Investigating Differentiated Instruction in Middle School

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IDR^{2}eAM

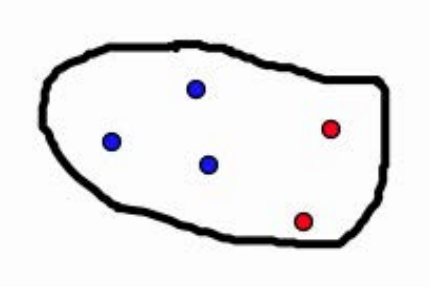
- Investigating Differentiated Instruction and Relationships between Rational Number Knowledge and Algebraic Reasoning in Middle School
- Differentiating instruction = Proactively tailoring instruction to students' different needs, such as students' readiness and cognitive abilities, interests, and learning profiles and backgrounds (Tomlinson, 2005)
- *Purpose of IDR^{2}eAM:* To investigate how to differentiate mathematics instruction in middle school for students with different key cognitive characteristics

Experience/Interest in DI?

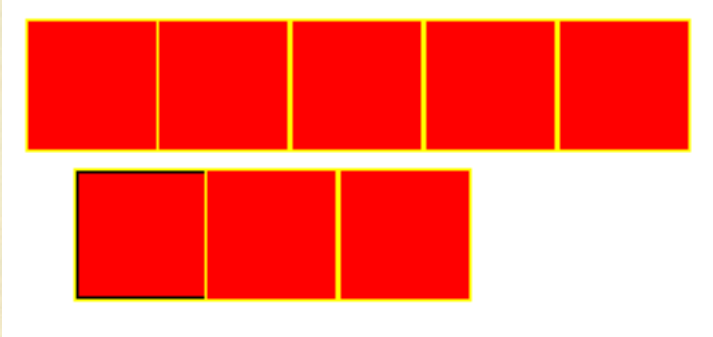
- What experiences have you had in differentiating instruction in your classroom?
- What interest do you have in differentiating instruction in your classroom?

Students' Cognitive Characteristics with Fractions

- Fractions as solely parts out of wholes

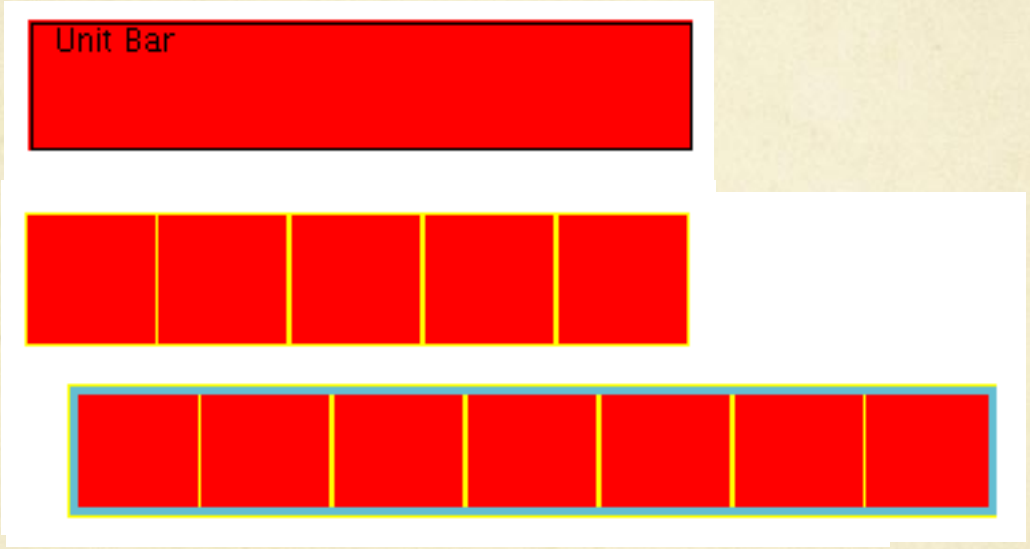


- Fractions as an extent (a quantity such as length)



Student's Cognitive Characteristics with Fractions

- Fractions as quantities and multiplicative relationships: any fraction is a multiple of a unit fraction



