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MATH 5280
challenging math for adventurous learners

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ed and adventurous math learners

How Open-Ended Math Problems Keep on Giving

Imagine open-ended math tasks that get students *asking* questions as well as answering them. *Creative Math Prompts* lead learners to build and test their own ideas.

ns
Students Back

comparisons? Helping these students reach their full potential may mean challenging some popular beliefs.

The 5280 Math Newsletter

Sign up for the 5820 Math Newsletter. Keep up with work I am doing as well as the latest in math talent development: classroom resources, tools and strategies, challenging and engaging math problems, interesting articles, websites, and blogs.

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Jerry Burkhart, 2018. 5280math.com

My Background

- B.A. Physics, M.A. Mathematics, M.A.T. Mathematics Education
- Gifted Math Specialist (21 years) in MN
  - teach math classes to gifted learners (primarily upper elementary and middle school)
  - develop and implement deep, challenging math resources for grades 1 – 8
  - train teachers in meeting needs of gifted math students in grades 1 – 8
- Teach Algebra and Calculus courses to highly gifted high-school students in the Minnesota Talented Youth Math Program (Johns Hopkins model) (7 years)
- Write the *Advanced Common Core Math Explorations* book series for grades 5 – 8
- Speak, train, and consult in area of Gifted Math Education (5 yrs)
- Design and teach Mathematical Thinking courses for highly gifted students in India

What were your best and worst math classes like as a student?

Imagine…

Math Classrooms

where all students confidently explore and discuss deep concepts with peers who support and *stretch* their thinking.

Schools

where *integrated* systems support every math student—struggling to gifted, privileged to disadvantaged.

A World

where all adults remember liking their math classes and *take for granted* their ability to understand and do math.

International Comparisons

2015 TIMSS RESULTS (8TH GRADE)

EDUCATION SYSTEM	Mean	10th Percentile	90th Percentile
Canada	527	434	613
Chile	427	323	531
Chinese Taipei-China	599	459	714
United Kingdom-England	498	414	624
Hong Kong-China	594	489	686
Japan	586	470	699
Republic of Korea	606	491	711
Lebanon	442	345	539
Lithuania	511	409	608
Russian Federation	538	429	641
Singapore	621	505	715
Sweden	501	406	590
Turkey	458	324	599
United States	518	408	624
Average	**493**	**364**	**613**

2015 PISA RESULTS (15 YEAR OLDS)

EDUCATION SYSTEM	Mean	10th Percentile	90th Percentile
Canada	516	400	627
Chile	423	313	534
Chinese Taipei-China	542	404	670
United Kingdom	493	371	610
Hong Kong-China	548	426	659
Japan	532	416	643
Republic of Korea	524	391	649
Lebanon	396	268	531
Lithuania	478	365	590
Russia	494	387	601
Singapore	564	436	682
Sweden	494	376	609
Turkey	420	317	529
United States	470	355	585
Average	490	373	605

See The Teaching Gap, by Stigler and Hiebert

Ten Myths That Hold Bright Math Students Back

1. Math is mainly about performing procedures accurately and quickly.
2. Mathematically talented people have special abilities that ordinary people lack.
3. Acceleration is highly effective in meeting the needs of bright math students.
4. Skill-based math tests can effectively measure bright students' abilities and learning.
5. Elementary teachers do not need to understand math deeply.
6. Bright math students' needs can be met entirely within mixed-ability classrooms.
7. Identifying needs of bright math students is necessarily harmful and elitist.
8. Bright math students often need just a little extra challenge.
9. Bright students can learn math on their own.
10. Bright math students deserve special opportunities and experiences.

Jerry Burkhart, 2018. 5280math.com

Who tends to believe the myths?

- U.S. culture as a whole 1, 2
- Leaders in gifted education 1, 2, 3, 4
- Leaders in math education 6, 7, 8
- Classroom teachers 1, 2, 4, 5, 8, 9, 10
- Gifted students and their families 1, 2, 3, 4, 10
- You ?

GOALS

TODAY

Identify beliefs that hold gifted math students back.

Examine some consequences of these beliefs.

Plan concrete actions to move gifted math students forward.

LONG-TERM

***Integrate* best practices in gifted and math education.**

Change mindsets about what math is and how we learn it.

Implement resources and systems that support deep learning in math.

