# Math Anxiety, Contributing Factors, and Possible Remedies

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UCLA PLI Action Research Project: PDSA Cycle #1a
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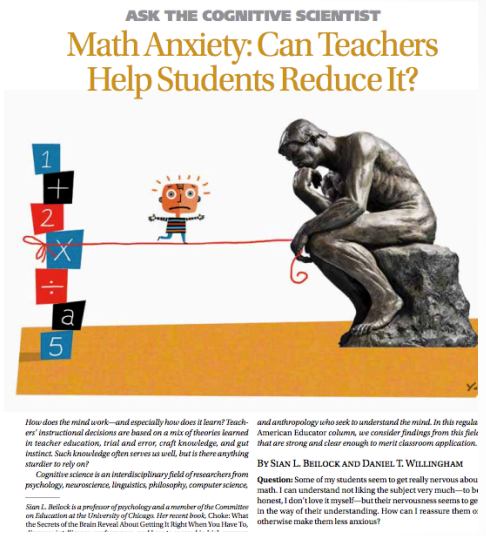
# Grounding: Math Anxiety: Can Teachers Help Students Reduce It?

"Math Anxiety: Can Teachers Help Students Reduce It"-*American Educator* Summer 2014

- Review the article
- Keep the following questions in mind, feel free to use your answers from the reflection questions:
  - What does the text say?
  - What does it mean?
  - Why does it matter?
- Fill in the "Say, Mean, Matter" chart



ASK THE COGNITIVE SCIENTIST

Math Anxiety: Can Teachers Help Students Reduce It?



*How does the mind work—and especially how does it learn? Teachers' instructional decisions are based on a mix of theories learned in teacher education, trial and error, craft knowledge, and gut instinct. Such knowledge often serves us well, but is there anything sturdier to rely on?*

*Cognitive science is an interdisciplinary field of researchers from psychology, neuroscience, linguistics, philosophy, computer science, and anthropology who seek to understand the mind. In this regula American Educator column, we consider findings from this fiel that are strong and clear enough to merit classroom application.*

By Sian L. Beilock and Daniel T. Willingham

*Sian L. Beilock is a professor of psychology and a member of the Committee on Education at the University of Chicago. Her recent book,* Choke: What the Secrets of the Brain Reveal About Getting It Right When You Have To,

**Question:** Some of my students seem to get really nervous abou math. I can understand not liking the subject very much—to be honest, I don't love it myself—but their nervousness seems to ge in the way of their understanding. How can I reassure them o otherwise make them less anxious?

**Reflect and Discuss**

| Quote<br>What does it Say? | Mean<br>What does it Mean? | Matter<br>Why is it significant? |
|---|---|---|
| | | |

# Share Out

**Reflect and Discuss**

| Quote<br>What does it Say? | Mean<br>What does it Mean? | Matter<br>Why is it significant? |
|---|---|---|
| | | |

# What is Math Anxiety?

- *The feelings of tension, apprehension, or fear of situations involving math* (Beilock & Willingham, 2014)
- State anxiety (vs. trait anxiety) only present when thinking about or doing math
- Affects 25% of the general population

Different Components:

- Affective-general fear or dislike of math
- Social/Performance-board work in front of class, small group with peers
- Test/Situational Anxiety-such as taking a test or working on word problem

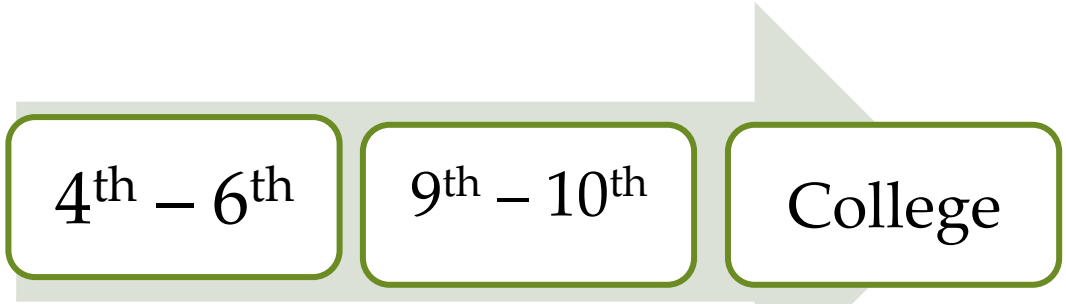
# Math Anxiety & Stereotype Threat

- Math Anxiety: Decreased performance stems from conscious worry over an expectation of high performance level

- Stereotype Threat: Decrease performance due to unconscious negative effect from an expectation of low performance level

# Ages of Onset

- 93% of American adults self-identify as being bad at or disliking math
- Three Major ages of onset (Hembree, 1990)




- Grades K-3-onset due to stereotype threat (Beilock et al., 2010) or due to low proficiency with early numeracy skills (number sense and place value concepts)

# Why Math Anxiety is a Social Justice Issue?

*Math anxiety is a social justice problem because one or more of its contributing factors including environmental, personality/ dispositional, and situational factors can create and exacerbate math anxiety in the classroom beginning in the elementary years.*

