
# TI-Nspire + CCSS = students and teachers learning together

# Linda Griffith

- Linda Griffith earned a BSE and MSE from the University of Central Arkansas. She received a Ph.D. in mathematics education from The University of Texas at Austin.
- After teaching at the West Side School District in Greers Ferry, AR, Dr. Griffith served as
  - instructor at Austin Community College in Austin, Texas
  - assistant instructor at The University of Texas at Austin
  - assistant professor at The University of Alabama at Birmingham
  - and is currently a professor of Mathematics at the University of Central Arkansas (UCA) in Conway, Arkansas.
- Dr. Griffith will serve as the Southern Regional Representative for the National Council of Supervisors of Mathematics beginning in April of 2013. She has served as an officer in the Arkansas Council of Teachers of Mathematics. She is a national instructor for the Teachers Teaching with Technology program.
- She currently is reassigned to work with the Arkansas Department of Education on the comprehensive professional development plan for implementation of the Common Core State Standards for Mathematics.

## Ray Barton

- Ray Barton teaches mathematics at Olympus High School in Salt Lake City. He is interested in technology as a tool for facilitating student engagement in the mathematical practices.  He conducts workshops for teachers and enjoys discovering how other teachers assist students in learning and practicing mathematics.  Ray has been a $T^3$ Instructor since the beginning of the organization.

# Jennifer Wilson

- Jennifer is in her 20th year of teaching mathematics at Northwest Rankin High School, where she uses TI-Nspire CAS™ and the TI-Nspire™ Navigator™ System every day both to teach her students and learn from them. She enjoys writing mathematics curricula using technology and working with educators to incorporate good questioning techniques, engaging problems, and formative assessment in their classrooms. Jennifer recently received the Presidential Award for Excellence in Mathematics and Science Teaching.

# How students should work: Standards for Mathematical Practice

- Make sense of problems and persevere in solving them
- Reason abstractly and quantitatively
- Construct viable arguments and critique the reasoning of others
- Model with mathematics
- Use appropriate tools strategically
- Attend to precision
- Look for and make use of structure
- Look for and express regularity in repeated reasoning

CCSS, 2010

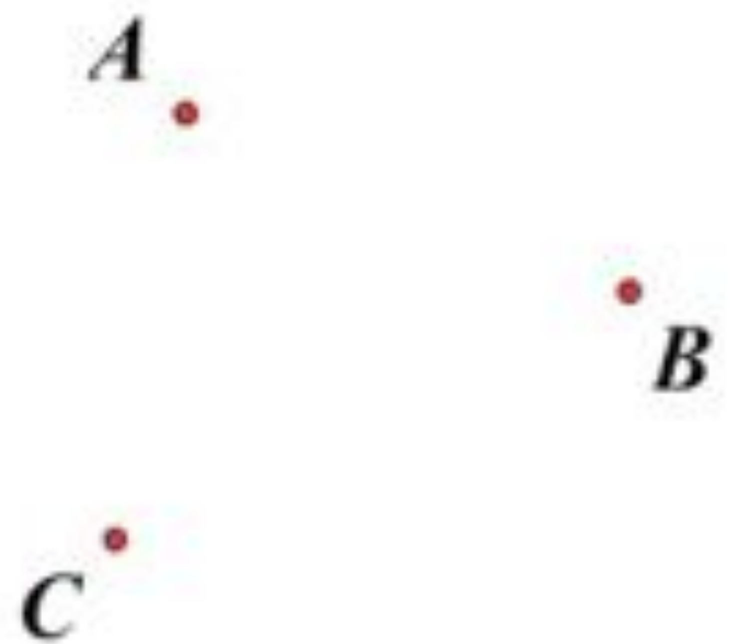
True or False?

1. $(x+2)^2 = x^2+4$

2. $\dfrac{x+3}{x} = 3$

3. If $y=\ln(\pi)$, then $y'=\dfrac{1}{\pi}$.

You have been asked to place a fire hydrant so that it is an equal distance from three locations indicated on the following map.



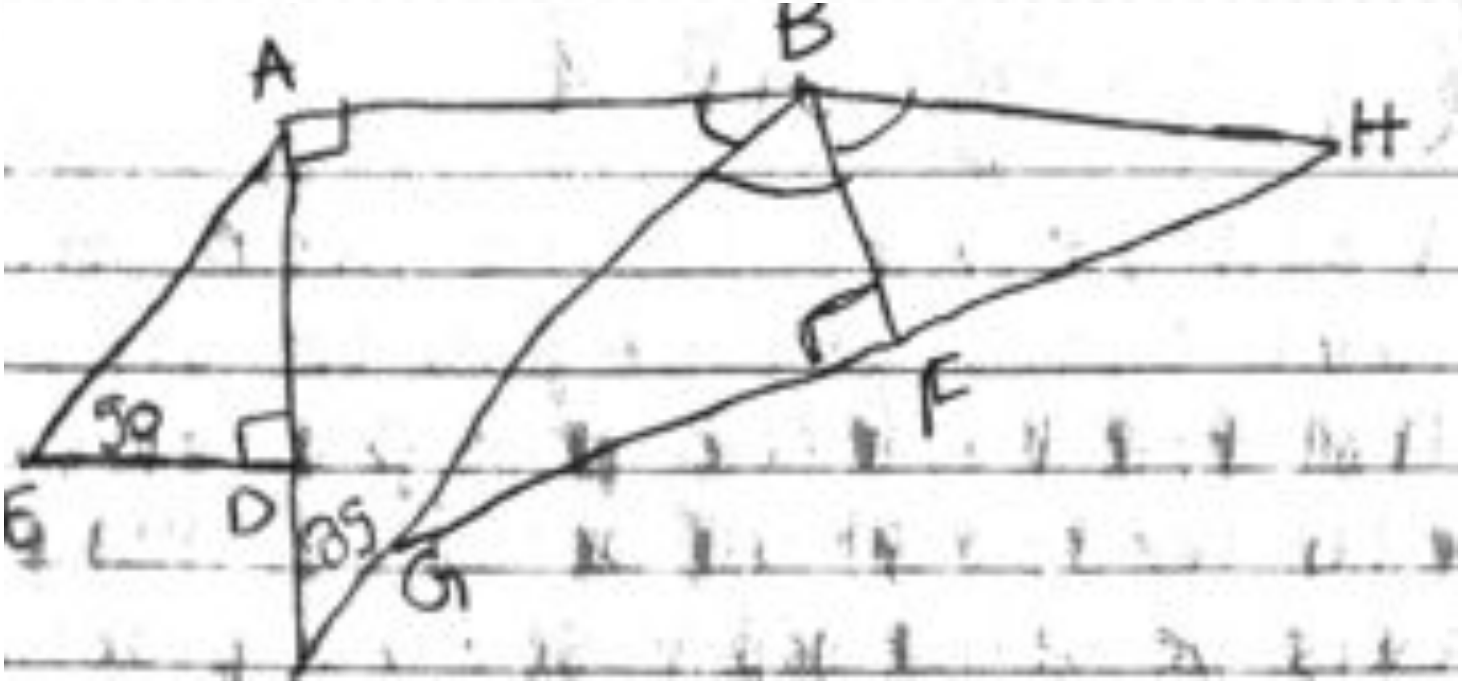
# Make sense of problems and persevere in solving them

I wanted to give up so bad, but I didn't.
I kept working, and even though I was one
of the last people to finish I still was proud of
myself. I am learning not to give up and to
keep going even though I can't figure it out

1. reflected over x-axis - [illegible]
2. reflected over y-axis - [illegible]
3. rotated 180° - [illegible]
4. reflected over y=x - [illegible]
5. reflected over y=-x - [illegible]
6. rotated -90° - [illegible]
7. rotated 90° - [illegible]


CCSS, 2010

# Make sense of problems and persevere in solving them

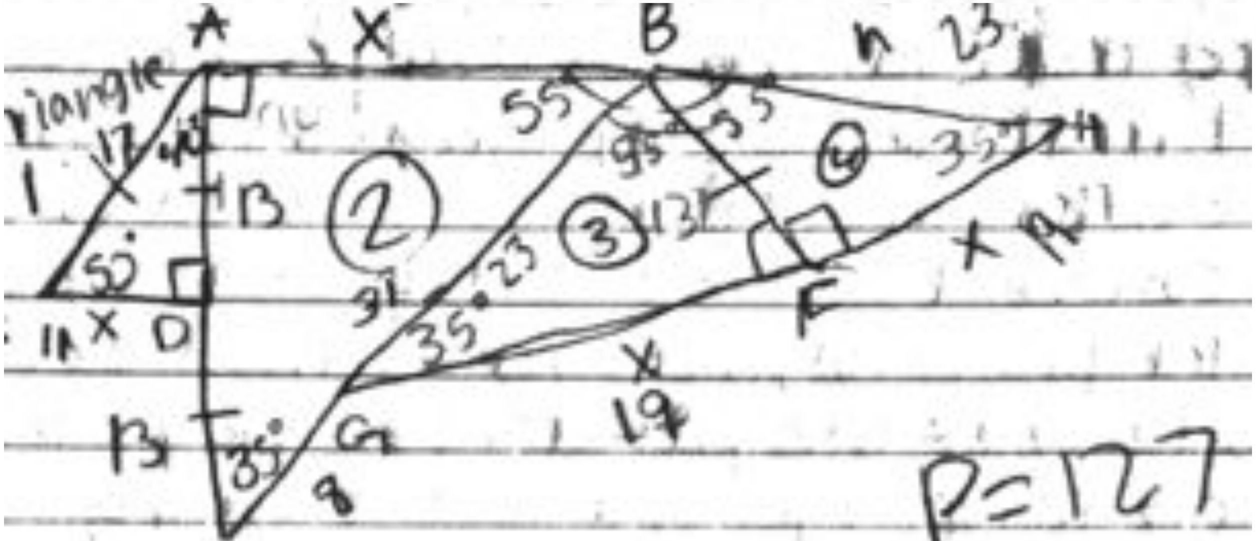







CCSS, 2010

# Make sense of problems and persevere in solving them




I started by finding the second leg of triangle 1. I used the formula tan(50) = $\frac{13}{x}$ & I got 11 for that. Then I did the pythagoream theorm & got 17. Next I found the second leg of triangle 2. For this I did tan(35) = $\frac{x}{26}$ which is 18 and again





CCSS, 2010

# Model with mathematics

This quarter I had the opportunity to model with mathematics. I go cycling every weekend, but I always wondered how exactly the sensor on my tire was able to figure out that I rode twenty-eight miles. I knew it has something to do with how many times the sensor went around in a circle and the circumference of my tire. Now, because we learned about linear distance, I know that the computer calculates it by taking the diameter of my wheel and finding the circumference of my tire and multiplying that by how many times the sensor goes around the tire. So, since the tire of my bike has a diameter of 28 inches that means that it has a circumference of 28π. Theoretically, if the sensor goes around 4,000 times, I would travel on my bike about 5.5 miles.



