THE ROLE AND IMPORTANCE OF THE STANDARDS FOR MATHEMATICAL PRACTICE

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THEMES FOR TODAY

- Introduce a comprehensive model of college and career readiness.
- Show the relationship between the model and the Standards for Mathematical Practice.
- Explain a novice-expert continuum for understanding the Standards for Mathematical Practice across grade levels and subject areas.
- Show how schools can use the Standards to make connections across subject areas and grade levels.

WHAT WAS YOUR JOURNEY TO COLLEGE READINESS LIKE?
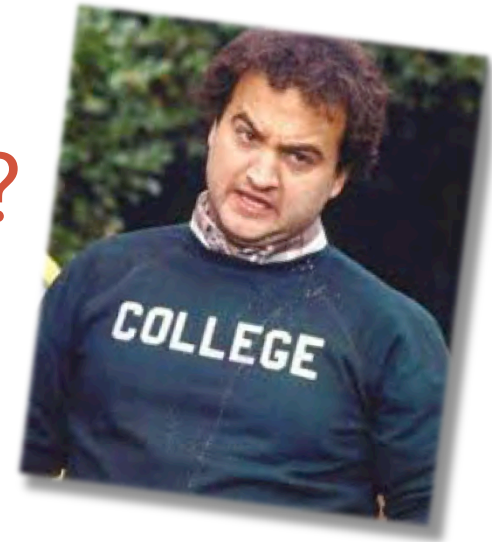
- In what ways were you ready for college?
- In what ways weren't you ready?

MUCH OF TODAY'S CONTENT IS DRAWN FROM:

DAVID T. CONLEY

Getting Ready for
COLLEGE,
CAREERS,
and the
COMMON
CORE

What Every Educator Needs to Know
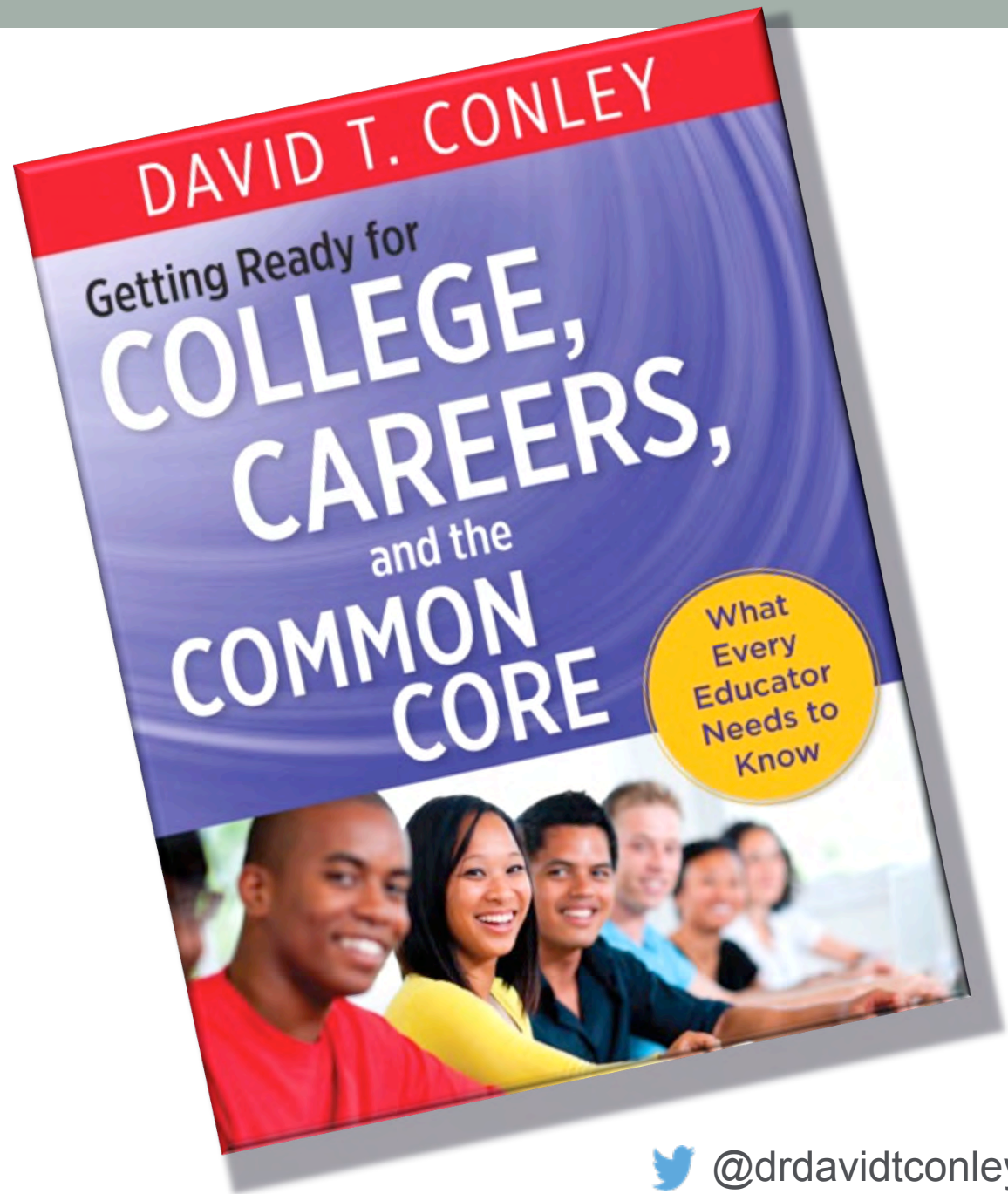
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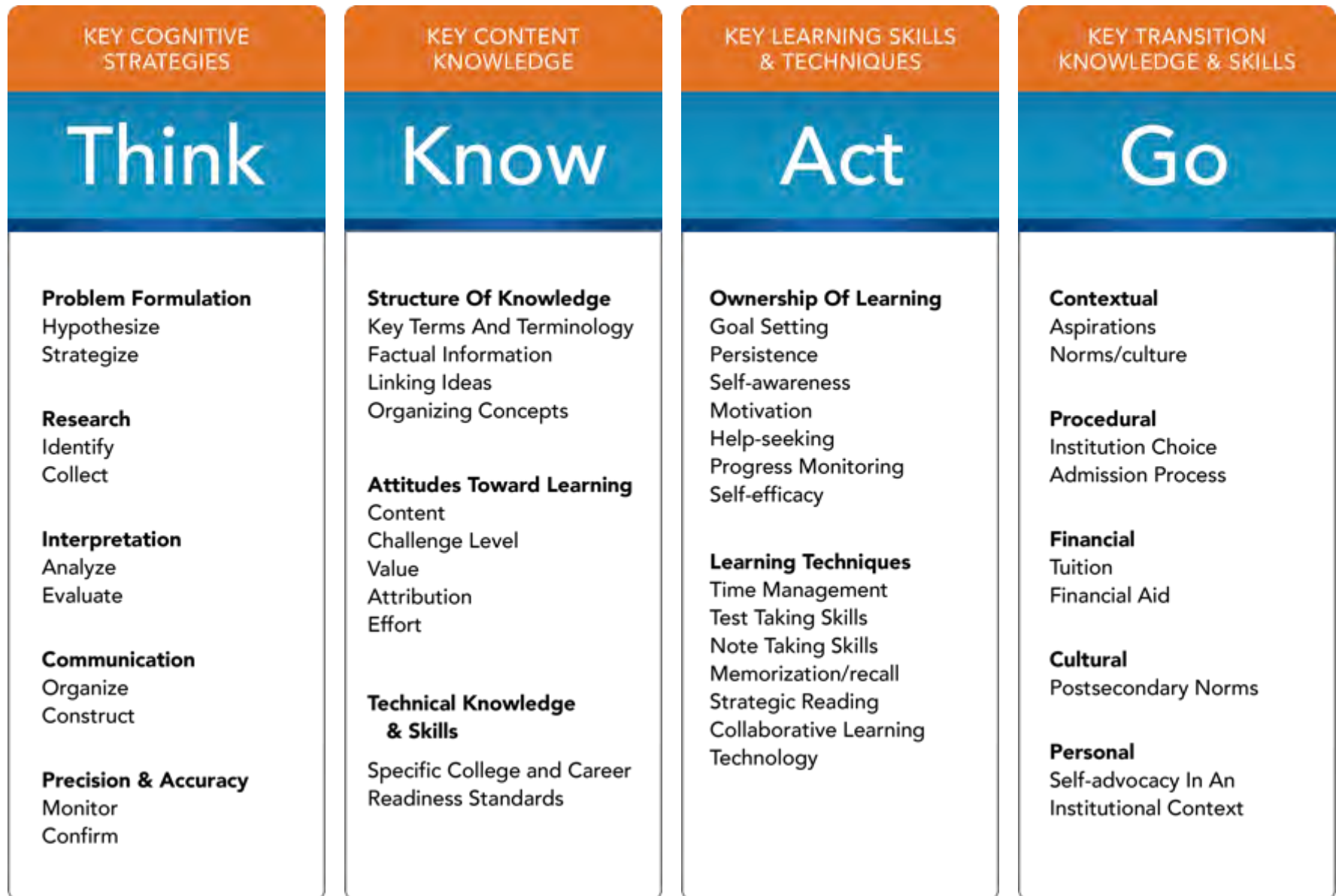# WHAT DOES IT MEAN TO BE COLLEGE AND CAREER READY?

MY DEFINITION OF
COLLEGE AND CAREER READY

- A college and career ready student possesses the content knowledge and skills necessary to be successful in postsecondary education or training programs that lead to a family sustaining career.

- Not every student needs exactly the same content knowledge, but all students must be adaptive learners who can acquire specialized knowledge and skills when called on to do so.

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THE FOUR KEYS TO COLLEGE AND CAREER READINESS

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THE FOUR KEYS TO COLLEGE AND CAREER READINESS

KEY COGNITIVE STRATEGIES	KEY CONTENT KNOWLEDGE	KEY LEARNING SKILLS & TECHNIQUES	KEY TRANSITION KNOWLEDGE & SKILLS
Think	**Know**	**Act**	**Go**

Problem Formulation Hypothesize Strategize **Research** Identify Collect **Interpretation** Analyze Evaluate **Communication** Organize Construct **Precision & Accuracy** Monitor Confirm	**Structure Of Knowledge** Key Terms And Terminology Factual Information Linking Ideas Organizing Concepts **Attitudes Toward Learning** Content Challenge Level Value Attribution Effort **Technical Knowledge & Skills** Specific College and Career Readiness Standards	**Ownership Of Learning** Goal Setting Persistence Self-awareness Motivation Help-seeking Progress Monitoring Self-efficacy **Learning Techniques** Time Management Test Taking Skills Note Taking Skills Memorization/recall Strategic Reading Collaborative Learning Technology	**Contextual** Aspirations Norms/culture **Procedural** Institution Choice Admission Process **Financial** Tuition Financial Aid **Cultural** Postsecondary Norms **Personal** Self-advocacy In An Institutional Context