# Why Do We Care?

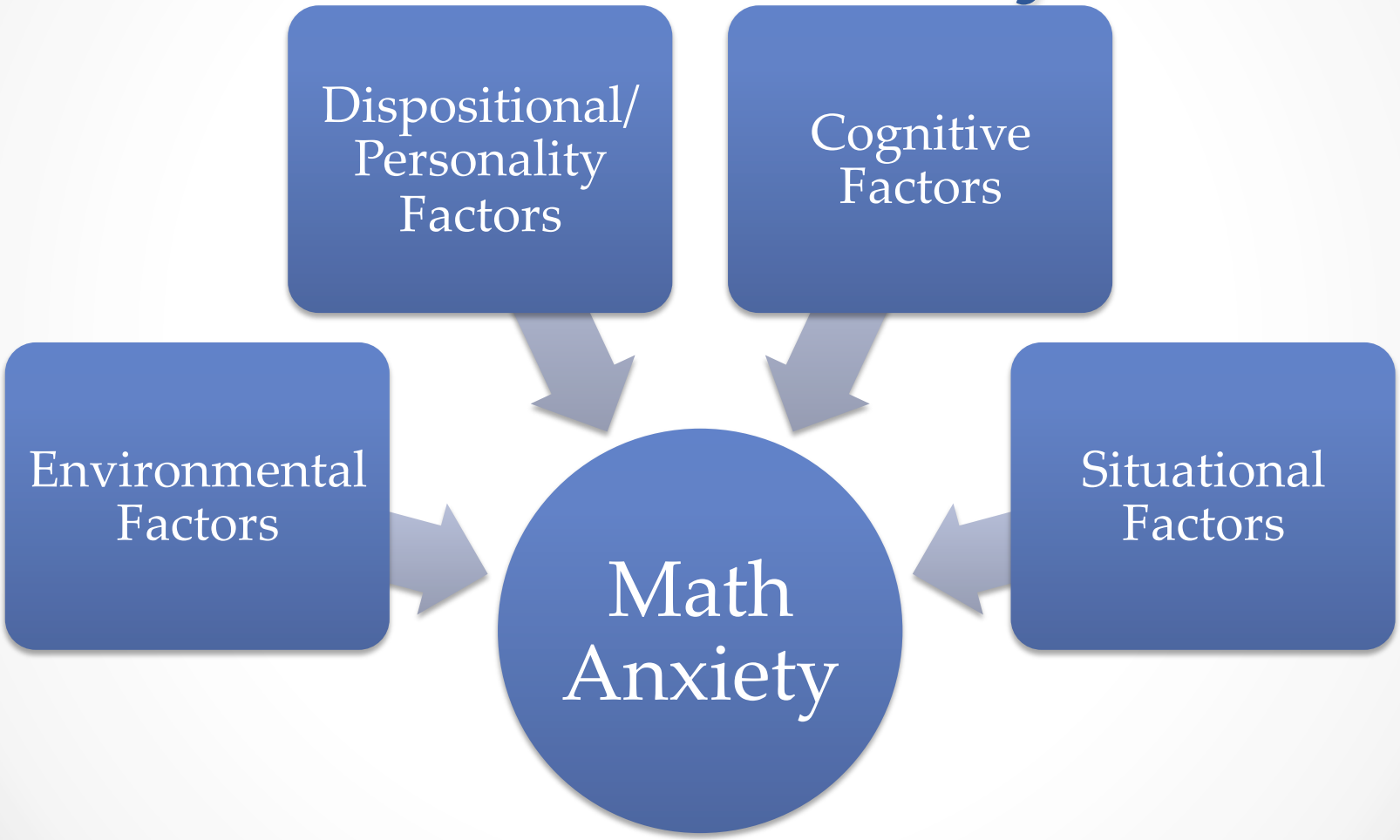
- STEM careers: fastest growing jobs, & 78% of growth over the last decade was in computer and math fields
- Accountability (Ashcraft & Moore, 2009): after anxiety onset in 4-5th grade, standardized tests are no longer an accurate measure of math ability
- Remediation of math anxiety is associated with over a twenty percentile point gain on standardized tests (Ma, 1999)

# Contributing Factor Sort Activity

With a partner:

1) Sort the cards into categories of factors which contribute to math anxiety

# Contributing Factors of Math Anxiety



# Environmental Factors

- Negative experiences in the classroom or family context-e.g. insensitivity to students
- Teacher and parent characteristics-e.g. being anxious about math
- Extrinsic expectations-e.g. low expectations of students

"It's OK, not everyone can be good at these types of problems." –Fixed Mindset Message

