



Mindset and Math

I notice... *I wonder...*

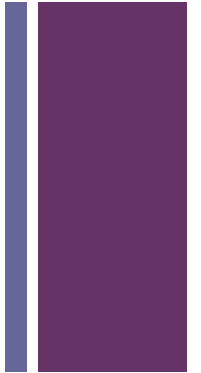
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2	1
3	10
4	2
5	100
6	11
7	1000

Number	Code
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9	20
10	101
11	10000
12	12
13	100000
14	1001
15	110



The Role of Mindset
in Developing Mathematical Talent
NAGC Phoenix, 2015

Presenter: Jerry Burkhart



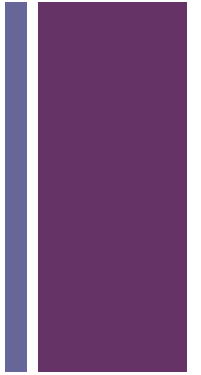
One of the most obvious differences among individuals in attacking word-problem solving is their willingness or unwillingness to keep at it, to pick it up after an interval and try again even if an apparent solution turns out to be false. Some people's attention is disrupted by failure. Others have just the opposite reaction: The joy of mathematics is precisely the challenge of it, the feeling that it is there to come back to, and the knowledge that there is no need to finish it in one sitting. Failure, or lack of immediate success (which is quite another way to think about failure), bothers them not at all.



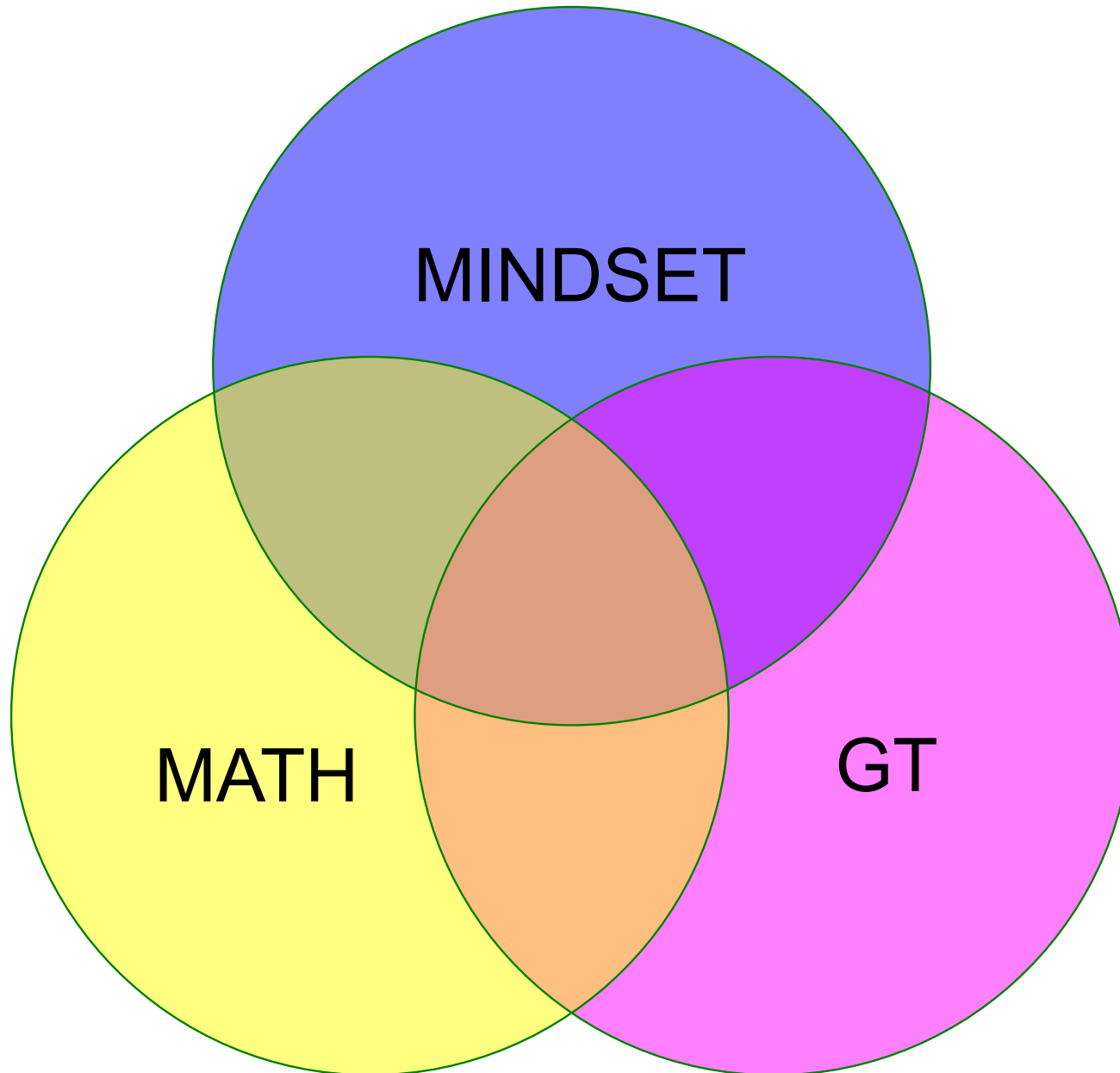
Every child deserves an
equal opportunity to
struggle.