Years 1-2

- After school math class for nine 7th and 8th grade students with diverse cognitive characteristics
  - Occurs each semester (4 classes total over 2 years)
  - 9 weeks, 18 sessions
  - Video-recorded with 3 cameras and Screenflow software
- Selection of students based on classroom observations, initial interview, math worksheet

Years 3-5

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

Questions Under Investigation

- (1) How does differentiating mathematics instruction function with middle school students?
- (2) How do students with different key cognitive characteristics use their rational number knowledge to develop algebraic reasoning, and vice versa?
- (3) How does differentiated instruction impact students and teachers, both cognitively and affectively?
- (4) How do teachers develop understanding of and skill at differentiating mathematics instruction for middle school students with different key cognitive characteristics?

Two Goals

- Tailor instruction to students' needs
- Develop cohesive classroom community

Tailoring Instruction: An Example

- Set-up:
  - Use of **parallel tasks** to provide choice
  - Work on problems that follow-up on students' work with parallel task choice, a form of **tiered instruction**

Parallel Tasks

- I. *Weight of Candy Bars Problem.* Ming has five identical candy bars. Each bar weighs *h* ounces. Draw a picture of what 1/7 of all the candy looks like. How much does 1/7 of all the candy weigh? Explain your drawing and your answer.
- II. *Sharing Candy Bars Equally Problem.* Ben has three identical candy bars. Each bar has the same unknown length. How can you share these bars equally with five people? Show how to make the equal shares. Draw out the share for one person and tell how much of a candy bar one person gets. How much of all the candy does one person get? Explain your answers.

Mathematical Topic

- We were using equal sharing problems and taking fractions of multiples of unknowns primarily to see if students would reason distributively. For example:
  - (II) 1/5 of 3 bars is 1/5 of 1 bar + 1/5 of 1 bar + 1/5 of 1 bar, which is 3/5 of 1 bar.
  - Note that here to take 1/5 of multiple bars the student takes that fraction of each bar. More formally : 1/5 x 3 = 1/5(1 + 1 + 1) = 1/5 + 1/5 + 1/5 = 3/5

- However, there are many other good reasons to work on problems like these, which include:
  - Development of fractional knowledge
  - Development of ideas of division in relation to fractions (fractions as quotients)
  - Development of mathematical notation that can be used to represent the process of students' reasoning