# Dispositional/Personality Factors

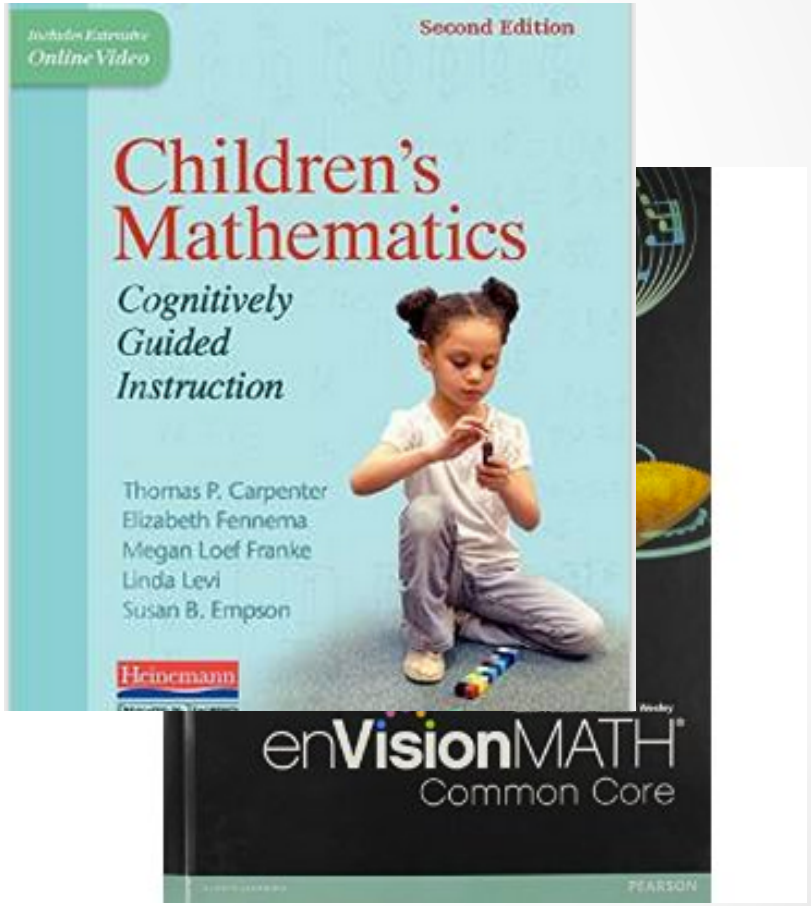
- **Self-esteem**-e.g. "I feel good about doing math well."
- **Self-concept**-e.g. personal beliefs about ones math abilities/skills
- **Self-efficacy**- e.g. "I can/can't do it."
- **Self-regulation**-goal setting, monitoring, rehearing, organizing
- **Attitude**-e.g. "I don't like math.", "I'd rather not do math."
- Confidence
- **Learning Behavior**-e.g. study skills

# Cognitive Factors

- Ability thinking abilities
- Logical thinking abilities
- Visual-Spatial processing abilities

# Situational Factors

- Classroom factors
- Instructional approach
- Assessment approach
- Curriculum factors



# Contributing Factor Sort Activity

| Environmental Factors | Dispositional/Personality Factors | Cognitive Factors | Situational Factors |
|---|---|---|---|
| A teacher demonstrates a distant and unsupportive attitude and this in turn creates avoidance reactions and feelings of anxiety related to mathematics for some of students. | Student thinks or states "I'm not good at math" | Students in a third grade class have various levels of abstract thinking ability. | One teacher's approach to teaching math is explicit and teacher centered while the other's is implicit and student-centered |
| Teacher has math anxiety and passes their negative attitude about math onto their students. | Student say, "I can't do order fractions." | A teacher recognized that several students have good visuo-spatial processing abilities | One teacher mainly uses the textbook as the curriculum while another teacher's math curriculum is mainly based on the use of word problems and real world contexts. |
| A father or mother holds different beliefs about the math ability of their children and in some cases this relates to their gender. | One student makes goals and plans for their learning, manages their time, and monitor's their own understanding of the material, while another student does not. | A female, Latina student demonstrates a strong ability in logical thinking. | One teacher uses timed tests to build fluency with basic math facts while another uses number talks to build computational fluency. |
| Teacher demonstrates low expectations for some students through disparaging comments and in some cases this might be related to their ethnicity, language proficiency, or gender. | In a surveying their students a teacher finds that 70% of students like math and 30% don't. | | One teacher often has students working in cooperative groups on math tasks while another teacher mainly has students working independently. The room arrangements also reflect the different approaches. |

# Math Anxiety Affects Working Memory

- We all have varying amounts of Working Memory, which only last up to a few minutes and has limited capacity in terms of number of things it can hold.
- Anxious thoughts consume valuable thinking time used to problem solve and reason mathematically
- Thus math performance suffers.

Source: Beilock, S. & Willingham, D. "Math Anxiety : Can Teachers Help Reduce it". *American Educator. Summer 2014.*

# Math Anxiety Affects Working Memory

- Working memory is taxed by mental arithmetic: carrying, borrowing
- Highly anxious people do worse on tasks that require working memory capacity
- Controlling for anxiety and taxing working memory reveals the same effect
- WM is NOT involved in rote memory tasks like retrieving simple math facts

(Ashcraft, 2002)

# Math Anxiety Interventions

- Psychological Interventions
  - Expressive Writing
  - Recognition & Reappraisal of psychological responses to math anxiety
- Socio-psychological Interventions
  - Teaching and Communicating a Growth Mindset

*How to Teach Math*-Jo Boaler

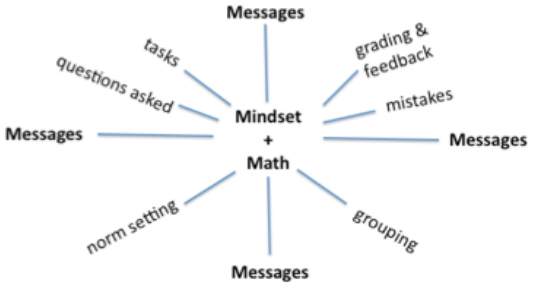
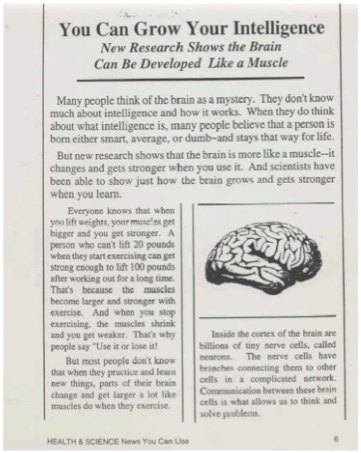



Figure 1. Aspects of Classroom Teaching that Communicate Mindset Messages.