Mary Slade



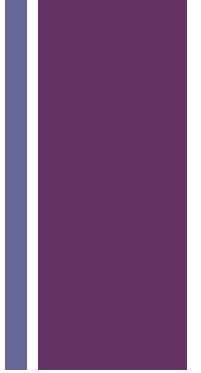


The Big Picture



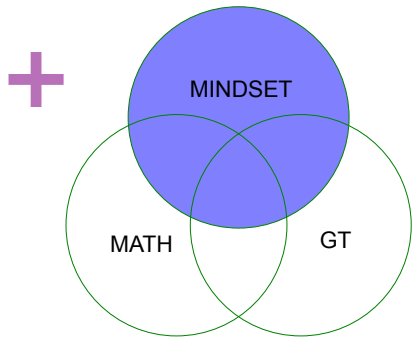


GOALS



Explore Practical Strategies at the Intersection of Mindset, Math, and Gifted

- Developing a growth mindset
- Selecting appropriate problems or activities
- Introducing activities
- Supporting students during the problem solving process
- Assessing student work



Mindset

Carol Dweck, 2008

Fixed mindset

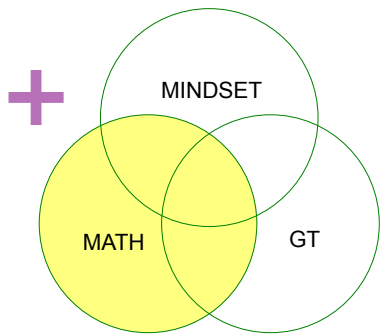
Intelligence is static. Therefore, I...

- avoid challenges.
- give up easily.
- see effort as fruitless or worse.
- ignore negative feedback.
- feel threatened by the success of others.

