CRATE PROBLEM

Please take a couple minutes to work on the “Crate Problem” and “Partial Crate Problem” on your handout.

If you have time before we start, discuss it with those around you and consider how middle school students might explain their work on this task.

TIERED INSTRUCTION: ONE STRATEGY FOR DIFFERENTIATION IN MIDDLE SCHOOL

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Who We Are

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- Former middle & high school teacher (9 years)
- Associate Professor, IU Bloomington

OUR GOAL TODAY

- Share lessons learned from a teacher-researcher partnership to study differentiating instruction in middle school math classes.

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.

6 years, 3 phases	
Phase 1 (2013-2015)	Amy taught after school math classes to groups of students (3)
Phase 2 (2015-2016)	Teacher Study Group with 15 m.s. teachers from around the state to explore differentiating together
Phase 3 (2016-2019)	Amy and classroom teachers co-taught units in which we designed to differentiate in classrooms (2)

DIFFERENTIATION, TO US

DEFINITION: proactively tailoring instruction to students' mathematical thinking while aiming to develop a cohesive classroom community (Tomlinson, 2005)

TEACHING PRACTICES:

- (1) using research-based knowledge of students' mathematical thinking
- (2) providing purposeful choices and different pathways
- (3) inquiring responsively during group work
- (4) attending to small group functioning
- (5) conducting whole classroom discussions across different thinkers

- (1) and (3) are about the heart of differentiating:
  GETTING TO KNOW STUDENTS' THINKING

SOME PRACTICES FOR DIFFERENTIATING

Providing Purposeful Choices

- **Choice Problems (Land, 2017)**
  - same problem with number choices
  - students choose numbers that are a good level of challenge for them
- **Parallel Tasks (Small & Lin, 2010)**
  - same big idea, 2-3 problems
  - students choose problem

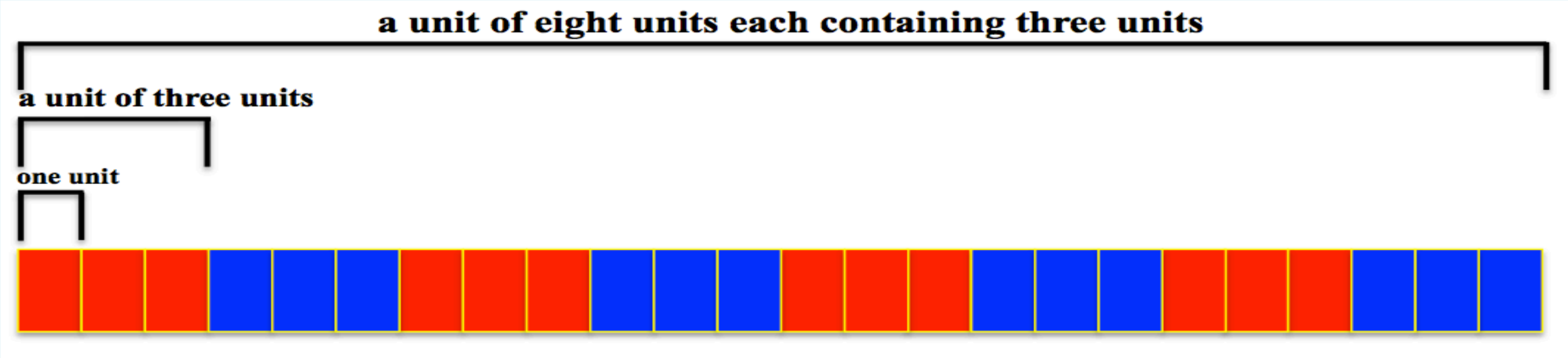
Designing Different Pathways

- **Tiering Instruction –**
  - same big idea
  - different sequences of problems
  - teacher designs/choses based on formative assessment

Inquiring Responsively in Groups

- listen, observe, ask questions
- try to understand how students are understanding problems
- pose questions, adaptations of problems, follow-up problems

UNITS COORDINATION - OVERVIEW

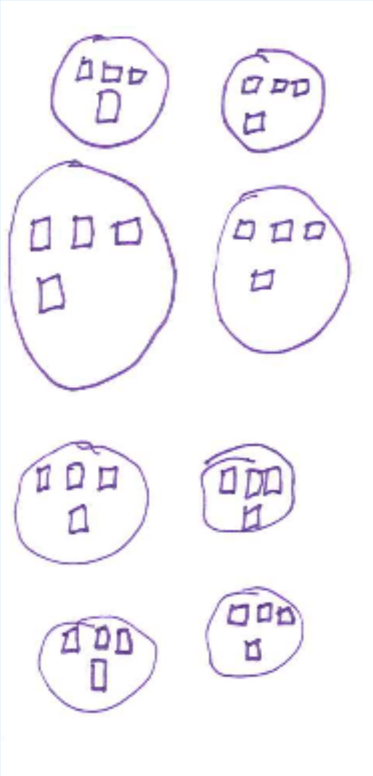


UNITS COORDINATION – 3 STAGES

	Students' unit structures	Students' reasoning on the crate task
Stage 1	Students can take one level of units as given, and may coordinate two levels of units in activity.	Often must "build up from ones" to nest quantities, and cannot keep multiple levels in mind when operating further.
Stage 2	Students can take two levels of units as given, and may coordinate three levels of units in activity.	They can iterate composite units, so a package can be both a package and 4 cans even as they're building up 8 of them into a box. Sometimes conflate boxes and packages when working with a crate.
Stage 3	Students can take three levels of units as given, and thus flexibly switch between three-level structures.	They can usually move flexibly among packages, boxes and crate without conflation.

