Professional Development Notes for Linear Equations Unit

***Building buildings***

**Materials**:

***Building Buildings*** instructional sequence

Cline Video

Transcriptions

Cline and Hibbard Lesson Image

Research Practice Briefs

Launching

Questioning

Lesson Imaging[[1]](#endnote-1) book, if desired

**Context of the video**

The video that you will see comes from the first day of a new unit on linear relationships, including writing equations, making sense of rate of change and re-inventing the slope formula. Students begin this unit by imagining themselves as foreman at a construction company overseeing the building of a skyscraper. They interact with pictures, graphs, and equations throughout the instructional sequence, moving from reasoning in the concrete to the abstract. The 8th grade students you will see are in the eighth week of school and attend an inclusion pre-math 1 class (i.e., regular 8th grade math).

Gryphon Middle School is public school located in a suburb of a large metropolitan in the Southeast, United States. The middle school serves approximately 1000 students, 400 above the state average middle school. Demographic data shows that the Gryphon is approximately 51% White, 23% Black, 22% Hispanic and 6% other (including Asian, American or Alaskan Native, Hawaiian or Pacific Islander or multi-racial). 61% of the student population is characterized as coming from low-income families. While it is rated an F school by the State, students make annual growth targets, yet have a low percent proficiency on the State test in mathematics. Students with disabilities, in particular, have <5% proficiency rate.

**Teachers**: Mr. Cline and Ms. Hibbard are in their first year of co-teaching together. Mr. Cline has taught mathematics for 24 years and has a bachelor’s and master’s degree in mathematics and mathematics education, respectively. Mr. Cline is also a National Board Certified teacher. Ms. Hibbard has taught elementary and special education for over 10 years.

**Students**: There are 34 students in this classroom, 21 regular education and 13 with an IEP or 504 plan. Students used *Connected Mathematics Project 3* in their 7th grade year and were accustomed to an inquiry format of instruction. Seventh grade teachers used the lesson imaging approach when planning and attempted to incorporate the 5 Practices[[2]](#endnote-2) in their teaching routine daily. Mr. Cline and Ms. Hibbard carried on this instructional approach with 8th grade and incorporate it into their inclusion setting.

**The instructional sequence: *Building Buildings***

The intent of the Building Buildings sequence is to engage students in a realistic context in which linear relationships grow naturally. The problems are grounded in the context of building skyscrapers at a constant rate of say, 4 floors per week, for example. Students have pictures to aid them in structuring the linear relationship as a starting number (aka y-intercept) and a rate. Initially, students work problems that focus on structuring a certain week, say the 7th week, as a beginning amount and 7 rates of change. The sequence of problems supports students to invent their own equations as well as re-invent the slope formula (y2-y1/x2-x1) in ways that are meaningful to them. Students’ symbolizing progresses from pictures of buildings (with floors showing) to straight lines for buildings, to dots to ordered pairs. Tables, graphs, and equations are scattered throughout rather than taught sequentially.

Potential PD Activities:

1. *Role of instructional materials.* Look through the students’ pages to discuss how the students’ activity grows over time.

* How do the pages and students’ work on those pages move from concrete to abstract reasoning?
* How do the students’ activity on the pages encourage re-invention of linear equations, graphs, and tables, as well as slope formula?

1. *Non-traditional lesson planning.* Read through Cline’s and Hibbard’s lesson image.

* How does the teachers’ thinking look different than how you typically plan a lesson?
* How does the lesson image correlate with the *5 Practices for Orchestrating Mathematical Discussions* book, if appropriate?
* What is the value of anticipating students’ strategies before teaching?
* Why have the teachers chosen the particular sequencing in the whole class discussion section?

1. *What’s in a launch?* Read the Launching research-practice brief.

* What makes a launch effective?
* What is the difference between launching a UNIT versus launching a daily problem?
* Watch the first bit of the Buildings video which includes the launch of the buildings UNIT. What role did the video play in setting the context? How did the teacher relate the video to the buildings unit?

1. *Engineering a mathematical discussion.* The video depicts a short excerpt from the first day of the buildings UNIT. Watch the beginning of the whole class discussion session.

* How did the teachers use anticipated students’ strategies to engineer the whole class discussion? How was it different than their lesson image?
* When did the students talk and when did the teacher? What is the difference between their roles?
* What role did symbolizing and notating play in supporting students’ reasoning?
* When did the teacher let the students show their own personal symbols and when did he introduce them? In what ways is it productive and in what ways might it be constraining?

1. *Role of questioning.* Read the Questioning research-practice brief. Watch the whole class debrief from the video and discuss the questioning technique that the teachers used.

* Write down all of the questions the teachers ask. How would you categorize these questions?