CCSS, 2010

# Model with mathematics

One mathematical practice that I realized was being used was modeling with mathematics. During one of the first class periods, we were asked to place a fire hydrant equidistant from three points (in this case, three buildings). Without knowing it, some of us were creating perpendicular bisectors. We learned that when using perpendicular bisectors, you're able to find the point which is equidistant from the vertices (the circumcenter).

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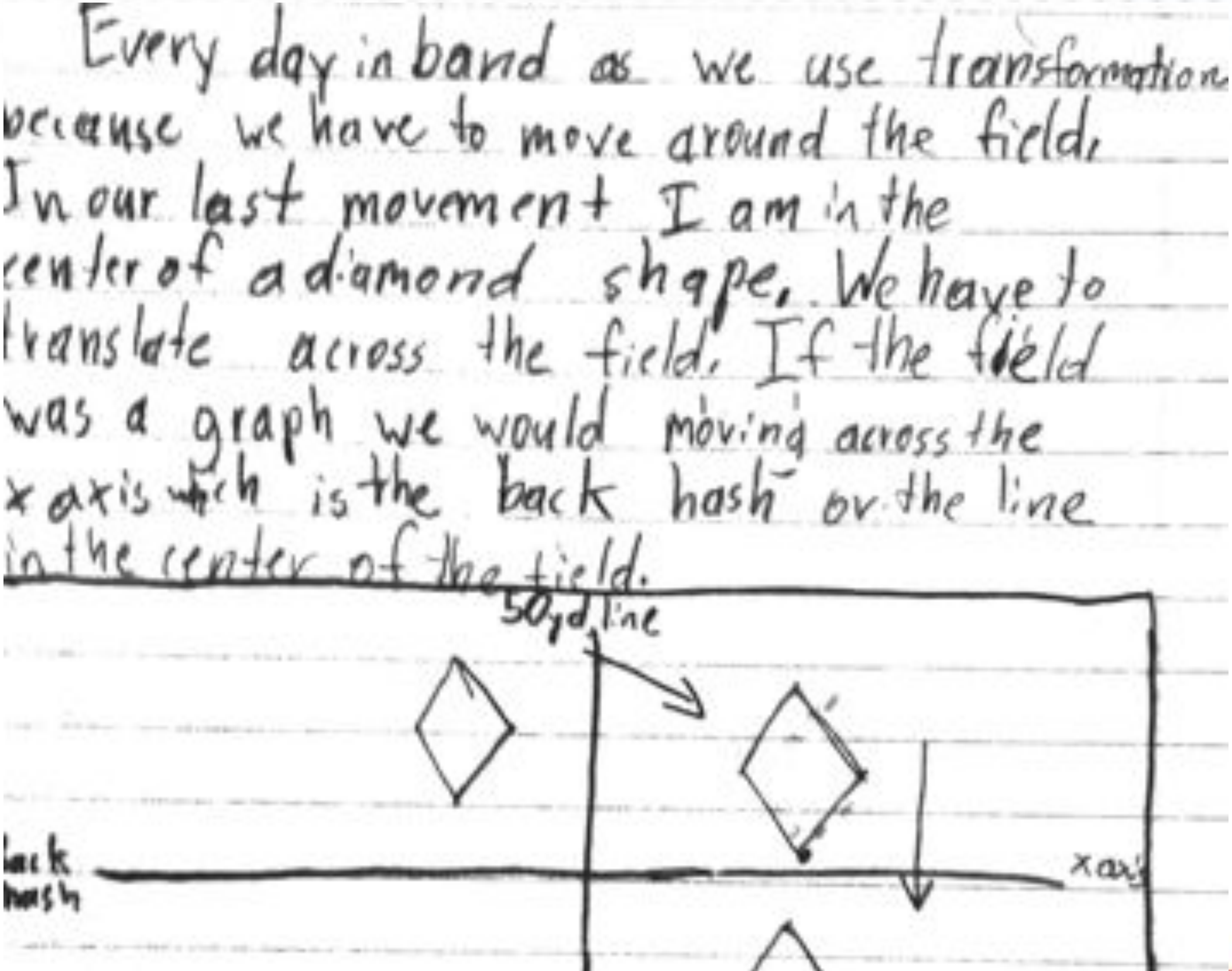
# Model with mathematics


Every day in band as we use transformation because we have to move around the field. In our last movement I am in the center of a diamond shape. We have to translate across the field. If the field was a graph we would moving across the x axis which is the back hash or the line in the center of the field.

# Attend to precision

Attending to precision was very important in this unit because one negative sign could very easily give you a wrong answer. For example, the problems $-\csc(150°)$ and $\csc^{-1}(150°)$ are totally different problems. In my head, when I think of inverse cosine, my mind says negative cosine even though I know very well that I mean inverse. My ignorance of precision lead to confusion among my table, but I am slowly learning to pay more attention to my words. Saying things, thingys, and "whatchamacallit" are not acceptable anymore.

CCSS, 2010

# Attend to precision

"The pitcher's mound on a regulation softball field is 46 feet from home plate. The distance between the bases is 60 feet. How far from third base is the pitcher's mound? Give your answer to the nearest foot."

Being an avid baseball fan, I took it upon myself to solve this problem by myself. While the rest of my table was taking the easy way out by simply using Law of Cosines, I (for some strange reason) thought that it would be easier to use the Pythagorean theorem several times to find the answer.

This covers a few journal topics. This is an example of Make Sense of Math Problems and Persevere in Solving Them. I drew a diagram of the field and used many patterns of pythag. I also checked my answer with my peers, who solved it differently than I did, and got the correct answer. This example is also Model with Mathematics because it applied to the real world by using a baseball field.





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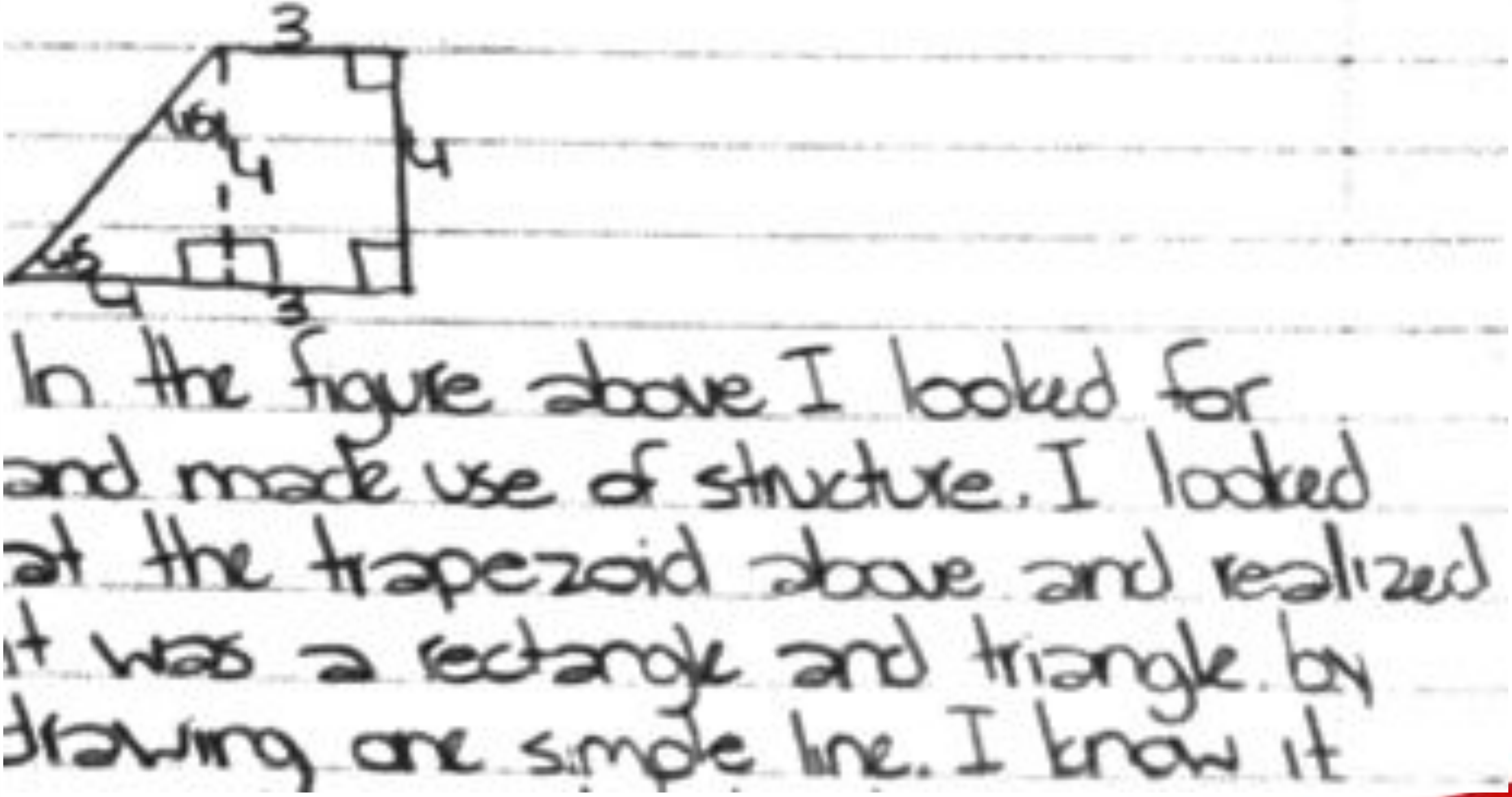
# Look for and make use of structure