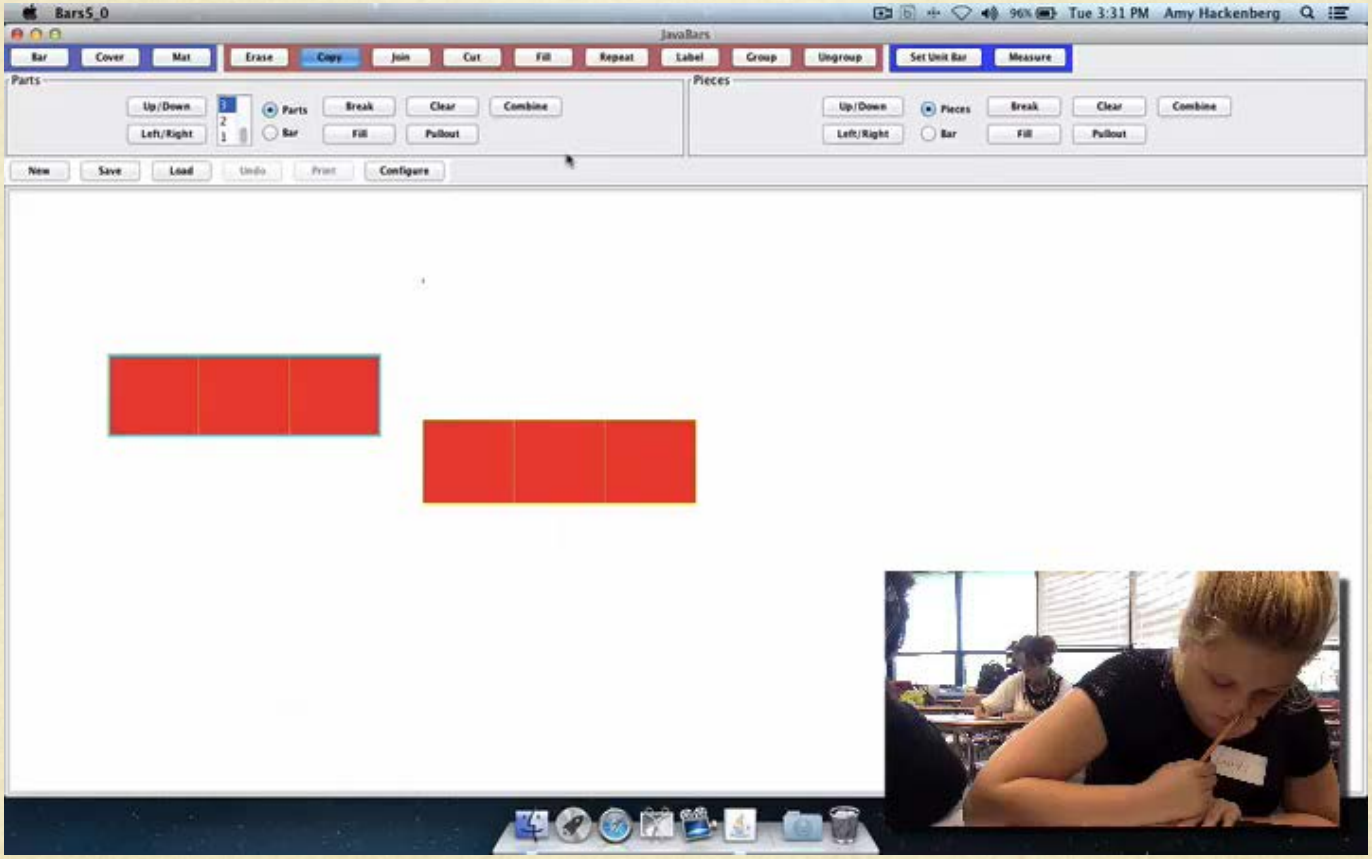
Classroom Set-Up

Clip #1: Lucy and Paige

Problem for Lucy and Paige

- Initially they had chosen to work on **Parallel Task II**, sharing 3 candy bars equally with 5 people.
- *Their current problem:* There are three bakers this morning, and just two cookie dough logs.
  - How can you share these logs equally with three bakers? Show how to make the equal shares. Draw out the share for one baker.
  - How much of a log does one baker get? How much of all the dough does one baker get? Explain your answers. You can use paper or JavaBars.