## Growth Mindset Material Used

- **the growth mindset training used a 4-page article developed for the study**
  - **you can read this article at: http://www.brainology.us/websitemedia/youcangrowyourintelligence.pdf**



You Can Grow Your Intelligence

*New Research Shows the Brain Can Be Developed Like a Muscle*

Many people think of the brain as a mystery. They don't know much about intelligence and how it works. When they do think about what intelligence is, many people believe that a person is born either smart, average, or dumb–and stays that way for life.

But new research shows that the brain is more like a muscle–it changes and gets stronger when you use it. And scientists have been able to show just how the brain grows and gets stronger when you learn.

Everyone knows that when you lift weights, your muscles get bigger and you get stronger. A person who can't lift 20 pounds when they start exercising can get strong enough to lift 100 pounds after working out for a long time. That's because the muscles become larger and stronger with exercise. And when you stop exercising, the muscles shrink and you get weaker. That's why people say "Use it or lose it!

But most people don't know that when they practice and learn new things, parts of their brain change and get larger a lot like muscles do when they exercise.

Inside the cortex of the brain are billions of tiny nerve cells, called neurons. The nerve cells have branches connecting them to other cells in a complicated network. Communication between these brain cells is what allows us to think and solve problems.

HEALTH & SCIENCE News You Can Use 6

www.brainology.us



mindset works

# Which Students are Predisposed to Math Anxiety

- Students that are missing some basic math building blocks upon entering formal schooling.
  - Counting objects
  - Magnitude
  - Visuo-Spatial Skills
- Students affected by their social environment.
  - In the classroom
  - At home
  - In society in general (women and minorities)

# A Psychological Remedy for Math Anxiety: Expressive Writing

- Simple, clinical technique
- Students writing freely about their thought and feelings about an important stressor they are feeling.
- Provide physical and psychological benefits
  - Reduced negative thoughts and ruminations
  - Better health
  - Increasing the availability of working memory resources in the brain

Please take the next 5 minutes to write as openly as possible about your thoughts and feelings regarding the math problems you are about to perform. In your writing, I want you to really let yourself go and explore your emotions and thoughts as you are getting ready to start the math problems. You might relate your current thoughts to the way you have felt during other similar situations at school or in other situations in your life. Please try to be as open as possible as you write about your thoughts at this time.

# It's Your Turn

With a partner:

1) Write down two scenarios/situations (1 paragraph each) in narrative form in the math classroom in which expressive writing could be provided by the teacher as an opportunity for their math anxious students.

Consideration:

1) Teach this technique as a whole class the first time before a math test or a problem-based lesson which might induce anxiety in math anxious students. Students can write in their math journals. *Be sure to explain the rationale and how this helps reduce stress/anxiety*.
2) Thereafter provide this opportunity before math tests and problem-based math lessons.

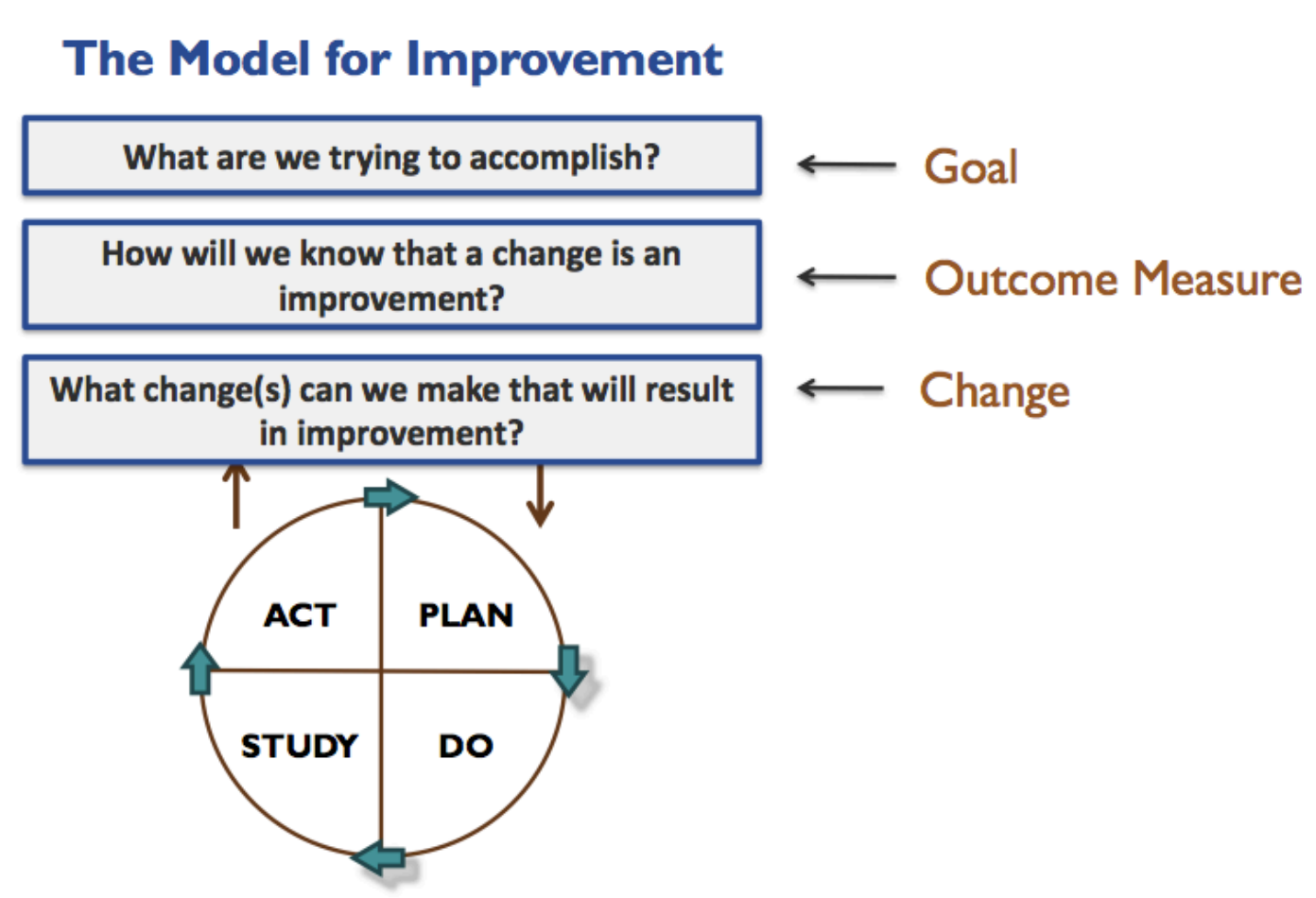
# Aim: What Are We Trying to Accomplish?