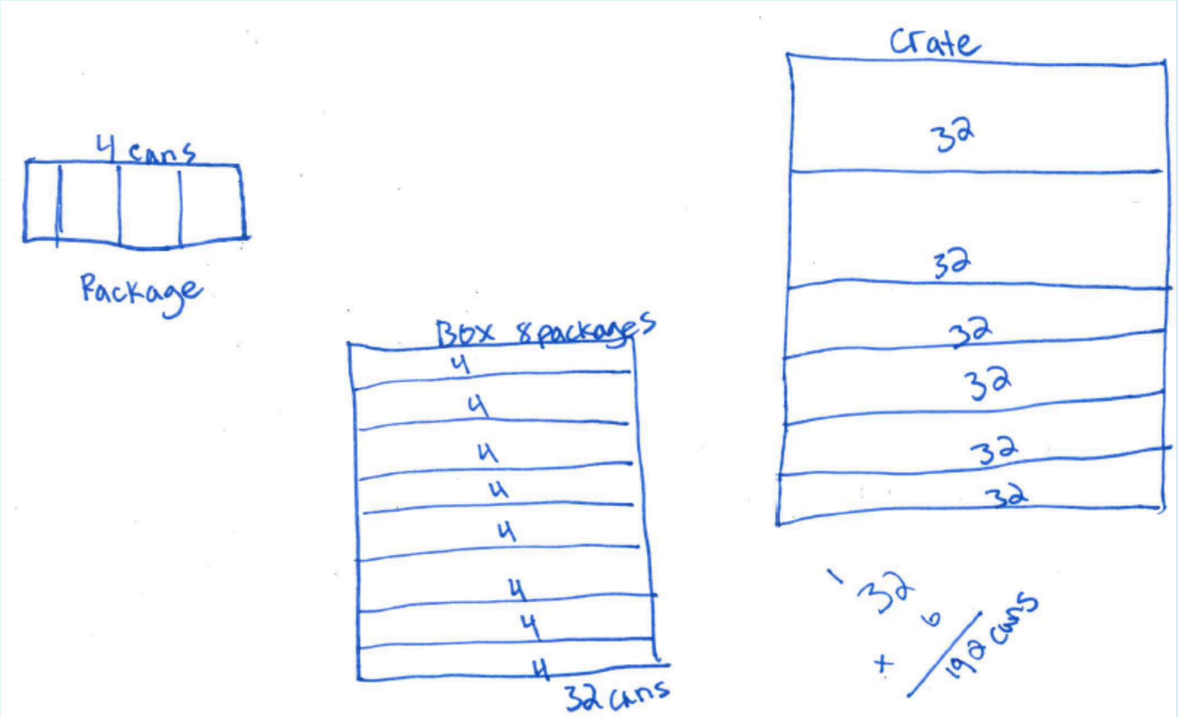
UNITS COORDINATION - ALYSSA

Stage 1	Students can take one level of units as given, and may coordinate two levels of units in activity.	Often must "build up from ones" to nest quantities, and cannot keep multiple levels in mind when operating further.

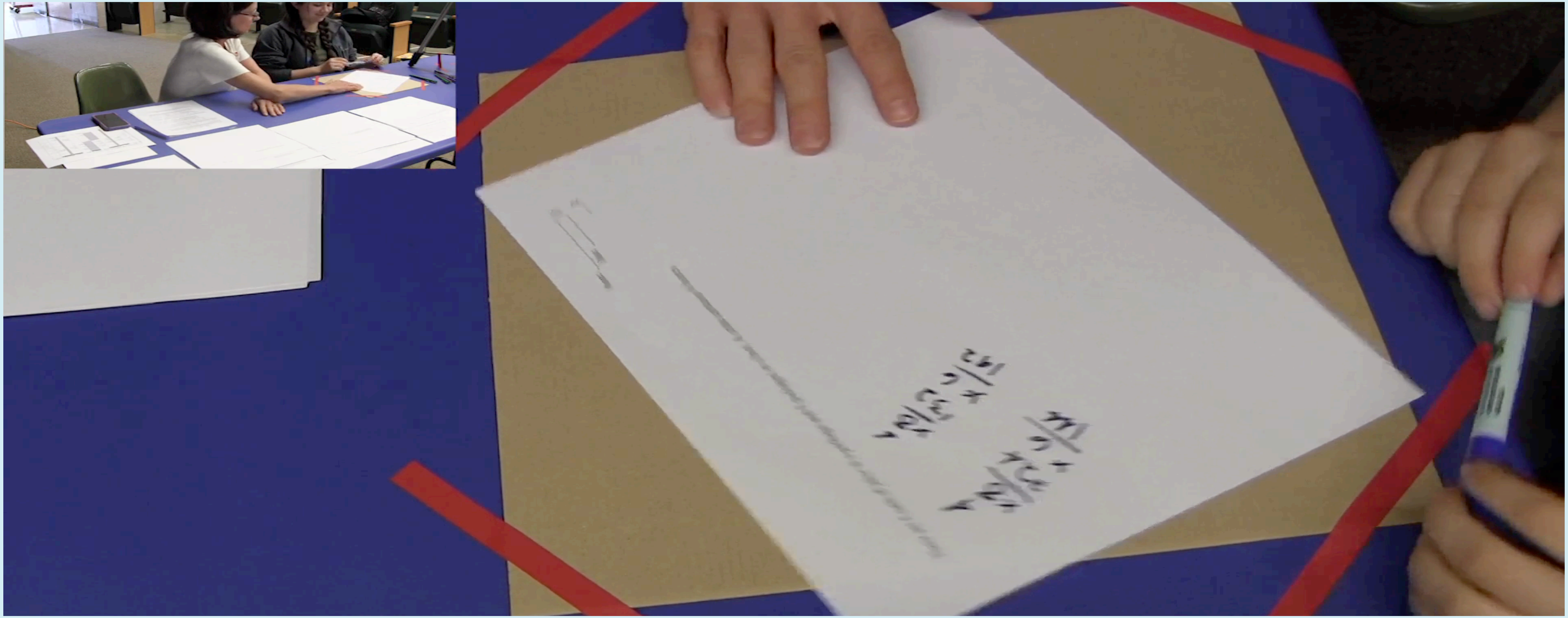


UNITS COORDINATION – JANINE

Stage 2	Students can take two levels of units as given, and may coordinate three levels of units in activity.	They can iterate composite units, so a package can be both a package and 4 cans even as they're building up 8 of them into a box. Sometimes conflate boxes and packages when working with a crate.

