Abbreviated Mathematics Anxiety Scale (Hopko, Mahadevan et al., 2003)	Not at all	A Little	A fair Amount	Much	Very much
Having to use the tables in the back of the math book.					
Thinking about an upcoming math test 1 day before.					
Watching a teacher work an algebraic equation on the blackboard.					
Taking an exam in a math course.					
Being given a homework assignment of many difficult problems that is due the next class meeting.					
Listening to a lecture in math class.					
Listening to another student explain a math formula.					
Being given a “pop” quiz in math class.					
Starting a new chapter in a math book.					

RATE 1(DISAGREE) - 5 (AGREE)

1. I cringe when I have to go to math class.
2. I am uneasy about going to the board in a math class.
3. I am afraid to ask questions in math class.
4. I am always worried about being called on in math class.
5. I understand math now, but I worry that it's going to be really difficult soon.
6. I tend to zone out in math class.
7. I fear math tests more than any other kind.
8. I don't know how to study for math tests.
9. It's clear to me in math class, but when I go home it's like I was never there.
10. I'm afraid I won't be able to keep up with the rest of the class.

Check your score:

40-50 Sure thing, you have math anxiety

30-39 No doubt! You're still fearful about math

20-29 On the fence!

10-19 Wow! Loose as a goose!

Front Psychol. 2017 Jan 19;8:11. doi: 10.3389/fpsyg.2017.00011

The Modified Abbreviated Math Anxiety Scale: A Valid and Reliable Instrument for Use with Children

Emma Carey [1,*], Francesca Hill [1], Amy Devine [1], Dénes Szűcs [1,*]

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PMCID: PMC5243819 PMID: 28154542

Coping With Math Anxiety

SPECIFIC LEARNING DISORDERS

- In the DSM-5 this is classified under Specific Learning Disorders, neurodevelopmental disorder
  - Dyslexia-reading
  - Dyscalculia-math
  - Dysgraphia-written expression(grammar, punctuation, organization of written expression)

SPECIFIC LEARNING DISORDER

When diagnosing person must meet 4 criteria:

1. Having a difficulty for at least 6 month despite targeted help
2. Having academic skills that are substantially below what is expected for the child's age and cause problems in school, work, or everyday activities
3. The difficulties start during school-age even if some people don't experience significant problems until adulthood (when academic, work and day-to-day demands are greater)
4. Learning difficulties are not due to other conditions, such as intellectual disability, vision or hearing problems, a neurological condition (e.g., pediatric stroke), adverse conditions such as economic or environmental disadvantage, lack of instruction, or difficulties speaking/understanding the language

From Psychiatryy.org American Psychiatric Association

DYSCALCULIA

- “Difficulties with learning number number-related concepts, with processing numerical information, with learning arithmetic facts or with using the symbols and functions to perform accurate or fluent math calculations.”
- Normally appears when young
- 3%-7% worldwide
- When solving math, it isn’t just one area of the brain working it is several:
  - Visual processing
  - Short term memory
  - Language
  - Long term memory
  - Understanding quantities and amounts
  - Calculation

DYSCALCULIA

- Often there are concurrent conditions
  - ADHD
  - Other Specific Learning Disorders
  - Sensory Processing disorders
  - Autism Spectrum Disorder
  - Anxiety/Panic disorders
  - Behavior disorders
  - Bipolar
  - Depression

DYSCALCULIA

In children

- Number sense
- Estimating
- Memory sequences
- Multiplication tables
- Analog Clock difficulties
- Math Anxiety

