# Mathematical practices: Getting our students to think outside the box! 

Please grab an index card at the front of the room.
Write down a mathematical content question to which you have always wanted to know the answer.

Ex: Where does the quadratic formula come from? Why is the number of subsets of any set of size $n$ equal to $2^{\text {n }}$ ?

## Mathematical Standards of Practice

- MP1: Make sense of problems and persevere in solving them.

How do we help our students keep going? What will prevent them from giving up?

- MP4: Construct viable arguments and critique the reasoning of others.

How do we help our students defend their reasoning and identify flaws in other students' reasoning?

- MP7: Look for and make use of structure.

How can we use what we know to solve new problems?

- MP8: Look for and express regularity in repeated reasoning.

What patterns can we use to solve new problems or to create shortcuts in solving old ones?

# MP1: Make sense of problems and persevere in solving them 

-Grit
-Growth Mindset
-Engagement
-Outside the box thinking

## GRIT

-Tenacity
-Perseverance
-The ability to never give up
-Resilience

## GRIT

- Long math problems $\neq$ Hard math problems
$L O N G=$ mary s simple steps leading to an exciting
solution.
HARD $=$ reaving a a great deal of effort \& thought
LONG math problems $\neq$
HARD math problems


## GRIT

- Long math problems $\neq$ Hard math problems
- Make it part of your everyday conversation

I Show CRIT When I:
continue to (My wiley ball after animus.

## GRIT

- Long math problems $\neq$ Hard math problems
- Make it part of your everyday conversation
- Be comfortable struggling yourself
- Wrong answers lead to right answers
- It's ok to take a longer time to process
- Productive struggle


## Mindsets

-Growth Mindset

- Resilience
- Wrong answers lead to right ones
- Learn from our mistakes
-Fixed Mindset
- I am a failure
- I will never get it right


## Engagement

- Use problems that involve situations in the world around them
- Allow them to recognize mathematics in the world around them even if it is not mathematics they use
- Not all problems need to be "real world"

Math. The only place where people buy 60 watermelons and no one wonders why.


## Engagement

- Use problems that involve situations in the world around them
- Allow them to recognize mathematics in the world around them even if it is not mathematics they use
- Not all problems need to be "real world"
- Demonstrations are always a plus!


## Outside the Box / Sophisticated Thinking

- You need to think outside the box


## What does 2581 equal?

$$
\begin{array}{ll}
8809=6 & 5555=0 \\
7111=0 & 8193=3 \\
2172=0 & 8096=5 \\
6666=4 & 1012=1 \\
1111=0 & 7777=0 \\
3213=0 & 9999=4 \\
7662=2 & 7756=1 \\
9313=1 & 6855=3 \\
0000=4 & 9881=5 \\
2222=0 & 5531=0 \\
3333=0 & 2581=? ? ?
\end{array}
$$

## Outside the Box / Sophisticated Thinking

- You need to think outside the box
- Blogging


## The Deceit of Statistics

"I remember when Dr. Jaffe showed us how to calculate the percentage of women who have been tested positive and actually have cancer, I found that unbelievably shocking. I have been enlightened! After learning this and completing the project on news articles, I now have a total different perspective whenever numbers are presented in articles. I have a tendency to question the credibility of the author/ journalist: 'Is he being bias? Is he wording his sentences differently on purpose to confuse us? What's his purpose of writing this?'"

## Tying Everything Together

"You talked about math being interconnected and how we can find similarities between all different forms of math this statement makes me wonder what the world would be like if people never made those connections. How math, along with other information, needs to be connected in order to move forward and expand on ideas. If we never used algebra in other forms of math (such as equations or functions) we could never do trigonometry, geometry, calculus etc. We need to understand all basics of math to interpret harder problems. And we have problems in everyday life that we can connect back to math fundamentals. This fact is why we need to learn math, because math fixes real world problems, and although a lot of ' us say 'oh we are never gonna use this', a lot of the time we do and we don't even realize it. Basic math gets around to everyday life and we need to be able to math those connections in order to use the math we have learned over the years"

## The World As We Know It

"Lately , I have been trying to understand math more deeply. I try to connect it with the world around me after fully understanding the mathematical aspect of it. For example, when I learn how to do steps in a problem, I try to see why exactly I do the step \& what happens if the problem was different or what would happen if I never do the step. (If that makes sense). Then I try to connect it to something in real life such as cooking, 'what would happen if I add this ingredient twice' compared to 'what would happen when I square this number.'"

