Virtual Lesson Study: A How-to Guide

A look at how the Illinois Content Specialists modified traditional Lesson Study in order to facilitate a virtual version

Table of Contents

Introduction	3-6
Sample Meeting Schedule	7-11
Checklist for Preparing Research Lesson	12
Research Lesson from Pilot	13-26
Results of Post-Survey	27-29
Conclusion	30-32
Resources	33

Introduction

What is Lesson Study?

Lesson Study is a form of long-term professional learning in which teachers engage to systematically examine their practice with the goal of becoming more effective. Teachers work collaboratively in small groups to plan, research, teach, observe and critique a research lesson. This lesson becomes a research proposal, which contains the rationale and plan of the lesson, as well as assessment questions for team members and outside observers to gather data on. This process deepens the interaction of colleagues by developing habits of self-reflection and critical thinking. Lesson study reduces teacher isolation, encouraging them to open their doors to observation and respectful, constructive criticism. School- or district-wide lesson study can create shared expectations of the curriculum, the standards, and goals of instruction. The practice of lesson study flips professional learning upside-down by being teacher-driven, classroom-based, and using a teacher's daily practices as the research.

> "The most alarming aspect of classroom teaching in the United States is not how we are teaching now but that we have no mechanisms for getting better." (Stigler and Hiebert, preface xi)

Lesson study has been used for more than a hundred years in Japan, but has only gained traction in the United States since the turn of the century. *The Teaching Gap*, published in 1999 brought attention to this practice. Stigler and Hiebert describe how while much of the quality instructional research has taken place in the United States, we haven't taken this research and made effective changes to teaching. Teachers have attempted to implement new instructional strategies according to research from NCTM and NSF in the US, but these attempts, without proper and continuous training, have been largely ineffective. "Teachers can misinterpret reform and change surface features—for example, they include more group work' use more manipulatives, calculators, and real-world problem scenarios; or include writing in the lesson—but fail to alter their basic approach to teaching mathematics" (Stigler and Hiebert, pg 107).

In Japan, however, teachers use this research to successfully make changes to their instruction, which is seen on a large-scale throughout the country. *The Teaching Gap* attributes this success to using lesson study. Lesson study allows teachers to collaborate and discuss the needs of

their students within the context of a new teaching style. Teachers ask a research question, collaboratively plan a lesson, present the lesson with data collection from multiple observers, and discuss the outcomes of that data to make appropriate changes to their broader instructional practices and curriculum. Textbooks in Japan incorporate lessons that are the product of previous lesson study research.

The National Center for Education Evaluation and Regional Assistance (NCEE) conducted a comprehensive literature review identifying 643 studies of professional development interventions related to math in grades K–12. Of these, only two used a research design for assessing the effectiveness of math PD meeting the WhatWorksClearninghouse evidence standards and found positive effects on students' math proficiency. A lesson study was one of these two. Rebecca Perry and Catherine Lewis from Mills College found statistically significant positive effects on students' proficiency in their work with lesson study focused on linear (measurement) model of fractions.

"In the lesson study approach small groups of teachers observed and analyzed fractions lessons that they planned collaboratively. The lesson study groups met 12–14 times over five months during the school year… Teachers took turns leading the group, following the lesson study cycle outlined in the intervention materials. Instructors and consultants provided the intervention materials (including a fractions toolkit that included materials to help students learn how to represent fractions on a number line) and were available to answer teachers' questions as they led their teacher study groups. Implementation was thus similar to actual practice in a school or district. This study resulted in a significant increase of fractions knowledge on a test at the end of the year in grades 2, 3, and 5 but not in grade 4."

How does this connect to everything educators are REQUIRED to do?

Lesson study supports the implementation of the Illinois Learning Standards in all content areas. Our pilot group was math teachers and instructional coaches. Here are the math content standards which were the focus of our research lesson:

- Mathematical Practice Standards: For the pilot group, we focused on Practice Standard 3: Construct Viable Arguments and Critique the Reasoning of Others when planning our

lesson. In the future, each team can choose a focus based on the needs of their students.