In Adults

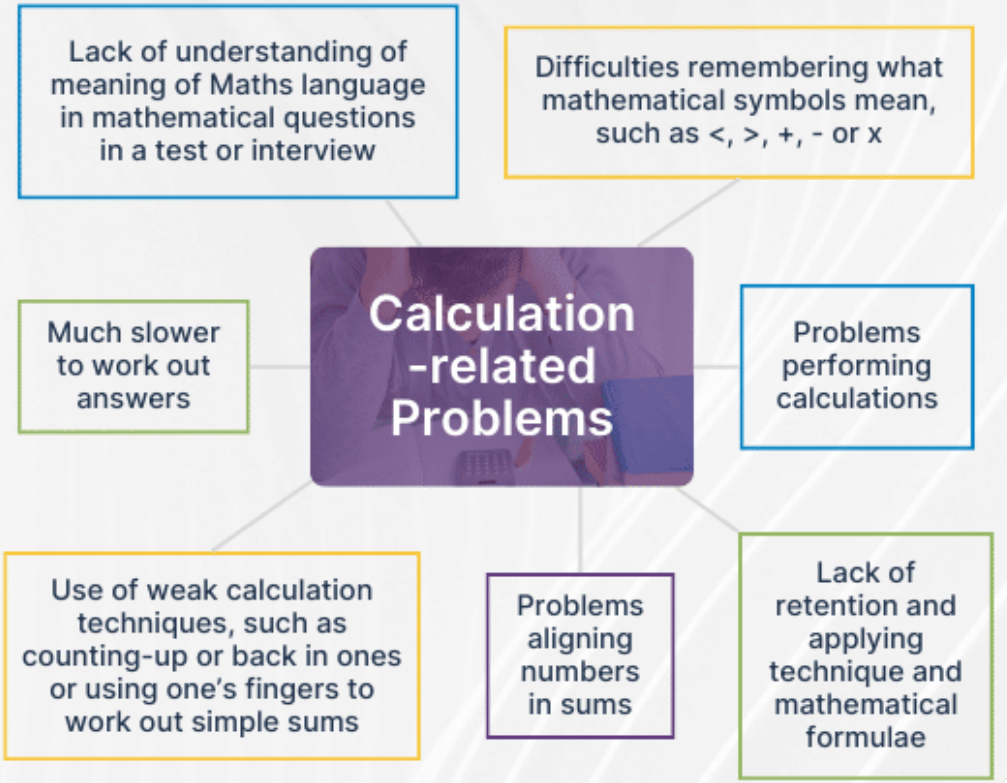
- Mistakes in copying/memorizing logins, dates, phone numbers
- Bill and money counting issues
- Directions, maps and graphs, speed and distances
- Time management

Potential Challenges

Related to Dyscalculia in Adults

Potential Challenges

Related to Dyscalculia in Adults



https://dyscalculianetwork.com/dyscalculia-for-adults/

LAUREN

- Veterinary Assistant Level 2 in Worthington Ohio
- Specializes as the triage nurse
- Also diagnosed with ADHD
- Wasn't diagnosed as a child due to irresponsibility
  - Was often told she needed to apply herself more
- 30 psychologist- Neuropsychologist
- 9-hour assessment
  - Tests
  - Memory tests
  - Time management questions
  - Anxiety inducing
- Tested and diagnosed at 40 years old in the top 4 percent

LAUREN

- Can’t read analog clocks
- Finance and counting money
- Decimal points
- Asking for clarification…repeatedly
- Regimented schedule
- Fight or flight triggered in some situations

DYSCALCULIA SUPPORT

- Numberphile Youtube Professor Brian Butterworth from University College London
- Dyscalculia Services founded in 2010
- Dyscalculia.org
- CogniFIT Dyscalculia training
- Dyscalculia Network- has app suggestions
- Through my eyes- Can help others understand what having dyscalculia is like

PSYCHOLOGICAL SAFETY

- Open communication, voicing concerns, asking questions, seeking feedback without fear of judgement
- When students feel psychologically unsafe they then tend to hide or not do something due to not wanting to look incompetence, this can lead to anxiety
- Don't be afraid to admit you make a mistake or are wrong
  - Be willing to share past mistakes – we all have them
- Demonstrate learning empathy

Key tips to providing a psychologically safe learning environment in the clinical setting

Philip Hardie [1,✉], Roisin O'Donovan [2], Suzi Jarvis [3], Catherine Redmond [1]

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MATH RESILIENCE

- Changing the terminology- student isn't "stupid" they are panicking
  - Figure out the why?
- Help with relaxation techniques
  - Good for testing and math
    - Calming the heartbeat and panic can clear the mind
- Help students articulate that they might need support or more challenge
  - Or too much challenge pushing them into the panic mode
    - Change wording if you want, Spicy, mild, or extreme
- Make mistakes less scary

Figure 2. A growth zone diagram (based on Lee and Johnston-Wilder, 2017).