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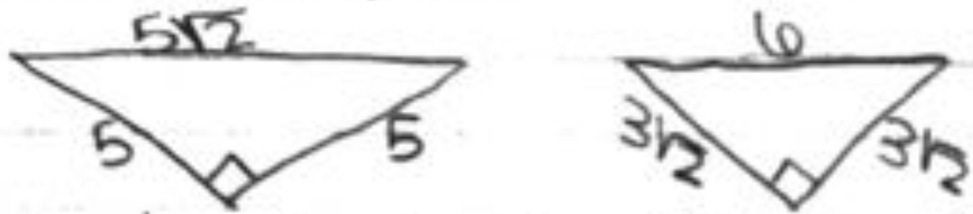
# Look for regularity in repeated reasoning

same way. The √2 of the hypotenuse will always be in the answer although it may not be seen like √2. Here are examples:




The triangle to the left has √2 shown in the answer but the triangle to the right has √2 in the answer because 3√2·√2 is not in lowest forms. I looked for regularity in repeated reasoning and found an interesting answer.



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## Construct viable arguments and critique the reasoning of others

In math class, this is probably the most used mathematical practice we use. In Mrs. Wilson's math class, she always gives us the oppurtunity to explain how we got an answer. For instance, when we finish bellringers, if someone has a qustion about a problem, Mrs. Wilson is always looking for a student that understands the problem to explain it. By doing this, it is clear to see how a fellow classmate acheived the correct answer once he or she is finished, Mrs. Wilson will ask if anyone got the correct answer, but worked it a different way. By seeing the

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## How students should work: Standards for Mathematical Practice

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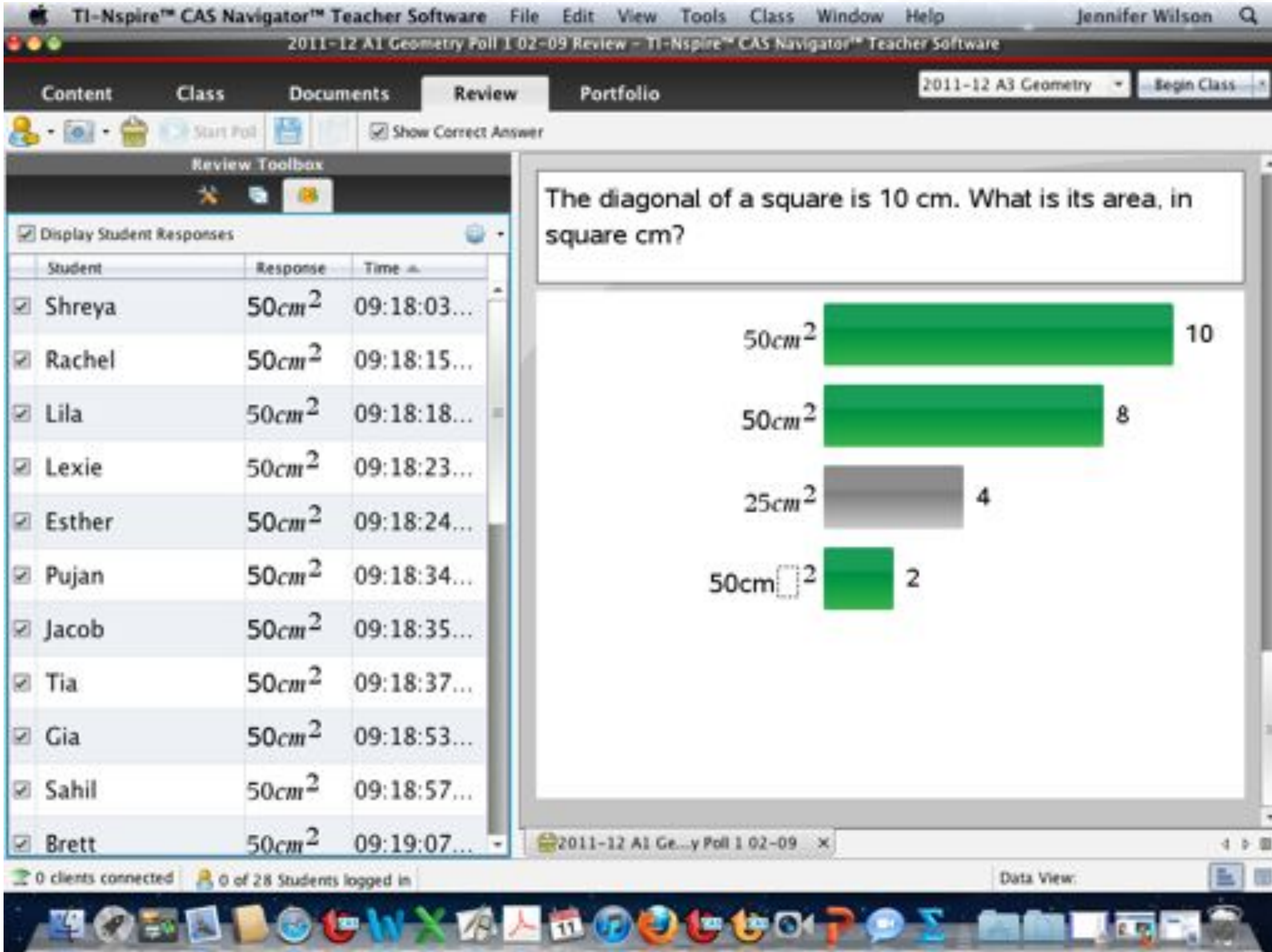
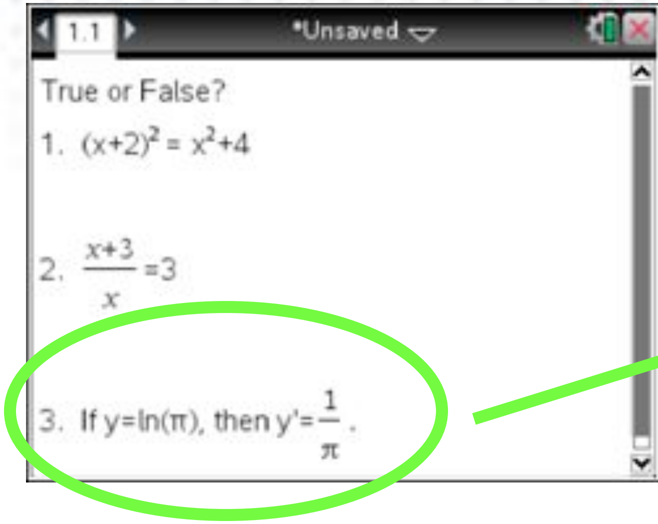
CCSS, 2010

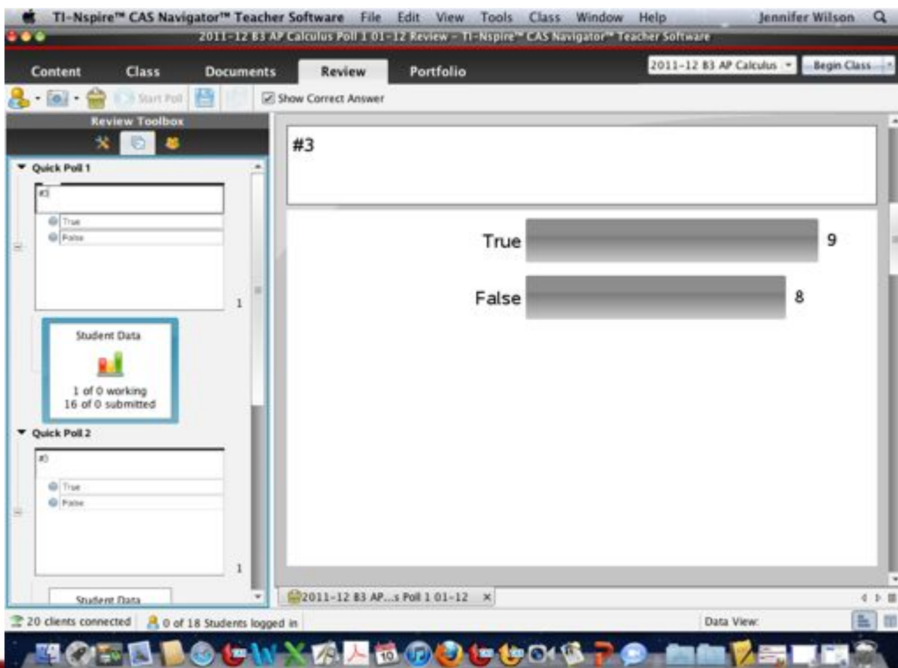
# What information do you see that might be useful in a discussion?