By April 30, 2015 100% of students with medium to high levels of math anxiety in two fourth grade classes will see a reduction in their math anxiety scale score of 10 points (1 Standard Deviation) and an increase in their mindset assessment profile of 5 points (1 Standard Deviation).

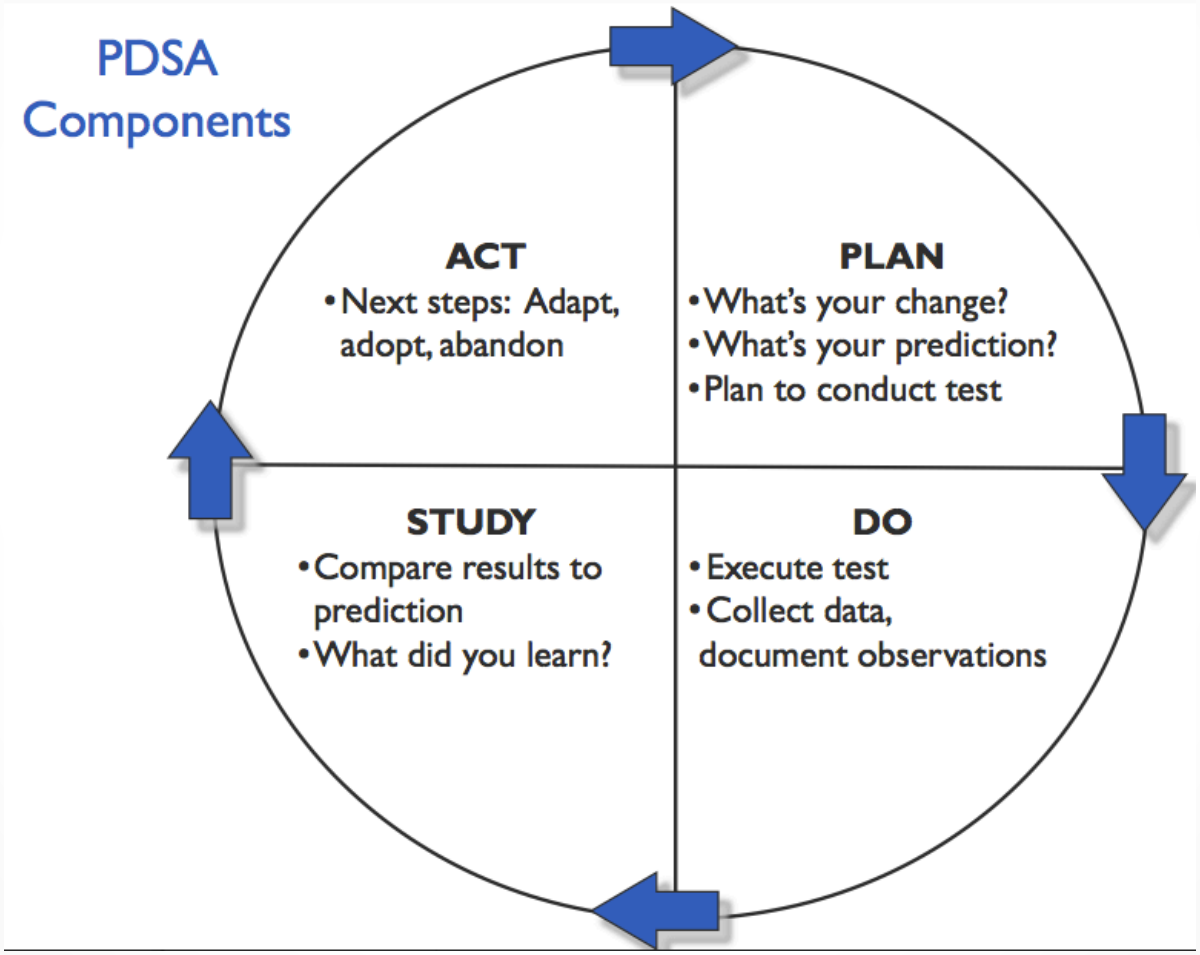
# What Changes Might Lead to Improvement?