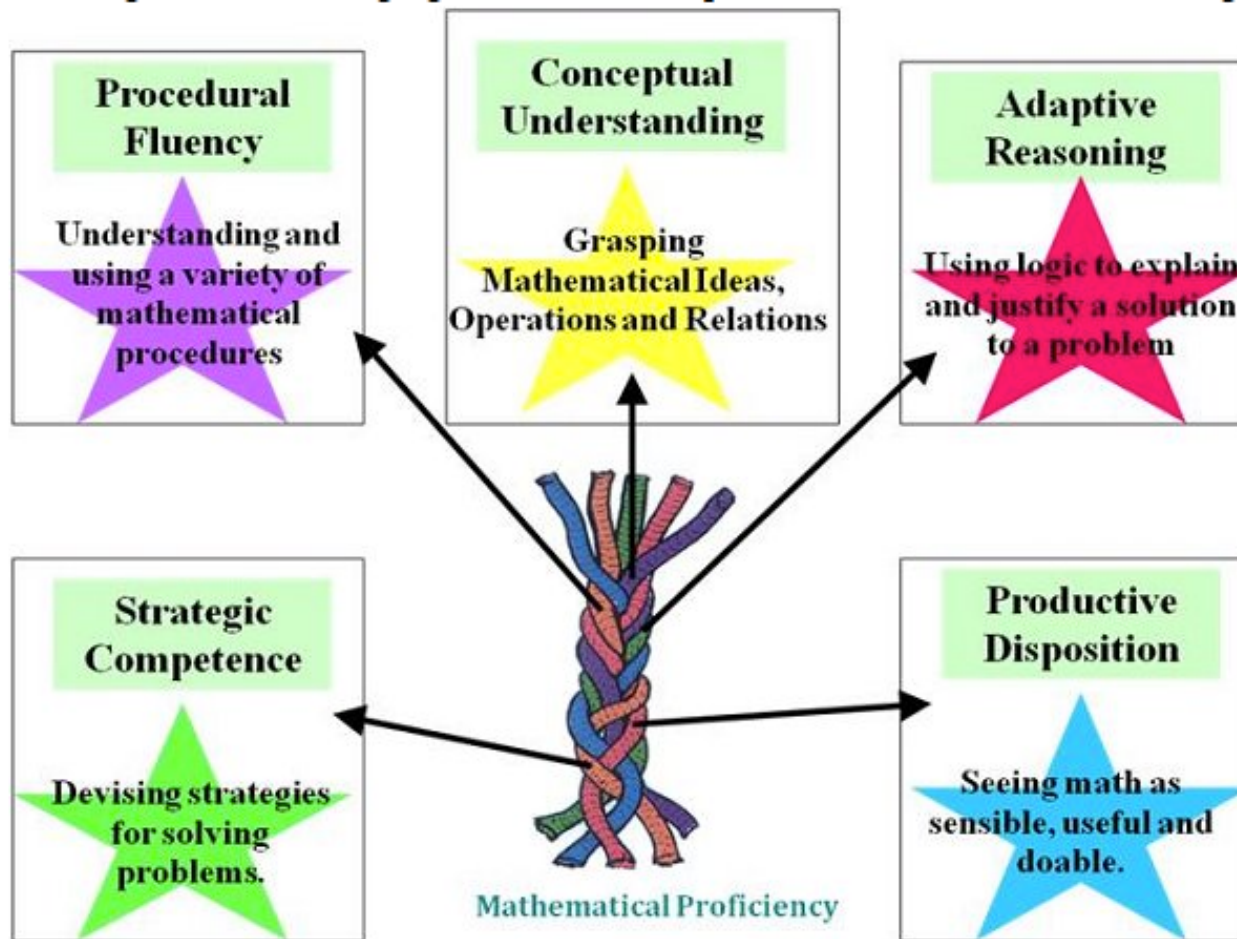
Growth Mindset

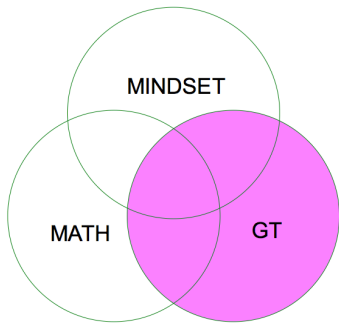
Intelligence can be developed. Therefore, I...

- embrace challenges.
- persist in the face of setbacks.
- see effort as a path to mastery.
- learn from criticism.
- find lessons and inspiration in the success of others.

