WHAT DO YOU NOTICE: Strategies for Inquiry with TI-84 Plus Technology

Karen Campe ♦ karen.campe@gmail.com | John LaMaster ♦ lamaster@pfw.edu | T³ National Instructors

Inquiry Strategies enable students to use critical thinking to build understanding of math topics. These techniques provide entry points into problem-solving, encourage engagement and sense-making, and can make the math learning deeper and more durable.

A. What do you notice, what do you wonder?

- This strategy is a way to get students involved in a mathematical context before being asked to do something with it.
- **HOW:** Present a graph, equation, problem scenario; give students individual think time to note down what they notice and wonder about the context.
- Sometimes students will attend to mathematical features of the situation that aren't part of the intended lesson objectives—don't be afraid to "take the scenic route" to discuss important math.
- Sources:
  - Search for #NoticeWonder
  - Annie Fetter @MFAnnie of MathForum
  - Also this blog post although elementary focused, good overview.

Example 1:

1. On your calculator, graph:	2. On your calculator, graph:
Y1= x^2	**Y1=** x^3
Y2= x^4	**Y2=** x^5
Y3= x^6	**Y3=** x^7
What do you observe?	What do you observe?

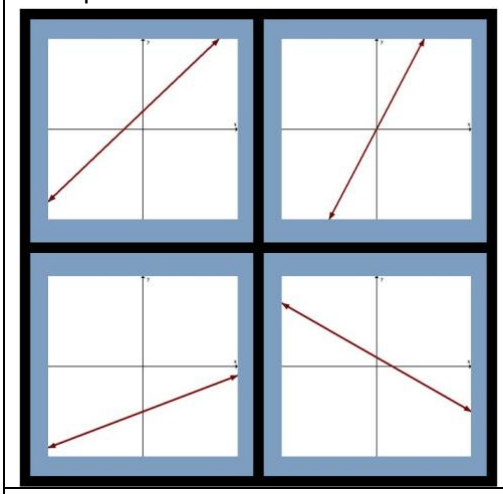
Example 2:
Graph the following 3 functions on an appropriate window. What do you notice? What do you wonder?

$y = 2x^2 - 8$ $\quad$ $y = x^2 - 16$ $\quad$ $y = \dfrac{2x^2 - 8}{x^2 - 16}$

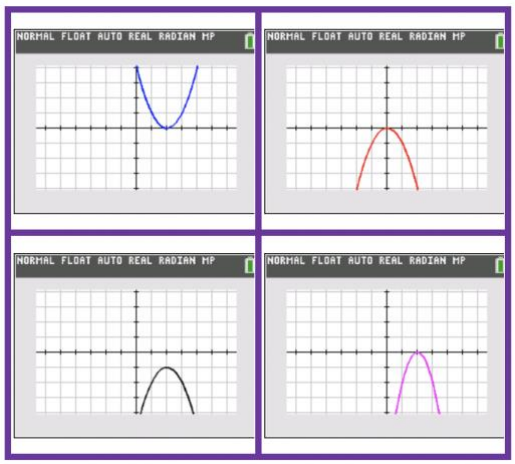
B. Which One Doesn't Belong?

- This strategy has students generate a reason why each one of the four choices doesn't belong, and justify why their choice is valid. A well-constructed WODB will have good reasons why each of the 4 options does not belong with the other 3.
- **HOW:** Present 4 items, give students individual think time to note down what they think doesn't belong and why. Orchestrate discussion about why EACH of the 4 items might not belong.
- Provides access for all and encourages mathematical thinking, communicating, and justifying (and supports Mathematical Practices 1, 2, 3, 6).
- Sources:
  - Search for #WODB
  - Website http://wodb.ca/ maintained by Mary Bourassa @MaryBourassa
  - Lots of blog posts, including Jennifer Wilson T3 Instructor and Mashup Math and ATMIM

