BEYOND WHAT DO YOU NOTICE? More Strategies for Inquiry with TI-84 Plus Technology

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Dropbox Folder: http://bit.ly/InquiryStrategies

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.

Tips for implementing these ***THINKING ROUTINES***:

- ✓ Get students involved with a mathematical context – a graph, equation, or problem scenario.
- ✓ Give students individual think time to note down what they notice about the context *before sharing*.
- ✓ Discuss & elaborate important concepts afterwards to make the math stick.

A. 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 Mathematics Teacher May 2019, and Teacher Guide.
  - Karen's 7 for 7 talk: The Power of the Action-Consequence-Reflection Cycle Video.

Example 1: Power Functions

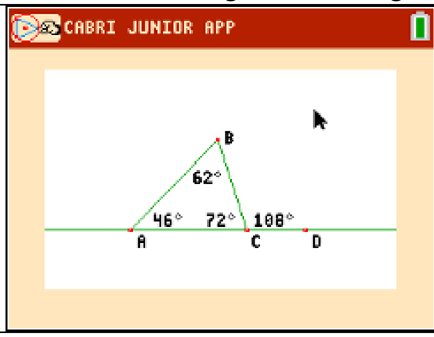
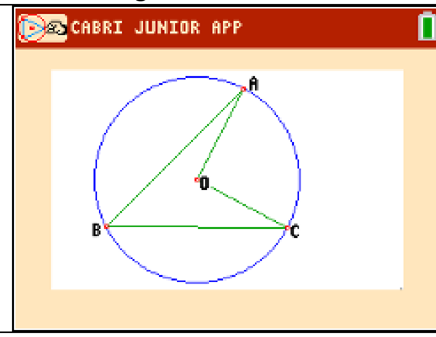
A. On your calculator, graph: **Y1=** x^2 **Y2=** x^4 **Y3=** x^6 What do you observe?	B. On your calculator, graph: **Y1=** x^3 **Y2=** x^5 **Y3=** x^7 What do you observe?

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

Example 3: Use Sliders 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 4: 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)

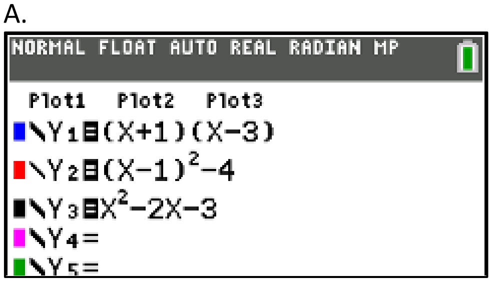
A: Interior & Exterior Angles of a Triangle	B: Circle Angles
	

B. Same and Different (Compare and contrast)

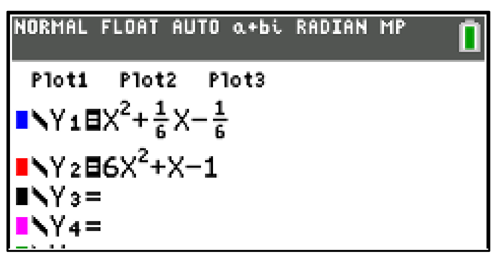
- This strategy asks students to compare and contrast features of two mathematical situations. They may require different solution strategies, be similar *except* for one feature, or have mathematically meaningful nuances to notice.
- **HOW:** Present two math situations, have students examine and note how they are the same and how they are different.
- Powerful when Ss must choose among various solving techniques (systems of equations, solving quadratic equations, simplifying exponents & radicals, right triangles, calculus integration).
- Sources:
  - Karen's Reflections & Tangents Blog Same and Different and Same & Different Calculus Edition
  - Search for #SameDifferent
  - https://www.samebutdifferentmath.com/ from Sue Looney (@LooneyMath)
  - https://samedifferentimages.wordpress.com/ & https://minimallydifferent.com/
  - Same Surface Different Deep (SSDD) problems from Craig Barton @mrbartonmaths

Example 5: Comparing Quadratic Functions

A.