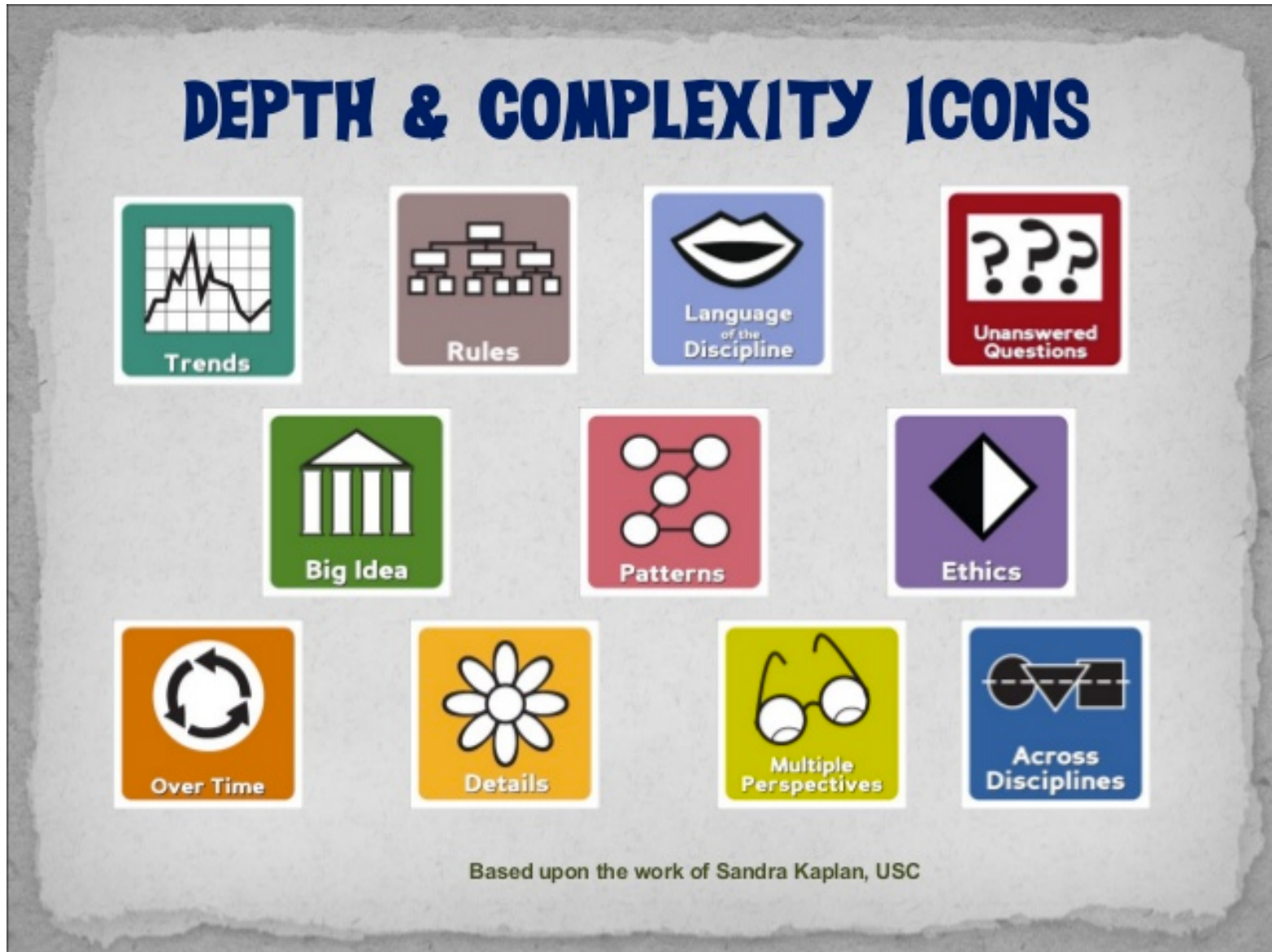


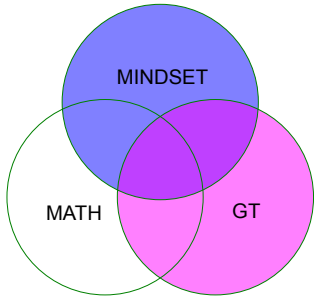
Mathematical Proficiency



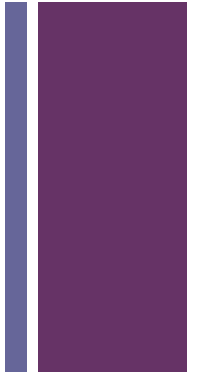


Kaplan's Icons



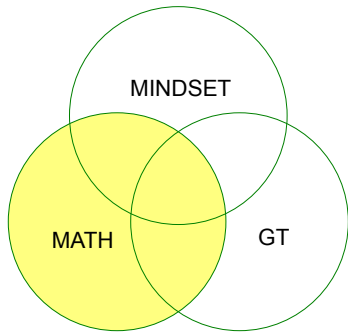


Mindset and Giftedness



“It is important to note that even students who have always gotten good grades may have a fixed mindset. These higher-achieving students are often concerned about how smart they appear to be, so they prefer tasks that they can already do well and try to avoid tasks in which they may make mistakes.”

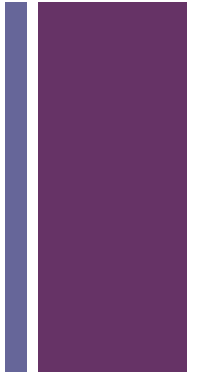
Principles to Actions: Ensuring Mathematical Success for All,
National Council of Teachers of Mathematics, 2014

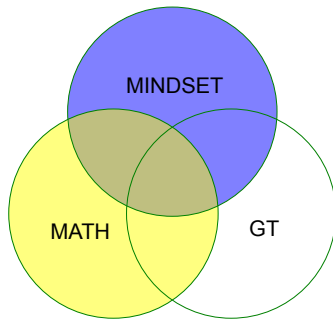


What do you believe?

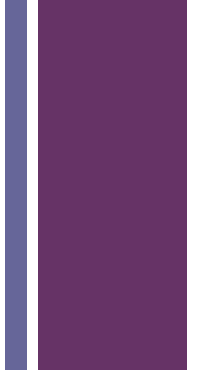
The subject of math is...

- about computation and procedures (learning the “right steps”).
- about getting right answers.
- about thinking logically.
- linear / step-by-step.
- skills-based.
- left-brain.
- concrete.
- hard.



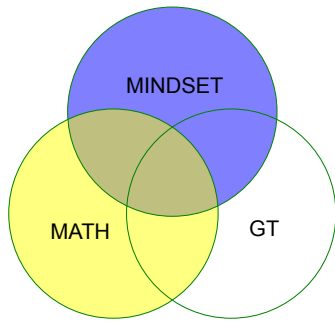


The Special Case of Math...



“Informally, we have noted in our research that students tend to have more of a fixed view of math skills than of other intellectual skills.”

Mindsets and Math/Science Achievement, Dweck, 2008



Mindset and Math

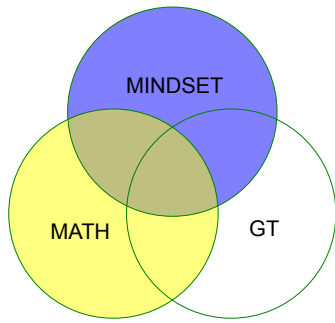
Personal Beliefs About Math Ability



” I was never good at math.”

"I'm a _____ person, not a numbers person.”

“Some people are math people. Others aren’t.”

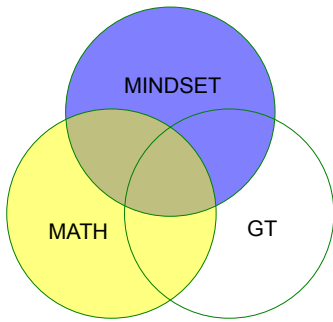


Mindset and Math

Personal Statements About Doing Math



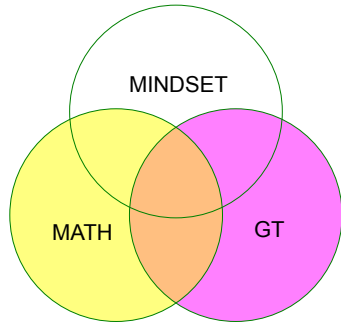
- “I can’t remember how to do this kind of problem.”
- ”I understand the concept. I just don’t know what the problem is asking.”
- "I can do the steps if you just show me how.”
- "I know the answer, but I don't know how I got it.”



