

# Investigating Differentiated Instruction and Algebraic Reasoning in Middle School

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# What Differentiated Instruction (DI) is NOT

- ◆ Individualized instruction only
- ◆ Reactive
- ◆ Giving a "normal" assignment to most students and a "different" assignment to struggling or advanced students
- ◆ Tracking: Another way to provide homogenous groupings (within a diverse class)

# What DI is:

- ◆ Proactively tailoring instruction to students' different learning needs, such as students' readiness and cognitive abilities, interests, and learning profiles and backgrounds (Tomlinson, 2005)
- ◆ Responsive and adaptive
- ◆ Rooted in (formative) assessment
- ◆ Student-centered
- ◆ A blend of whole-class, small group, and individual instruction

# Why Differentiate?

- ◆ ***Professional observations:***

- ◆ My students in the same class are in many different places in their understanding.
- ◆ What I do in class works differently with different students; my instruction is not “the same” instruction for all students in the same class.
- ◆ Students benefit from interacting with many different thinkers, which they don’t get to do in tracked classes.

- ◆ ***Professional choices:***

- ◆ Want to communicate mathematically with more students
- ◆ Need to help more students be successful
- ◆ Want alternatives to tracking

# Why Differentiate?

- ◆ U.S. classrooms are increasingly diverse in many ways: Culturally, ethnically, linguistically, and cognitively
- ◆ Tracking, a widespread response to diversity, is often accompanied by many inequities.
- ◆ Classrooms without differentiated instruction are often not serving students well... even advanced students.
- ◆ To promote equitable outcomes (a fundamental principle of mathematics education from NCTM) requires differentiating instruction!

# What if you Differentiate?

- ◆ You open up more problems in your teaching practice!
- ◆ But they are good problems to have.
- ◆ Such as:
  - ◆ **Tailoring instruction:** How do you change problems and activities to fit with different learners' ways of thinking?
  - ◆ **Developing classroom community:** How do you have classroom discussion when students have worked on different problems?
  - ◆ **Managing different ways of thinking:** What can/should students take away from the different ways of thinking of their peers?

# Our IDR<sup>2</sup>eAM Project

- ◆ Investigating **D**ifferentiated Instruction and **R**elationships between **R**ational Number Knowledge and **A**lgebraic Reasoning in **M**iddle School
- ◆ **Years 1-2:** Teach after school math classes (design experiments) for groups of nine 7<sup>th</sup> and 8<sup>th</sup> grade students with diverse cognitive characteristics.
  - ◆ So, in the project we are focused on differentiating instruction for cognitive diversity.

# Our IDR<sup>2</sup>eAM Project

- ◆ **Year 3:** Form a study group with about 15 middle school classroom teachers in Indiana to explore how to differentiate math instruction in whole classrooms.
- ◆ **Years 4-5:** Co-teach with classroom teachers in classroom experiments to explore differentiated instruction in topics related to rational numbers and algebraic reasoning.



# Features of DI in Years 1-2

1. Formative assessment
  2. Mathematics problems with choices: e.g., Parallel Tasks
  3. Flexible and intentional small groups
  4. Student work in small groups
  5. Whole classroom discussion about a topic, across different problems
- ◆ **Important Note:** #1-2 above esp. require developing clarity about Big Mathematical Ideas and Goals.