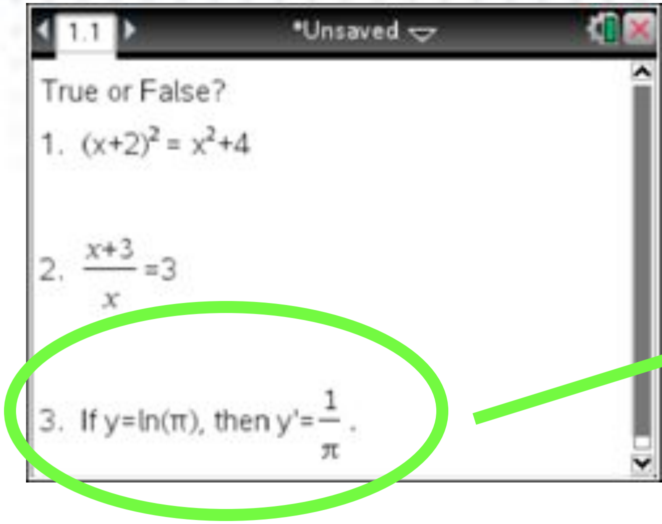



If y= ln(π), then y’ = 1/π

Nearly half correct

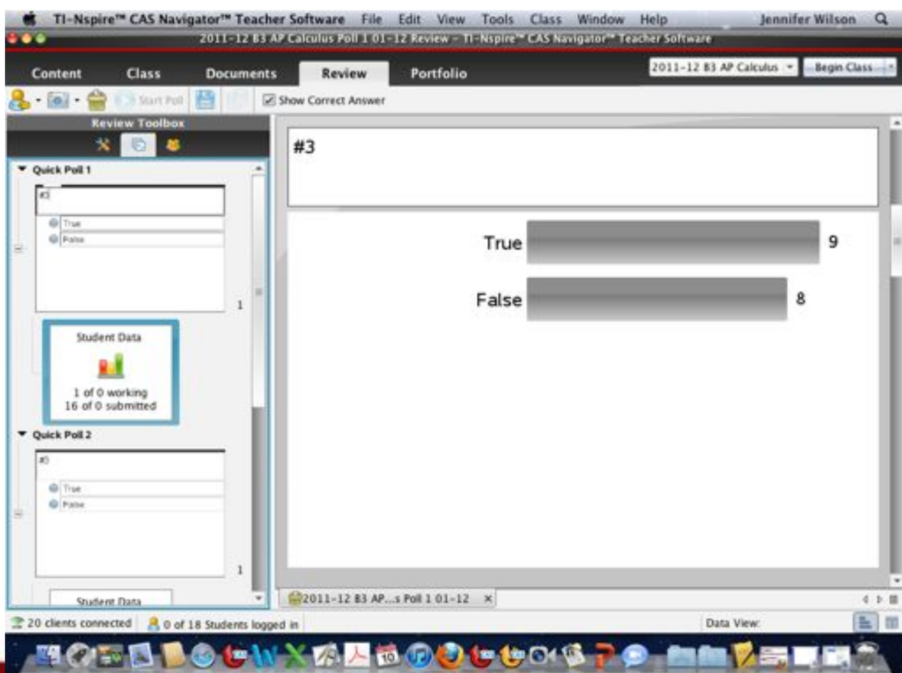



Now what?

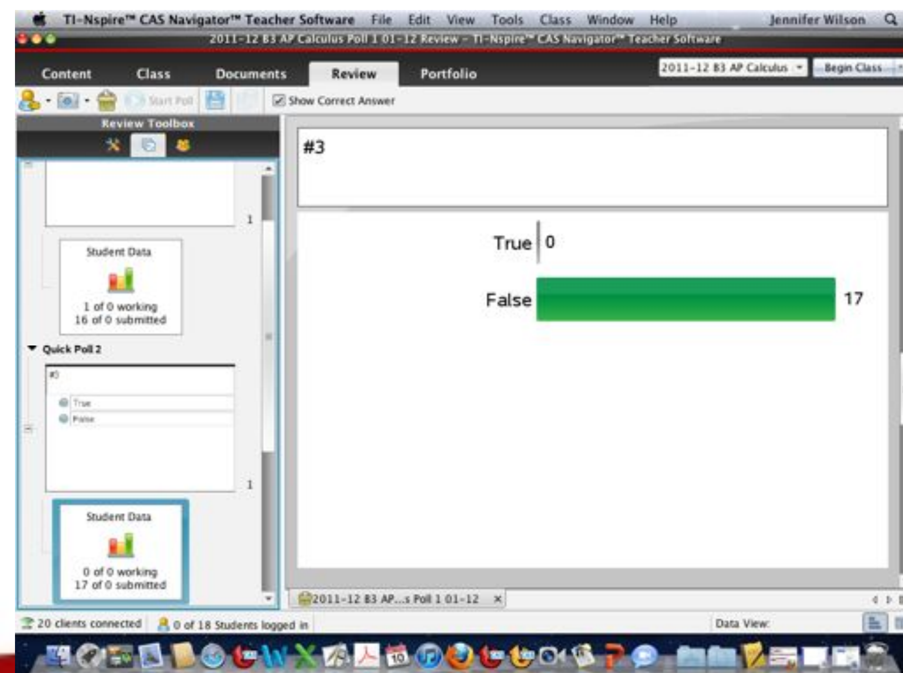



If y= ln(π), then y’ = 1/π

Nearly half correct



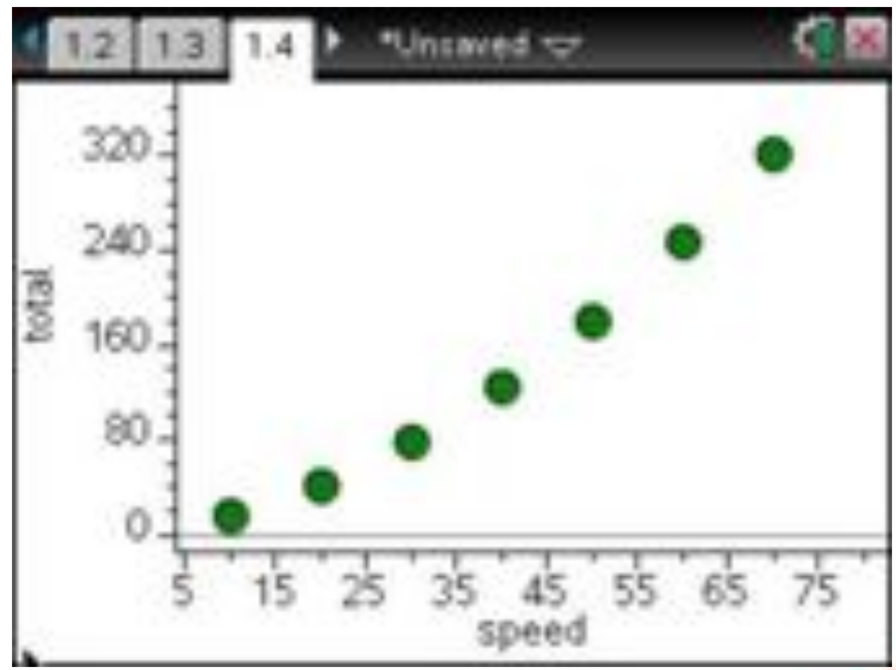

Convince someone



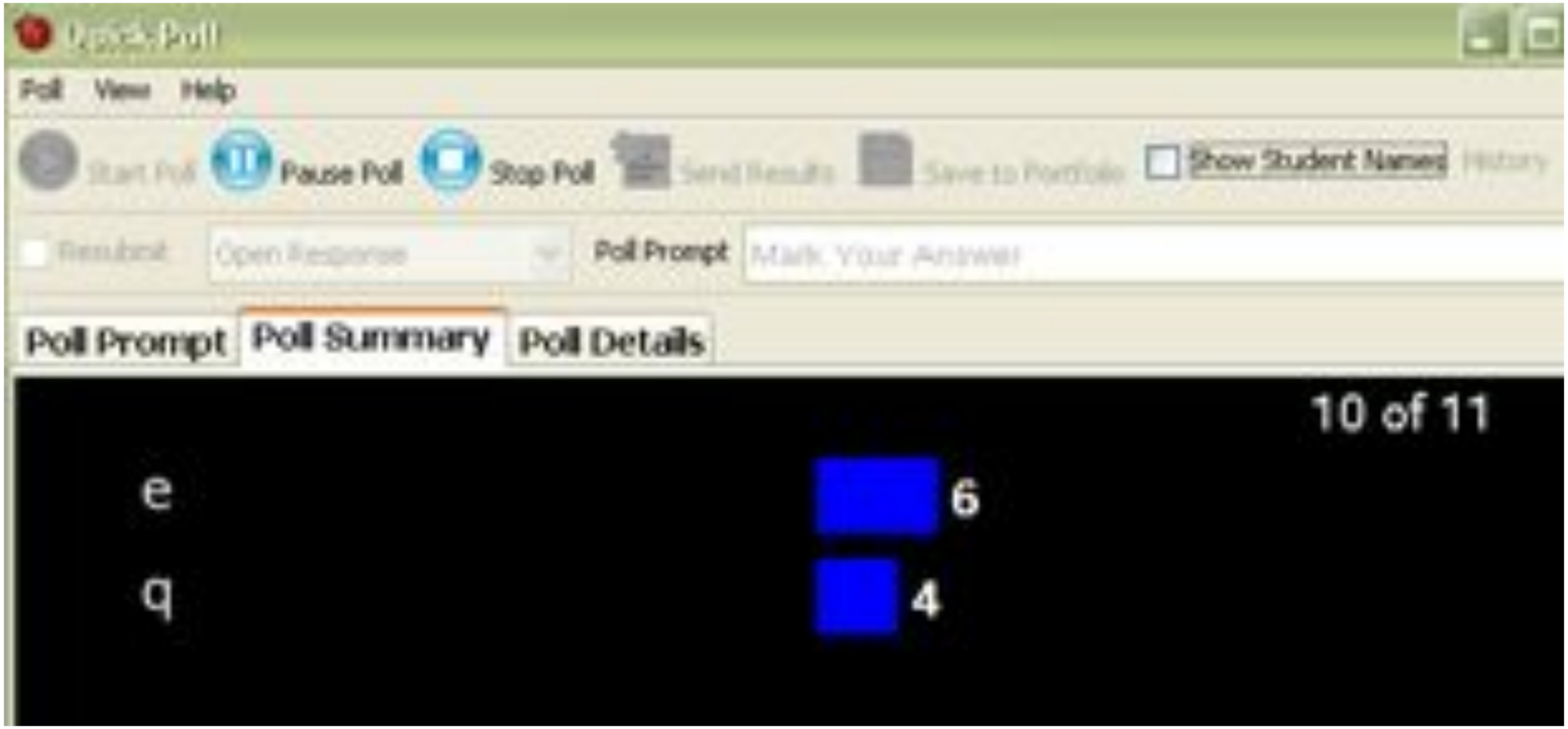
# What pattern does this data follow?