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THE FOUR KEYS AND THE STANDARDS FOR MATHEMATICAL PRACTICE

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KEY COGNITIVE STRATEGIES

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"SOME ASSEMBLY REQUIRED"
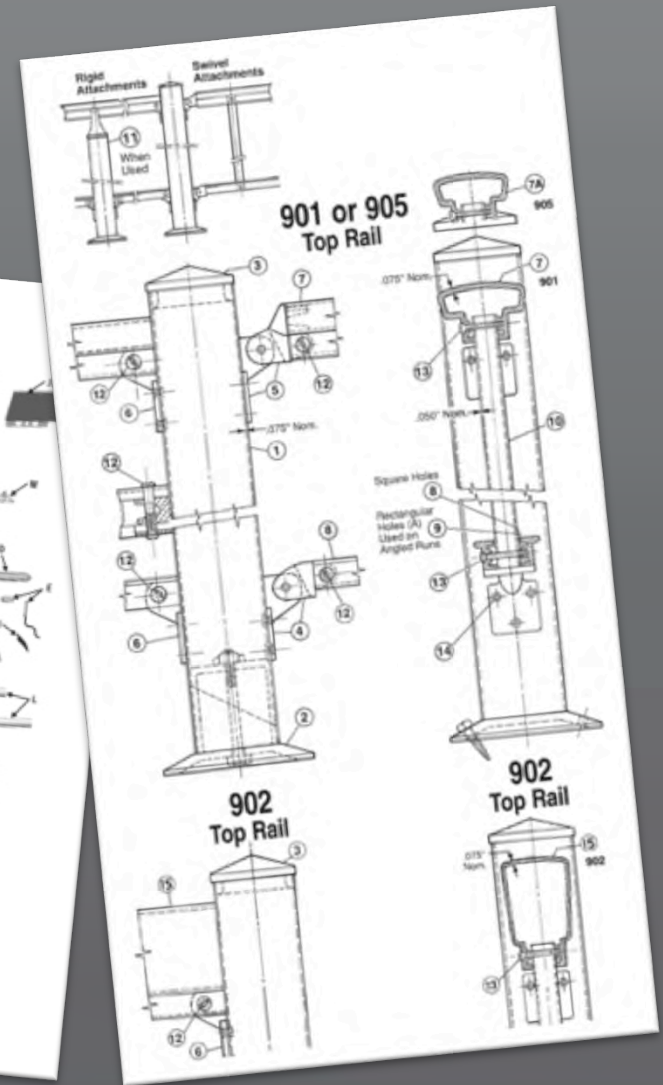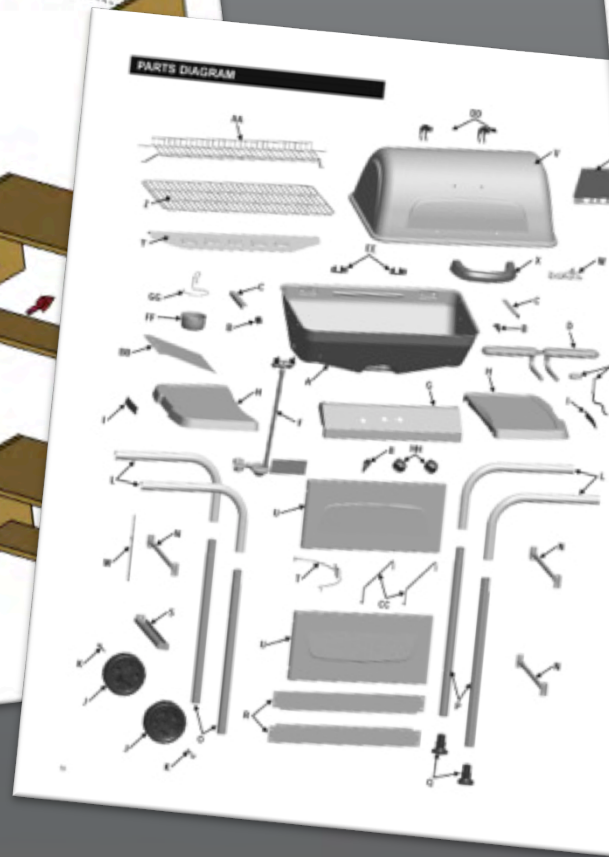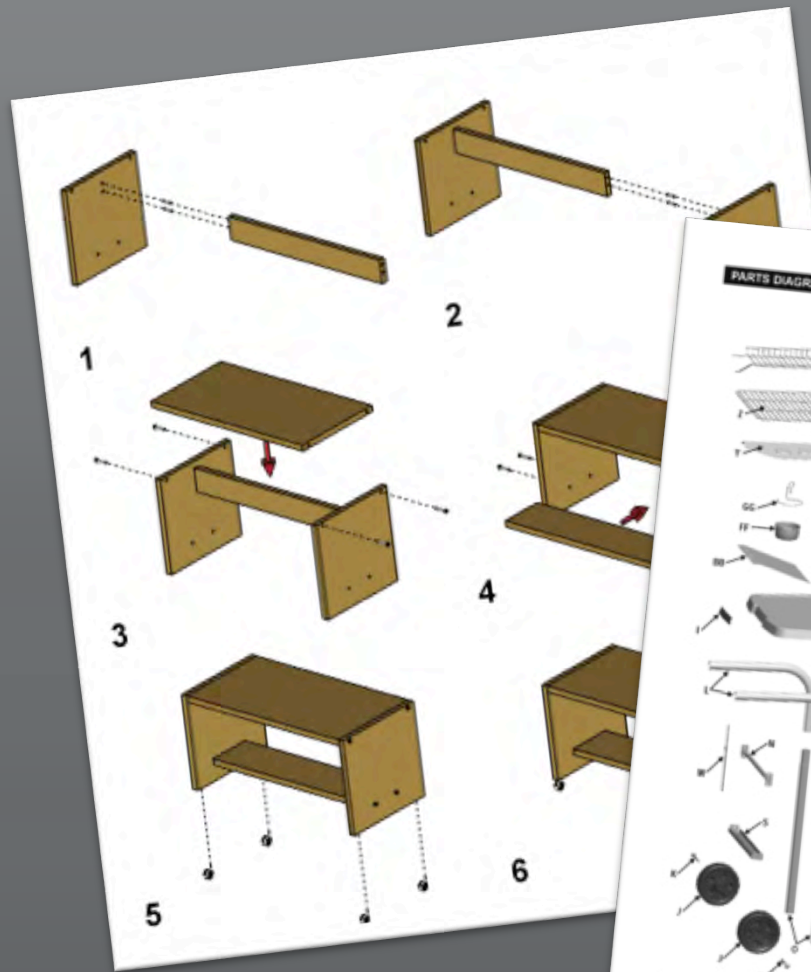
COGNITIVE STRATEGIES FOR DEEPER LEARNING