Debating the amount of one baker's share

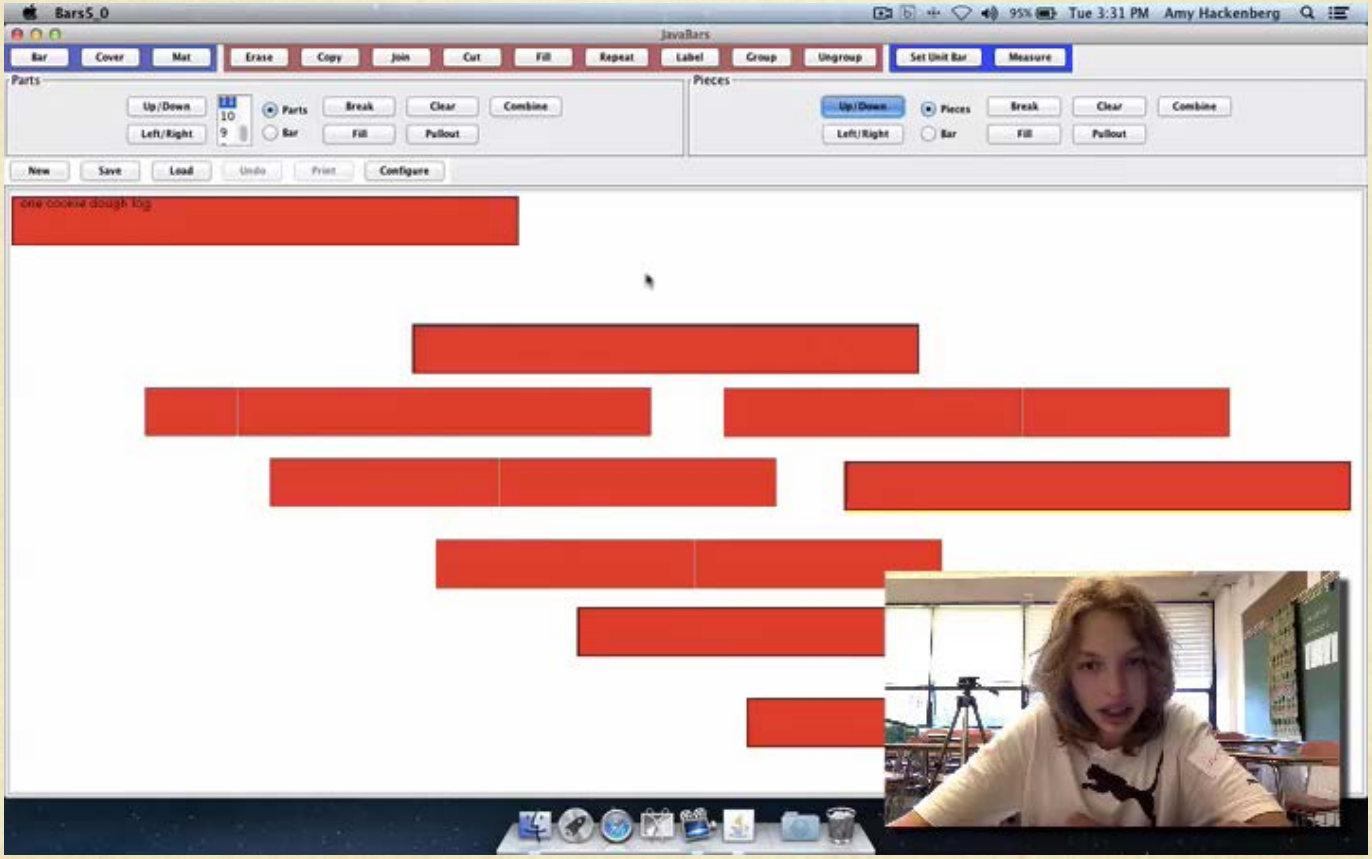


Clip #2: Samantha, Gabriel, & Martin

Problem for Samantha, Gabriel, and Martin

- Initially they had chosen to work on **Parallel Task I**, taking 1/7 of the weight of 5 candy bars, each of which weighed *h* ounces.
- *Their current problem:* This morning the bakers have eight cookie dough logs, each of weight *m* ounces. They want to find the weight of 1/11 of that amount. Draw a picture of what 1/11 of all the dough looks like, but do not join the logs end to end (they don't fit on the screen). How much does 1/11 of all the dough weigh? Explain your drawing and justify your answer.