| Change Ideas | Addressing these Major Improvement Areas |
| --- | --- |
| • Expressive Writing<br>• Communicating a Growth Mindset → | Classroom Climate |
| • Teaching a Growth Mindset → | Student Mindset & Student Self-Efficacy in Relation to Doing Math |
| • PD on Math Anxiety, Communicating a Growth Mindset, Teaching a Growth Mindset → | Teacher Mindset & Self-Efficacy in Relation to Teaching & Doing Math |

# Learning Cycle: PDSA Cycle



# Learning Cycle: PDSA Cycle



# Learning Cycle: PDSA Cycle

| | | | | | |
|---|---|---|---|---|---|
| **Test Title:** | **Protocol checklist for post-observation conversation** | | **Tester:** | 2 case managers / 6 new teachers | |
| **What change idea is being tested?** | Checklist to guide post-observation conversations (based off of conversation protocol) | | **Date:** | April 14-18, 2014 | |
| **What is the goal of the test?*** | Test use of checklist as a way to ensure case managers remember all of the protocol steps | | **Cycle #:** | 1 | **Driver being tested:** Feedback |

**Identify your overall goal: To make something work better? Learn how a new innovation works? Learn how to test in a new context? Learn how to spread or implement?*

## (1) PLAN

| Questions. What questions do you have about what will happen? | Predictions. What do you think might happen as a result of this change? |
|---|---|
| (Q1) Will the case manager like using the checklist? | Yes, s/he will feel that it was a helpful reminder of the protocol steps. |
| (Q2) Will there be any steps missing/skipped/rearranged? | No |
| (Q3) Will the case manager think the new teacher was enagaged? | Yes |
| (Q5) Did the checklist help the new teacher be clear about next steps? | Yes. All new teachers will report feeling sure about next steps. |

Details. Describe the who/what/when/where of the test. Include your data collection plan.

Task: Create the checklist using the post-observation protocol.

The case manager will bring the checklist to the post-observation conference with the new teacher and follow the steps outlined. The case manager will fill out a data collection sheet and the tracking tool with information from the conversation and the new teacher will fill out a response card anonymously (provided via email or in the teacher's lounge).

Respond Card Questions: I am clear of the next steps: Strongly disagree, Disagre, Neither, Agree, Strongly agree.

## (2) DO

Briefly describe what happened during the test, surprises, difficulty getting data, obstacles, successes, etc.

All of the conferences happened as scheduled and both case managers used the checklist. About half of the conversations ended before the scheduled time (they were quick). All new teachers and case managers were able to access the response cards easily and felt comfortable filling them out.

## (3) STUDY

| Record results. Use measures based on your predictions. How do measures compare to your predictions? |
|---|
| Both case managers felt that the checklist was a helpful way to ensure they followed all of the steps in the conversation protocol. |
| All of the steps were followed in order, but one case manager struggled with step 3 and 4 (responding to challenges noted by the new teacher while also trying to provide objective data from the observation) |
| Data collected in tracking tool shows high engagement scores for all 6 teachers |
| 3 teachers reported Neither Agree/Disagree, 3 reported Agree |

Was the test successful? What did you learn?

The test was successful in ensuring that case managers knew all of the steps of the protocol. Additionally the checklist maintained the quality of the conversation by keeping the new teacher engaged. However, we learned that new teachers are struggling with taking clear next steps from the conversation. We learned that the protocol may need to be revised or other guidance may need to be provided in order to strengthen the discussion of next steps and ensure there is more clarity. Additionally, we will keep an eye on steps 3 and 4 to see if that problem continues for other case managers.

## 4) ACT

What will you do next? Describe modifications/decisions for the next cycle

We will create a "Next Steps" sheet for the case manager and new teacher to complete together. If the new teachers are still not clear after this test, then we will ask for more qualitative data to see if there is something else we need to improve in the protocol. Maybe there is something around the length of the conversations (they were short as noted in Do section).

# Practical Measures-How Do We Know If Change is an Improvement

| Change Idea | Measures |
|---|---|
| PD: Math Anxiety | Pre and Post Survey & SMART Goal Template |
| PD: Growth Mindset & Communicating Mindset | Pre and Post Survey & SMART Goal Template |
| PD: Growth Mindset a& Teaching a Growth Mindset | Pre and Post Survey & SMART Goal Template |
| Using Process Praise & Feedback | Frequency of Use & Teacher Survey & Observation |
| Portraying Challenge, Effort, and Mistakes as Highly Values | Frequency of Use & Teacher Survey & Observation |
| Growth Mindset Lessons | Checklist for Implementation of Components of Growth Mindset Lessons & Formative Assessment & Feedback for Student Growth |
| | |