Respond to these statements…

- "I forgot how to _____ (name a math process)."
- "He needs to know his math facts before he is ready for the challenge work."
- "Just do it how I showed you, and you'll always get it right."
- "The thing I like about math is that there's always a clear-cut _____ (answer or process)."
- "I can't help my daughter in math, because they teach different ways to do it now."

Myth 1

Math is mainly about performing procedures accurately and quickly.

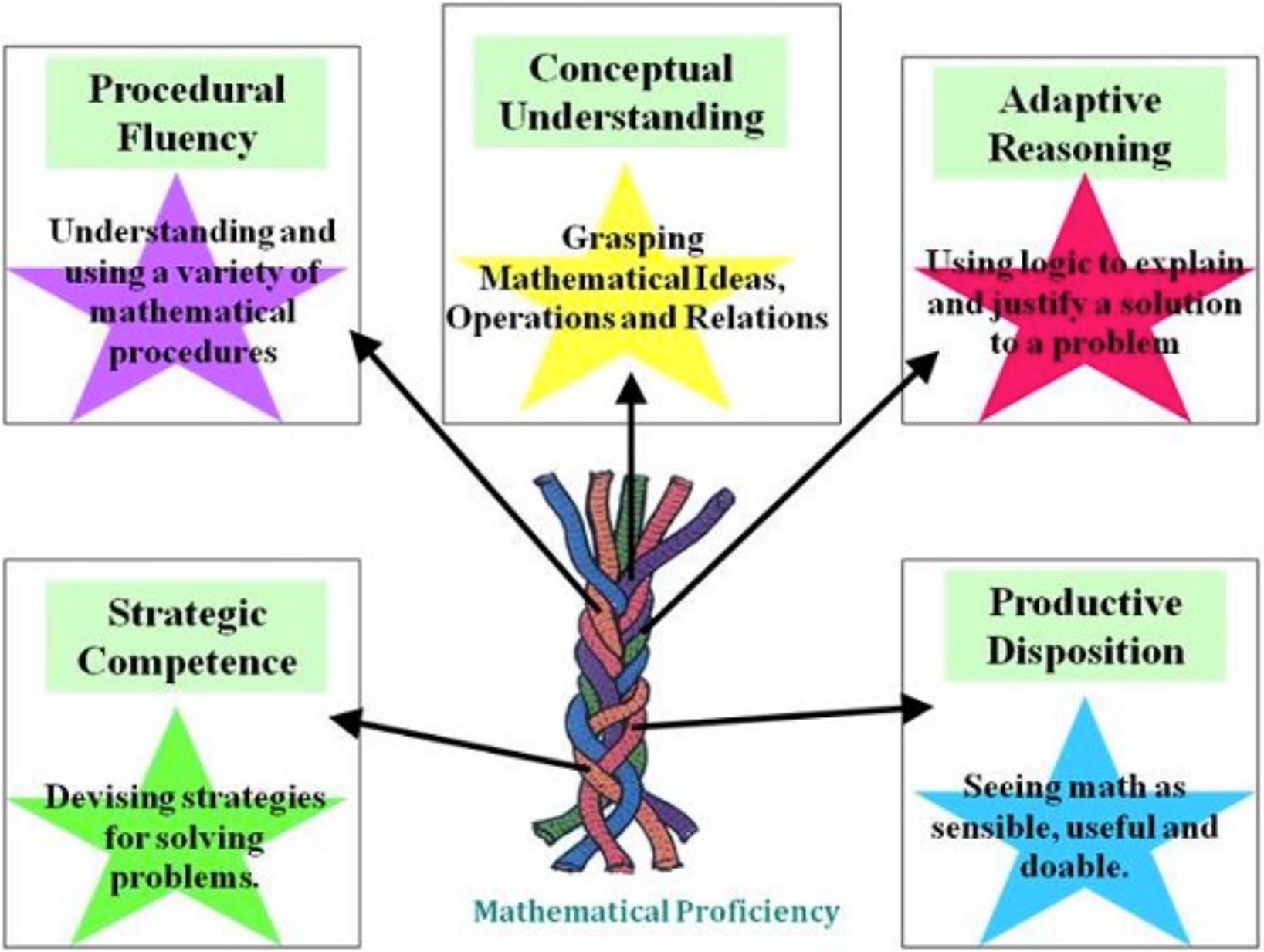
A grain of truth

Procedural fluency is one of many components of math proficiency.

The deeper truth

Math is mainly about understanding, creating, and reasoning about patterns and relationships.