- Mathematical Content Standards: The pilot group chose 8.EE.C.8 Analyze and solve pairs of simultaneous linear equations. In the future, each team will choose at least one content standard to focus on throughout the lesson

Lesson study supports educators as they strive to improve their instruction and student learning. This form of professional learning will support teacher growth in all 4 domains of the Danielson Framework:

- Domain 1: Lesson study is all about planning and preparation. Group members actively demonstrate their knowledge of content, pedagogy, students, and resources, and use these to set instructional outcomes and design coherent instruction.
- Domain 2: With our pilot group's goal of Mathematical Practice Standard 3: Construct Viable Arguments and Critique the Reasoning of Others, teachers create an environment of respect and rapport, establish a culture for learning, and in the process, lead to improved management of classroom procedures and student behavior.
- Domain 3: Lesson study and Practice Standard 3, tend to focus on appropriate questioning strategies that allow for the student to discover their own learning, which is engaging to students and demonstrates flexibility.
- Domain 4: Lesson study is all about reflecting on teaching, growing and developing professionally. In the process teachers, are participating in a professional community, while demonstrating professionalism.

Lesson Study can be used to raise awareness of the Social Emotional Learning Standards (http://www.ilclassroomsinaction.org/sel.html). The pilot research lesson encouraged discourse, facilitated group work, and engaged students in critiquing the reasoning of others. These activities support Social Emotional Learning Goal #2, specifically C. "Use communication and social skills to interact effectively with others" and D. "Demonstrate an ability to prevent, manage, and resolve interpersonal conflicts in constructive ways." The research lesson could be written to address any of the SEL standards making Lesson Study an excellent opportunity to for

educators to become more familiar with these standards and create opportunities to discuss and evaluate their use in planning instruction.

Sample Meeting Schedule

Before it Starts

2 weeks +:

- Schedule the 8 2-hour meetings
- Determine Research Theme
    - We chose Math Practice 3 for our pilot (Construct viable arguments and critique the reasoning of others.)
- Determine grade levels for lesson
    - We chose grades 6-8 for our pilot (keep in mind that doesn't limit the participants to 6-8 teachers – we had HS teacher participants that were very helpful in our process and teachers from lower grade levels could benefit and have insights worth sharing as well)
- Determine the ideal number of participants
    - We originally had 10 participants in the pilot, but lost 3 within the first few weeks due to busy schedules
    - 7 participants and 2 facilitators was ideal for our virtual setting
    - Decide what you will do if too many people drop out (will you have a waitlist?). What is your "ideal" number? How many participants are too few/too many?

Team Meetings (Virtual)

We scheduled every meeting as 1 hour, but quickly realized that wasn't always enough. Our suggestion is to schedule 2-hour meetings. The following schedule reflects our meeting agendas during the pilot. Every lesson study has different components that may take different amounts of time to develop. Flexibility should be considered in scheduling.

Meeting #1:

- Introduce team members
    - Share name, job title, location in the state, and one thing we love to do when NOT teaching
- Overview of technology
    - Features of Zoom
    - Etiquette of virtual meetings (mute when not talking, expectations of participants)
- Introduction to Lesson Study
    - An overview of the process and protocol
    - Share the template to be completed for our Research Lesson (http://www.lsalliance.org/resources/)
    - Determine Research Theme for the lesson

- Assignment for next week – read Chapter 6 from The Teaching Gap (https://www.aft.org/sites/default/files/periodicals/TeachingWinter98.pdf), consider being the deliverer (is your location/classroom conducive to gathering of the team), email leaders if interested in delivering the lesson

Meeting #2:

- Discuss article from homework – share questions/observations
- Introduce participants who volunteered to deliver –
    - Discuss pros and cons of the various locations (grade level, class size, geographic location in relation to other participants, etc.)
    - Discuss the standards that would be appropriate for the timeline in the various classrooms (which represents the greatest need?)
- Select the Deliverer and determine the standards that will be the focus for the lesson
- Assignment for next week – research lesson ideas for the selected standards (look through materials you use in your classrooms or search online), share ideas in google doc

Meeting #3:

- Discuss shared materials
    - What were the strengths and weaknesses of the various activities and lessons?
    - Which ones will engage students in the Research Theme?
    - What parts of the standards are addressed by the materials shared?
    - What parts of the standards are neglected by the materials?
- Define the goals of the lesson and the unit
- Begin to piece together a lesson
- Assignment – continue to consider all elements of the lesson, how to increase engagement, make it more student-centric, differentiation, inquiry, engineering, manipulatives, collaboration, etc.

