Carnegie Learning

Session 132: Expressing Regularity in Repeated Reasoning with CCSSM

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Session Objectives

- Participants will–
  - Engage in mathematical activities in which they "look for and express regularity in repeated reasoning"
  - Discuss this SMP in terms of specific mathematical topics
    - Exponential Functions
    - Right Triangles
    - Informal and Formal Formula Derivation
    - Other Topics

Why is this SMP Important?

- 1
- 1 1
- 2 1
- 1 2 1 1
- 1 1 1 2 2 1

- What is the next row?
- Do you see the pattern? What is your generalization?

Why Is This SMP Important?

Consider the following "recipes" that provide dates and times, hidden in code:

- Recipe 1
  - 8 T milk
  - 2 eggs, lightly whipped
  - 11 oz sour cream
  - Splash of lemon
  - Dash of salt
- Recipe 2
  - 2/5 T milk
  - 4 eggs, beaten
  - 12 oz cottage cheese
  - Half an orange
  - Pinch of pepper

Do you see a pattern?
Are you ready to make a recipe of your own?

Why Is This SMP Important?

- **NCTM's *Connecting the NCTM Process Standards & the CCSSM Practices***:
  - "If students do not expect there to be patterns or regularities in their mathematical work… then it is unlikely they will make it a common part of their mathematical activity to look for and express regularity in their repeated reasoning" (p. 106).
  - This practice provides "important insights into the relationship between procedural and conceptual work in mathematics classrooms" (p. 106).

Let's Explore Some Mathematics!

- Exponential Situations to Exponential Equations
- Right Triangles to Trigonometric Ratios
- Some Polygon Formulas

Bridging Procedural knowledge and Conceptual Knowledge

- What other topics do students often "know" only procedurally?

- How can we employ this SMP to assist in bridging the procedural and the conceptual?

Discussion and Questions

- How can you encourage students to look for and express regularity in repeated reasoning?
- What questions can we ask to encourage students to look for and express regularity in repeated reasoning?
- How does this SMP support and connect to the other SMPs?

A point to remember about steps…

- Many students have reached an implicit understanding with their math teachers:
  - *If the teacher will simply tell the students the rules and when to use them, then the students will simply follow the rules.*
- Results:
  - *Students who can mindlessly apply rules without having any understanding of what they are doing, and who are unable to use what they have learned to solve any complex or novel problems.*

Silver, Kilpatrick, and Schlesinger, 1995

References

- Koestler, C., Felton, M. D., Bieda, K. N., & Otten, S. (2013). *Connecting the NCTM process standards & the CCSSM practices*. Reston, VA: National Council of Teachers of Mathematics.

- Silver, E. A., Kilpatrick, J., & Schlesinger, B. (1995). *Thinking through mathematics: Fostering inquiry and communication in mathematics classrooms*. College Board.

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Exponential Situations to Exponential Equations

1. Suppose that Raul deposits $1000 into an account that earns 5% compound interest each year. Complete the table to show Raul's account balance after each year. **Write out how you would calculate the account balance, in terms of $1000, in addition to writing the account balance in terms of the prior balance.**

Time (years)	Interest Earned (dollars)	Account Balance (dollars)
0	0	1000
1	1000(0.05) = $50	1000 + 1000(0.05) = 1050
2	1050(0.05) = 52.5	

What do you notice about the account balance (in terms of the initial deposit and the compound interest)? Can you write a general formula for this scenario?

Adapted from scenarios in the Carnegie Learning, Inc. Georgia Coordinate Algebra text.
Presentation 132. Kelly Edenfield. NCTM Regional – Louisville, KY. November 8, 2013.

Exponential Situations to Exponential Equations

2. At this moment, the population of Downtown is 20,000, and the population of Uptown is 6000. But over many years, people have been moving away from Downtown at a rate of 1.5% every year. At the same time, Uptown's population has been growing at a rate of 1.8% each year.

Complete the table to show the populations of Downtown and Uptown after each year. **Write out how you would calculate the populations, in terms of the original populations, in addition to writing the population in terms of the prior year's population.**

Time (years)	Downtown Population		Uptown Population
0	20,000		6,000
1	20,000 – 20,000(0.015) = 19,700		6,000 + 6,000(0.018) = 6108
2			
3			
4			
5			

What do you notice about the populations (in terms of the initial populations and the growth/decline)? Can you write a general formula for these scenarios?

- How are these scenarios similar and/or different from Raul's scenario?
- How can we use these three scenarios to write a general formula for exponential functions?
- How do you know if the exponential function is increasing or decreasing?

Adapted from scenarios in the Carnegie Learning, Inc. Georgia Coordinate Algebra text.
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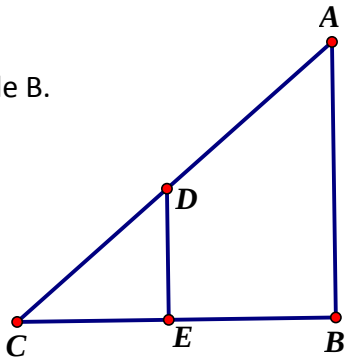
Similar Right Triangles to Trigonometric Ratios

HSG-SRT.C.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

Consider the following right triangle ABC, with right angle at angle B. $\overline{DE}$ is parallel to side $\overline{AB}$.



1. How do you know that $\Delta ABC \sim \Delta DEC$?

2. Measure each of the sides of both triangles (in mm). Record the approximate measures.

3. For each triangle, using angle C as the reference angle, label the opposite side, adjacent side, and the hypotenuse.

4. Determine the side length ratio for triangles ABC and DEC, using angle C as the reference angle. Write your answers as decimals rounded to the nearest thousandth.

Side Length Ratio	Triangle ABC	Triangle DEC
$\frac{side\ opposite\ of\ angle\ C}{hypotenuse}$		
$\frac{side\ adjacent\ to\ angle\ C}{hypotenuse}$		
$\frac{side\ opposite\ of\ angle\ C}{side\ adjacent\ to\ angle\ C}$		

What do you notice?

5. How could we test our conjecture?

Adapted from Lesson 8.1 in the Carnegie Learning, Inc. Georgia Analytic Geometry text.
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