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THE STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
   - Find meaning in problems
   - Look for entry points
   - Analyze, conjecture and plan solution pathways
   - Monitor and adjust
   - Verify answers
   - Ask themselves the question: "Does this make sense?"

2. Reason abstractly and quantitatively.
   - Make sense of quantities and their relationships in problems
   - Learn to contextualize and decontextualize
   - Create coherent representations of problems

3. Construct viable arguments and critique the reasoning of others.
   - Understand and use information to construct arguments
   - Make and explore the truth of conjectures
   - Recognize and use counterexamples
   - Justify conclusions and respond to arguments of others

4. Model with Mathematics.
   - Apply mathematics to problems in everyday life
   - Make assumptions and approximations
   - Identify quantities in a practical situation
   - Interpret results in the context of the situation and reflect on whether the results make sense

5. Use appropriate tools strategically.
   - Consider the available tools when solving problems
   - Are familiar with tools appropriate for their grade or course (pencil and paper, concrete models, ruler, protractor, calculator, spreadsheet, computer programs, digital content located on a website, and other technological tools)
   - Make sound decisions of which tools might be helpful

6. Attend to precision.
   - Communicate precisely to others
   - Use clear definitions, state the meaning of symbols and are careful about specifying units of measure and labeling axes
   - Calculate accurately and efficiently

7. Look for and make use of structure.
   - Discern patterns and structures
   - Can step back for an overview and shift perspective
   - See complicated things as single objects or as being composed of several objects

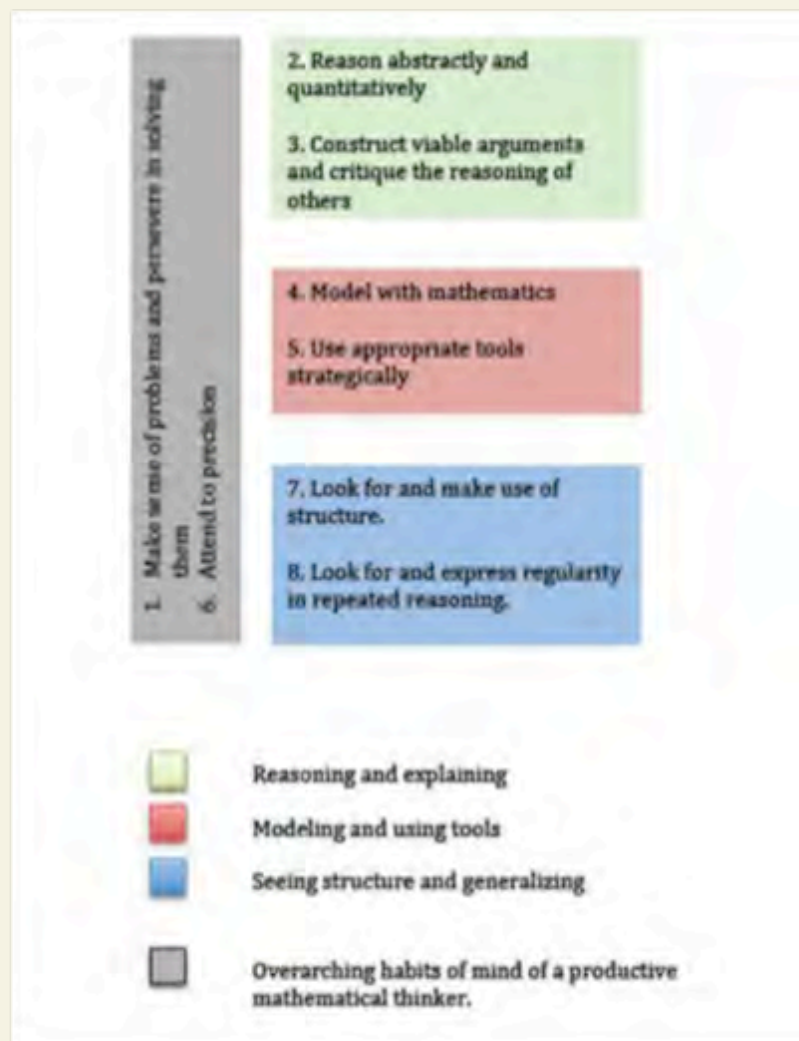8. Look for and express regularity in repeated reasoning.
   - Notice if calculations are repeated and look both for general methods and shortcuts
   - In solving problems, maintain oversight of the process while attending to detail
   - Evaluate the reasonableness of their immediate results

CROSSWALK FROM KEY COGNITIVE STRATEGIES TO THE STANDARDS FOR MATH PRACTICE

Problem Formulation	
• Hypothesize	1, 2
• Strategize	1, 5, 2
Research	
• Identify	3
• Collect	3
Interpretation	
• Analyze	4, 8
• Synthesize	7
Communication	
• Organize	3, 4
• Construct	3, 5, 6
Precision/Accuracy	
• Monitor	6, 8
• Confirm	6

The SMP and the KCS

- The SMP have their own coherence.