From *Experiments in Doing* by Jill Gough

| speed | react | brake | total |
|---|---|---|---|
| 10 | 11 | 5 | 16 |
| 20 | 22 | 20 | 42 |
| 30 | 33 | 45 | 78 |
| 40 | 44 | 80. | 124. |
| 50 | 55 | 125. | 180. |



# Quick poll results.  Now what?



New and MUCH more interesting questions are now possible.

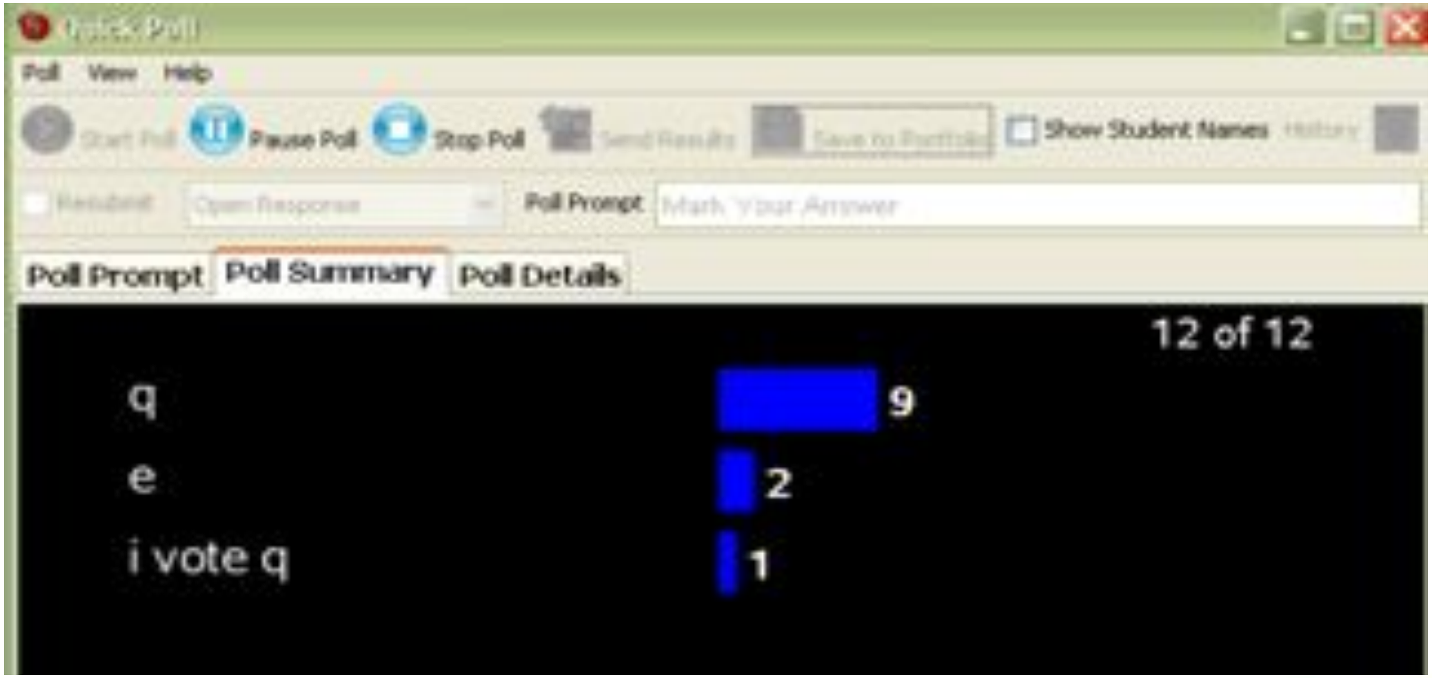
1. Is the majority always right?

2. Can we listen to an opposing view and try to understand their reasoning?

3. Can each side make a reasonable argument for why they made their choice?

4. Are you willing to consider that the other side might be right?

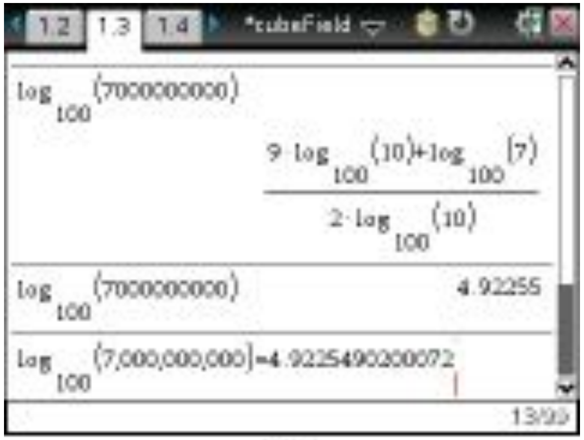
The minority view, quadratic functions, explained first. Then a member of the majority party raised her hand and said “I voted exponential, but I can now give another reason why it is, in fact, quadratic. Is that okay?” WOW! We stopped and voted again.



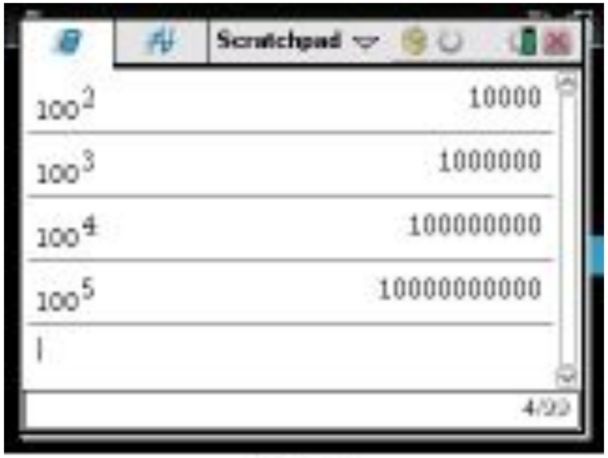
# Six Degrees of Separation

If you had 100 friends and each friend had 100 friends and so on… what could be the maximum degree of separation between you and anyone in the world?

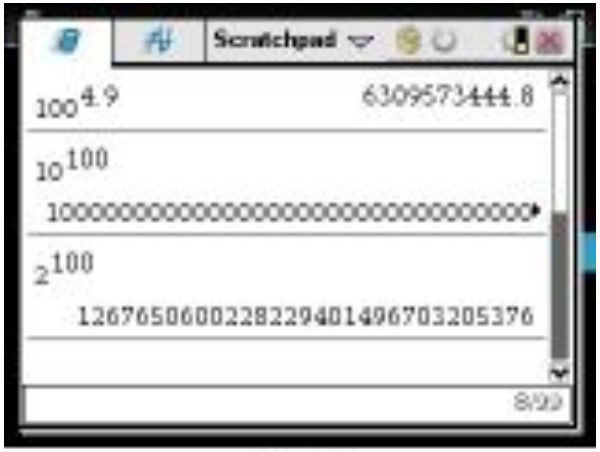
# In what sequence should the following screens be discussed in class?  Why did you choose that sequence?