STRATEGIES

- Make math less of a daunting task, Be excited about it
  - If you don't have a passion for it, fake it till you make it!
  - Connect those math problems to real life cases, not just from the book, talk about case studies
  - Make it relevant, not just in pharmacology
  - Celebrate the wins, especially for those struggling, but make it genuine, goodies help
- Have the students help each other, growing that safety

STRATEGIES

- Use physical props
  - Fluid bags, medicines, clocks, graph paper, colored pencils
- Ask where the problem is or where did it start to feel confusing rather than just allowing a “I don’t get it”
  - Sometimes them explaining where the step is missed helps them see it
- Have them write out every step in the beginning one 0 off makes a difference

- Explain formulas in multiple ways, and use that wording

$$C_1 \times V_1 = C_2 \times V_2$$

Concentration of the drug
(Dextrose is 50%)

Volume of the drug to add
(Amount of drug to be added to the bag)

Concentration of the final Solution/ Dose
(% dextrose ordered)

Volume of the final solution
(the volume we are adding to in mLs/Total)

$$C_1 \times V_1 = C_2 \times V_2$$

Rearranges to:

$$\boldsymbol{V_1 = \frac{C_2 \times V_2}{C_1}}$$

This now becomes:

$$\boldsymbol{Amount\ to\ be\ added\ in\ mL} = \frac{\%\ ordered \times Volume\ in\ bag\ (mL)}{Concentration\ of\ dextrose\ (50\%)}$$

$$\frac{\text{Weight X Dose}}{\text{Concentration}} = \text{amt to be given}$$

1. $\frac{\text{Weight of patient X dose}}{\text{Concentration}} = \frac{\text{amount ml}}{\text{1 hour}}$

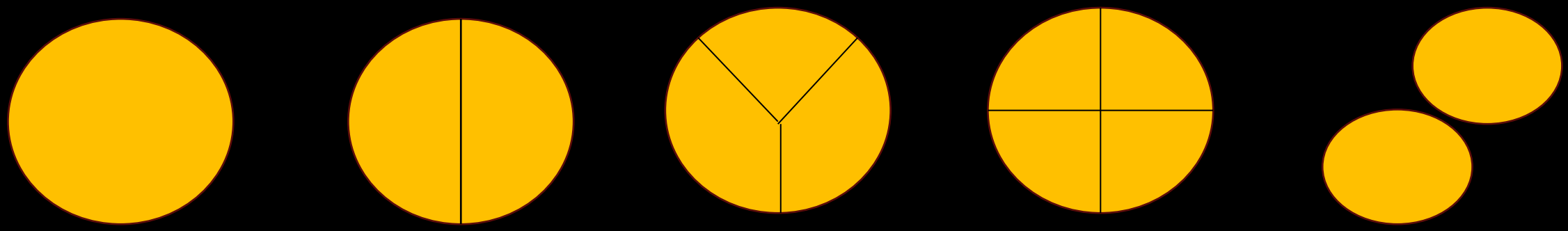
2. $\frac{\text{Amount putting into (ml/bag/burette)}}{\text{fluid rate}} = \frac{\text{hours total amount running}}{\text{bag/burette/syringe}}$

3. $\frac{\text{Amount ml}}{\text{1hr}} \times \frac{\text{hours total amount running}}{\text{Bag/burette/syringe}} = \text{Answer in ml/ bag/burette/syringe}$

$$\frac{\text{Wt of patient (kg)}}{1} \text{ X } \frac{\text{Dose (mg)}}{\text{1(kg/hr)}} \times \frac{\text{1 (hr)}}{\text{(ml) Fluid rate}} \times \frac{\text{Amt put into(ml)}}{\text{1(bag or Burette or syringe)}} \times \frac{\text{1 (ml)}}{\text{Concentration (mg)}} = \text{Answer } \frac{\text{ml}}{\text{Bag/burette/syringe}}.$$

- Proof of concept:
- Give 10ml/kg Plasmalyte bolus to a 4.9kg cat.
  - At what rates will you set your fluid pump for:

Over 1 hour =	Over 30 min =	Over 20 min =	Over 15 min =	Over 2 hours =
10ml x 4.9kg x 1hr 49 ml/h	(2) 30min's in 1 hour 49ml x 2 98 ml/h	(3) 20min's in 1 hour 49ml x 3 147 ml/h	(4) 15min's in 1 hour 49ml x 4 196 ml/h	SLOWER than 1 hour 49ml / 2 24.5 ml/h



- If you are able take away time limits for tests, or don't tell them about them
- Help them by using positive self messages, and positive comments
  - No starting the test saying "Well my other tests will even out this score"
- Advocate for good test taking
  - Do the easiest questions first
  - Make sure to check units!
- Review the questions after the test with them figuring out if it was a:
  - Careless error- comp errors, skipping problems
  - Concept error- if you did the problem still would get it wrong due to not understanding the concept
  - Study error- not spending enough time on the pertinent material

LAUREN

- Colored pencils (assigning a color to a number)
- Calculators
- Finger counting, tally marks
- Spelling out numbers
- Getting used to what drawn up volumes look like
- Practice with syringes using references (Finger)
- Doctors repeating, and repeating
- Has been able to develop a system with her team doing heartbeats/breathing
  - Checks with monitoring equipment or coworker

- Don’t let them second guess, but always double check
- KISS
- Help them build on what they can/know how to do
- Repeat, repeat, repeat- math questions and formulas
- Break down the math question and help talk through how to get to the end
- Use templates
- Use games
- Learn, do, teach