- The KCS offer another way to integrate all the elements of the SMP.

- The KCS also add information gathering to the SMP.

- The KCS model applies to all content areas, which helps bridge the SMP to other subject areas.

1. Make sense of problems and persevere in solving them
6. Attend to precision

2. Reason abstractly and quantitatively

3. Construct viable arguments and critique the reasoning of others

4. Model with mathematics

5. Use appropriate tools strategically

7. Look for and make use of structure.

8. Look for and express regularity in repeated reasoning.

Reasoning and explaining

Modeling and using tools

Seeing structure and generalizing

Overarching habits of mind of a productive mathematical thinker.

EXAMPLE VERBS: HYPOTHESIZE

- Predict
- Guess
- Extrapolate
- Interpolate
- Generalize
- Observe
- Generate

EXAMPLE VERBS: STRATEGIZE

- Task analyze
- Plan
- Brainstorm
- Examine alternatives
- Optimize
- Assemble
- Order

EXAMPLE VERBS: ANALYZE

- Categorize
- Order
- Group
- Graph
- Prioritize

- Outline
- Recognize patterns
- Spot outliers
- Identify trends
- Determine objectivity
- Identify errors in logic
- Be aware of misuse of statistics, graphs, charts

A "GOOD" ASSIGNMENT

Examining Natural Disasters

We have discussed and read about how natural disasters affect people and society.
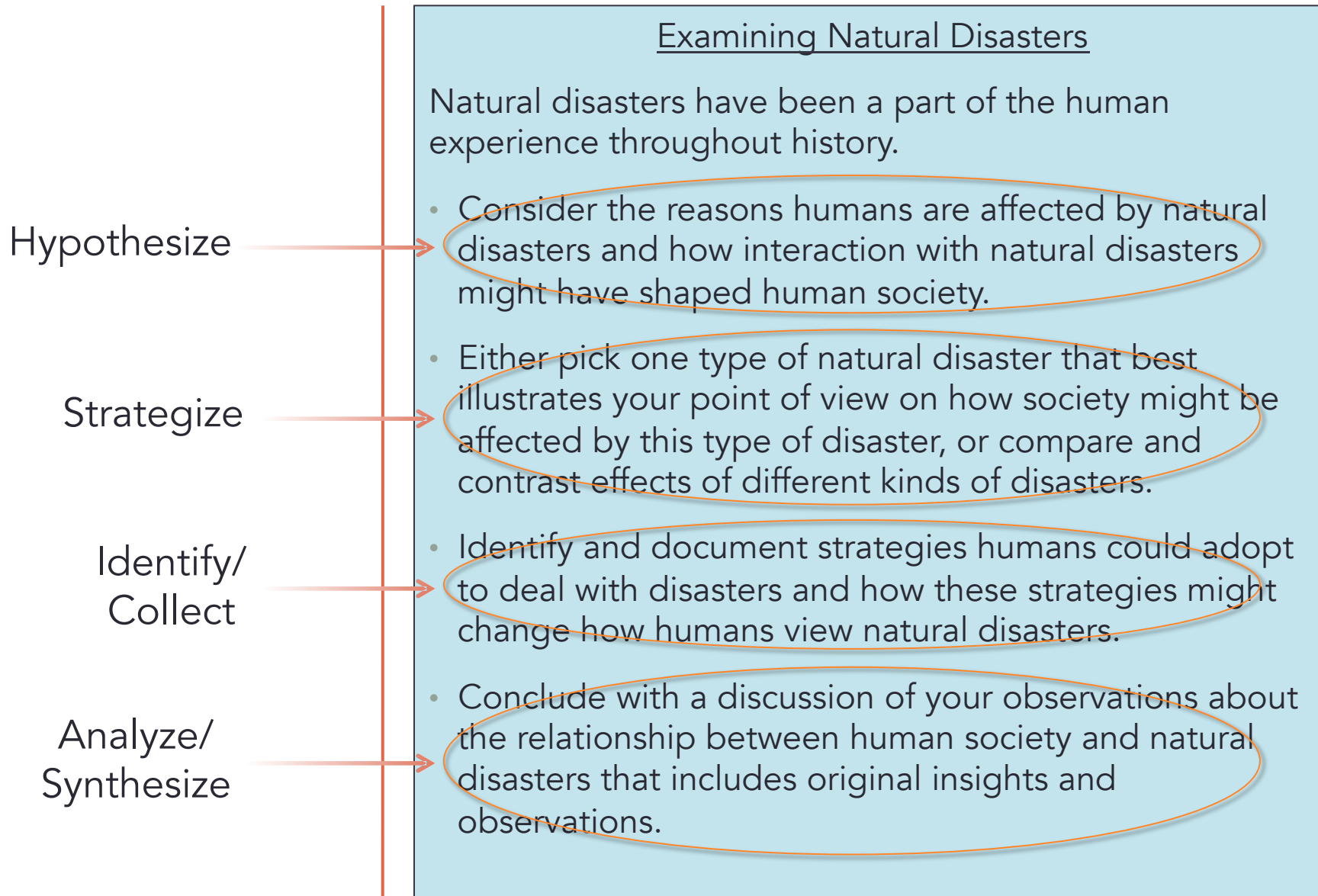
- Now, describe the effects floods have on civilization.