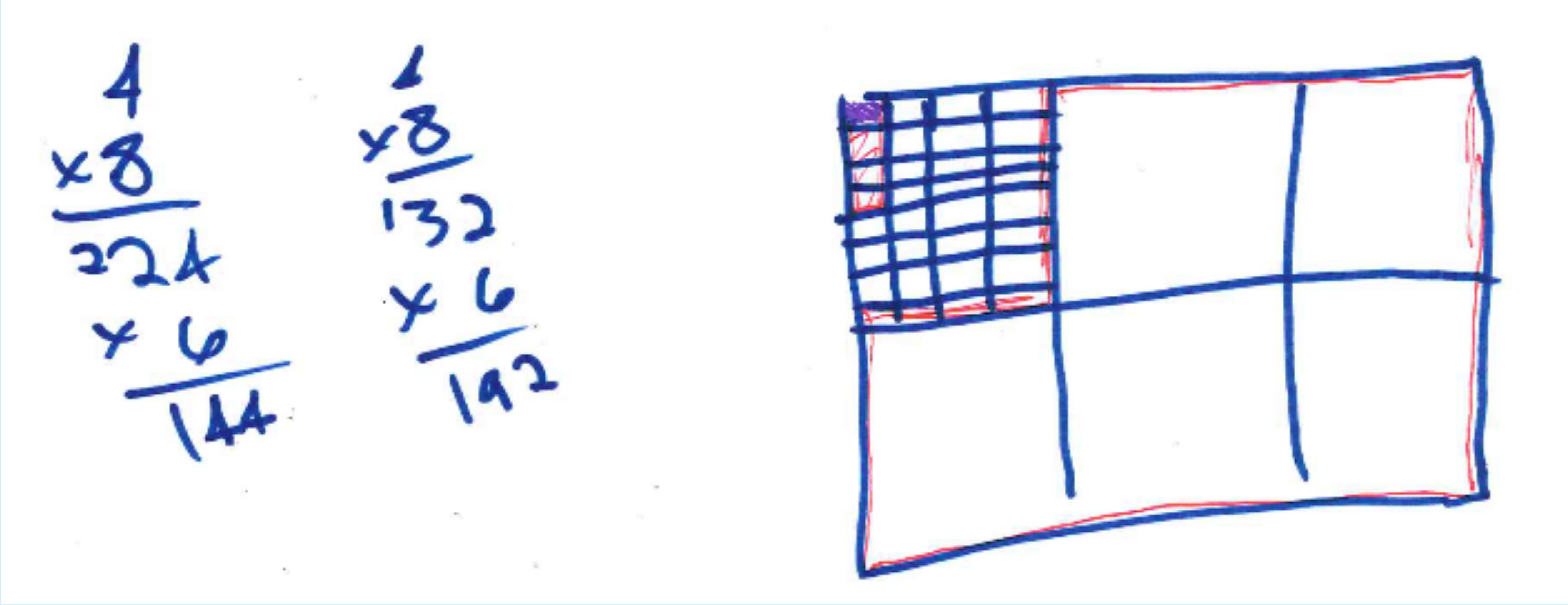


UNITS COORDINATION – JOANNA



UNITS COORDINATION – JOANNA

Stage 3	Students can take three levels of units as given, and thus flexibly switch between three-level structures.	They can usually move flexibly among packages, boxes and crate without conflation.



FALL 2017 OVERVIEW

- Comparing and Scaling unit from the Connected Mathematics Project (CMP 3):
  - Ratios and proportional reasoning
  - 18 regular 7th grade mathematics students (plus 2 not participating)
    - 5 stage 1, 9 stage 2, 4 stage 3
  - 26 days
  - 3 investigations
- Unit:

Inv.	Topic	Days	Differentiation strategies used
1	Quantifying orangeyness	1-8	Individual students pulled out from heterogeneous groups (jigsaw-ish), tiering instruction, norms
2	Quantifying speed	9-18	Tiering instruction, whole class discussion across different thinkers/problems
3	Understanding percentages	19-26	Choice of project topics, tiering within topic

PATTI'S PERSPECTIVE

Where did differentiating happen?

- Before the lessons (and between lessons)
  - Lesson Planning
  - Task Selection
  - Plan, Plan, Plan
  - Remediation/Enrichment
- During the lessons
  - Questioning
  - Class Discussion
  - Be a Kid-Watcher
- What continued after the unit was over?
  - Teacher-selected numbers for the same problem
  - Intentional question planning/Differentiated questioning during class
  - Choice activities