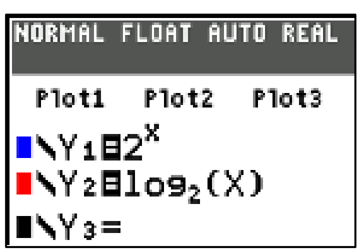
B.



Example 6: Graph on an appropriate window. How are the graphs the same? How are they different?

$y = x^2 + 6x + 8$ $\qquad$ $y = x + 2$ $\qquad$ $y = \dfrac{x^2 + 6x + 8}{x + 2}$

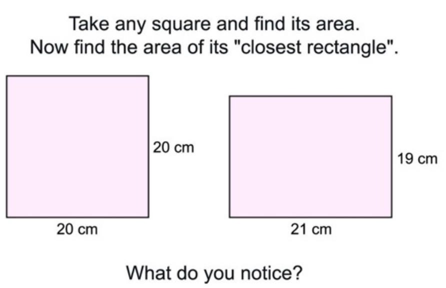
Example 7: Logs & Exponents



C. Specialize, Conjecture, Generalize (S-C-G)

- This strategy asks Ss to begin problem solving by attempting specific simpler examples; make conjectures, then generalize to verify.
- **HOW**: Present a problem situation or mathematical statement. Have students use a variety of examples to specialize "randomly, systematically, artfully" and look for patterns. Form a conjecture and generalize with algebra or other representations; justify WHY if desired.
- Sources:
  - NRich https://nrich.maths.org/problems
  - Jonathan Hall post https://bsky.app/profile/studymaths.bsky.social/post/3mcouc7v6bk2z
  - John Mason et. al. classic book "Thinking Mathematically" on Archive.org (Ch.1 in Dropbox)

Example 8: Squares and Square Number Surprises

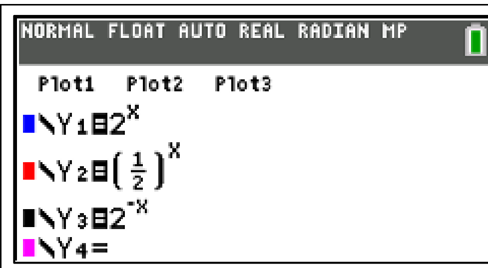
A. 	B. Add the squares of two consecutive integers, then subtract 1… what happens? C. Multiply two consecutive odd numbers then add 1 … what happens? D. Can you come up with any Square Number Surprises of your own? (**See Dropbox for more**)

Example 9: i–Surprises (**See Dropbox for the handout *i*–Surprises**)
What patterns do you notice with expressions like these? Use *a + bi* mode on TI-84 Plus CE.

A. $\dfrac{1}{1-\frac{i}{c}}$	B. $\dfrac{i}{1+\frac{i}{c}}$	C. $\dfrac{a+i}{a-i}$

D. Two Truths and A Lie (Find the Fiction)

- This strategy asks Ss to distinguish between true and false math statements. These can focus on common misconceptions, uncover a deeper property, or build a mathematical argument.
- **HOW:** Examine/CREATE 3 statements about a math concept, only two of which are true. Identify the wrong statement and be able to explain why or defend your position. Be sure to give individual think time before sharing.
- Use as a warmup to begin discussion, have Ss create these in groups or gallery walk to review a unit, or share on an electronic platform (Google Slides).
- Sources:
  - Jon Orr blog: https://mrorr-isageek.com/better-questions-two-truths-one-lie/
  - Sara Carter template: https://mathequalslove.net/two-truths-and-a-lie-template/

Example 10: Exponential Function Graphs	
Which statements are true about the graphs of these exponential functions? A. 2^x and 2^{-x} are reflections of each other. B. The graph of 2^{-x} goes below the x-axis. C. $\left(\frac{1}{2}\right)^x$ and 2^{-x} have the same graph.	

***Past materials on "What Do You Notice, What Do You Wonder?" and "Which One Doesn't Belong?" in Dropbox.**