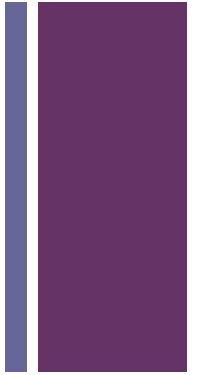
Mindset and Math

Research

- Mindsets can predict math/science achievement over time.
- Mindsets can contribute to math/science achievement discrepancies for women and minorities.
- Interventions that change mindsets can boost achievement and reduce achievement discrepancies
- Educators play a role in shaping students' mindsets.

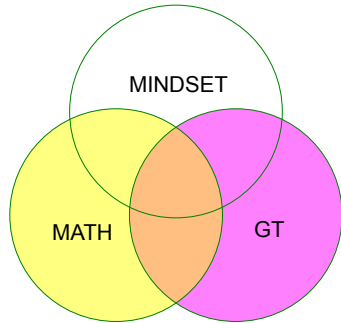


Math and Giftedness



What is your picture of a gifted math student?

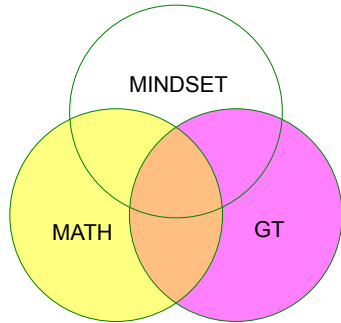
What is our society's picture of a gifted math student?



Math and Giftedness

Cultural Images

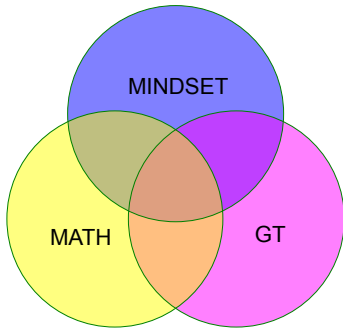
- Gets 'A's in math
- Doesn't have to work hard in math
- Does complex calculations quickly/accurately/mentally
- Social, gender, race, stereotypes



Giftedness and Promise in Math

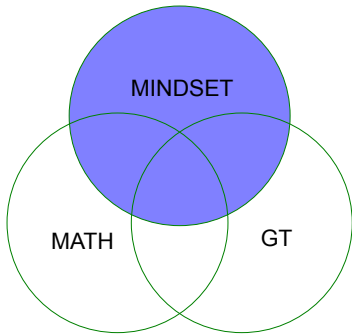
Selected Characteristics from Research

- Loves to explore patterns in a variety of situations
- Organizes and categorizes information
- Has a deep understanding of simple math concepts
- Generalizes structure from few examples
- Thinks logically and develops convincing arguments
- Processes information flexibly
- Digs beyond the surface of a problem
- Wants to know “why” and “what if”

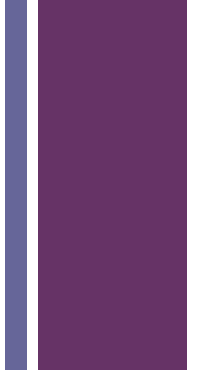


Mindset-Oriented Strategies for Developing Mathematical Talent

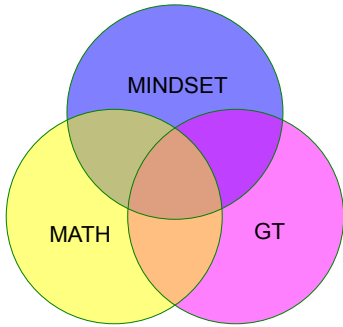
- General strategies for developing a growth mindset
- Choosing activities that encourage a growth mindset
- Introducing students to challenging activities
- Supporting students during the problem solving process
- Assessing and commenting on student work



Steps for Changing to a Growth Mindset



1. Learn to hear your fixed mindset “voice.”
2. Recognize that you have a choice.
3. Talk back with a growth mindset voice.
4. Take the growth mindset action.