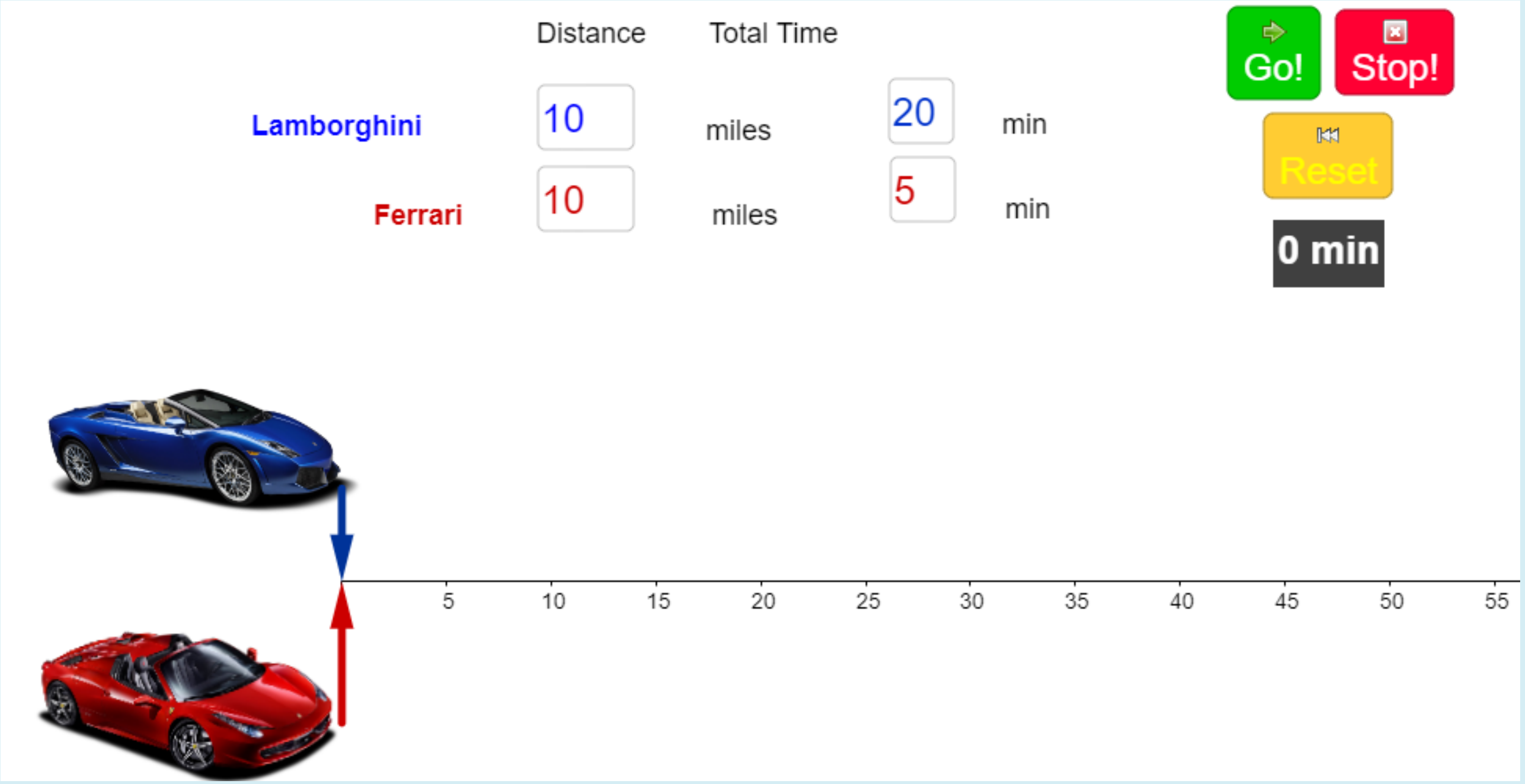
AMY'S PERSPECTIVE

- Why co-teach together rather than observe?
  - Need to be part of the interaction (teaching as a method to investigate learning)
  - Need to have multiple people learning together
- What made Comparing and Scaling a good unit for differentiation?
  - Multiplicative reasoning
  - Inquiry-based
- What did you learn about differentiation in running this experiment?
  - All stages of thinkers present in regular 7th grade classes (and 8th!)
  - Providing choices and different pathways can benefit student learning
  - How helpful it was to start from research-based knowledge, as we did with this unit

TIERING INSTRUCTION

- DEFINITION: designing different problems (or sequences of problems) for different groups of students based on conjectures about what will support students' learning needs (Tomlinson, 2005).
- Usually follows providing students with choices or getting to know student thinking in some way, such as through responsive inquiry

RACES APP



www.geogebra.org: Search Janet Bowers Races

Direct link: https://www.geogebra.org/m/J434Kb54

Try it out!

- Make the red car go slower when both cars travel the *same distance.*
- Make the red car go slower when both cars travel for the *same amount of time*.
- Make the cars travel the same speed when they travel *different distances/times*.

MAKING THE RED CAR GO SLOWER

- Source: Joanne Lobato's Math Talk project, www.mathtalk.sdsu.edu
- Days 9-11
- How do you measure fastness? How do you tell one car is faster?
- Make the red car go slower if:
  - Both travel the same distance
  - Both travel for the same time.
  - Write a general rule for how to make this happen.

- Making the red car go slower when distance values were the same was not problematic.
- Making the red car go slower when time values were the same was harder for some students.

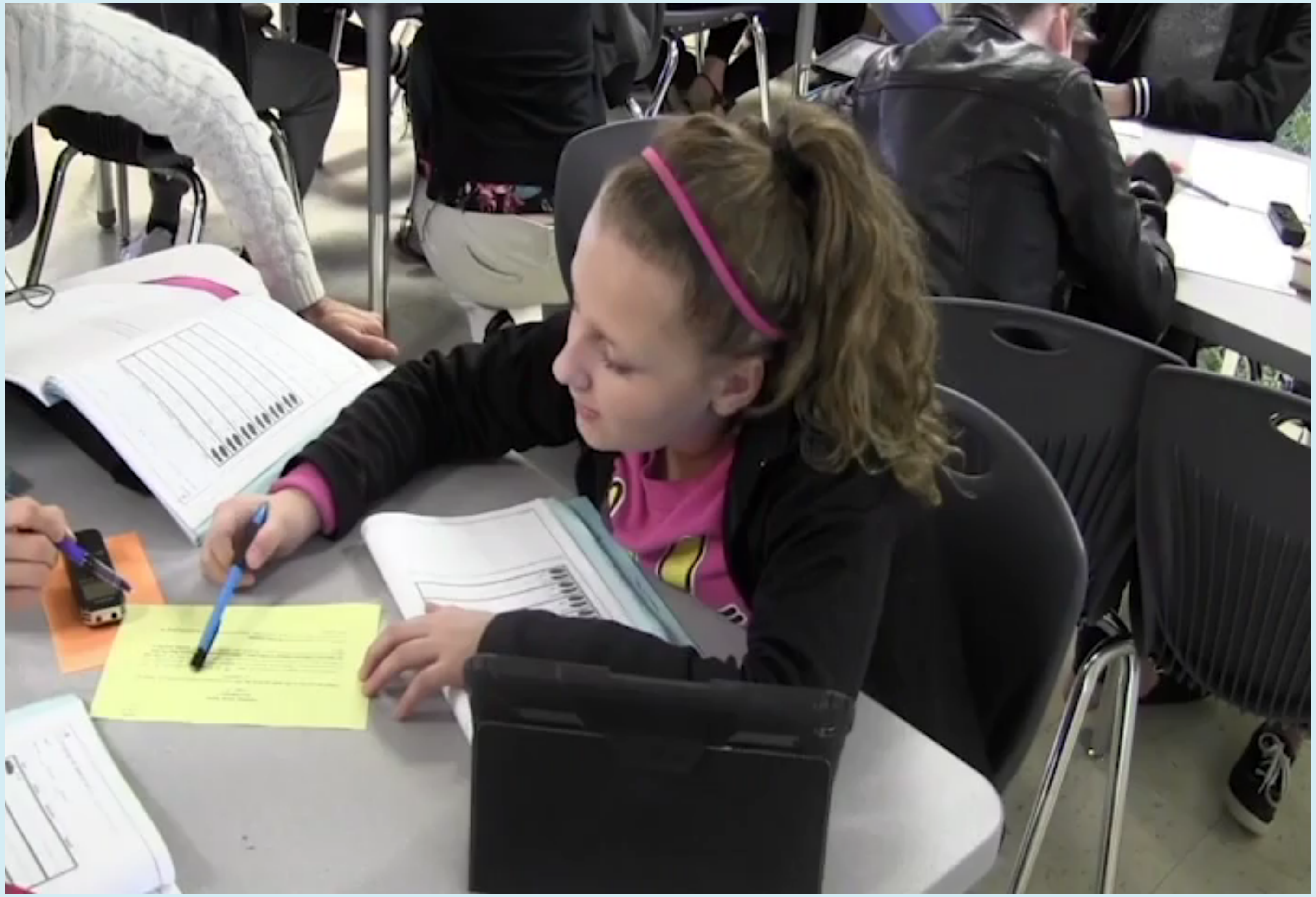
MAKING CARS GO THE SAME SPEED

- Days 12 & 13
- Blue car goes ___ miles in ___ minutes. Make the red car go the same speed.
  - Draw a picture to explain/justify