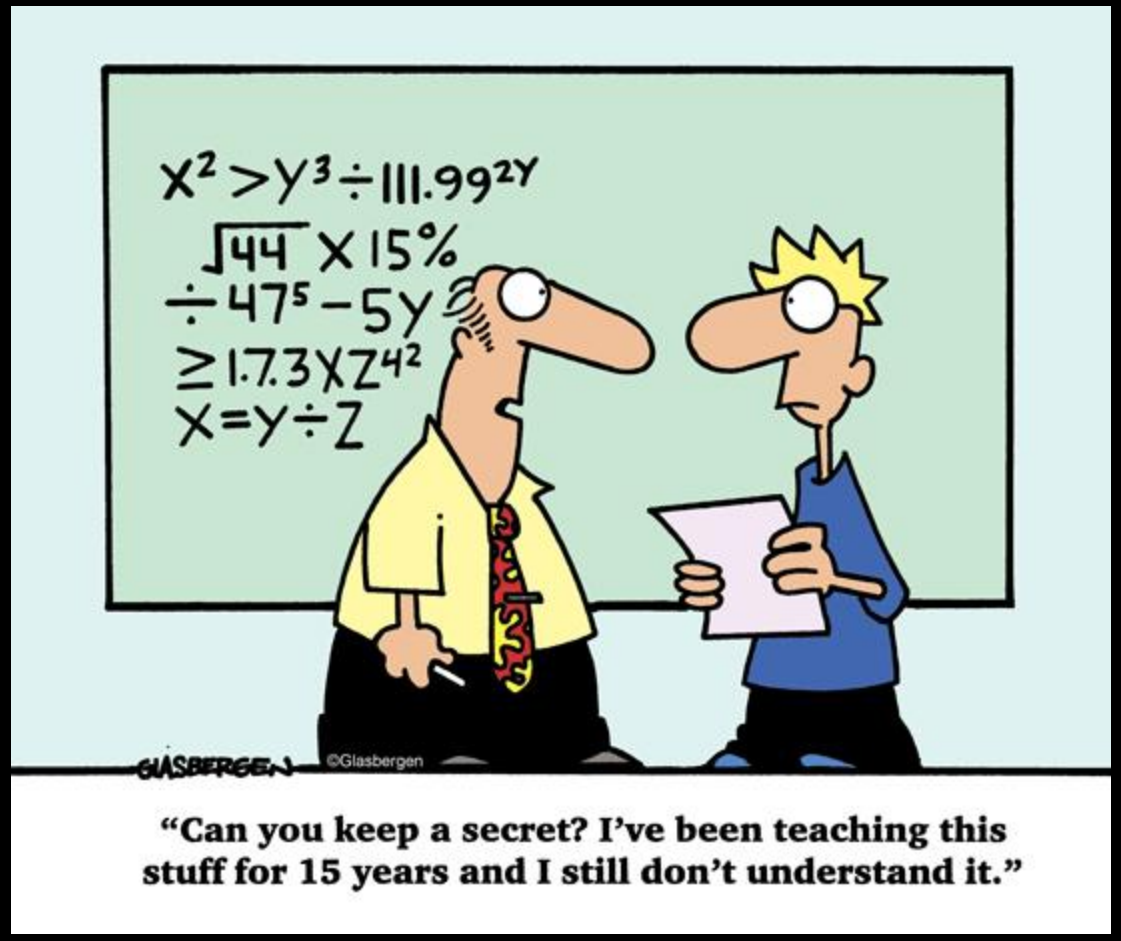
LABOR DISABILITIES ASSOCIATION OF AMERICA ACCOMMODATIONS

- Screen reading software
- Color-code materials
- Use calendars and schedules providing digital reminders
- Provide checklists
- Flowcharts
- Allow voice recorder for verbal instructions
- Mentors
- Calculator or talking calculator
- Provide additional training time

JOB ACCOMMODATION NETWORK

- Free consultation for employers
- Less than 19% of accommodations cost nothing
- 50% cost less than $500
- Online workplace Accommodation toolkit
  - Example policies and forms
  - Training presentations
  - Roleplay videos

THANK YOU!



"Can you keep a secret? I've been teaching this stuff for 15 years and I still don't understand it."

https://www.glasbergen.com/math-cartoons/

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REFERENCES

- Learning Disabilities Association of America. https://ldaamerica.org/what-is-dyscalculia/
- Centre for Educational Neuroscience. https://educationalneuroscience.org.uk/2023/09/22/finding-numbers-hard-facts-and-myths-about-dyscalculia/
- American Psychological Association. https://www.apa.org/monitor/2023/10/preventing-math-anxiety
- PMC National Library of Medicine. Spotlight on Math Anxiety. https://pmc.ncbi.nlm.nih.gov/articles/PMC6087017/
- PMC National Library of Medicine. The Role of Self-help in the treatment of mild anxiety disorders in young people: an evidence-based review. https://pmc.ncbi.nlm.nih.gov/articles/PMC3304342/
- Cleveland Clinic. Dyscalculia. https://my.clevelandclinic.org/health/diseases/23949-dyscalculia
- American Psychiatric Association. What is a Specific Learning Disorder. https://www.psychiatry.org/patients-families/specific-learning-disorder/what-is-specific-learning-disorder
- Understood for all. Dyscalculia. https://cdn-assets.understood.org/p0qf7j048i0q/5RsIIt1qjD0YvAsE9snkHV/351792ccd9cd4c8f541fb4100f21b738/Dyscalculia_fact_sheet_2025_Understood_Accessible.pdf
- PMC National Library of Medicine. The Diagnosis and treatment of Dyscalculia. https://pmc.ncbi.nlm.nih.gov/articles/PMC6440373/
- Scientific Research. Addressing Mathematics Anxiety: A Case study in a high school in Brazil. https://www.scirp.org/journal/paperinformation?paperid=123458
- Evsevier. Math Anxiety, a hierarchical construct: Development and Validation of the scale for Assessing math anxiety in secondary education. https://www.elsevier.es/es-revista-ansiedad-estres-242-articulo-math-anxiety-hierarchical-construct-development-S1134793717300532
- Scientific Research. Addressing Mathematics anxiety through developing resilience: Building on Self-Determination Theory. https://web.archive.org/web/20220517184655id_/http://wrap.warwick.ac.uk/81383/1/WRAP-mathematics-anxiety-resilience-self-determination-theory-Johnston-Wilder-2021.pdf
- University of Central Missouri. https://www.ucmo.edu/offices/learning-commons/digital-learning-commons/math-anxiety-test.pdf
- Through my eyes. https://www.understood.org/en/through-my-eyes#tme_header