- Be sure to describe the ways floods disrupt the economy and people's lives.

- List three steps that could be taken to lessen the effects of floods in the future.

- Tell which of these three steps you think will benefit the most people.

THE SAME TOPIC WITH STRATEGIC THINKING

Examining Natural Disasters

Natural disasters have been a part of the human experience throughout history.

- Consider the reasons humans are affected by natural disasters and how interaction with natural disasters might have shaped human society.

- Either pick one type of natural disaster that best illustrates your point of view on how society might be affected by this type of disaster, or compare and contrast effects of different kinds of disasters.

- Identify and document strategies humans could adopt to deal with disasters and how these strategies might change how humans view natural disasters.

- Conclude with a discussion of your observations about the relationship between human society and natural disasters that includes original insights and observations.

Examining Natural Disasters

Natural disasters have been a part of the human experience throughout history.

Hypothesize

- Consider the reasons humans are affected by natural disasters and how interaction with natural disasters might have shaped human society.

Strategize

- Either pick one type of natural disaster that best illustrates your point of view on how society might be affected by this type of disaster, or compare and contrast effects of different kinds of disasters.

Identify/ Collect

- Identify and document strategies humans could adopt to deal with disasters and how these strategies might change how humans view natural disasters.

Analyze/ Synthesize

- Conclude with a discussion of your observations about the relationship between human society and natural disasters that includes original insights and observations.

Credit Card Payments, Modeling a Functional Relationship

Sample #2

Have you ever wondered how credit cards work? Well I did a experiment on how credit cards are more damaging than gaining. I was learning the cost related to credit cards. When I made the purchase with the credit card I had to pay the minimum payment every month to the company. I also saw how long it would take for me to pay off my expensive item. Before I started anything I held one main question. What is the importance of interest?

Problem Formulation

On my search of different credit cards to purchase my coat that is $100.00. I came across the HSBC platinum master card. This credit card had a lot of useful information for me. The interest percentage rate was based upon your credit worthiness. It ranged from $12.99 - $19.99. I pretended to be a beginner with having no credit, therefore my rate was $19.99. The late fee each month was $35. The minimum interest charge was $1.00. I noticed there was valuable information and information that I didn't need.

Research

So my expensive item was a $100.00 coat. So by purchasing the coat I used the HSBC platinum mastercard. Before I started this experiment I had a prediction. to pay off my credit card I thought it would only take me 4 years by paying my minimum payment each month. So I set up a table. I made a column for each of the following, Months, Balance, minimum payment, interest, End of month Balance, and difference. So my first months Balance was $100.00. My minimum payment was $2.00 because 100x.02=2. So then I had to figure out how much my interest would be for my first month. I took 100 x .1999 ÷ 12. My answer was 1.665. so I rounded it to $1.67. 100-2= 98, 98+1.67=$99.67. My End of month

Balance would be $99.67. I continued this table until I noticed a pattern. So when I got to my 12th month I noticed that each month after paying my 2% and paying my interest I only paid .33¢. My End of month balance decreased constantly by $.33. I chose to make a table because it was easier to see all my calculations and it kept me organized.

8. Look for and express regularity.

By the end of all of my calc I came to owing $0.62 after 24 years and 3 months. After all of the 24 years the interest I paid was $242.67. while the cost of my item was $100.00. Furthermore when it came down to it my actual cost was $342.67. I feel the Good Credit Cards are the ones with out the annual fee because thats just extra money adding on as the years went by. But then again I feel there is No Good and Bad credit cards because in the end all they care about is taking all of your money. I would recommend that you wouldn't get any credit cards because over time, paying the minimum payment every month it tripled the cost of my item.

In this experiment I only paid for a item that was $100.00 on my credit card. After 25 years of paying off my $100.00, including interest my coast coast $342.67. I learned if its not cash then dont use a credit card because it is not there to help you. Credit cards are there to cheat you out your money. My Question in the beginning was what is the importance of interest and now I know. The importance of interest is over time it adds more and more money. My Item was $100.00 and after 25 years the interest made my item cost more than tripple the original Price.

Months	balance	Minimum payment	Interest	month balance	difference
1	100	2	1.67	99.66	-.34¢
2	99.66	1.99	1.66	99.34	-.38¢
3	99.34	1.98	1.65	99.01	-.33¢
4	99.01	1.98	1.65	98.68	-.33¢
5	98.68	1.97	1.64	98.35	-.33¢
6	98.35	1.97	1.64	98.02	-.33¢
7	98.02	1.96	1.63	97.69	-.33¢
8	97.69	1.95	1.62	97.37	-.33¢
9	97.37	1.95	1.62	97.02	-.33¢
10	97.02	1.94	1.61	96.69	-.33¢
11	96.69	1.94	1.61	96.36	-.33¢
12	96.36	1.93	1.60	96.03	-.33¢

After I did the 12 months I noticed it deducted $3.96. I did 3.96 • 24 and I Got $95.04. 96.03 - 95.04 and I Got $.99. 99 ÷ 33 = 3. So it would take 24 years and 3 months.

