

Investigating Differentiated Instruction and Algebraic Reasoning in Middle School

Amy Hackenberg

Fetiye Aydeniz

Ayfer Eker

Robin Jones

from Indiana University-Bloomington



This presentation is based upon work supported by the National Science Foundation under Grant No. DRL-1252575



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 IDR²eAM 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 7th and 8th grade students with diverse cognitive characteristics.
 - ◆ So, in the project we are focused on differentiating instruction for cognitive diversity.

Our IDR²eAM 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.

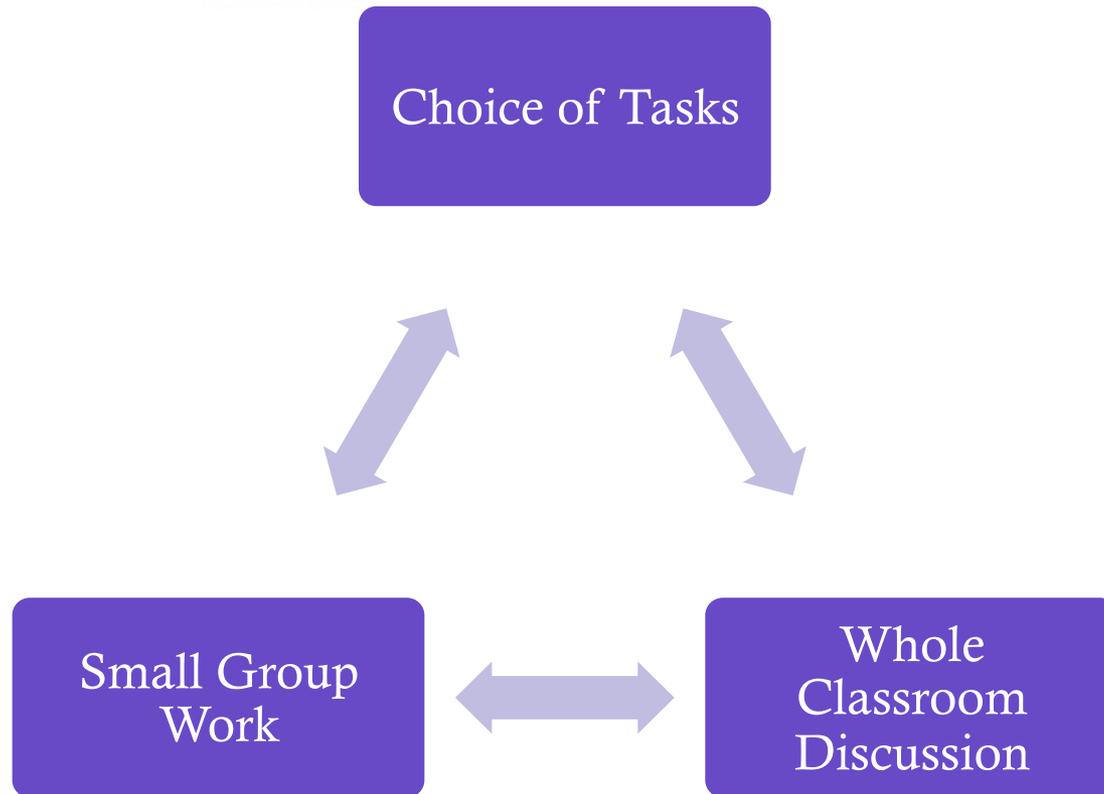
Classroom Set-Up



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



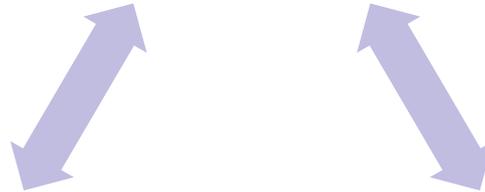
Episode 11

- ◆ 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

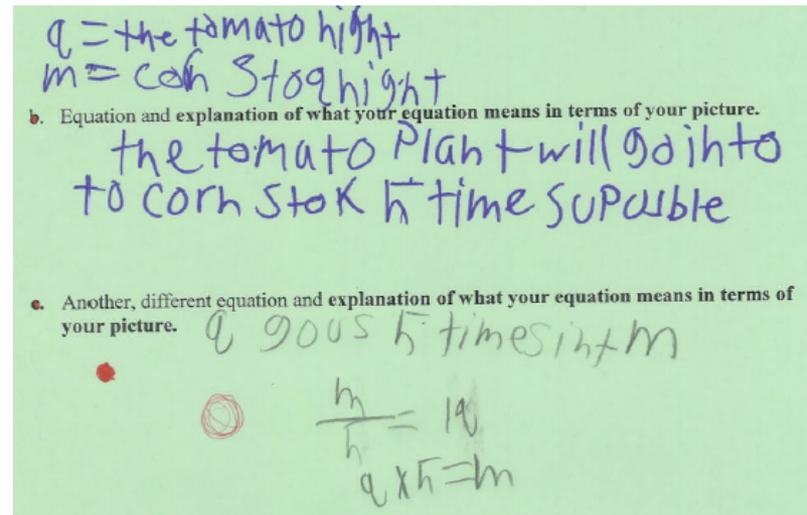
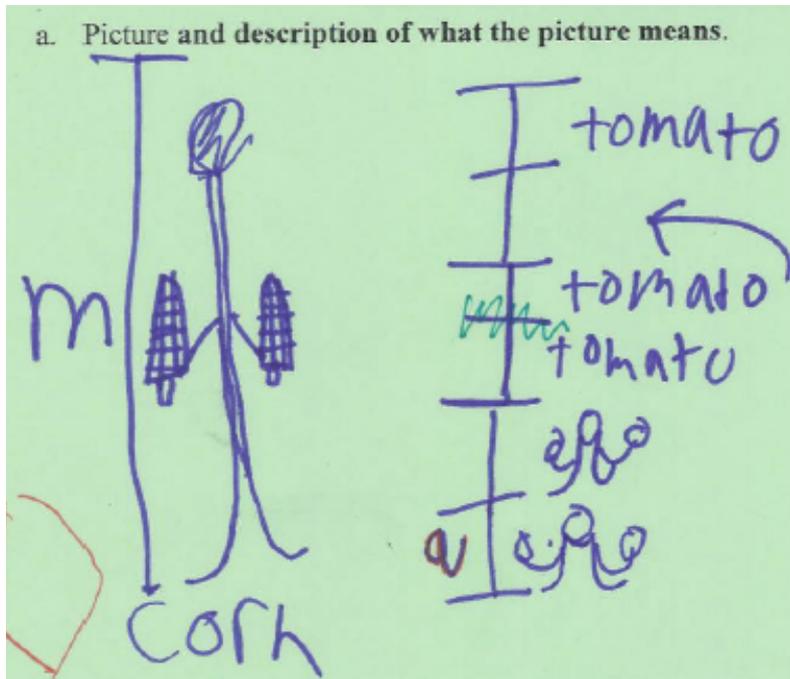
Goals in showing Episode 11

- ◆ 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 th grade math class	5
Advanced 7 th grade math	2
8 th grade prealgebra	1
Algebra (7 th & 8 th)	1 (8 th)

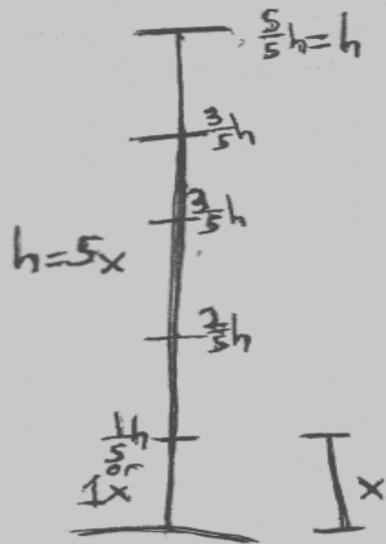
Student Work: Tim



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”