Tiering plan

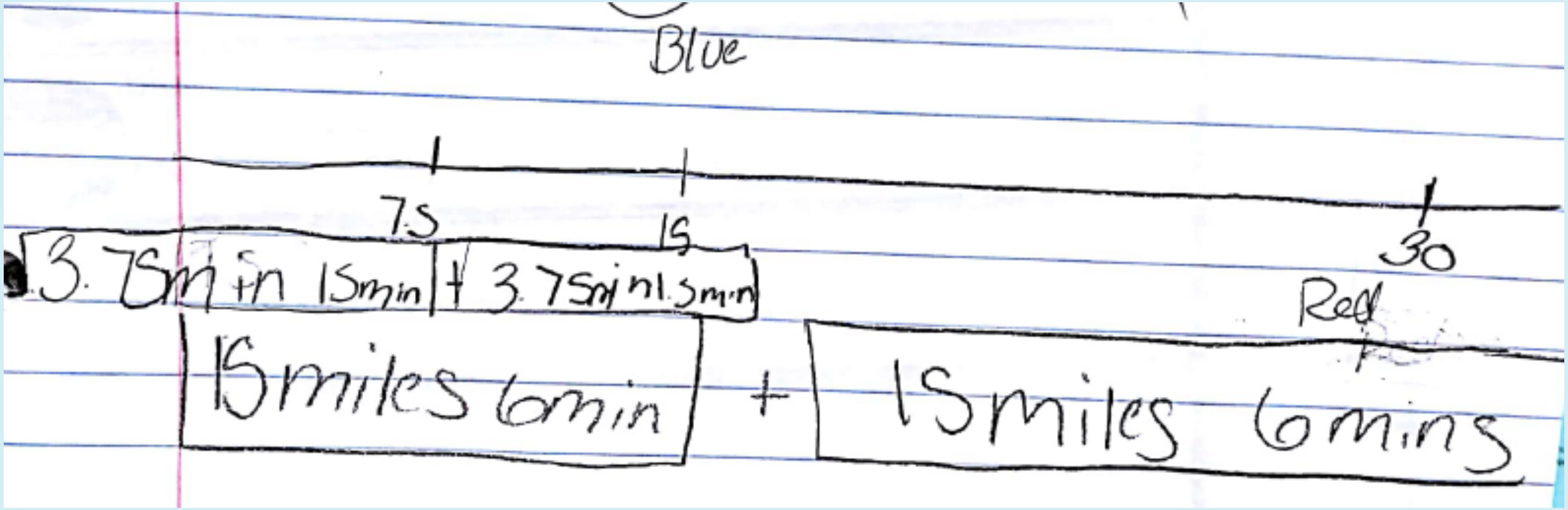
Units structure	Numbers	Reasoning
Stage 1	18 miles in 3 minutes	Whole number unit ratio (6 miles in 1 minute)
Stage 2	15 miles in 6 minutes	Mixed number unit ratio with ½ (2.5 miles in 1 minute)
Stage 3	15 miles in 9 minutes	Unit ratio hard to work with as a decimal (5/3 miles in 1 minute)

MAKING CARS GO THE SAME SPEED: SARA & LISA
15 MILES IN 6 MIN



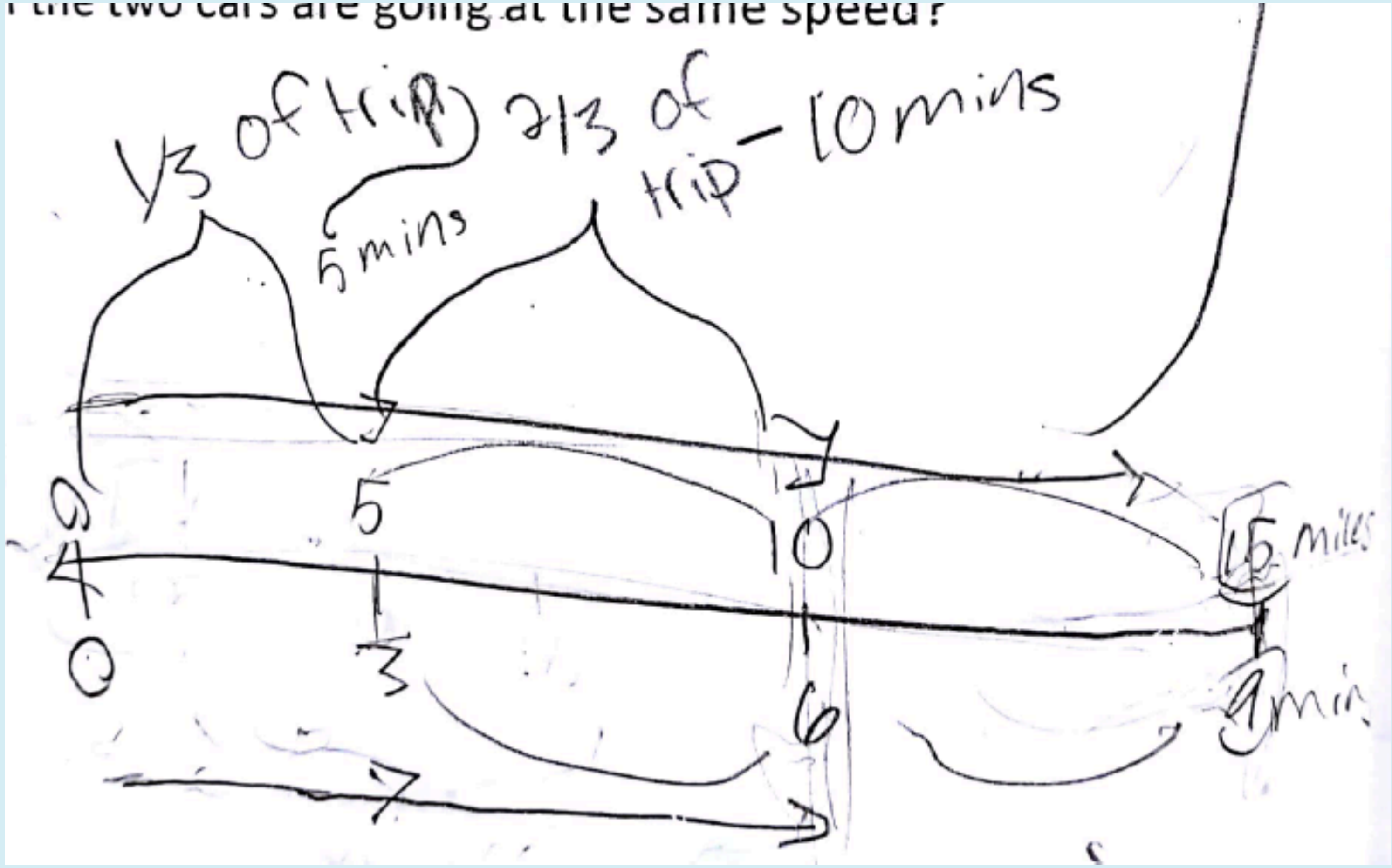
MAKING CARS GO THE SAME SPEED: SARA & LISA
15 MILES IN 6 MIN

