Differentiating Mathematics Instruction with Middle School Students: Findings in Progress

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Overview

- Describe IDR^{2}eAM project
- Share features of DI we are experimenting with
- Give example of this experimentation
- Describe our analytical process and invite advice about it

The IDR^{2}eAM Project

- **I**nvestigating **D**ifferentiated Instruction and **R**elationships between **R**ational Number Knowl**e**dge and **A**lgebraic Reasoning in **M**iddle School

- Research goals:
  - To investigate how to differentiate mathematics instruction for middle school students operating with at least two different levels of reasoning
  - To understand how students' rational number knowledge and algebraic reasoning are related for each of these mathematical thinkers.
  - In later years of the project we will also be investigating how classroom teachers learn to differentiate instruction.

Research Questions

- What are constraints in and affordances for differentiating mathematics instruction for middle school students?
- How do students operating with different multiplicative concepts use their rational number knowledge to develop algebraic reasoning, and vice versa?
- How does DI impact students and teachers, both cognitively and affectively?
- How do teachers develop understanding of and skill at differentiating mathematics instruction for middle school students at different levels of reasoning?

Project Timeline

- **Years 1-2:** Conduct design experiments with groups of nine 7th and 8th grade students with diverse cognitive characteristics.
  - We began retrospective analysis of Year 1 data in summer and fall 2014.
  - We are in our third, iterative experiment in spring 2015.
- **Year 3:** Form a study group with 10-15 middle school classroom teachers in Indiana to explore how to differentiate mathematics instruction in whole classrooms.
  - We will also continue retrospective analysis of Year 1-2 data.
- **Years 4-5:** Co-teach with classroom teachers in classroom design experiments to explore differentiated instruction in topics related to rational numbers and algebraic reasoning.

How do we define differentiated instruction?

- Proactively tailoring instruction to students' different learning needs, such as students' readiness and cognitive abilities, interests, and learning profiles and backgrounds (Tomlinson, 2005) while trying to develop a cohesive classroom community.
- We are focused on students' cognitive diversity; our definition/ characterization of DI is under development.
- An alternative to…
  - Tracking
  - Individualized instruction for all
  - The same instruction for all
  - Labeling one way of thinking as "normal" and others as "advanced" or "slow" and making adjustments for those thinkers.

Features of DI in Years 1-2

1. On-going formative assessment
2. On-going exploration of "big" mathematical ideas and goals (for teacher and project team)
3. Mathematics problems with choices: e.g., Parallel Tasks
4. Flexible and intentional small groups
5. Student work in small groups
6. Whole classroom discussion about a topic, across different problems

Painting a Picture

Parallel Tasks in fall 2013

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.

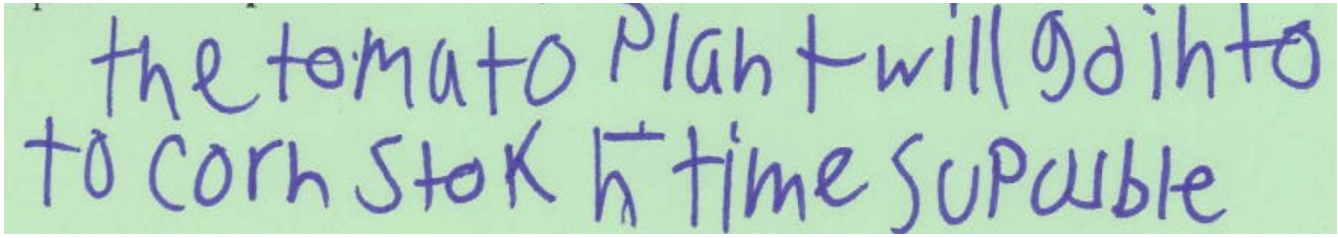
- Draw a picture of this situation and describe what your picture represents.
- Write an equation for this situation that relates the two heights. Explain what your equation means in terms of your picture.
- Can you write another, different equation that relates the two heights? Explain what your equation means in terms of your picture.

Fern Sunflower Heights Problem

A fern and sunflower are growing in the garden, each of unknown height. The height of the sunflower is 3/5 the height of the fern.

- Draw a picture of this situation and describe what your picture represents.
- Write an equation for this situation that relates the two heights. Explain what your equation means in terms of your picture.
- Can you write another, different equation that relates the two heights? Explain what your equation means in terms of your picture.

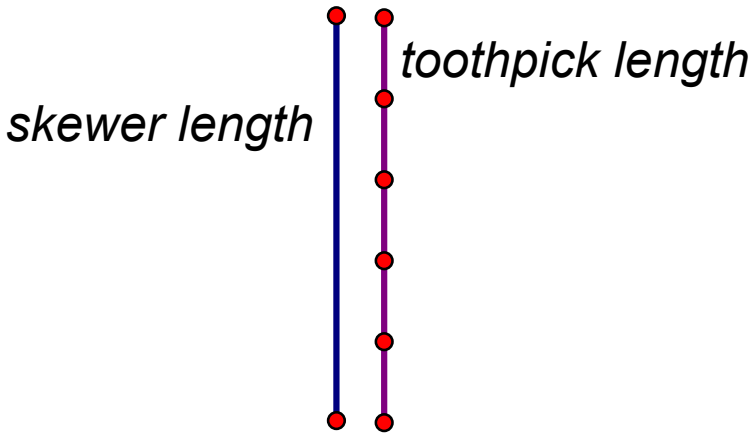
"Approximate" Multiplicative Relationships



- Tim: "Five tomatoes equals approximately corn stalk height."
- The relationship stays as approximate until we measure the heights of the plants and get actual numeric values.
- Similar thinking was also observed in other students' reasoning with multiplicative relationships between unknowns.

Change in Approach

- What problem situation might Tim, and others like him, view as definite?
- Measuring a single unknown with two different measurement units.
- E.g.,: 5 toothpick lengths fit into a skewer length. Imagine measuring the height of the room in each of these units.
- If x = # of toothpicks that fit into height of room and y = # of skewers that fit into height of room, 5y = x



Results?

- Unknown right now.
- Informally/anecdotally:
  - No more mention of "approximate" across two more experiments.
  - However, some students still have difficulty structuring relationships between unknowns in pictures and notation.
  - *Pedagogical benefit:* Students have to think a lot about the meaning of the letters. It is easy to write 5x = y thinking that x is a "toothpick" and y is a "skewer."
  - *Research benefit:* We can see pretty clearly the extent to which the letters represent quantitative unknowns for the students.

Our Analysis Process, initially

- Initially:
  - Student portraits (the beginning of second-order models)
  - Open coding of episodes (video data) by hand to track functioning of DI
    - Open coding using ATLAS.ti (about 2 months)
- Our assessment of initial analysis:
  - Captured student thinking well
  - Captured aspects of teacher-student interactions pretty well
  - Did not seem to capture student-student interactions, which we are now viewing as an important part of DI
- ***Bigger problem:*** Analysis of student thinking was separate from analysis of video for DI…

Insight

- Must keep analysis of student thinking and analysis of DI together…

Seeking Advice

- Is the change we've described from the fall experiment to the spring experiment about differentiating mathematics instruction (for you)?

References

- Tomlinson, C. A. (2005). *How to differentiate instruction in mixed-ability classrooms* (2nd ed.). Upper Saddle River, NJ: Pearson.

THANK YOU!

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