$y = 100 - 3.96x$

$(100 - 3.96x) \cdot 1999$

$= 19.80$

$= 18.41$

$= 17.62$

$= 16.82$

$= 16.03$

$= 15.24$

$= 14.45$

$= 13.66$

$= 12.87$

$= 12.07$

$= 11.28$

$= 10.49$

$= 9.70$

$= 8.91$

$= 8.11$

$= 7.32$

$= 6.53$

$= 5.74$

$= 4.95$

$= 4.16$

$= 3.37$

$= 2.57$

$= 1.78$

$= .99$

yearly interest each month

Out of 24 years the yearly interest I paid all together was $242.67

$+\ \dfrac{242.67\ -\ 24\ yrs\ interest}{100\quad 00\ -\ cost\ of\ item}$

342.67

actual cost

Actual cost

KEY CONTENT

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STRUCTURE OF KNOWLEDGE

- The SMP focus on the overarching nature of math as:

  - an abstract symbol system to understand the natural world.

  - a tool to undertake systematic empirical analyses in other subject areas.

  - a logic system for accepting or rejecting statements as true.

KEY CONTENT

- The challenge is to focus on key content in the Common Core and go deep in those areas.
  - Students need conceptual understanding across a wide range of topics.
  - They need in-depth mastery of a subset of all topics.
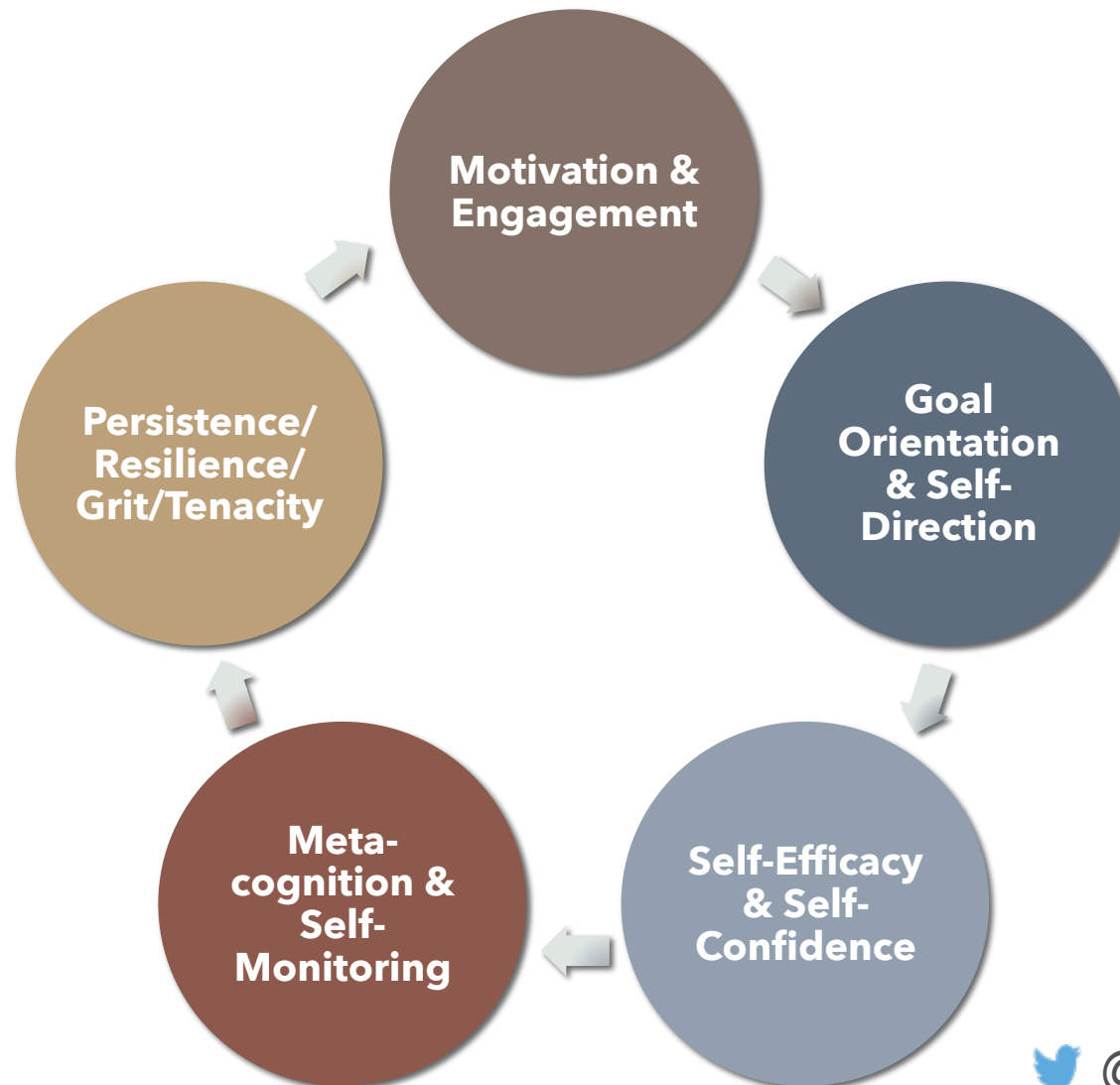 - The SMP can be a way to explore topics conceptually and gain depth on core topics.

ATTITUDE TOWARD KNOWLEDGE

- The SMP can help students:
  - develop academic mindset
  - connect math to their interests and aspirations
  - make clear the value of the content being taught
  - make math truly challenging for all students
  - provide depth as well as breadth

KEY LEARNING SKILLS & TECHNIQUES

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THE SMP SHOULD HELP PROMOTE OWNERSHIP OF LEARNING

Motivation & Engagement

Goal Orientation & Self-Direction

Self-Efficacy & Self-Confidence

Meta-cognition & Self-Monitoring

Persistence/ Resilience/ Grit/Tenacity

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KEY TRANSITION KNOWLEDGE & SKILLS

THE SMP CAN HELP STUDENTS PREPARE FOR COLLEGE BY:

- promoting analytic thinking

- introducing greater complexity into mathematical tasks

- creating problems with more than one right answer

- applying mathematics in other subjects, much like in college courses

- allowing for more project-based learning

MOVING FROM NOVICE TO EXPERT AS A MATHEMATICAL THINKER AND LEARNER

WHAT MAKES A NOVICE DIFFERENT FROM AN EXPERT?