LISA'S PICTURES
15 MILES IN 6 MIN



JOANNA'S GROUP
15 MILES IN 9 MIN

JOANNA'S PICTURE
15 MILES IN 9 MIN



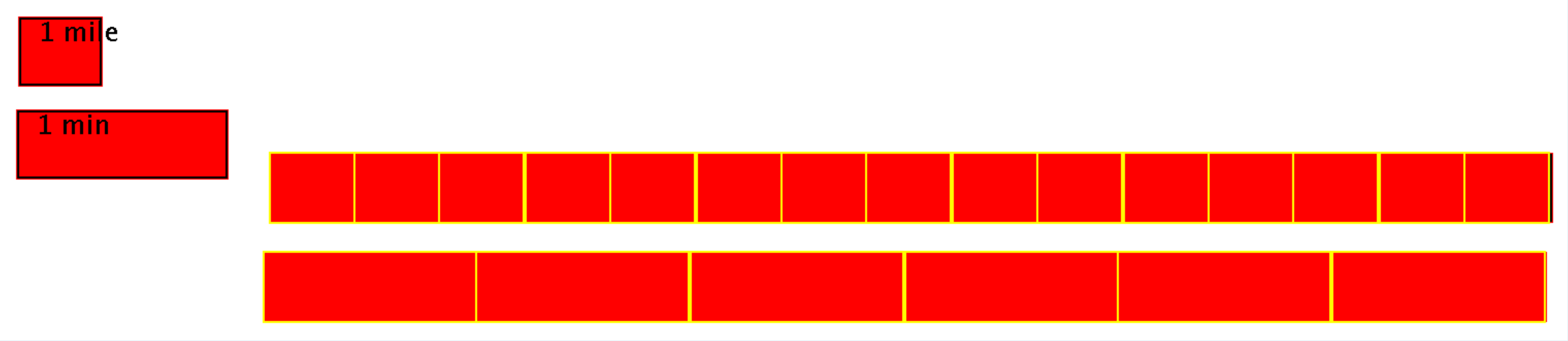
COMPARING THE GROUPS

- Both groups solved their problem. **What were their ways of thinking and how were they different?**
  - Joanna:
    - Multiples of the least common factors of the given values would produce the same speed.
    - She knew this was general and could produce many same speed pairs. She never considers doubling, but that is included in her general solution.
  - Sara and Lisa:
    - Doubling (and then tripling, quadrupling) was a process that became general for them on Day 12 (not right away).
    - But they did not create smaller distance-time pairs until prompted, and then they only halved. No thirding observed from them or other stage 2 students.
- **What was similar about their thinking?**
  - Neither fully articulated how their pictures showed that the distance-time pairs yielded the same speeds (on Day 13). They both came close.
- **Were the numbers choices good for them?**
  - Joanna: Yes.
  - Sara and Lisa: Yes, but.

…RELATIONSHIPS TO STAGES…

- Joanna:

- Sara and Lisa:



SARA AND LISA, CONTINUED

QUESTIONS?
BRAINSTORM/SHARING

- What’s a topic you will be working on soon with your students?
- How could tiering fit with this topic?
- If you are not sure about tiering, what about making choice problems?
  - What are your rationales for different number choices?

- What resources do you use for finding tasks?
  - We used CMP and Joanne Lobato’s project, mathtalk.sdsu.edu.