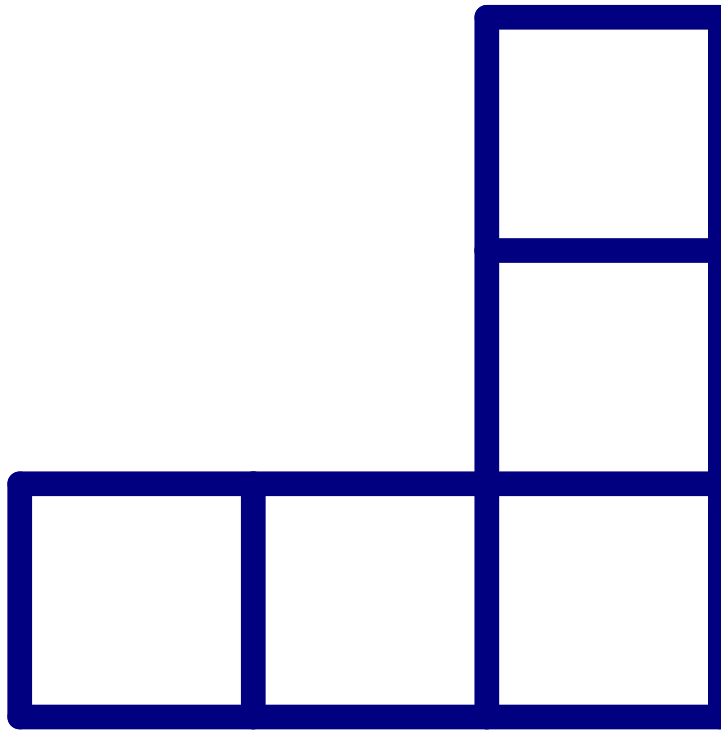


Math Activities that Develop a Growth Mindset...

- Take a significant amount of time to solve.
- Are open-ended with multiple points of entry and exit.
- Have multiple solution paths (or solutions).
- Provide opportunities for mathematical communication.
- Create "disequilibrium" or "productive frustration."
- Suggest possibilities for further exploration.

+ *I notice... I wonder...*

1, 2, 3, 4, 5

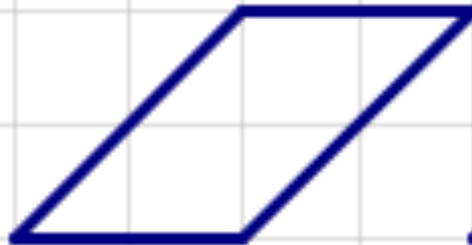
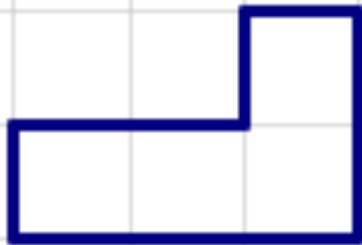


+ *I notice... I wonder...*

$\times 4$ $\div 8$



+ *I notice...* *I wonder...*



+ *I notice... I wonder...*

.	1	2	3	4	5	6	7	8	9	10
1	1	2	3	4	5	6	7	8	9	10
2	2	4	6	8	10	12	14	16	18	20
3	3	6	9	12	15	18	21	24	27	30
4	4	8	12	16	20	24	28	32	36	40
5	5	10	15	20	25	30	35	40	45	50
6	6	12	18	24	30	36	42	48	54	60
7	7	14	21	28	35	42	49	56	63	70
8	8	16	24	32	40	48	56	64	72	80
9	9	18	27	36	45	54	63	72	81	90
10	10	20	30	40	50	60	70	80	90	100

+ *I notice... I wonder...*

$$\frac{3}{5} \quad \frac{11}{18} \quad \frac{8}{13} \quad \frac{13}{21} \quad \frac{5}{8}$$

+ *I notice... I wonder...*

Bristlecone School District data

Mountain Heights Middle School:

51,600 square feet of floor space

470 students

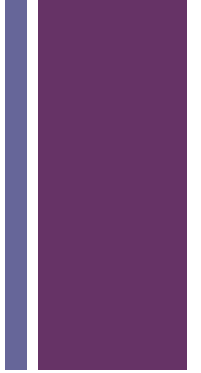
North Star Middle School:

118,300 square feet of floor space

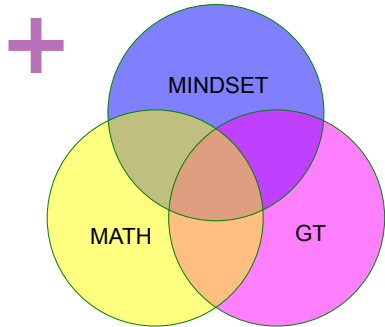
725 students



Reflecting on the Problems



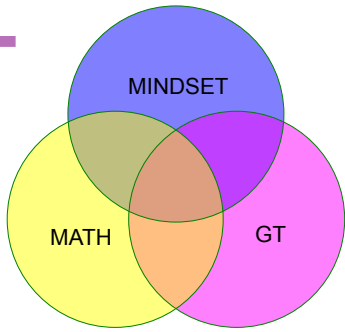
- What things might go wrong/go well when you assign these problems?
- What does or does not make this problem useful for developing a growth mindset?



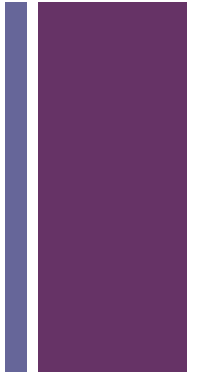
Encourage a growth mindset when introducing activities by...

- Letting students know what to expect in advance.
- Making it clear what you value.
- Telling students how you will support them through the process.
- Ensuring that students have the background knowledge and experience necessary to begin successfully.

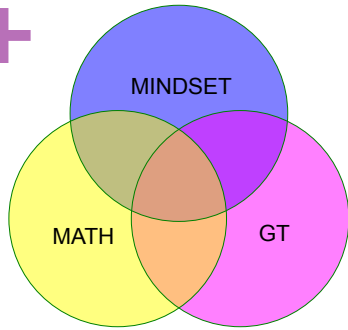
Doing this in advance is more effective than reacting later.