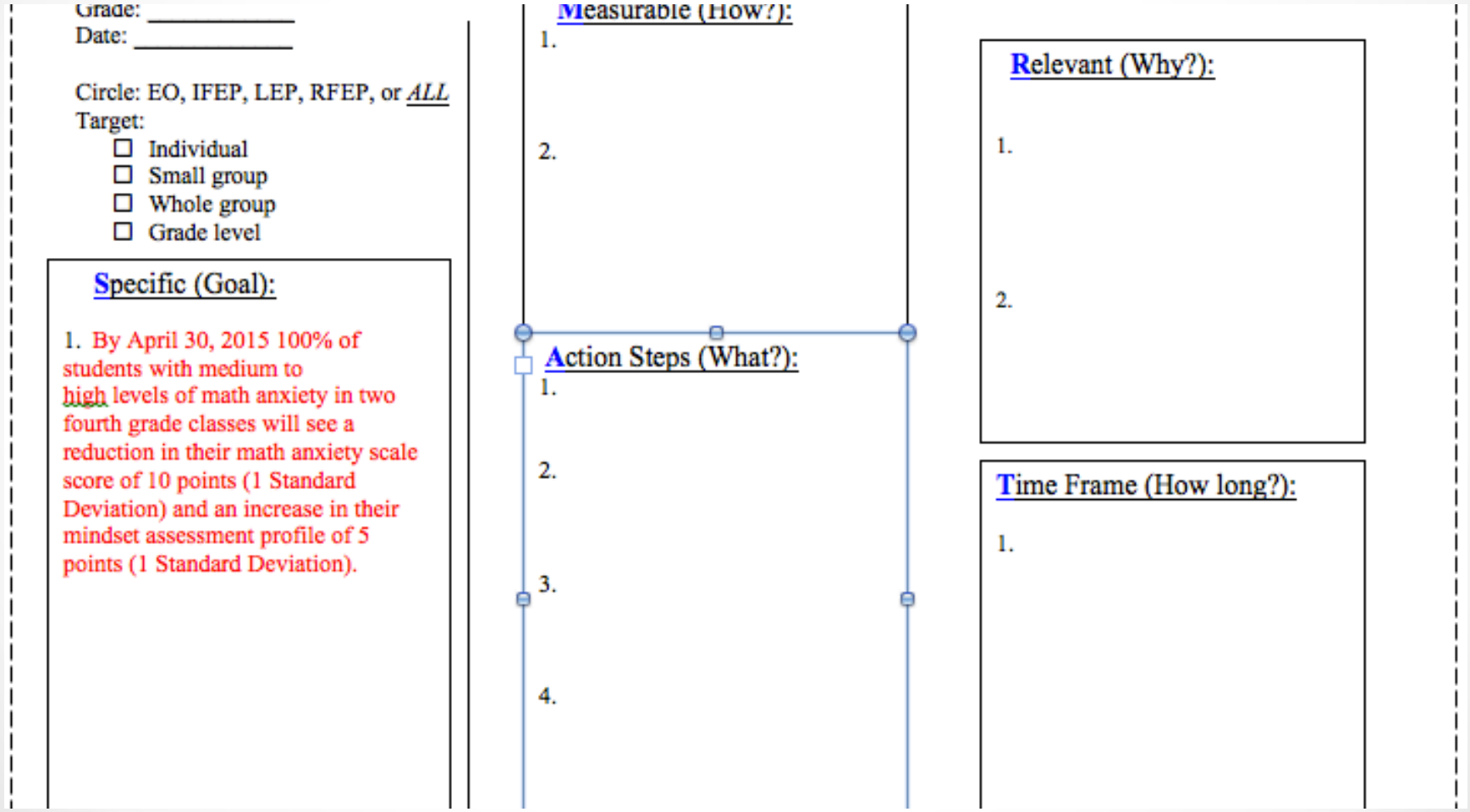
# Practical Measures-How Do We Know If Change is an Improvement

| Primary Driver ( Major Improvement Area) | Measures |
|---|---|
| Teacher Mindset | Teacher Mindset Assessment Profile |
| Teacher Efficacy in relation to Doing and Teaching Math | Teacher Survey on Growth Mindset Interventions and Teaching CCSS Math |
| Classroom Climate | Student Survey on dispositions and math anxiety & Teacher Observation |
| Student Mindset and Self-Efficacy | Student Survey on challenge, effort, mistakes, and learning behaviors |

# Timeline of Reducing Math Anxiety by Addressing Growth Mindset Action Research Project

- January 2015
  - Pre Action Research Baseline Data Collection
  - PDSA Cycles: PDs on Math Anxiety, Expressive Writing, Teaching and Communicating a Growth Mindset
- February/March 2015
  - PDSA Cycles: Process Praise/Feedback
  - PDSA Cycles: Communicating challenge, effort, mistakes as highly valuable
  - PDSA Cycles: Teaching Growth Mindset Lessons
- April 2015
  - Post Action Research Data Collection
    - Student Math Anxiety Levels
    - Student Mindset
    - Teacher Mindset
    - Grades

# SMART Goal Template



Grade: _____
Date: _____

Circle: EO, IFEP, LEP, RFEP, or *ALL*
Target:
- ☐ Individual
- ☐ Small group
- ☐ Whole group
- ☐ Grade level

**Specific (Goal):**

1. By April 30, 2015 100% of students with medium to high levels of math anxiety in two fourth grade classes will see a reduction in their math anxiety scale score of 10 points (1 Standard Deviation) and an increase in their mindset assessment profile of 5 points (1 Standard Deviation).

**Measurable (How?):**

1.

2.

**Action Steps (What?):**

1.

2.

3.

4.