✓ Did you ever teach someone to drive?

✓ How does a novice driver behave differently than an experienced driver?

#4KeystoCCR

Novice-Expert Continuum

Emerging Expert Thinker

Accomplished Thinker

Competent Thinker

Emerging Thinker

Accomplished Novice

Novice Thinker

Emerging Novice Thinker

Getting all students to the "emerging" level by the end of high school is sufficiently challenging.

NOVICE VS. COMPETENT THINKERS

As thinkers become more mathematically proficient, they demonstrate more or greater:

+ Insight

+ Efficiency

+ Idea Generation

+ Concept Formation

+ Integration

+ Solution Seeking

- The SMP are a way to develop expertise but also to gauge student progression toward expert.

- Student performance on tasks built around the SMP can elicit a range of responses.

EMERGING COMPETENT: shows some evidence of applying subject-area rules with insight beyond literal application; shows efficiency in completion of task but with several areas that could be improved; shows consistent evidence of proper use of conventional ideas with some variations on conventional ideas; has an acceptable solution strategy

ACCOMPLISHED NOVICE: follows subject-area rules correctly and in a way that demonstrates limited insight into the subject area; has areas of efficiency along with significant inefficiencies; shows consistent evidence of proper use of conventional ideas; approaches an acceptable solution strategy

NOVICE: follows subject-area rules literally; completes task inefficiently; shows some evidence of use of conventional ideas; presents findings without using concepts significantly; does not integrate or connect elements; falls short of a satisfactory solution strategy.

EMERGING NOVICE: follows wrong rules or no rules at all; is highly inefficient, redundant, confused; shows little evidence of proper use of conventional ideas; does not incorporate concepts and/or does not explain findings coherently; shows almost no integration or collection among elements; fails to show a solution strategy.

FIRST FOUR LEVELS

	Problem-sensing	Reason abstractly	Construct & critique reasoning	Model with math	Use tools strategic-ally	Attend to precision	Look for structure	Look for regularity
Competent	Find meaning in problems; look for entry points; analyze, conjecture and plan solution pathways							
Emerging Competent								
Novice	Complete problems without grasping meaning; solve when provided entry points; follow given solution pathway							
Emerging Novice								

THE ASSESSMENT CHALLENGE

DEEPER UNDERSTAINDG CAN ONLY BE GAUGED THROUGH A RANGE OF ASSESSMENTS

"Parts and Pieces" → "The Big Picture"

Standardized multiple-choice tests of basic skills	Multiple-choice and open-ended items	Standardized performance tasks	Teacher-developed performance tasks	Project-centered tasks
• *Traditional on-demand tests*	• *Common Core tests (SBAC/ PARCC)*	• *ThinkReady Assessment System (EPIC)* • *New Standards Project* • *AP*	• *Ohio* • *New York* • *Coalition of Essential Schools* • *Many charters*	• *Envision Schools* • *NY Performance Standards Consortium* • *IB Extended Essay*

WHO OWNS THE MATH PRACTICES STANDARDS?

THE STANDARDS FOR MATH PRACTICE CANNOT BE TAUGHT ONLY IN MATH CLASSES

- The SMP lend themselves to application in other subjects
  - Science:
    - Problem formulation
    - Modeling
    - Using tools to solve problems
    - Precision
    - Structure
  - Social studies:
    - Construct arguments
    - Model
    - Structure
    - Regularity in repeated patterns

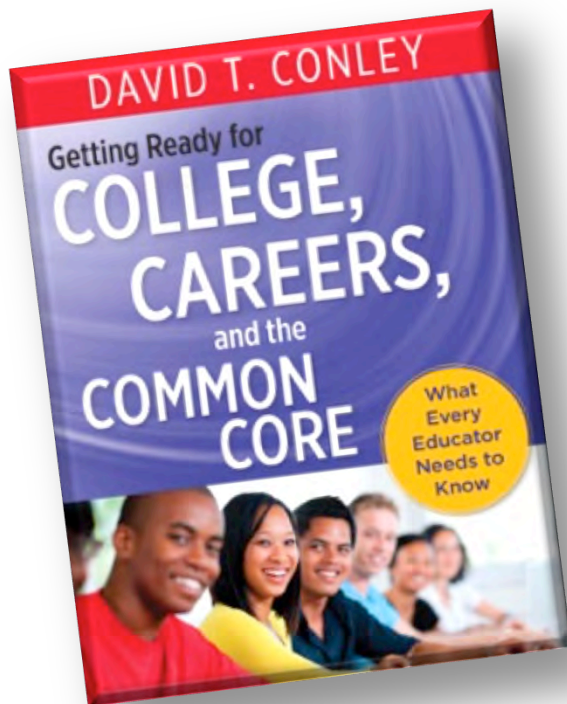# HOW WELL DO FACULTY IN YOUR SCHOOL COLLABORATE TO INTEGRATE THE SMP IN AN INTERDISCIPLINARY WAY?

- Thematic topics for the year or term?
- Joint unit planning?
- Division of labor between content teaching and application?
- Project-based assessments that span classrooms?
- Adoption of the SMP across disciplines?

A COUPLE OF QUICK EXAMPLES

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