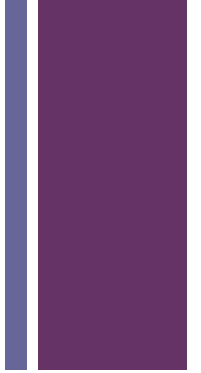
Let Students Know What to Expect



- It will take a long time.
- You will probably get stuck at some point.
- You will probably not get everything right.
- You might not finish.
- It is possible to show progress in your learning even if you don't get it "right."

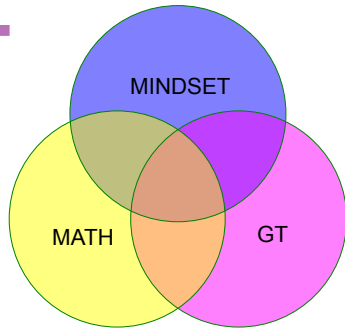


Let Students Know What You Value



- effort
- progress
- creative ideas
- thinking of other interesting questions to ask
- having good reasons for your answers
- explaining your thinking clearly
- making connections between ideas
- precise use of math vocabulary

Notice that these expectations give more control to students!



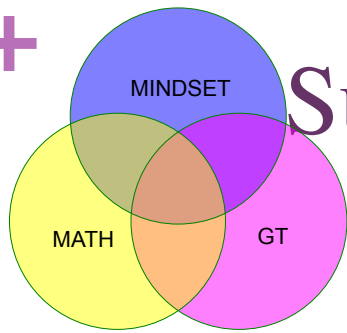
Tell Students How You Will Support Them

This may include:

- Telling them when they may approach you with questions.
- Encouraging them to collaborate with other students.
- Helping them clarify meaning of questions.
- Helping them learn to put their thoughts into words.
- Emotional support - helping them manage frustration.
- Occasional guiding questions or hints.

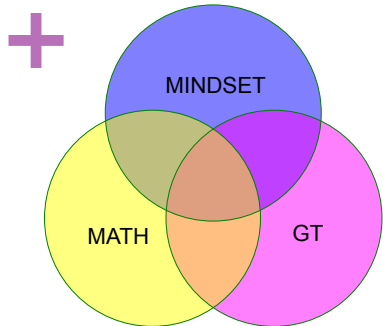
It probably will not include:

- Suggesting “steps” to do the problems.
- Telling them answers.



Support Students During the Problem Solving Process by...

- Creating conversation that:
 - Is built on *students'* ideas.
 - Includes open discussion of errors and how to learn from them.
 - Allows students to critique and learn from others' ideas.
- Talking openly about mindset, feelings, and experiences.
- Giving them strategies for managing frustration or fear.
- Resisting the urge to “rescue” students by decreasing the challenge level!



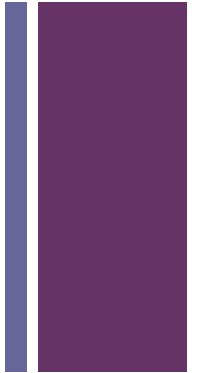
Encourage Growth Mindset through Assessment by...

- Praising effort and process, not ability and answers. (Dweck, 2008)
- Assessing *process*-oriented goals—not just answers
- Writing specific, thoughtful comments related to students' ideas.
- Writing comments focused on growth/progress in learning.
- Suggesting further questions to think about.
- Asking students to reflect on their experience (mindset, level of engagement, feelings, etc.) and how they responded to obstacles.



An Assessment Tool

Mathematical Criteria

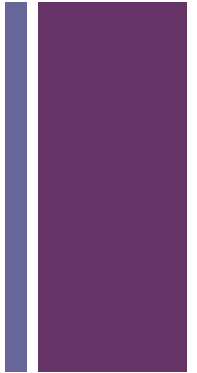


Mathematical Criteria	Descriptions of Standards
Depth of Understanding	The student understands why strategies and procedures work. The student makes use of connections between ideas.
Problem Solving	The student develops and implements effective problem solving strategies and verifies results using alternate approaches.
Elaboration and Communication	Words, calculations, and diagrams are used effectively with examples to produce thorough, clear, and concise explanations.
Generalizations and Reasoning	The student recognizes and extends patterns and uses logic to justify conclusions.
Correctness and Precision	Answers are correct. Calculations are accurate and stated with an appropriate level of precision. Math terms are used precisely.
Originality and Extensions	The student generates ideas and strategies that were not explicitly taught and/or proposes new questions to pursue.