1. *Inclusion.* This class has students with disabilities in it.

* What is the role of the EC teacher in this inquiry classroom?
* How do students with disabilities participate in this class?
* What supports are there to engage students with disabilities?

APPENDIX A

Cline’s and Hibbard’s Lesson Image

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| **Science, Engineering, or Mathematics Goal(s):**  Students will explore the context of overseeing a building that is constructed under the premise that the workers can build # floors per week at a constant rate. As they explore the various problems, they learn to structure a linear relationship as a starting amount (y-intercept) and a constant rate of change. Students will explore linear relationships, both positive and negative, through equations, graphs, tables, and stories. Students will also re-invent the slope formula through context (m=(y2-y1)/(x2-x1))  **State Standard(s):**  **NC.8.F.4** Analyze functions that model linear relationships.  • Understand that a linear relationship can be generalized by y = mx + b.  • Write an equation in slope-intercept form to model a linear relationship by determining the rate of change and the initial value, given at least two (x, y) values or a graph.  • Construct a graph of a linear relationship given an equation in slope-intercept form.  • Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of the slope and y-intercept of its graph or a table of values. |
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| **Launch** (Task presentation)  LAUNCHING THE UNIT-Play the YouTube video showing the piece by piece construction of a cruise ship to help students develop an image of building pieces at a time. Show only two minutes and the ask them to stop and jot, *Write down what you noticed about how the ship is being built.* Two minutes independent time. <http://digg.com/video/timelapse-construction-cruise-ship>  Ask students to share, capitalizing on comments that mention building the ship a cabin at a time. Relate this to the building context that they are going to explore for the next week. Introduce the Building Buildings sequence by putting this on the whiteboard and reading together:  *You are working for an imaginary construction company. This construction company makes skyscrapers, but not the way “REAL” construction companies work. They build a floor at a time, one on top of the other.*  *The FOREMAN of the construction company is in charge making sure the workers are building the buildings in a timely manner. So, the foreman goes out to the sight of at the end of each week and takes a digital photograph to show the progress of the workers.*  Show students the photos for several weeks:  Week 1 Week 2 Week 3  Ask students how many floors tall the building will be after 5 weeks of work. Brief discussion to establish that the workers appear to be constructing 2 floors per week.  LAUNCHING THE TASK:  Ask students to solve the three problems on the first page. They need to write something on their paper so that others can understand how they found their answer. Let students know they can draw pictures if they want to or if any students with disabilities need snap cubes to create the buildings, provide them. |
| **Exploration** (Anticipated student thinking—include class structure [in small groups, with partners, individually] and potential correct and incorrect strategies or solutions)  Possible solutions (Actual students):  DAISY’S  C:\Users\mstepha1\Downloads\IMG-0353.JPG  AMARI’S  C:\Users\mstepha1\Downloads\IMG-0355.JPG  ANDRY’S  C:\Users\mstepha1\Downloads\IMG-0352.JPG  DANILO’S  C:\Users\mstepha1\Downloads\IMG-0348.JPG  GABBY’S  C:\Users\mstepha1\Downloads\IMG-0347.JPG  When monitoring students’ exploration, make sure they have something written down and look for solutions like the ones above. Remind yourself not to fix incorrect strategies or tell them how to do it. If someone is stuck, ask them to draw buildings if that will help. Look for tables or some solution strategies that resemble tables so I can capture that symbolization on the board and introduce a table to keep track. |
| **Whole-Class Discussion** (Include tools, symbolizing, technologies, and questions you might pose)  SELECTING AND SEQUENCING:  If I get the five strategies above, I will have students put them all on the board at the same time while others are finishing their explorations. I will have Daisy and Danilo present since it is the most concrete way and the easiest for students to understand if they did not have a way. They are very similar in that they have pictures of buildings in between, with Danilo’s getting close to a table structure. Then, I will have Andry present because there are no pictures and I can introduce a two-way table as an easier way to keep track. Then, we may have Gabby and Amari present to debate about why they both got the same answer but different calculations. Be sure I focus on the meaning of the numbers in each solution method and where they appear in the pictures. |
| **Assessment** (Evidence of student learning)  Have students complete the page for homework. |

1. Stephan, M., Pugalee, D., Cline, J., & Cline, C. (2016). *Lesson imaging in math and science: Anticipating student ideas and questions for deeper STEM learning*. Alexandria: VA, Association of Supervisors and Curriculum Designers. [↑](#endnote-ref-1)
2. Smith, M. S., & Stein, M. K. (2018). *Five Practices for Orchestrating Productive Mathematical Discussion*. National Council of Teachers of Mathematics. [↑](#endnote-ref-2)