## The World As We Know It

"This post really made me think deeply about my ability to take upon mathematics. Recently, I've been trying to change my fixed mindsets into growth mindsets. I've been constantly told that one can not be simply 'bad' at something. In order to be 'good' at something, it comes with lots of practice and the formation of good habits. Perhaps we can activate that part of our brain and become mathematical geniuses with good habits and practice."

## Outside the Box / Sophisticated Thinking

- You need to think outside the box
- Blogging
-What if?


# MP4: Construct viable arguments and critique the reasoning of others 

- Conceptual Understanding
- Why? Why? Why?
- Allowing students to use their strengths to express themselves
- Allow struggling students to be leaders
- Student Choice


## Conceptual Understanding

- In class
- Homework
- Exams
- Projects


## Why? Why? Why?

- Students justify their reasoning
- Students challenge each others' reasoning
- Students wonder


This is the graph of which trigonometric function?
a) $\tan ^{-1} x$
b) $\cot x$
c) $\sec x$
d) $\csc x$

$$
\begin{aligned}
& b^{x} * b^{y}= \\
& \text { a) } 2 b^{x+y} \\
& \text { b) } b^{2(x+y)} \\
& \text { c) } b^{x y} \\
& \text { d) } 2 b^{x y} \\
& \text { e) none of the above }
\end{aligned}
$$

## Turn and Talk

Turn to the person next to you and share the questions on your index cards.

Try to answer each other's questions or can you find a way to pose the same question to your students.

# Methods of Communicating Mathematically 

- Writing
- Speaking
- Diagramming
- Abstract Symbols
- Modeling


## Self-Choice

- Differentiation
- Topics of Analysis
- Projects
- Problems


## MP7: Look for and make use of structure MP8: Look for and express regularity in repeated reasoning

- We look for natural patterns
- Apply our knowledge of the human mind

$$
8 * 7
$$

$$
9 * 6
$$

$$
6 * 8
$$



$$
7 * 6
$$

$$
9 * 7
$$

$$
6 * 4
$$



## Answers

$\cdot 56$
$\cdot 54$
-48
$\cdot 72$
$\cdot 42$
$\cdot 63$
$\cdot 24$

- 56


## Revamping the Curriculum

- Equations
- Graphs
- Transformations
- Simplification


## Cool Factor

- Throughout my many years of mathematics, teachers have spewed at me various equations and formulas to use in solving a wide array of problems. With this barrage of material, I was never actually learning mathematics, as I was frantically and thoughtlessly memorizing seemingly obscure problems to receive nice grades. The value of education is not the grades one receives, rather, it is the knowledge one gains;
- Though my grades were high, math to me had no inherent value and I neither cared for how these many equations were derived nor received any gratification or satisfaction from solving meaningless equations- I was not learning.
- In this course, however, I really do admire how we always look for the neglected "whys" of mathematics. Derivation has been core in this unit and has illuminated to me the value of mathematics. From exploring why the quadratic formula is what it is, to having some fun with the Pythagorean Theorem in order to reveal Pythagorean identities, mathematics seem all the more important. As opposed to loathing and complaining why we are doing what we are doing, I am considerably more invested in achieving knowledge and actually learning, as that is the true purpose of education.
- The "cool factor" of mathematics is omnipresent. Students must provide the instruments and teachers must strike the best sounding chords to achieve harmony. Instruments required include grit, enthusiasm, and willingness; what teachers must bring to the chorus is about the same. Learning is a shared bond that requires the investment and synergy of both ends, when one end refuses to cooperate, a cacophony of only grades being valued is the product. But when everything falls together, a harmony of knowledge, and satisfaction from it, is resulted-true education


## KeyTakeaways

- Instilling grit requires
- changing a student's mindset
- making it part of everyday conversation
- allowing students to use their strengths
- giving a little freedom
- Never forget to ask Why?
- Encourage students to ask questions
- Get students to talk about mathematics
- Think outside the box
- Build on students' natural tendency to search for patterns
- Reevaluate your curriculum
- How does the brain work?


## Reflection

As you leave consider:

- What resonated with you?
- What is one thing you can implement in your classroom on Monday?

I would love to have your cards back!
Please feel free to contact me: jaffe.elisabeth@bcchsnyc.net