Clip #2: Samantha, Gabriel, & Martin



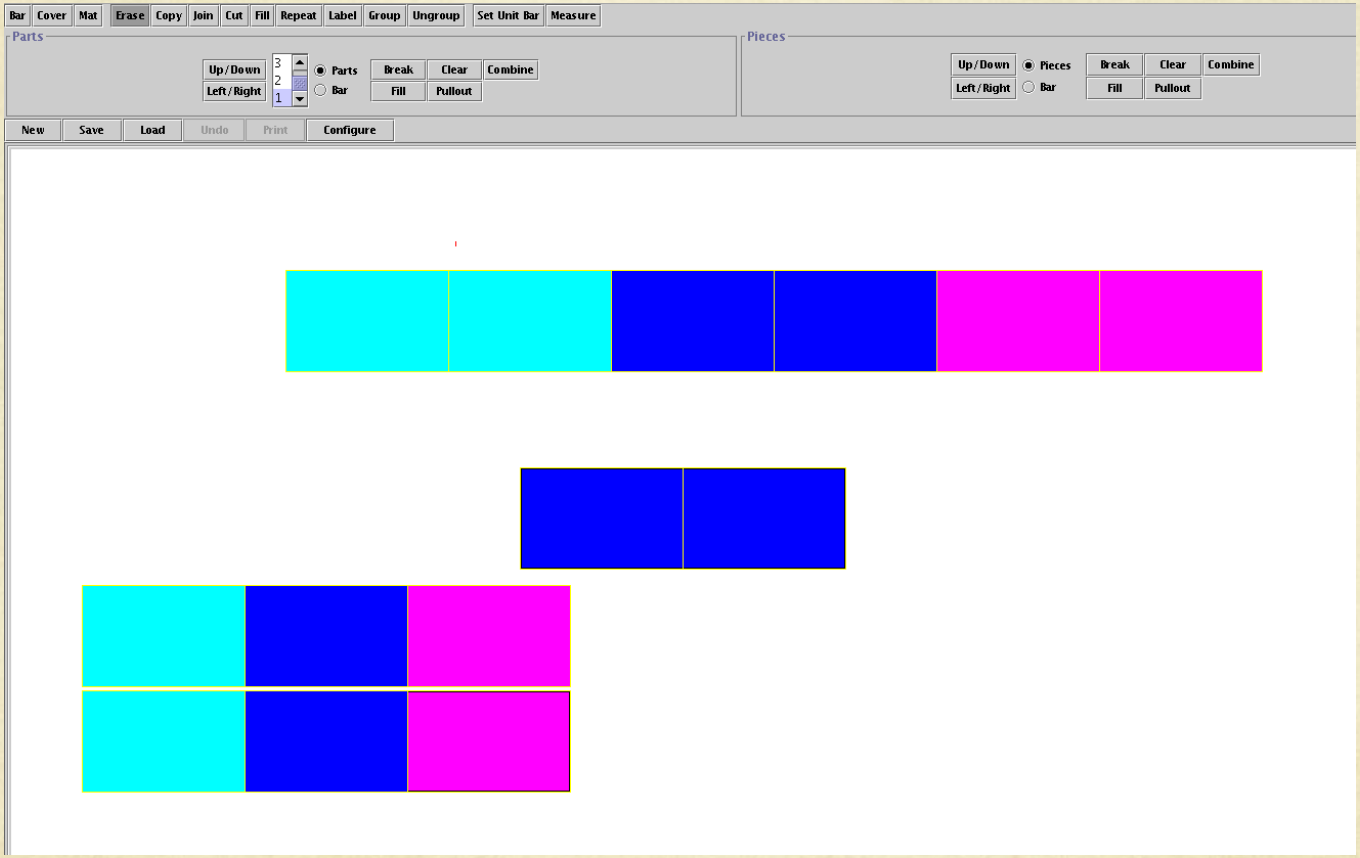
What we think this shows...

- Similar topics of discussion across groups
- Different levels of detail and focus:
  - Paige and Lucy were discussing how to think about the share in relation to 1 log (one view was under debate)
  - Martin and Gabriel were discussing how to they were developing the idea that 1/11 of 8*m* is 8/11 of 1*m*, so they had developed both views

Developing Classroom Community, an Example

- Set-up:
  - Whole-class discussion at the next class meeting
  - Each student had a handout of the drawings from each group
- Foci of discussion:
  - How did each group think about their problem?
  - What are common patterns in ways of thinking or common issues across groups?

Paige and Lucy's Final Picture



Clip #3: An Example

What we think this shows...

- Not supposed to show perfection—not all students besides Paige and Lucy were necessarily engaged, although some were (Connor)
- Is supposed to show conversation about issues that they had been grappling with, and that became a topic for all to consider
- How challenging (and potentially productive) it can be to understand someone else's thinking in a discussion

Issues with DI include...

- Norms for what is fair and norms for working independently
- Flexible grouping
- Level of visibility of differentiation
- Identification of Big Ideas in instruction

THANK YOU!

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References for DI

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- http://differentiationcentral.com/