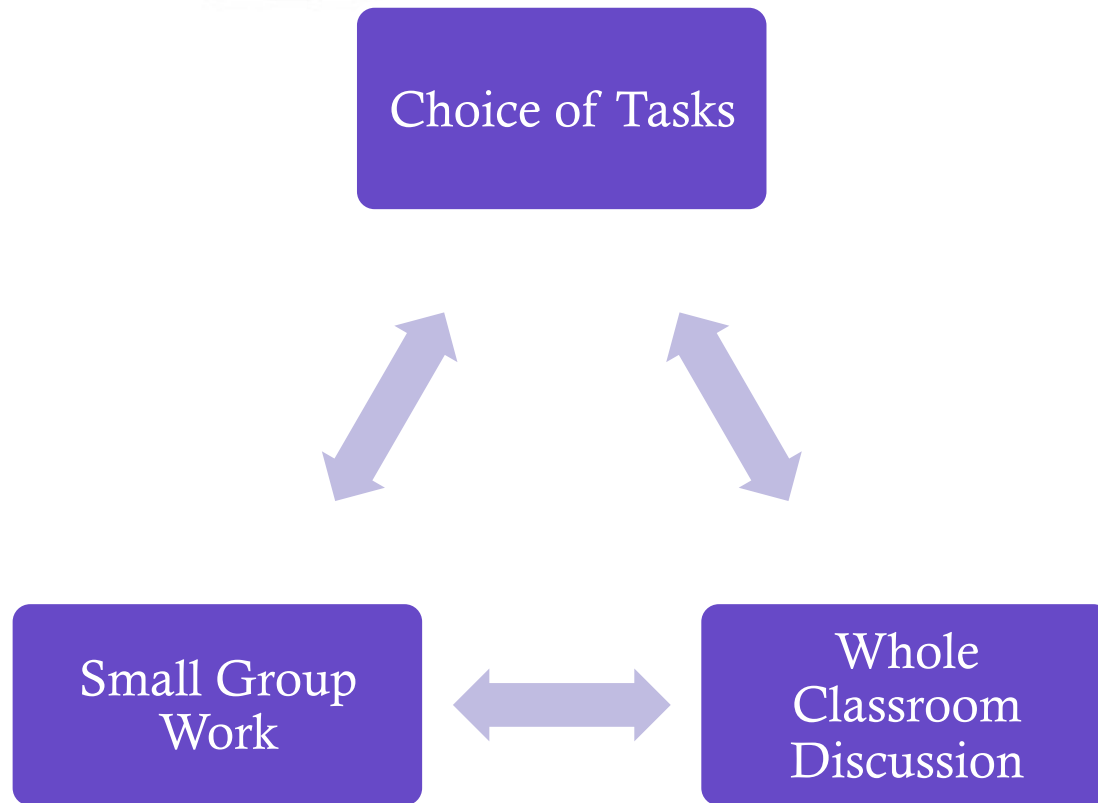
# Classroom Set-Up



# Overview of Fall 2013 Class

Episodes	2-4	5-9	9-12	13-18
Topic	Nature of quantitative unknowns	Equal sharing problems	Representing multiplicative relationships between unknowns	Reasoning with ratios

# Overview of Episode Structure



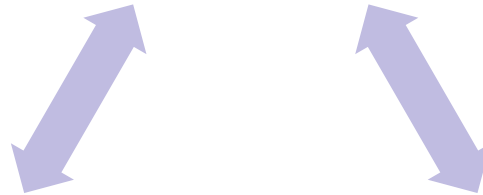
# Episode 11

- ◆ Students had worked on the Corn Stalk Tomato Plant Height Problem at the end of Episode 9, finishing in Episode 10
- ◆ We were poised to discuss the problem at the start of Episode 11.
- ◆ Goals of whole classroom discussion (initially):
  - ◆ Share/broadcast student ideas
  - ◆ Recognize similarities in thinking, pictures, and equations
  - ◆ Identify differences in thinking, pictures, and equations