Meeting #4:

- Finalize lesson Introduction and Task
- Brainstorm the "Anticipated Student Responses"
    - Predict all the ways students will approach the task and how the teacher will support each unique response
- Assignment
    - Reflect on the student responses we have predicted. Do you agree with them? Did we miss any?
    - Assign remaining parts of the Lesson Template to participants and have them brainstorm titles for the lesson

Meeting #5:

- Review submitted work as a group and make edits as agreed
- Revisit anticipated responses
- Discuss the closure of the lesson
    - How will students demonstrate understanding?
    - How will the teacher meaningfully wrap the lesson up? (In our pilot lesson, the students shared their work in a gallery walk and the teacher led students to connect the various methods different groups used—How did different methods reach the same solution? What accounts for variations in solutions? Which answer is the "most correct?" Which method was the most efficient? Can we apply this method in another situation?)
- Assignment
    - Finish any remaining components of the template

Meeting #6:

- Complete the Unit Plan
    - How does this lesson fit in the unit?
    - What activities will the students do before this lesson? What will the students do after this lesson?
- Review any other components of the lesson plan that weren't finished in the last meeting
- Assignment
    - Have participants read through the template and make comments where they think edits should be made

Meeting #7:

- Review comments made on the template and resolve any issues brought to light
- Do a dry run of the lesson to see how it flows and make sure everyone is on the same page—we found that we all had a slightly different take on how the paper lesson plan would translate into the live lesson
    - All participants should do the task or activity as though they are the student—in order to trouble shoot the task/activity and work out any glitches

Meeting #8:

- Finalize all the details before the lesson delivery
    - Who will make copies? How many?
    - Go over the schedule for the day, lunch details, travel arrangements, etc.
    - What needs to be prepared ahead of time? (sample "student" work, power point, etc.)
    - Materials for the lesson (chart paper, markers, clipboards, etc.)
- Run through the lesson plan again

- Have the lesson deliverer talk through the lesson as though he/she is teaching it

Pre-Lesson Discussion (Face-to-Face)

The day of the lesson delivery, the whole team meets 45 minutes before class begins to get organized and go over the roles during the lesson. A knowledgeable other leads a brief meeting that disseminates instructions and answers last minute questions.

- The lesson deliverer discusses the seating chart, group organization, room layout (where will the gallery walk work be displayed, where will teacher be when addressing the class, where do the projected images display, etc.)
- Discuss student characteristics that may be pertinent to the delivery of the lesson
- Participants (other than the lesson deliverer) are to be "invisible"—they should only observe, not talk to students, not assist students, not participate in instruction
- Participants should make notes of their observations as the lesson unfolds—how do students respond to the task, what questions do they ask, do they stay on task, what do they say to each other, what do they say to the teacher, what mathematical reasoning do they apply, what math practices do they engage in
- Participants could choose to focus on specific students or groups during the lesson or travel the room and spend time observing several students or groups

Delivery of Research Lesson (Face-to-Face)

Lesson Deliverer follows the lesson plan developed by the team as closely as possible. The other participants collect data on the printed lesson plan.

Post-Lesson Discussion (Face-to-Face)

First, offer a "Congratulations!" and "Thank you!" to the lesson deliverer for volunteering their time, talent, and classroom. Allow the lesson deliverer to reflect on the lesson. Then, do a quick round robin sharing one profound observation from the lesson. Conduct a robust conversation of observations that relate to the research theme.

- Were our predicted student responses accurate? Which of our predictions did not occur? What did we see that we had not predicted?
- How deeply did students engage in the Research Theme (in our case Math Practice 3)?
- What mathematical reasoning did the students apply?
- How did the students work together to reach their solutions? Did every student participate equally?
- What parts of the lesson/task went well? What parts of the lesson/task did not go well?
- What can we change to better reach the goal of the lesson?
- Assign participants to record reflections before the next (and final) virtual meeting (*should be scheduled soon after lesson delivery day)

Final Meeting (Virtual)

During this final lesson study meeting, participants work together to formulate a reflection and prepare the lesson plan for publishing.