Math Proficiency Strands



Kilpatrick, J., Swafford, J., Findell, B. (Ed.). (2001). *Adding it up: helping children learn mathematics*. Washington, DC: National Academy Press.

Myth 1 has consequences…

- Students do not *retain*, *transfer*, *apply,* or *value* learning.
- Math courses get harder each year.
- Students feel no connection to math.
- People develop math anxiety.
- Educators identify and develop math talent less effectively.
- Deep, slow, or creative thinkers turn away from math.
- People believe other Myths as well.

What can I do about Myth 1?

- Learn more about the 5 Proficiency Strands for math. Recognize and develop the other four strands in students and colleagues.

- In math class:
  - Use resources that support deep mathematical learning*.
  - Use your *students*' ideas to inform your instruction.

- Ask for professional development supporting best practices in math.**

- Reach out to the math leaders in your district. Look for ways to collaborate.

* 5280mathcom. has a good selection of resources.
**see *Mathematical Mindsets* by Jo Boaler, and visit youcubed.com
follow Dan Meyer (@ddmeyer)

Respond to these statements…

- “I’m not a math person.”
- “It’s not rocket science.”
- “Did you hear about the math whiz who can multiply 4-digit numbers in her head in 15 seconds?”
- “He’s great with numbers, but he has no _____ (common sense / social skills…).”
- “Uh-oh.”
  (Alex Trebek, after introducing Math as the Final Jeopardy category)

Myth 2

Mathematically talented people have special abilities that ordinary people lack.

A grain of truth

People have different capacities for understanding and doing math.

The deeper truth

Math ability is changeable, and most people greatly underestimate their mathematical potential.

Myth 2 has consequences…

- People are unrealistic about their own math ability.
- Students choose not to work hard at math.
- Bright students hide their math abilities.
- Many people feel uneasy or distrustful when they encounter math in daily life.
- People may “take pride” in being uncomfortable with math.

What can I do about Myth 2?

- Don't think or speak of yourself as "not a math person." Address it when other adults do this.
- Provide opportunities for creativity in your math class.*
- Praise ability less. Praise effort more.**
- Break down stereotypes about people who are good at math.***

*See *Creative Math Prompts* at 5280math.com
**See *Mindset* by Carol Dweck for more about ability vs. effort
***See books for Danica McKellar and Eugenia Cheng to address stereotypes

In spite of significant research in the field of gifted education supporting the practice of accelerating gifted math students, some people remain skeptical.

- Who are the skeptics?
- Why do they resist the practice of acceleration?

Acceleration

Depth

Myth 3

Acceleration is a highly effective means of meeting the needs of bright math students.

A grain of truth

Acceleration meets some needs of some bright math students.

The deeper truth

Acceleration as often practiced *inhibits* many students' learning and growth in math.

Myth 3 has consequences…

- **Accelerated math students spend most of their time at lower levels of thinking** (in Webb's Depth of Knowledge or Bloom's Revised Taxonomy)
- Gifted students are underprepared for advanced math courses.
- Gifted math students lose confidence, retake courses, and/or drop out of math courses in high school or college.
- Deep, slow thinkers doubt their math ability. **We lose some of our most talented students**!
- Gifted math students lack knowledge of important math concepts beyond the standard curriculum.
- Gifted students misunderstand what math is.

What can I do about Myth 3?

- Collaborate with math leaders to identify and support math talent.

- Deemphasize math tasks that focus on speed and accuracy. Choose longer tasks that develop deep understanding, reasoning, creativity, and communication.*

- Help your students develop new mindsets about what math is and what math ability looks like.**

- Offer presentations to families of gifted math learners. Show alternatives to acceleration by engaging them in examples of deep math tasks and projects.

*5820math.com focuses on these types of resources
**See *Mindset* by Carol Dweck,
Mathematical Mindsets, by Jo Boaler, and the website youcubed,com
and my presentation, *The Role of Mindset in Developing Mathematical Talent*
at 5280math.com/presentations

Think about these statements…

- “She got 100% on the end-of-unit math test, so she is ready to move on to the next topic.”
- “He got a 70% on the pre-test, so he shouldn’t be in the advanced group for this unit.”
- “She needs to be accelerated into algebra, because she had the highest score on _____ (a standardized test).
- ”Pre-testing is a great differentiation strategy in math, because they either know it or they don’t.”

Myth 4

Skill-based math tests effectively measure bright students' abilities and learning.