An Assessment Tool

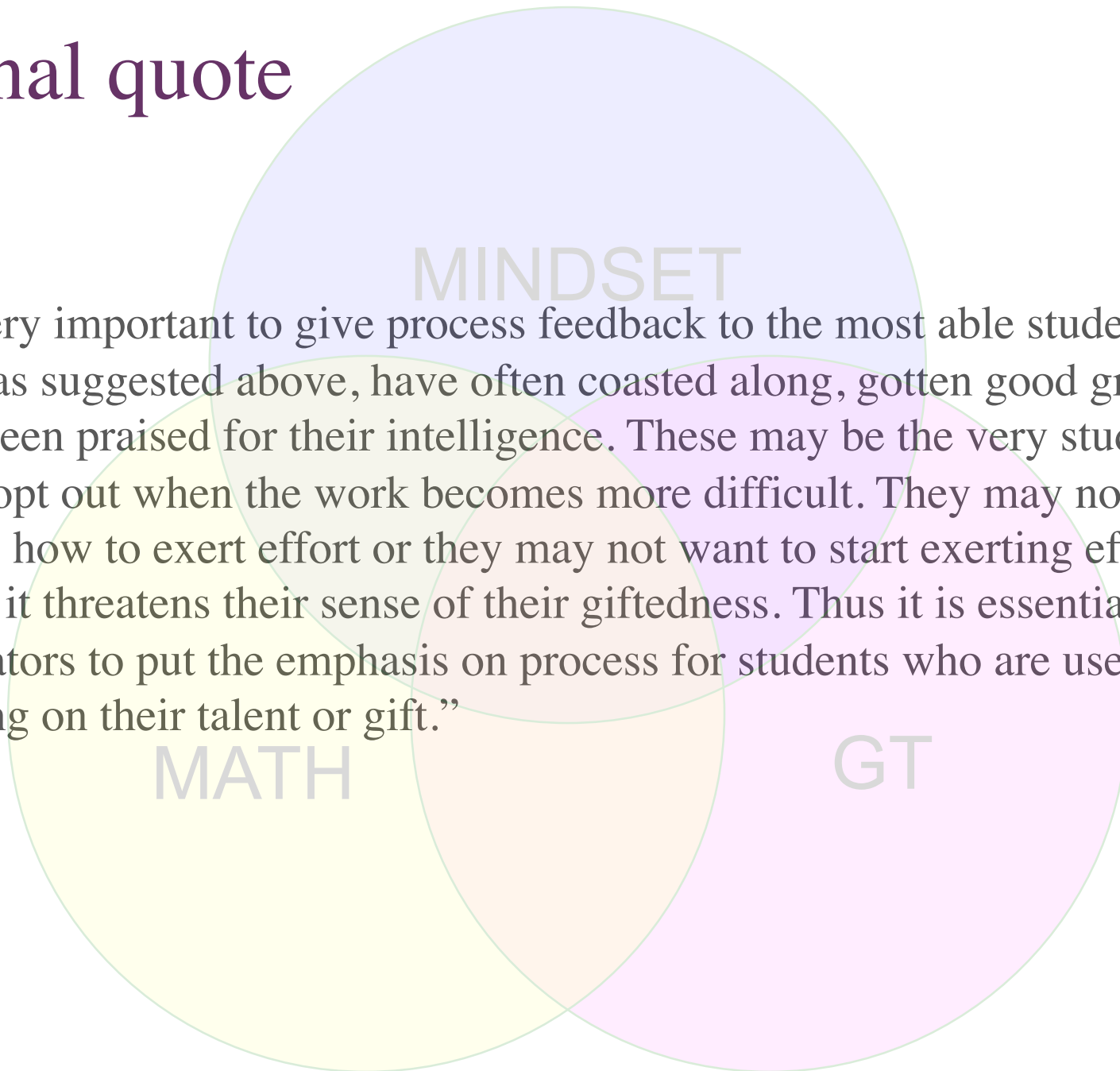
General Criteria



General Criteria	Descriptions of Standards
Effort and Perseverance	The student's work shows evidence of consistent effort needed to make progress appropriate to her/his current level of understanding. The student persists through difficulties.
Organization, Appearance, and Legibility	Pages and problems are in order. The work for each problem is shown in one place. It is easy to tell the order in which computations were done and ideas were used. Writing is legible. The heading is complete.
Spelling, Grammar, and Punctuation	Spelling is correct, especially mathematical vocabulary. Grammar is correct, including subject/verb agreement and the use of complete sentences. Punctuation is correct, especially capital letters and periods.
Follow-Through	The student's assignment is assembled and stapled before the beginning of class on the due date. The completed and graded assignment has been signed by a parent/guardian and return to the teacher in a timely manner.

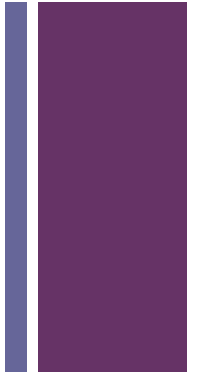
+ A final quote

“It is very important to give process feedback to the most able students, who as suggested above, have often coasted along, gotten good grades, and been praised for their intelligence. These may be the very students who opt out when the work becomes more difficult. They may not know how to exert effort or they may not want to start exerting effort, since it threatens their sense of their giftedness. Thus it is essential for educators to put the emphasis on process for students who are used to relying on their talent or gift.”





The Role of Mindset in Developing Mathematical Talent



Thank you!

Jerry Burkhart

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