RESOURCES

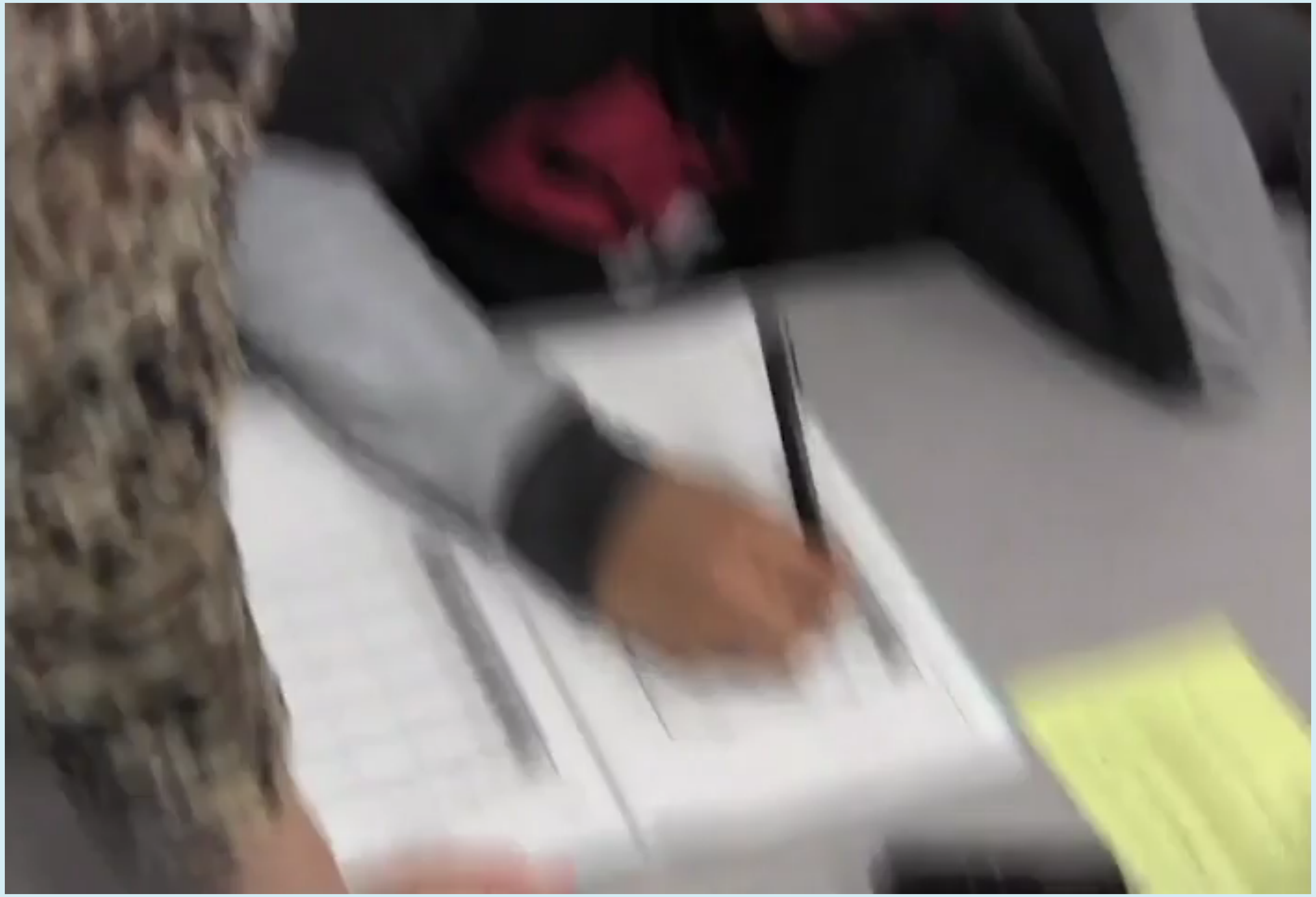
- Races app: https://www.geogebra.org/m/J434Kb54
- Carol Tomlinson's Website: http://www.caroltomlinson.com/
- Joanne Lobato's Math Talk project: https://mathtalk.sdsu.edu/
- Our Idream website: http://www.indiana.edu/~idream

- Heacox, D. (2002). *Differentiating instruction in the regular classroom: How to read and teach all learners, grades 3-12*. Minneapolis, MN: Free Spirit Publishing. Lappan, G., Phillips, E. D., Fey, J. T., Friel, S. N., Grant, Y., & Stewart, J. (2014). *Connected mathematics 3*. Boston, MA: Pearson Education, Inc.
- Laud, L. (2011). *Using formative assessment to differentiate mathematics instruction, grades 4-10: Seven practices to maximize learning*. Thousand Oaks, CA, and Reston, VA: Corwin and NCTM.
- Tomlinson, C. A. (2005). *How to differentiate instruction in mixed-ability classrooms* (2nd ed.). Upper Saddle River, NJ: Pearson.