A grain of truth

Skill-based math tests provide some insight into bright students' abilities and learning.

The deeper truth

Skill-based math tests alone are insufficient and are often misinterpreted.

Myth 4 has consequences…

- Students are placed in advanced courses for which they are not well prepared.
- Some gifted students do not receive the high level of challenge that they need.
- Students are accelerated into advanced content based on a superficial understanding of prior concepts.
- Some students who already understand a concept deeply are not challenged, because they made superficial errors on a pre-test.

What can I do about Myth 4?

- Incorporate concept-based and problem-solving measures in the math talent identification process.
- Use concept-based items on pre- and post-assessments in the classroom.

Resources:
Challenge resources in your curriculum
Common Core Progressions documents
Cr*eative Math Prompts* (5280math.com)
Ten Plus One tasks (5280math.com)
Math Problem Solving Inventory (contact me: 5280math.com/contact)

Think about these statements from teachers…

- “Primary teachers are generalists. They can’t be expected to be math experts.”
- “I don’t need to learn more math. I just need to learn the best ways to explain it.”
- “This way of teaching math is just another fad. It will pass soon.”
- “What was good enough for me is good enough for my students.”

Myth 5

Elementary teachers do not need to understand math deeply.

A grain of truth

Elementary teachers do not need extensive knowledge of secondary mathematics.

The deeper truth

All math teachers need and can gain deep knowledge around the content that they teach.

Myth 5 has consequences…

- Feeling unsure of how to ask probing math questions
- Feeling unsure of which math standards to emphasize
- Feeling unsure of how to respond when a student takes an unusual approach to a math task
- Misinterpreting the cause of a student's misconception
- Not seeing alternatives to accelerating a gifted student
- Feeling uncomfortable working with a gifted student
- Missing teachable moments

What can I do about Myth 5?

- Learn more math *as you teach*: record students' ideas; reflect and discuss with your colleagues; incorporate these things into the work of your PLC.

- Ask for professional development around math content.

- Read Liping Ma's book "Knowing and Teaching Elementary Mathematics."

- Look into "Lesson Study." (Stigler and Hiebert)

Resources:
Stigler and Hiebert, Lesson Study https://files.eric.ed.gov/fulltext/EJ795305.pdf
Liping Ma "Knowing and Teaching Elementary Mathematics"

Think about these statements from teachers and administrators…

- "You must challenge every student in your math class."
- "I just can't find time to work with my small group of gifted kids in math."
- "Both students learn when a gifted math kid helps another student."
- "I need to keep gifted math kids in my class so that there will be some leaders."

Myth 6

Bright math students' needs can be met entirely within mixed-ability classrooms.

A grain of truth

All students can benefit when bright students take part in mixed-ability math classrooms.

The deeper truth

Bright math students also need frequent, focused opportunities to work with others who are thinking at similar levels.

Myth 6 has consequences…

- Classroom conversations fail to stimulate and stretch bright math students out of their comfort zones.
- Teachers feel that, no matter how hard they work, they are shortchanging their bright math students.
- Bright math students have fewer opportunities to collaborate closely with peers.
- Bright math students do not develop perseverance because they rarely test the limits of their abilities.
- Bright math students are unable even to *imagine* their full potential.

What can I do about Myth 6?

- While continuing to differentiate for bright learners in the regular classroom, allocate special time to meet individual needs outside the regular classroom setting.

- Collaborate with grade level teachers to share students.

- Advocate for and support school and district efforts to create appropriate experiences for highly gifted learners.

This article about Jo Boaler describes a typical view in the math education community

MINDSHIFT

Students Share The Downside Of Being Labeled 'Gifted'

https://www.kqed.org/mindshift/49653/students-share-the-downside-of-being-labeled-gifted

A response by Gail Post

psychologist; expert on the psychology of giftedness;
author of the “Gifted Challenges” blog

Let's consider the following:

1. Boaler uses her status as a Stanford math education professor to add authority to an opinion piece about the emotional well-being of gifted students, *presumably a topic outside of her area of expertise.* I don't doubt the sincerity of her concerns or her compassion for these students. But she is not in a position to *diagnose* the cause of their psychological distress; she only can speculate. In fact, other than assigning blame to their gifted designation, no other possible explanation for their unhappiness is considered. Did these students feel pressure from parents or teachers? Were they bullied or isolated from peers? Do they suffer from anxiety or perfectionism? Did they struggle with existential depression and feelings of alienation? Did they have a trauma history? The possibilities are endless.

https://giftedchallenges.blogspot.com/2018/03/no-its-not-time-to-ditch-gifted-label.html

Myth 7

Identifying needs of bright math students is necessarily harmful and elitist.