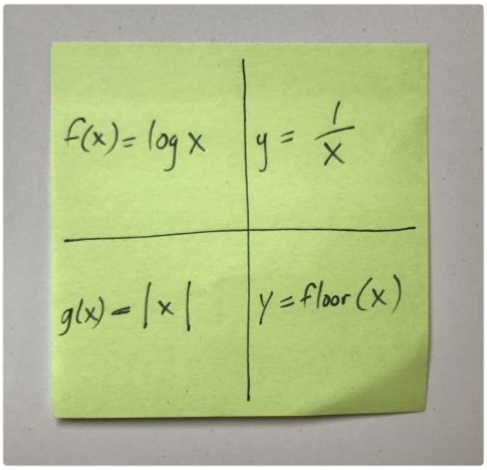
Example 3: source WODB.ca



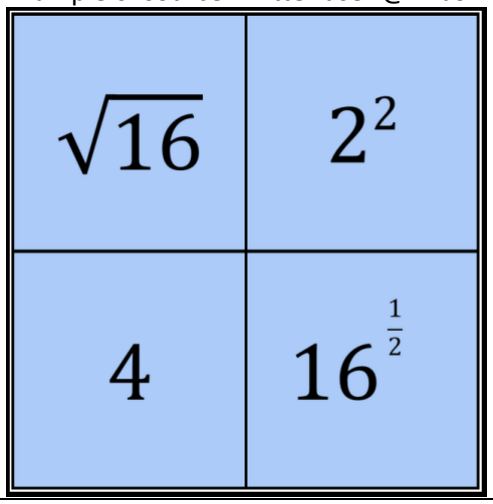
Example 4: source Karen Campe



Example 5: source Twitter user @tangentz1



Example 6: source Twitter user @MrJohnRowe



C. Action-Consequence-Reflection: What changes, what stays the same?

- This strategy asks students to perform a mathematical action, observe a math consequence, and reflect on the result, making mathematical meaning.
- Categories of this technique include using graphs/sliders, dynamic tables, and looking for invariants.
- **HOW:** Have students engage in a mathematical action context, ask themselves "what changes, what stays the same?, and record observations, reflections, predictions, conclusions.
- Key components: Require students to record, Ask good questions, Summarize results with class.
  - What will happen if…?
  - What must I change to make … happen?
  - How is … affected by …?
  - What changes, what stays the same?
  - When will … be true?
  - Why does this happen?
- Sources:
  - karendcampe.wordpress.com Reflections & Tangents Blog Action-Consequence Advantage.
  - "Table Techniques" Article coming in Mathematics Teacher May 2019, based on this post.
  - John & Karen Webinar "Making Math Stick" Replay and Documents.

Example 7: Use Transformation Graphing to graph the general Quadratic Function $Y = Ax^2 + Bx + C$. How does each parameter affect the graph?

Example 8: Use Transformation Graphing to graph the Exponential Function $Y = A^x$.

- What happens as A increases from 2 to 10, incrementing by 1?
- What happens if A = 1 or A = 0? Why?
- What happens as A increases from 2 to 3, incrementing by 0.1? Can you estimate value of *e*?

Example 9: Searching for Invariants (something about a mathematical situation—a measurement, calculation, shape, or location—that stays the same while other parts of the situation change)

- Cabri Jr. Circle Angles
- Many Geometry and Trigonometry examples possible, see sources.

Example 10: Dynamic Tables to model Growth

I. Enter **Y1=** 2x and **Y2=** 2^x
Set the Independent variable to AUTO and the Dependent variable to ASK in [tblset].
Move *down* each column and notice how they grow.

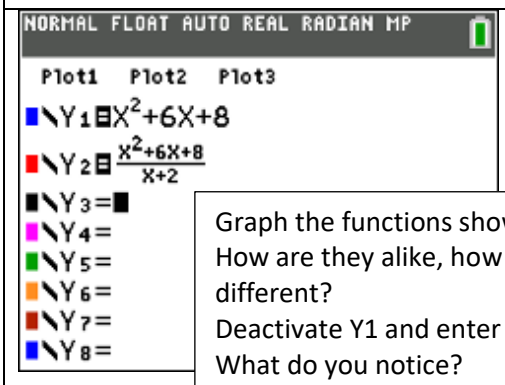
II. Model the situation below with equations
Set the Independent variable to ASK and the Dependent variable to AUTO in [tblset].
Determine how long for scenario B to catch up with scenario A.

A. You start with $100 and save $5 each week.	B. You start with $5 and each week save double the amount you saved the previous week.

D. Same and Different (Compare and contrast)

- This strategy asks students to compare and contrast features of two mathematical situations. They may require different solution strategies, be similar *except* for one feature, or have mathematically meaningful nuances to notice.
- **HOW:** Present two math situations, have students examine and note how they are the same and how they are different.
- Powerful technique when Ss must choose among various solving techniques (systems of equations, solving quadratic equations, simplifying exponents & radicals, right triangles, calculus integration).
- Sources:
  - Search for #SameDifferent
  - Same Surface Different Deep (SSDD) problems from Craig Barton @mrbartonmaths
  - Minimally Different Problems "intelligently varied Qs" from Jess Prior @FortyNineCubed
  - Michelle Rinehart T3 instructor How We Teach blog math talks, look for Alike & Different

Example 11: Comparing Functions
Tracer Ball Style, ZoomDecimal Window, Trace, Table



Graph the functions shown.
How are they alike, how are they different?
Deactivate Y1 and enter Y3 = X + 4.
What do you notice?

Example 12: Exponential Functions
What happens with different bases?
How is 2^x related to $\log_2 x$?