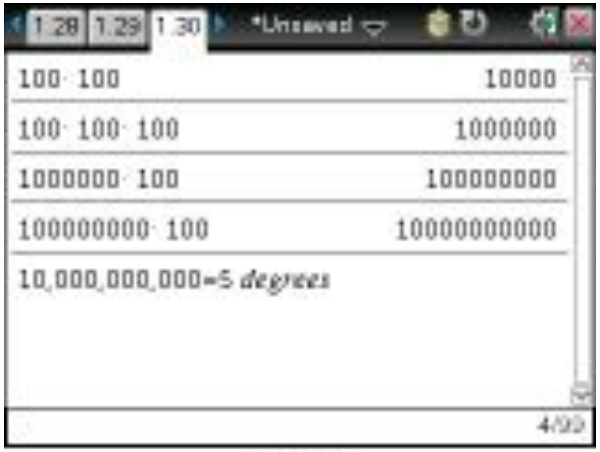

JOHN




JAROM

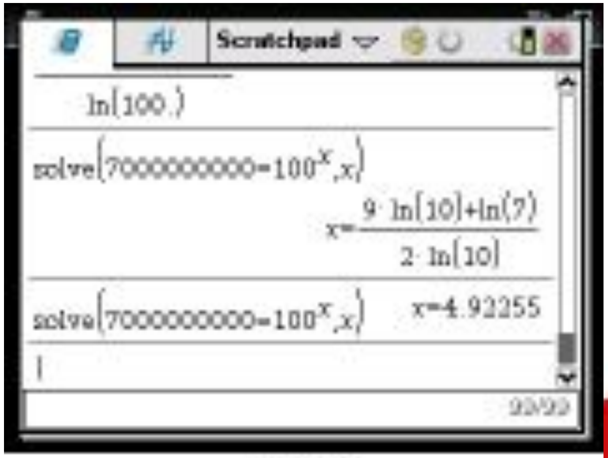



BENJAMIN




CONNELLY


ADAM




KALYAN

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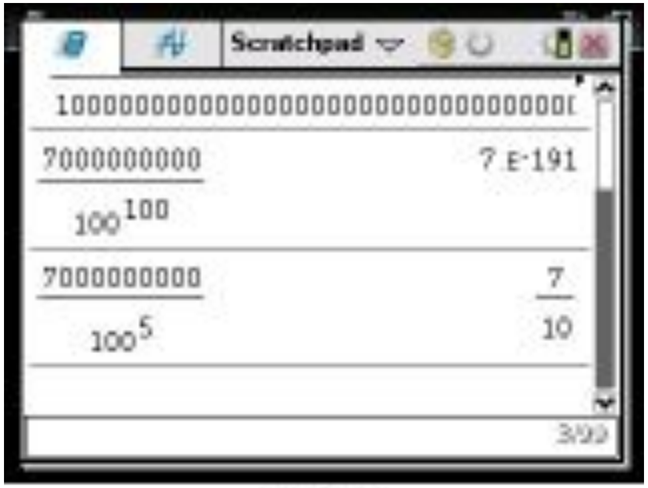
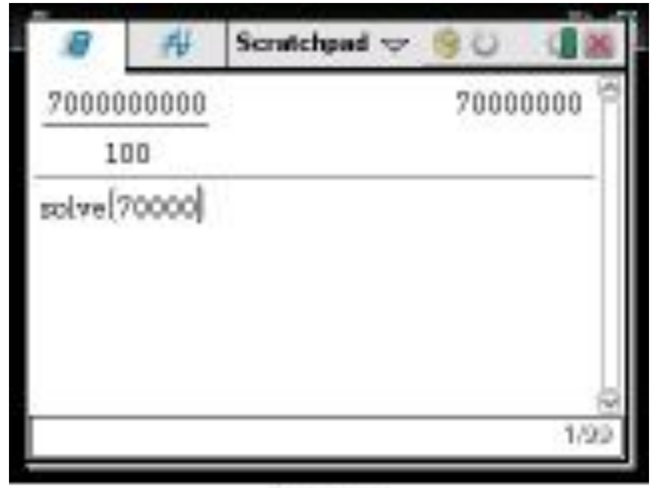
# What discussions might arise from the following wrong responses?




ELIZABETH




CHELSEA

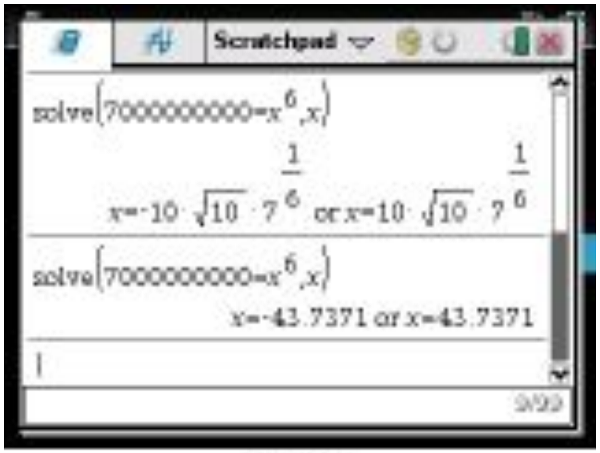

MELISSA


BENJAMIN

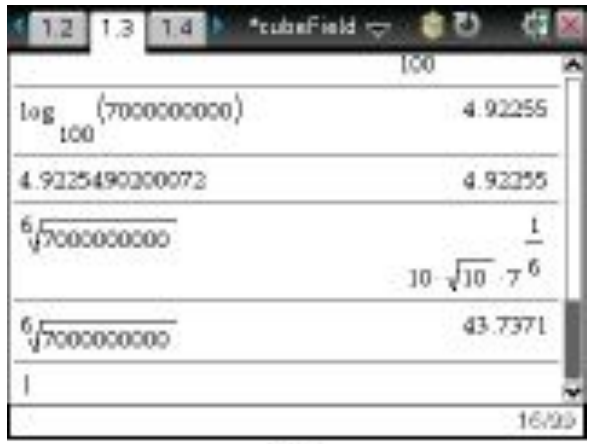
# Six Degrees of Separation

How many friends would each person need under these assumptions in order to have a maximum of six degrees of separation?

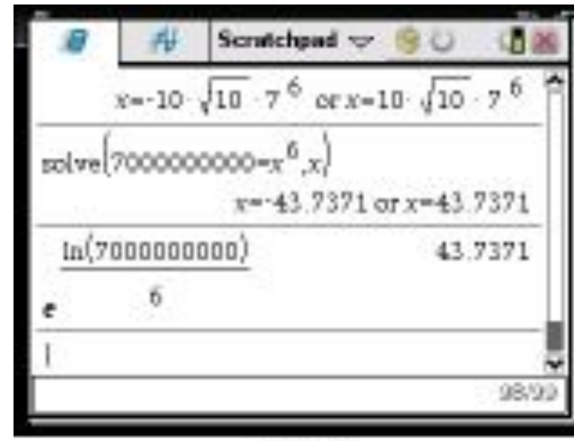
# What discussions might arise from the following student work? How might the sequence influence the discussion?