A grain of truth

Elitism exists in gifted education and has harmful consequences.

The deeper truth

Identifying bright math students and meeting their needs can support *all* students' learning.

Myth 7 has consequences…

- Administrators and legislators hesitate to commit fully to meeting needs of advanced learners.
- Educators underestimate the needs of their strongest math students.
- Teachers and administrators misinterpret behaviors and feelings of bright math learners or their families.
- Parents of bright math students hesitate to advocate for the needs of their children.
- Educators fail to see opportunities to integrate strategies for meeting needs of all learners.

What can we do about Myth 7?

- Have conversations with colleagues and stakeholders. Talk about how identifying bright math students and meeting their needs can *alleviate* rather than cause fixed mindset.

- Identify, acknowledge, and minimize elements of elitism associated with giftedness where you work.

- Address issues of access and equity in identification and programming for gifted math students. Let skeptics know that your are doing this!

Think about these statements…

- “She got really frustrated with that math problem. It must have been too hard for her.
- He lost interest in the problem, so I gave him something different to do.
- He is too focused on math. He needs to be better rounded.”
- “The best kinds of problems are just barely beyond a student’s reach.”
- “I didn’t give that math problem to my kids because even I couldn’t understand it.”

Myth 8

Bright math students often need just a little more challenge.

A grain of truth

Students should work only on math tasks that they can make conceptual sense of.

The deeper truth

Bright math students are usually capable of far more than we ask of them.

We *greatly* underestimate the abilities
of our bright math students!

Implementing *highly* challenging math tasks for
gifted students requires different
approaches to motivation.

Eight Strategies for Motivating Gifted Math Students

1. Let students know what to expect.
2. Redefine success.
3. Praise effort over ability.
4. Focus on process more than answers.
5. Offer emotional support.
6. Offer meaningful responses to written work.
7. Allow students to collaborate.
8. Debrief.

For more information, see 5280math.com/miscellaneous

from *Advanced Common Core Math Explorations: Ratios, Proportions, and Similarity,* by Jerry Burkhart. Prufrock Press, 2016 and at 5280math.com/miscellaneous

Myth 9

Bright students can learn math on their own.

A grain of truth

Many bright students are good at learning certain aspects of math independently.

The deeper truth

Nearly all math students need significant guidance in order to fully develop their potential.

Think about these statements from teachers and others…

- "The math enrichment class is a privilege. If you a*ct out*, you will return to the regular class."
- "Her *work habits* are not good enough for her to be in the advanced math class."
- "You can *buy time* to work on math enrichment by testing out of stuff you already know."
- "It's not fair that the advanced math class gets to do the fun stuff."
- "You may choose whether to do the challenge work in this unit."

Myth 10

Bright math students deserve special opportunities and experiences.

A grain of truth

All math students benefit from having a range of choices and opportunities.

The deeper truth

Experiences that target a student's needs should be treated as neither optional nor special.

Myth 10 has consequences…

- Gifted math students are denied experiences they need.
- Gifted students preferentially receive enriching experiences that would benefit others as well.
- Underachievement is encouraged (allowing gifted students to choose not to challenge themselves).
- Bright students feel that they deserve special treatment due to their abilities.
- Typical students feel left out.
- Achievement is emphasized over effort.

What can we do about Myth 10?

- Change our language. For example, speak of “meeting needs” rather than of “special classes” or “privileges.”
- Teach behavior skills and work habits *within* the context of advanced experiences.
- Speak of gifted students challenging themselves as an *expectation* rather than an “opportunity.”
- Make enriching tasks and higher order thinking skills available to all learners in appropriate contexts.

Imagine…

Math Classrooms

where students explore and discuss deep concepts with peers who support and *stretch* their thinking.

Schools

where *integrated* systems exist to support every math student—struggling to gifted, privileged to disadvantaged.

A World

where adults remember liking their math classes and *take for granted* their ability to understand and do math.

Beliefs drive decisions…

We can make our classrooms, our schools, and our world look like this by choosing beliefs that reflect our best understanding of how people learn mathematics.

MATH 5280

challenging math
for adventurous learners

Classroom Resources
Professional Development
Consulting

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