# Episodes 9-11

Episode 9 →  
Oct. 8, 2013

Choice of Tasks



Episode 10 →  
Oct. 10, 2013

Small Group  
Work



Whole  
Classroom  
Discussion

← Episode 11  
Oct. 15, 2014

# Goals in showing Episode 11

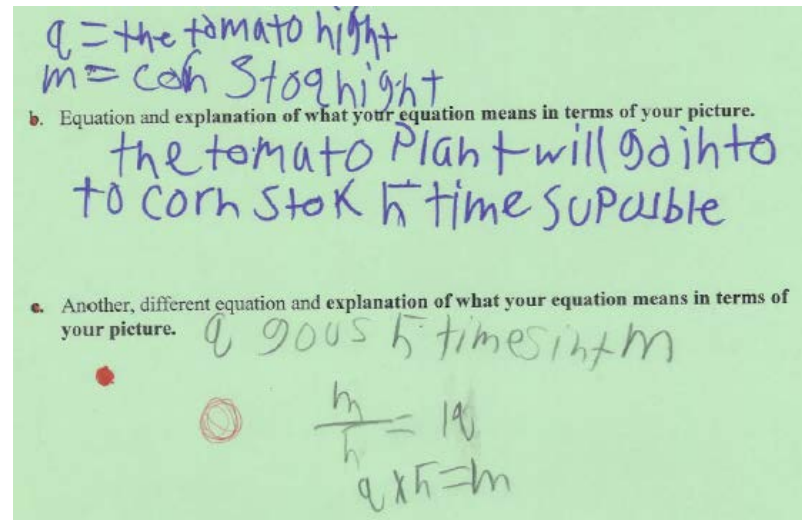
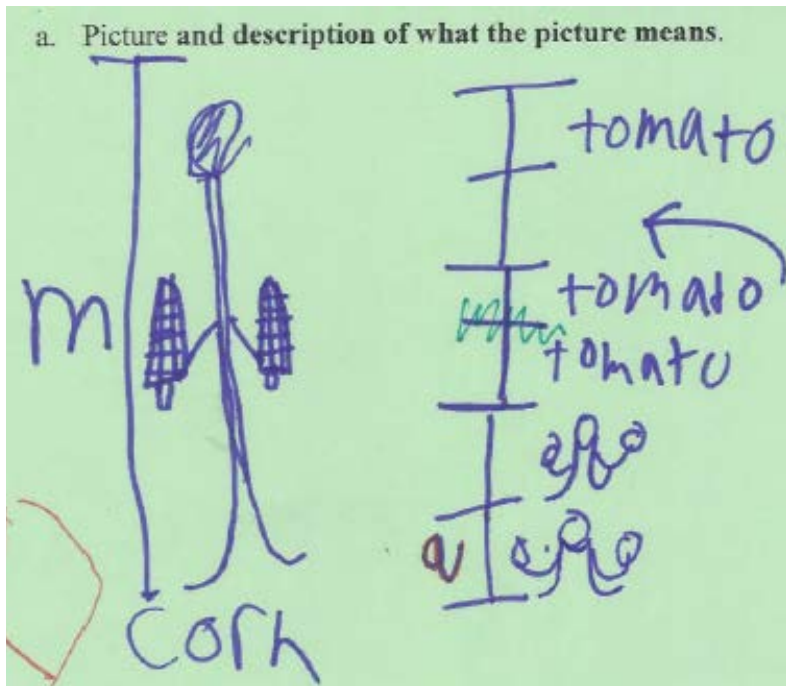
- ◆ Demonstrates ways of thinking that we needed to tailor instruction to (some of this was anticipated, some not!).
- ◆ Gives a flavor of whole classroom discussion across students with different ways of thinking.
- ◆ Gives a sense of benefits and challenges of differentiated instruction.

# Students in Episode 11

Course	Number of students
Regular 7 <sup>th</sup> grade math class	5
Advanced 7 <sup>th</sup> grade math	2
8 <sup>th</sup> grade prealgebra	1
Algebra (7 <sup>th</sup> & 8 <sup>th</sup> )	1 (8 <sup>th</sup> )



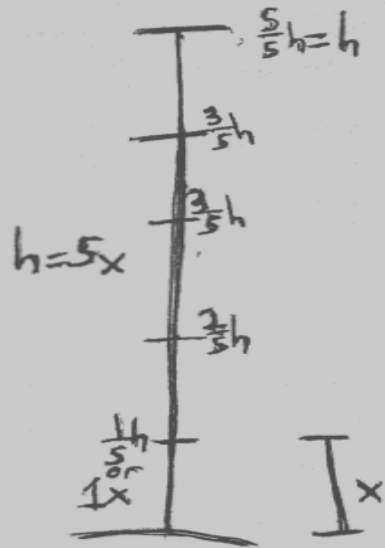
# Student Work: Tim



Tim's equations:  $m/5 = 1q$   
 $q \times 5 = m$

# Student work: Gabriel

a. Picture and description of what the picture means.