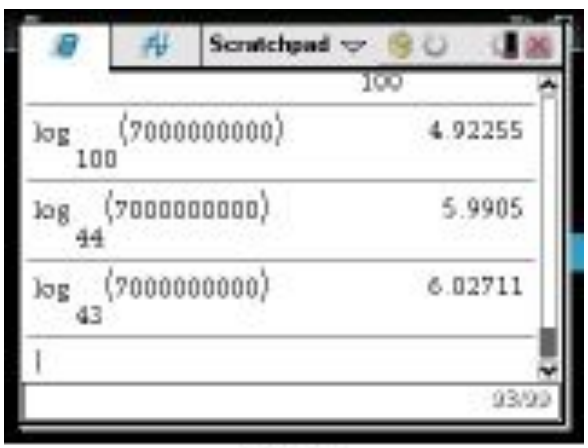

MELISSA



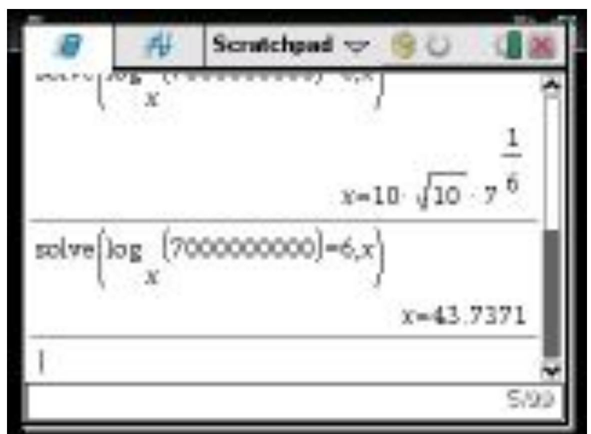

JOHN



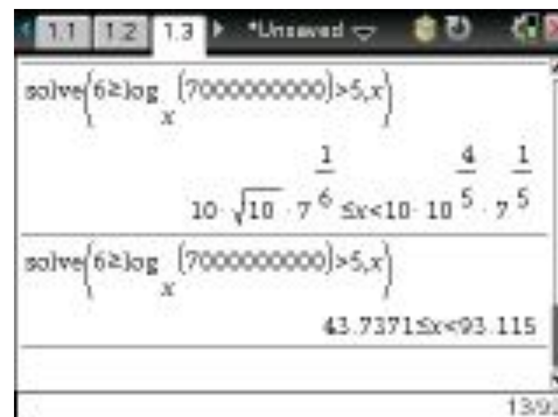

KALYAN




GONZALO

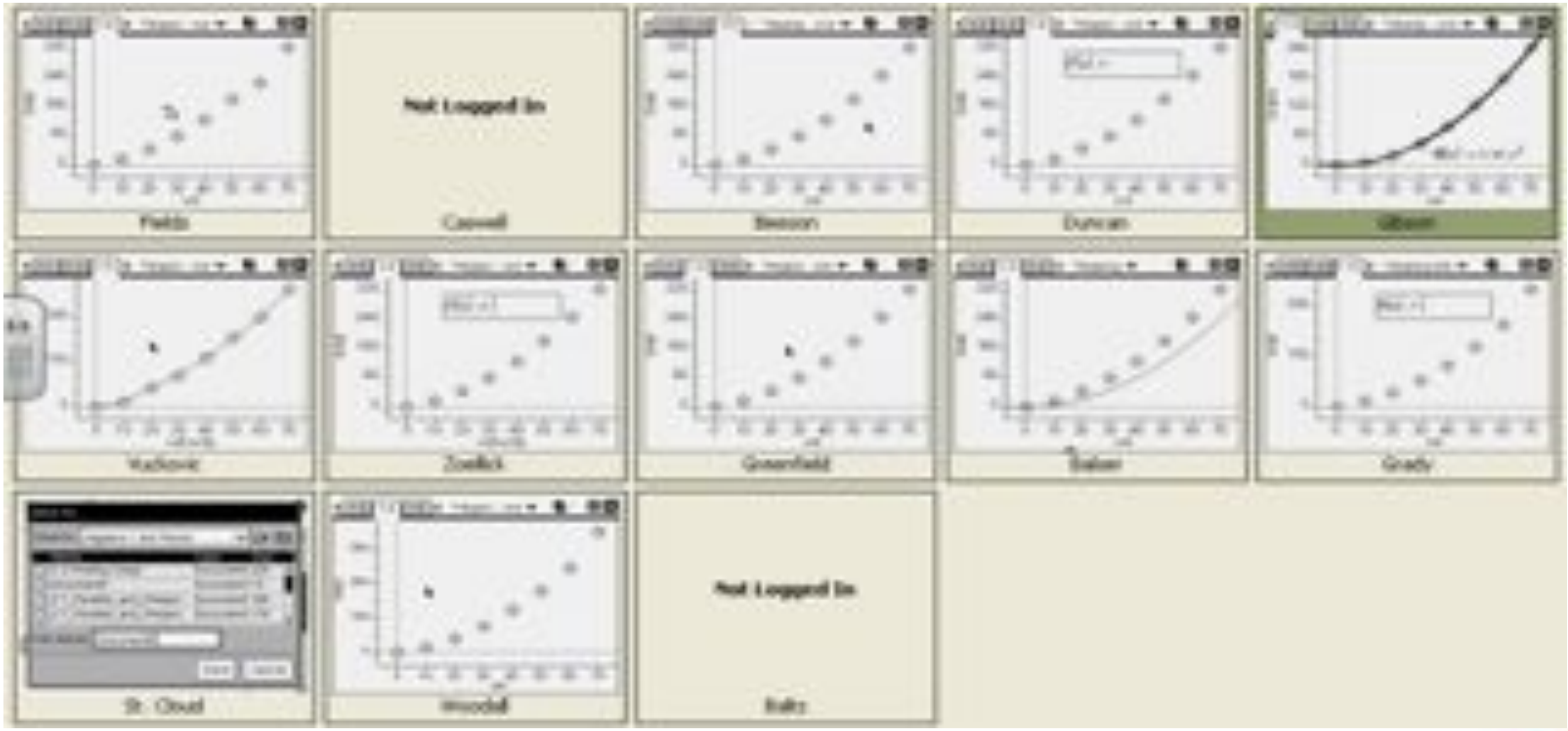



CHELSEA



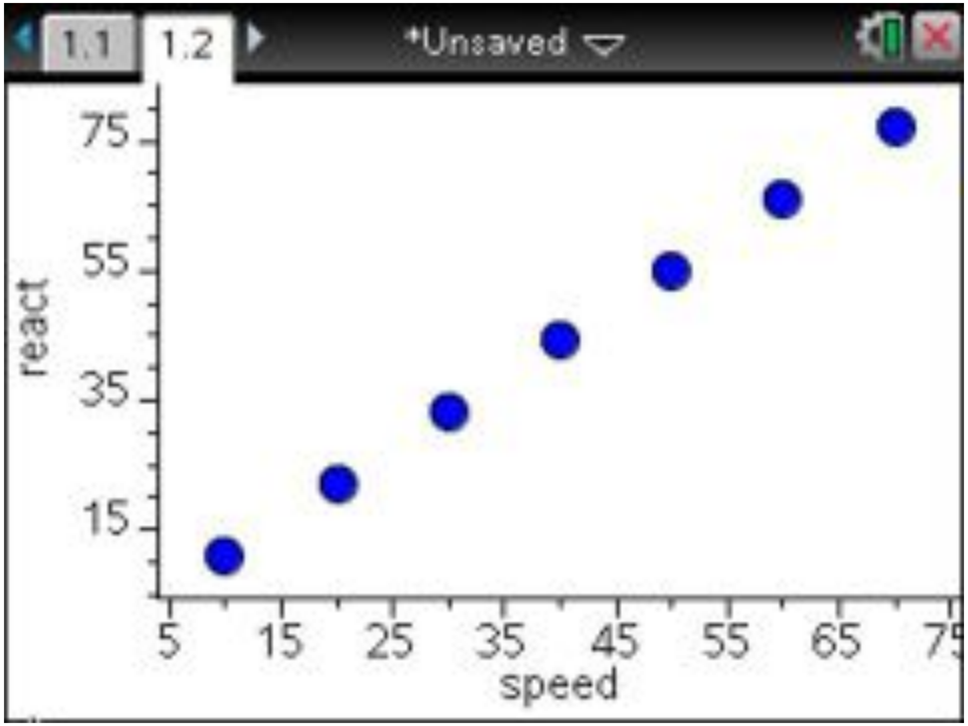

ADAM

# Write the equation that fits the total distance traveled in feet based on the velocity in miles per hour.




What is the next step for a teacher?

# Write a complete sentence about what the graph of reaction distance vs. velocity represented.



# Use Screen Capture to require responses from all students and to show and discuss selected responses.

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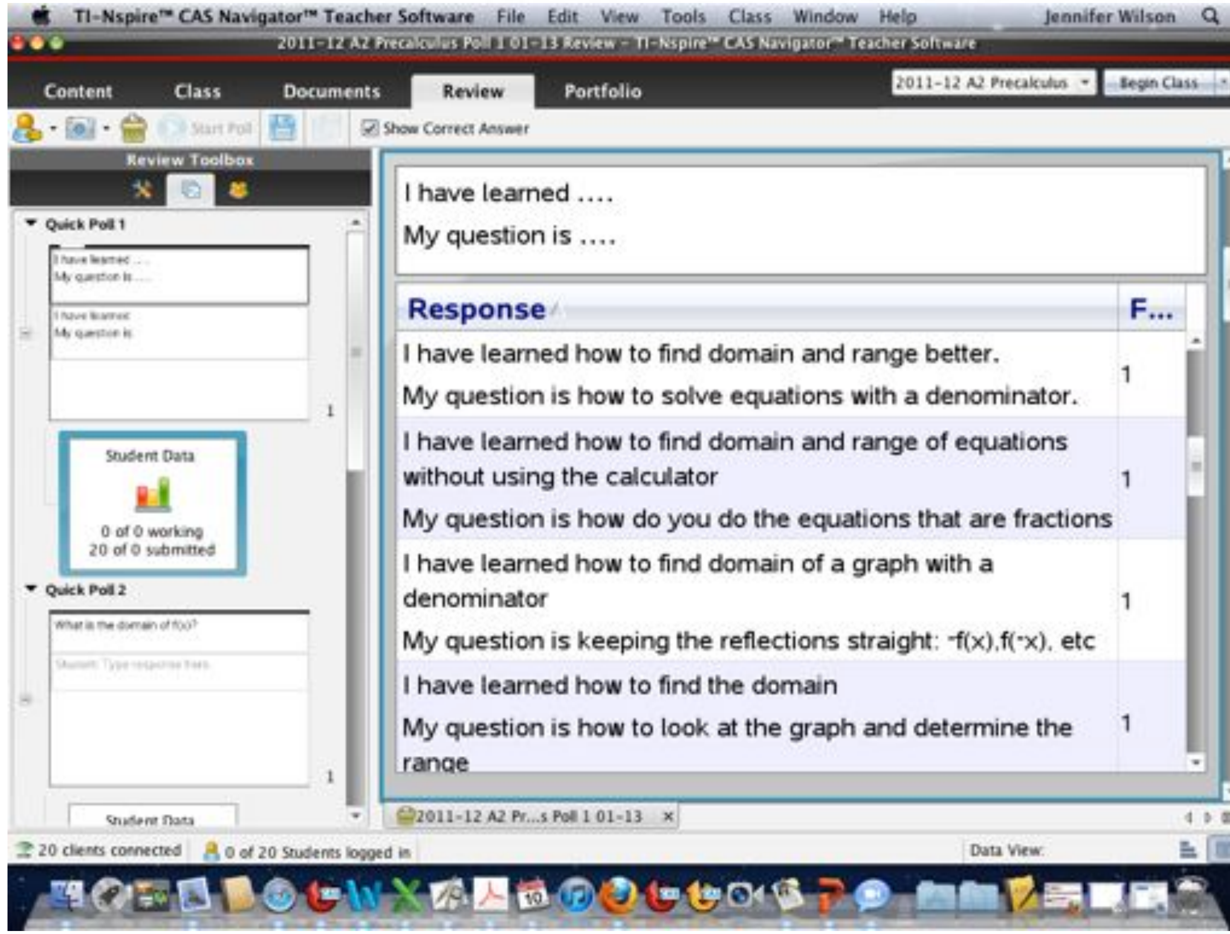
# Bringing closure to a lesson:

I have learned…

My question is….



# Teacher moves that promote mathematical learning

## Questioning

- Be relentless in asking what does it mean and why does it work
- Wait after asking a question before calling on a student and before reacting to a student answer to a question
- Deflect questions to students
- Expect and create opportunities for full participation from all students

# Teacher moves that promote mathematical learning

## Discussion

- Orchestrate productive discussion among students
- Activate the five strategies for managing a discussion: anticipate responses, monitor student work, select work to be presented, sequence student responses in meaningful way, connect responses to the mathematical goals of the lesson

# Teacher moves that promote mathematical learning

## Formative Assessment

- Engage students in defending responses to peers
- Celebrate wrong answers as places to learn, promoting discussions about what is good about wrong answers and why they are wrong
- Engage students in providing feedback to one another
- Be relentless in focusing on what students are thinking about the mathematics

# Teacher moves that promote mathematical learning

## Tasks

- Tasks should have a worthwhile mathematical objective
- Choose or frame tasks in ways that allow opportunities for discussion
- Establish and maintain the cognitive demand of tasks by the questions posed and interventions that support student reasoning