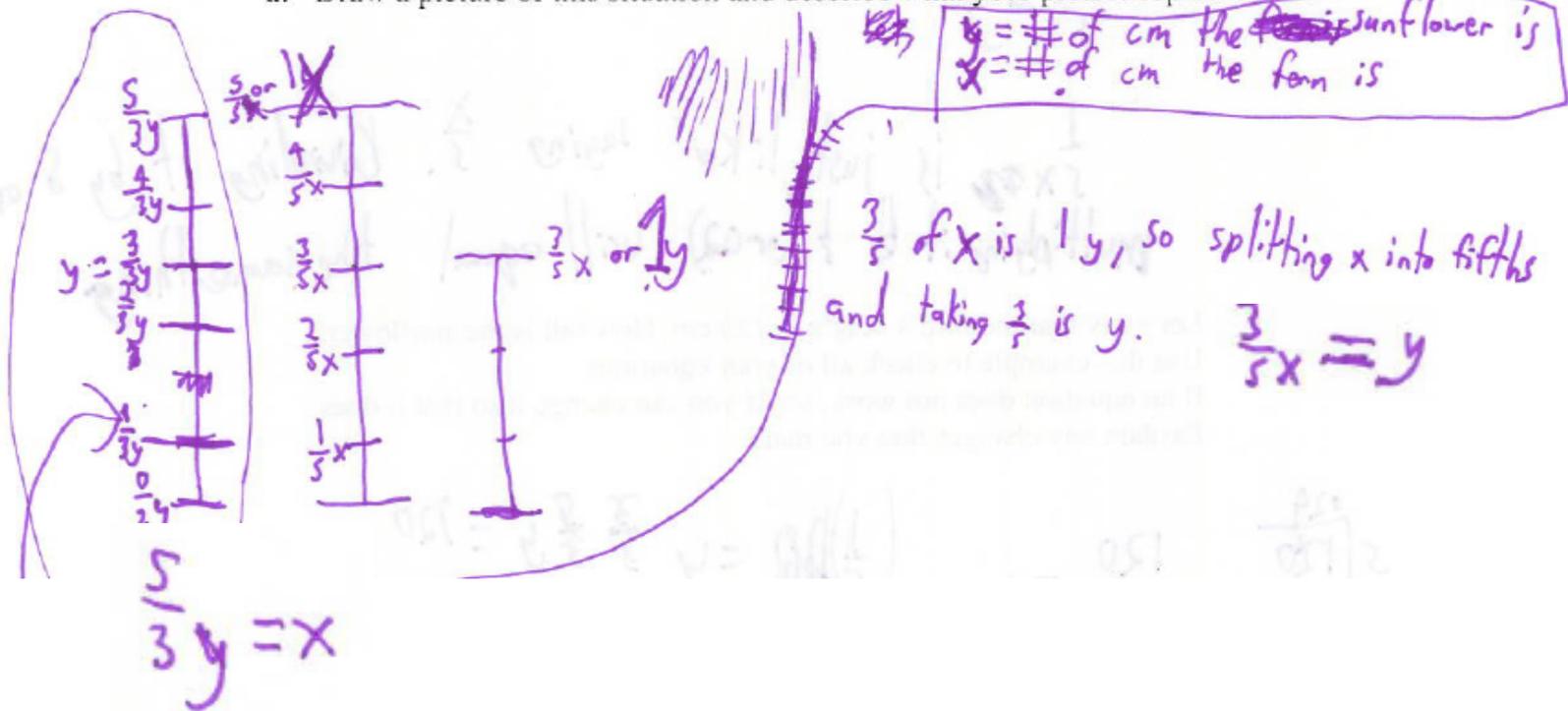
- ◆ Surprised us!
- ◆ When the heights are unknown, then everything is unknown/uncertain, including the relationship.
- ◆ When the heights become known, then the relationship can become known too.

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 IDR²eAM 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.

THANK YOU!

- ◆ IDR²eAM project website:
<http://www.indiana.edu/~idream/>
- ◆ Amy: ahackenb@indiana.edu
- ◆ Fetiye: faydeniz@indiana.edu
- ◆ Ayfer: ayeker@indiana.edu
- ◆ Robin: robijone@indiana.edu