**Relevant (Why?):**

1.

2.

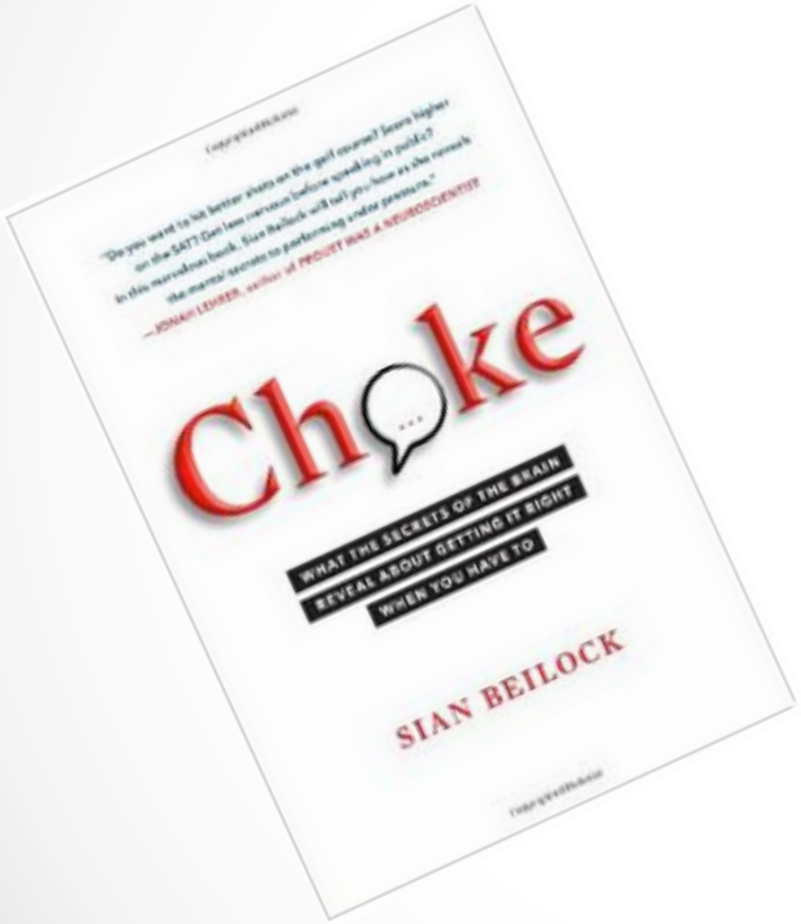
**Time Frame (How long?):**

1.

# What's Next

- PD Post-Survey
- PDSA Cycle #2a: PD on Growth Mindset and Communicating a Growth Mindset
  - Playlist
  - PD Pre-Survey

# Thank You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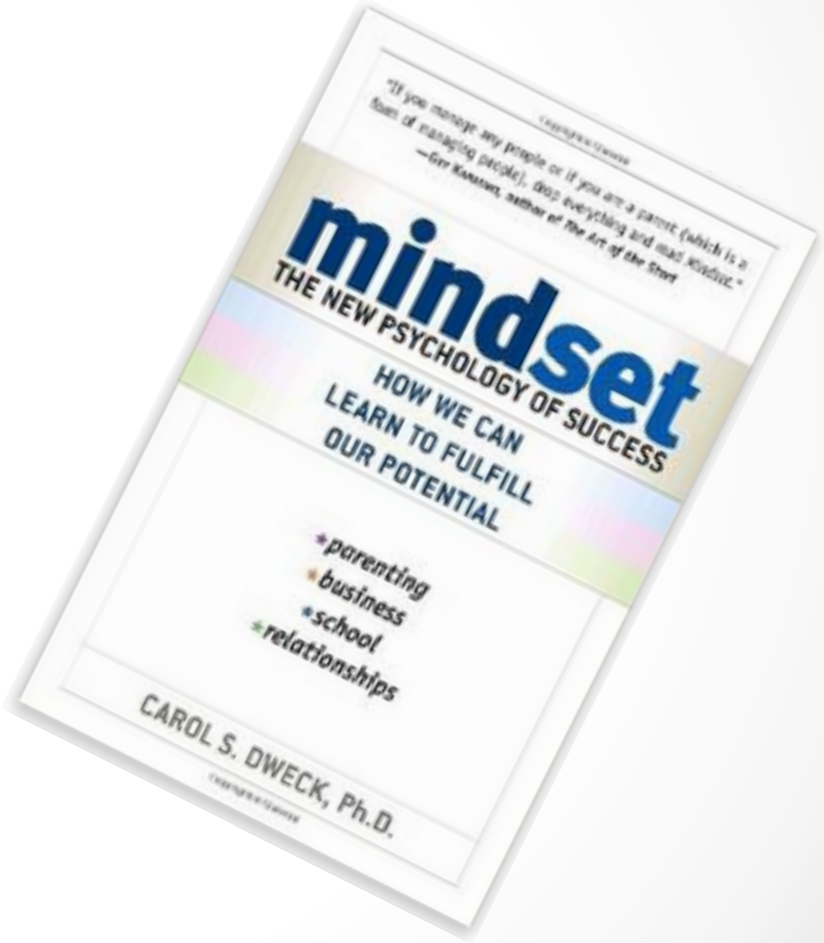
mindset
THE NEW PSYCHOLOGY OF SUCCESS
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CAROL S. DWECK, Ph.D.