# How can teacher moves support the implementation of the Mathematical Practices?

# Grain Size

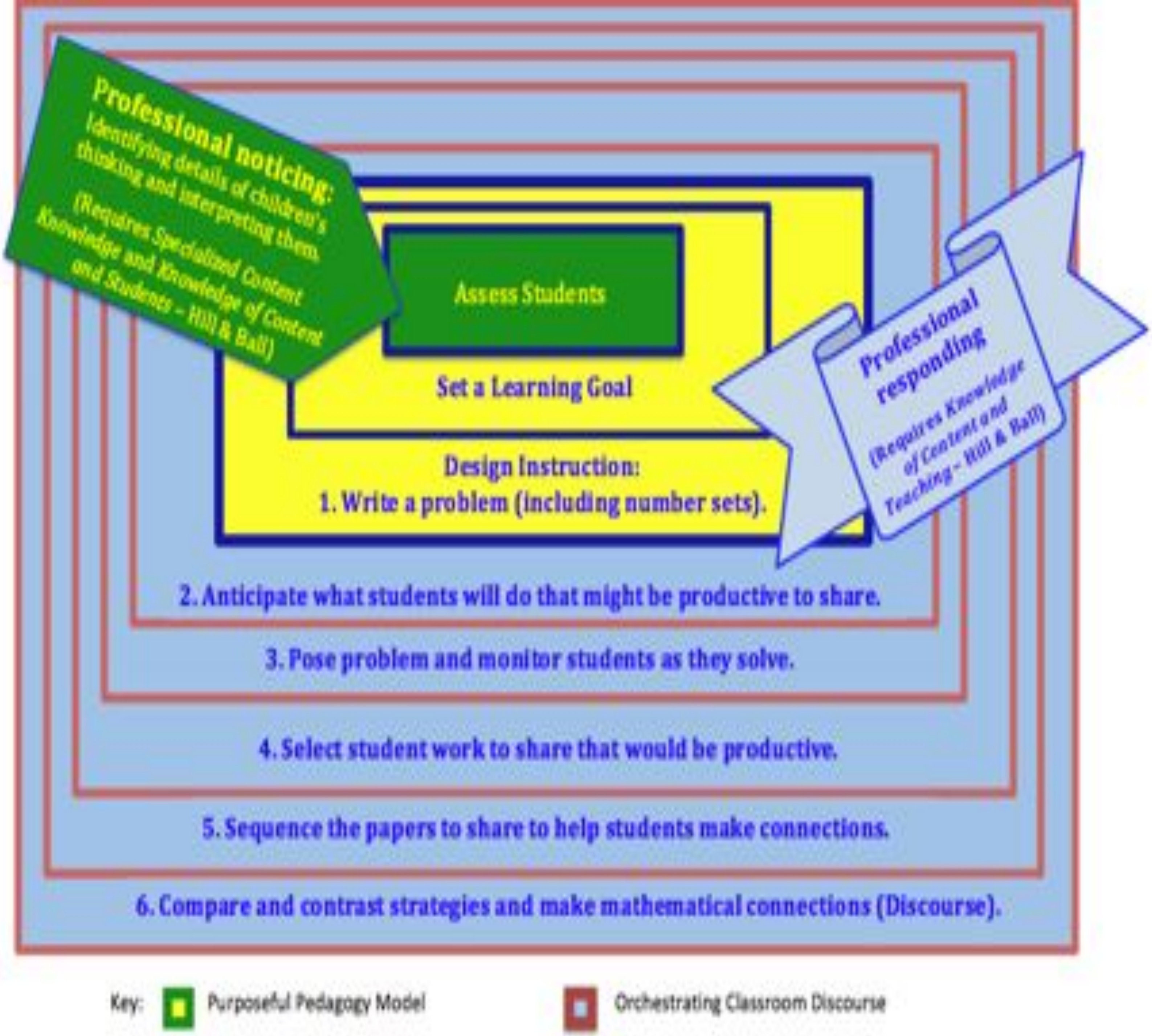
- Unit planning
- Units integrated across topics
- Standards in more than one unit
- The glue that holds the course together is in every unit (focus and coherence)

# Teacher Goals

- How do I get my students to get the correct answer to this problem or complete this task?
- What is the mathematics my students will learn from working on this problem or task?

# The Foundation

- Jacobs, Lamb, and Philipp on professional noticing and professional responding;
- Smith, Stein, Hughes, and Engle on orchestrating productive mathematical discussions;
- Ball, Hill, and Thames on types of teacher mathematical knowledge; and
- Levi and Behrend (Teacher Development Group) on Purposeful Pedagogy Model for Cognitively Guided Instruction.


Professional noticing: Identifying details of children's thinking and interpreting them.
(Requires Specialized Content Knowledge and Knowledge of Content and Students – Hill & Ball)
Assess Students
Set a Learning Goal
Design Instruction:
1. Write a problem (including number sets).
Professional responding
(Requires Knowledge of Content and Teaching – Hill & Ball)
2. Anticipate what students will do that might be productive to share.
3. Pose problem and monitor students as they solve.
4. Select student work to share that would be productive.
5. Sequence the papers to share to help students make connections.
6. Compare and contrast strategies and make mathematical connections (Discourse).
Key:
Purposeful Pedagogy Model
Orchestrating Classroom Discourse

# Step 1

- Write or select a problem or task that has the potential to reveal some mathematics that will help reach the learning goal.
- What is the mathematics this task or problem has the potential to reveal?

# Step 2

- Anticipate what students will do that might be productive to share.
- Remember there are productive failures.

# Step 3

- Pose the problem and monitor students as they solve.
- Teachers role during this process is called professional noticing.
- Requires that they have the teacher specialized content knowledge.


Subject Matter Knowledge
Pedagogical Content Knowledge
Common Content Knowledge (CCK)
Knowledge at the mathematical horizon
Specialized Content Knowledge (SCK)
Knowledge of Content and Students (KCS)
Knowledge of Content and Teaching (KCT)
Knowledge of curriculum

# Steps 4 and 5

- Select student work to share that would be productive.
- Sequence the papers to share to help students make connections.

# In the Classroom – 1

# In the Classroom – 2

# Step 6

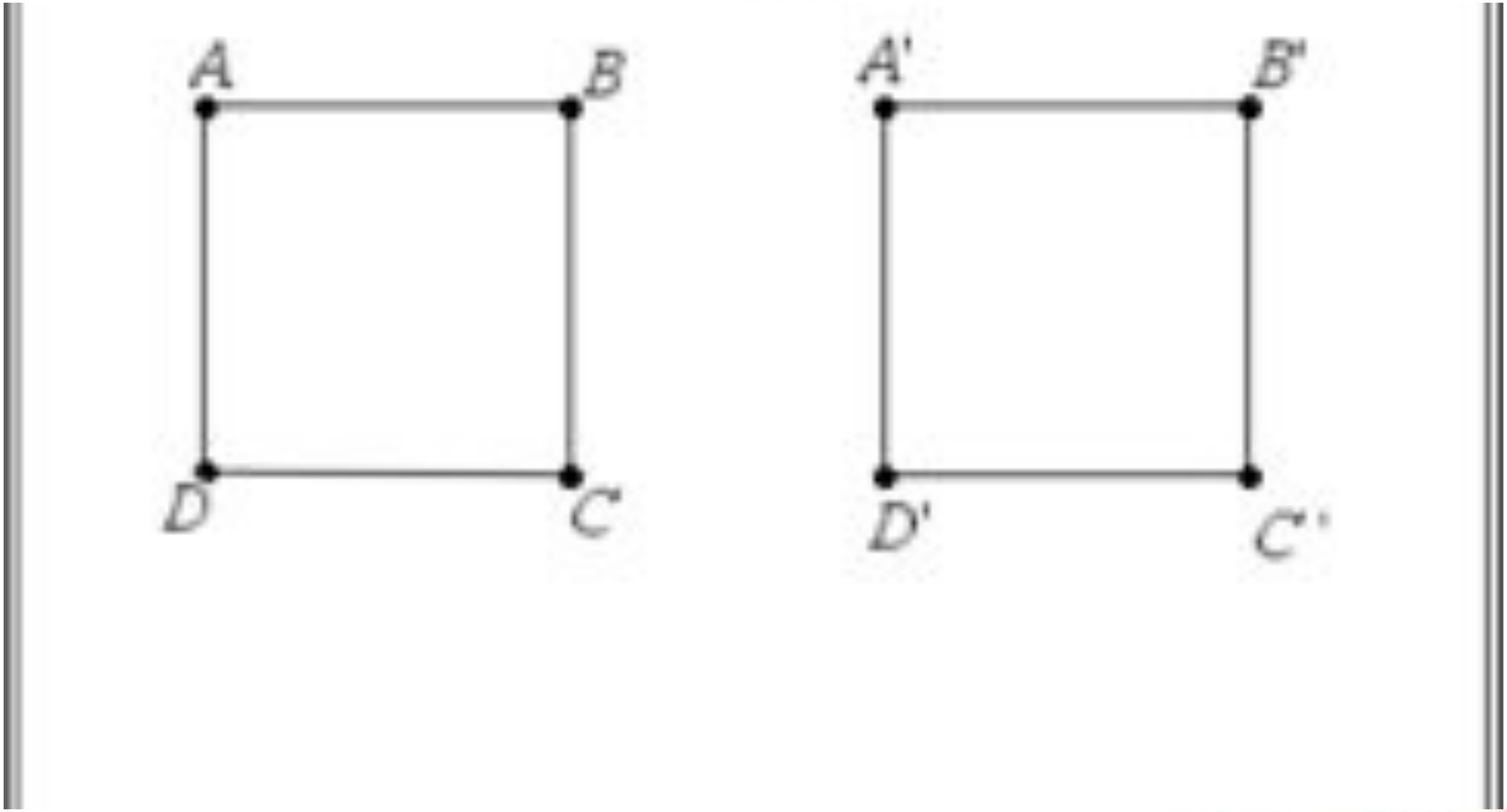
- Compare and contrast strategies and make mathematical connections (Discourse).

# TI Technology

- Publish View
- Navigator

# What are your questions?

# What would happen to the area of A'B'C'D' if you "slant" the sides?



# Bringing it all together

## How students should work:
## Standards for Mathematical Practice

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