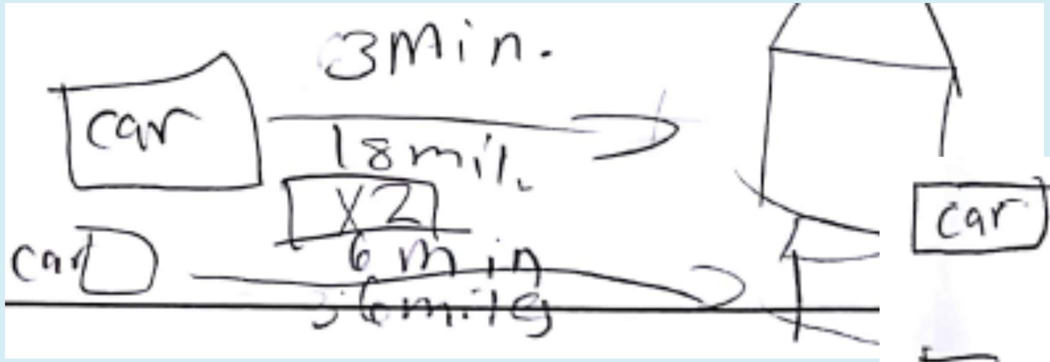
THANK YOU

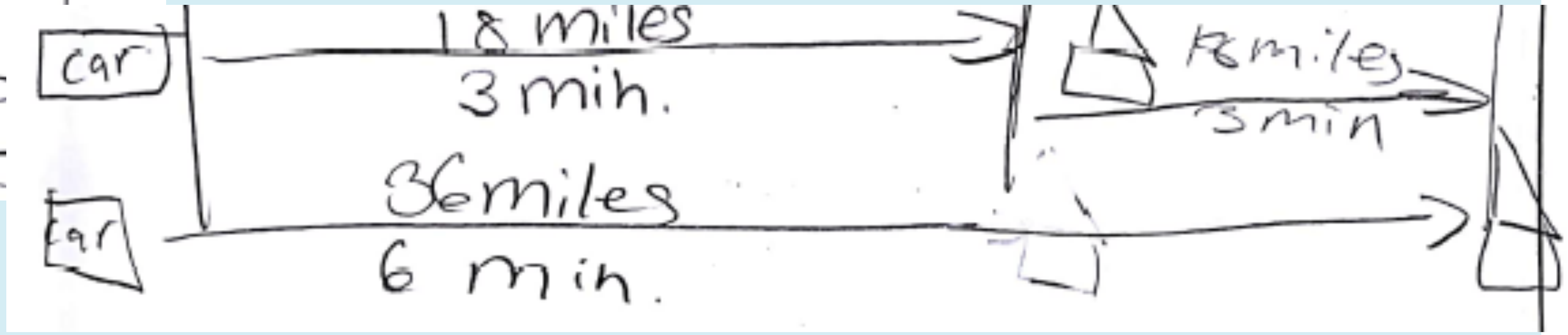
http://www.indiana.edu/~idream/

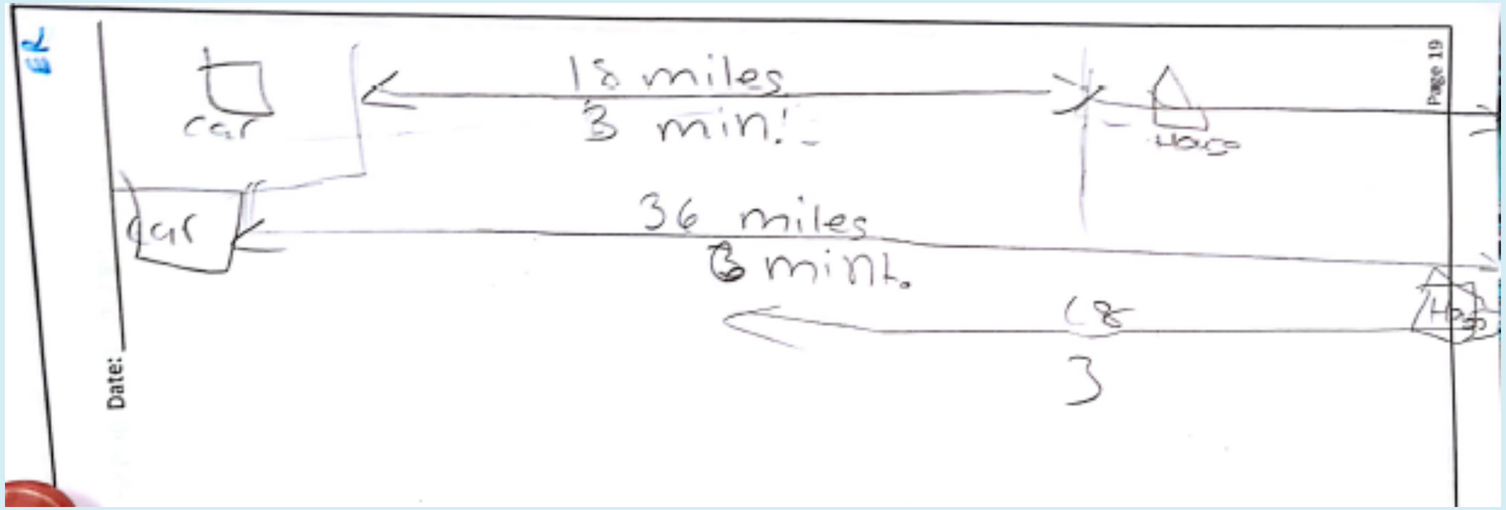
EMILY – DEVELOPING A PICTURE



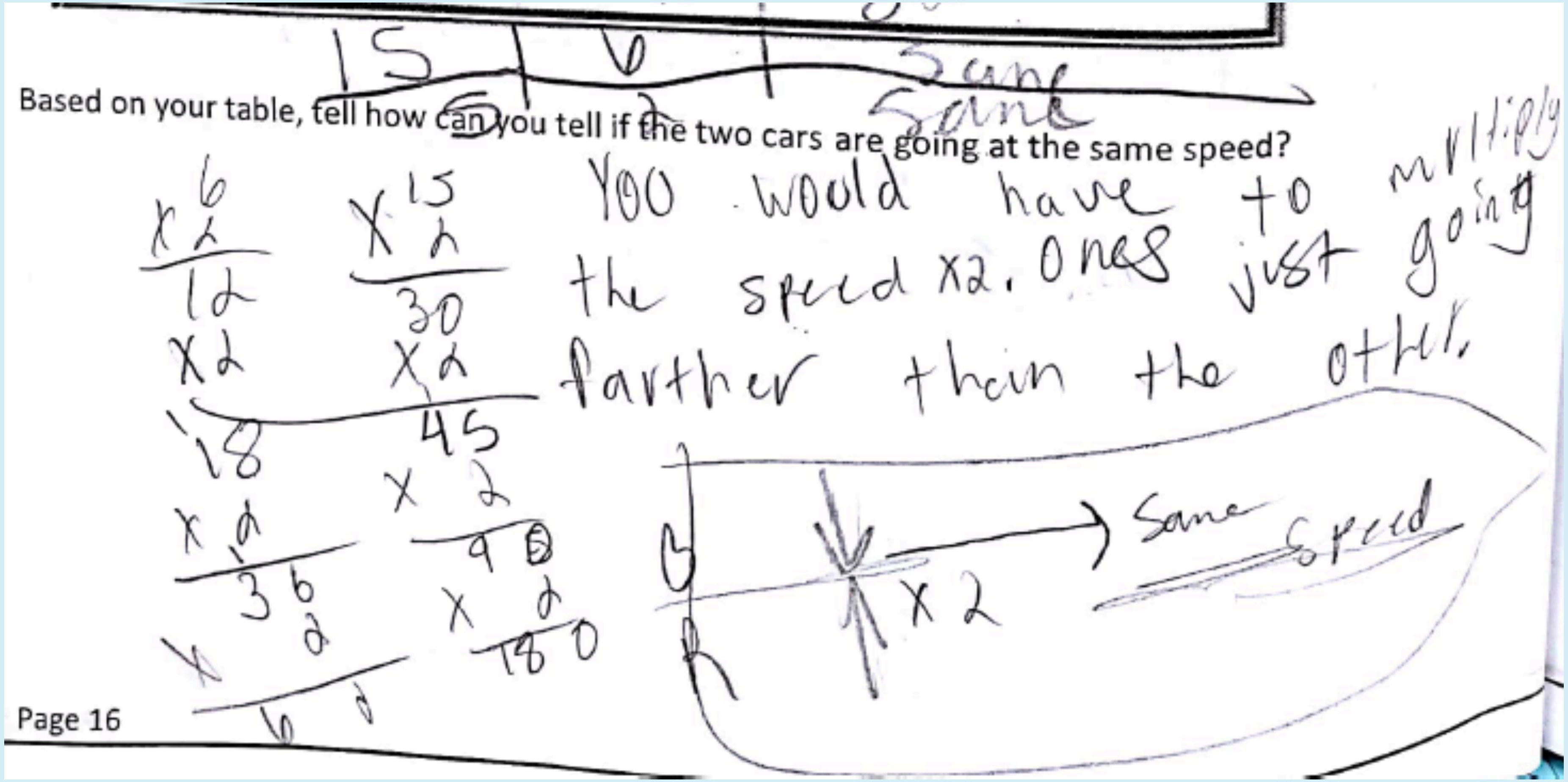
EMILY’S PICTURES







SARA'S PICTURES



MARK’S PICTURE