

## Understanding How to Differentiate Instruction for Middle School Students

From the IDR<sup>2</sup>eAM Project: **I**nvestigating **D**ifferentiated Instruction and **R**elationships between **R**ational Number Knowledge and **A**lgebraic Reasoning in **M**iddle School

### Five Pedagogical Activities that Influenced Differentiating Instruction

Our analysis revealed five pedagogical activities that facilitated DI:

- (1) Using Hypothetical Learning Trajectories (HLTs, Simon, 1995; Steffe, 2004) in lesson planning;
- (2) Providing students with choices;
- (3) Monitoring actively during group work;
- (4) Attending to small group functioning;
- (5) Conducting whole classroom discussions across different thinkers.

The latter three pedagogical activities also, at times, impeded DI.

### Parallel Tasks

**I. Corn Stalk Tomato Plant Heights Problem.** A tomato plant and corn stalk are growing in the garden, each of unknown height. The height of the corn stalk is 5 times the height of the tomato plant.<sup>1</sup>

- a) Draw a picture of this situation and describe what your picture represents.
- b) Write an equation for this situation that relates the two heights. Explain what your equation means in terms of your picture.
- c) Can you write another, different equation that relates the two heights? Explain what your equation means in terms of your picture.
- d) If you wrote an equation using division, can you write it with multiplication? Explain what your new equation means in terms of your picture.
- e) Let's say that the stalk of corn's height is 150 cm. How tall is the tomato plant?  
Use this example to check all of your equations.  
If an equation does not work, see if you can change it so that it does.  
Explain any changes that you make.

**II. Tree Heights Problem.** Next to the school are two trees, each of unknown height. The crabapple tree is  $\frac{3}{5}$  the height of the maple tree.

- a) Draw a picture of the situation and describe what your picture represents.
- b) Write an equation for this situation that relates the two heights. Explain your equation in terms of your picture.
- c) Can you write another, different equation that relates the two heights? Explain this equation in terms of your picture.
- d) If you wrote an equation using division, can you write it with multiplication? Explain what your new equation means in terms of your picture.
- e) Let's say that the maple tree's height is 20 feet. How tall is the crabapple tree?  
Use this example to check all of your equations.  
If an equation does not work, see if you can change it so that it does.  
Explain any changes that you make.

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<sup>1</sup> In subsequent experiments we specified that the heights were measured in the same units, e.g., centimeters.

**Problem from Episodes 11 and 12**

**Fern Sunflower Heights Problem.** The height of a sunflower is one-fourth the height of a fern. We don't know either height, so they are both unknowns.

- a) Draw a picture of the situation and describe what your picture represents.
- b) Write an equation for this situation that relates the two heights. Explain your equation in terms of your picture.
- c) Can you write another, different equation that relates the two heights? Explain this equation in terms of your picture.
- d) If you wrote an equation using division, can you write it with multiplication? Explain your new equation in terms of your picture.
- e) Let's say that the fern's height is 56 inches. How tall is the sunflower? Use this example to check all of your equations. If an equation does not work, see if you can change it so that it does. Explain any changes that you make.

**Transcript for clip of Whole Class Discussion, Episode 12, 10/17**

Teacher: Yeah, [can we] multiply  $q$ , our larger height, by something to produce the smaller height? [Connor puts up his hand.] Is it possible to do that and if so, how do we do it? [Gabriel and Martin have their hands up.]

Tim: Well, it's possible, but I don't know a way though.

Teacher: You don't know what would work. What do you think Connor?

Conner: Maybe you could multiply it like, by itself and then divide it by something. [Martin's hand is up higher now, and Gabriel's is down.]

Teacher [at the board]: Okay. Connor said, maybe like multiply it by itself,  $q$  times  $q$ , or you're saying multiply by 1, or—

Conner: Multiply it by 2.

Teacher: Multiply it by 2. And then divide it by [pause] something? [The teacher writes on the board. Gabriel chimes in with dividing.]

Conner: Yeah. Divide it by dot dot dot. [The class had used "dot dot dot" to indicate unknown-ness in pictures that represented quantitative unknowns.]

Teacher [laughs, writing on the board]: dot dot dot; divided by dot dot dot, equals  $c$ ? Okay, maybe, maybe we could do something like that, but this equation will still use division. What I want to know is can we actually just use multiplication?

Conner: No. I don't think so.

[Gabriel's hand is up and his mouth is in a big O.]

Martin: Yeah [put his hand up]. It's possible.