Let  $h$  be the height of the stalk  
Let  $x$  be the height of the tomato

$$5x = h \quad \text{or} \quad \frac{1}{5}h = x$$

\*Let  $h$  be the height of the stalk

\*Let  $x$  be the height of the tomato

# Excerpt from Episode 11



# Tim's idea of “approximate”

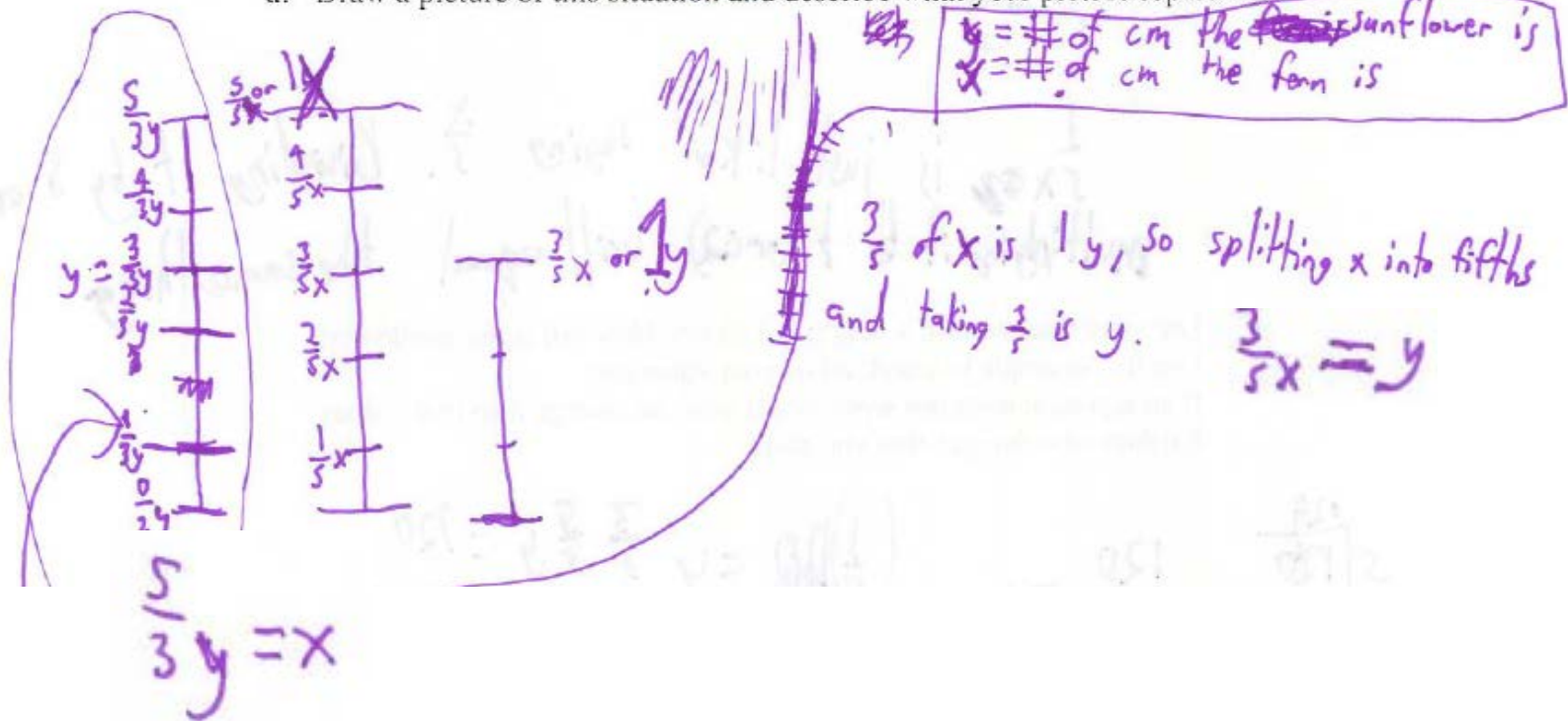
- ◆ Surprised us!
- ◆ When the heights are unknown, then everything is unknown/uncertain, including the relationship.
- ◆ When the heights become known, then the relationship can become known too.

# Who benefits and how?

- ◆ Tim: Got to air, examine, and defend, an idea that might stay hidden in non-differentiated classrooms.
  - ◆ True for others who are thinking similarly to Tim.
- ◆ Gabriel: Had to make his ideas very explicit in discussing them with Tim.
  - ◆ True for others who are thinking similarly to Gabriel.

# Gabriel (and others)

- 1) A fern and sunflower are growing in the garden, each of unknown height. The height of the sunflower is  $\frac{3}{5}$  the height of the fern.
- a. Draw a picture of this situation and describe what your picture represents.



# Reflections on the Whole Classroom Discussion

- ◆ Not expected!
- ◆ Several students other than Tim and Gabriel weighed in and seemed interested in the issue. (Stephanie, Connor, Lucy, Paige...)
- ◆ We have discussed benefits for the students; what learning went on for us?

# Implications for Instruction

- ◆ (1) We revised our approach to working with multiplicative relationships between quantitative unknowns.
- ◆ (2) We focused attention on helping small group and large group discussion function effectively.
- ◆ (3) We started to attend to how to structure students' exposure to different ways of thinking.



# Discussion Questions

1. What prompts you to want to differentiate instruction?
2. What experiences have you had with differentiating instruction?
3. “I would differentiate instruction if \_\_\_\_\_...”

# DI Study Group for Teachers

## 2015-2016

- ◆ If you are interested in exploring more with us, join the IDR<sup>2</sup>eAM study group for classroom teachers. **Structure of study group:**
  1. A professional development workshop in summer 2015.
  2. Monthly meetings during the 2015-2016 academic year.
  3. Preparation for monthly meetings, which include readings, examining student work and bringing it to the meeting, etc.
  4. A commitment to try out some aspect of differentiating instruction in your classroom during the 2015-2016 school year, and to write about your exploration.

Course credit or stipends will be provided. If you are interested in participating, please email Amy Hackenberg at [ahackenb@indiana.edu](mailto:ahackenb@indiana.edu).

# THANK YOU!

- ◆ IDR<sup>2</sup>eAM project website:  
<http://www.indiana.edu/~idream/>
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