- Have participants share their individual reflections—they can read what they prepared or copy and paste them into the google doc
- Edit and organize the individual reflections into one cohesive group reflection
- Thank everyone for participating
- Discuss future lesson study offerings and if anyone would be interested in facilitating a lesson study in their building/district/region

Checklist for Research Lesson

- ☐ The content is fully aligned to the Illinois Learning Standards
- ☐ The lesson models good instructional practice (ie. student centered learning, inquiry, discourse, problem-based learning, or Teaching through problem solving)
- ☐ The lesson provides opportunity to develop critical thinking skills, conceptual understanding, procedural skill and fluency, and/or application
- ☐ The lesson explicitly connects to prior learning
- ☐ The lesson incorporates differentiation strategies in an effort to meet the needs of all learners
- ☐ The lesson supports teachers as they collect evidence of students understanding (formative assessment)
- ☐ The lesson supports teachers as they provide consistent, meaningful, constructive feedback to students
- ☐ The lesson has effective closure (checks for understanding, emphasizes key information, ties up loose ends, correct misconceptions)

Research Lesson from Pilot

Lesson Research Proposal for **8th Grade Math** -- ***Solving Systems of Equations***

For the lesson on May 16, 2017

At Sherrard Junior High School, Kathy Felt's 8th Grade Math Class

Instructor: Kathy Felt

Lesson plan developed by: Amanda Carson, Heather Brown, Kathy Felt, Alfreida Jamison, Laura Kaplan, Kandace McCoy, Nicole Rogers, Jeanine Sheppard, and Rebecca Wattleworth

1. Title of the Lesson: The Colossal Cookie Calorie Caper - Using Systems of Equations

2. Brief description of the lesson

Students will use systems of equations to investigate the construction of a variety of Oreo Cookies. Students will compare original and double stuff cookies to determine the nutritional information in the stuffing and the wafer and use this to determine the total nutritional information in a triple double Oreo.

3. Research Theme

The lesson study group is focusing on Mathematical Practice Standard 3: Construct viable arguments and critique the reasoning of others. The goal is to get students to play a more active role in the learning and be more involved in discussion during the class. We hope to engage the students in a challenging task that can employ multiple solution paths then charge the groups with relating the mathematical reasoning of each method.

4. Goals of the Unit

This is the last unit of the year and is a preparation for the final exam. We are revisiting systems of equations because the students need stronger conceptual understanding of the topic.

5. Goals of the Lesson:

a) Students will persevere in solving the problem of how many calories are in a Triple Double Oreo Cookie using any mathematical method they are comfortable with and the nutritional information of a Classic Oreo and a Double Stuff Oreo.

b) Students will use whatever mathematical approach they are comfortable to find engage in the task as long as they can explain the mathematical reasoning behind their process.

c) Students will review the method they used to solve the problem against use of a system of equations and see how the methods compare.

d) Students will develop a deeper understanding of the mathematics behind solving a system of equations.

e) Students will evaluate the efficiency of the methods and determine when one method is more suitable than another.

f) Students will analyze nutritional information and use it in their problem solving.

6. Relationship of the Unit to the Standards

Related prior learning standards	Learning standards for this unit	Related later learning standards
6.EE.5 Understand solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? Use substitution to determine whether a given number in a specified set makes an equation or inequality true. **7.EE.4** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. **8.EE.6** Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation *y* = *mx* + *b* for a line intercepting the vertical axis at *b*.	**8.EE.8** Analyze and solve pairs of simultaneous linear equations. Research Lesson: **8.EE.8c** Solve real-world and mathematical problems leading to two linear equations in two variables.	**HS.A-REI.C.5** Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

7. Background and Rationale

Our lesson theme focuses on Mathematical Practice Standard 3: Construct viable arguments and critique the reasoning of others. The topic of our lesson is Solving Systems of Equations. As the end of the year nears, it is noted that not only do 8th grade students struggle with the concept of solving linear systems, but they also lack discussion strategies in order to solve those systems. Thus, our goal is not only to observe students critiquing strategies of others, but also observe them being more involved in discussion during class in order to more deeply understand the math behind the traditional algorithms for solving systems of linear equations (elimination and substitution). We believe that by using Oreo cookies as part of the lesson, students will be engaged, have fun, and see the usefulness of systems of equations in solving everyday problems.

8. Research and *Kyozaikenkyu*

We began our research by individually seeking out resources on teaching, reviewing, or applying systems of equations. Those deemed notable were shared via email with the group, then discussed as a group at our next meeting. Resources discussed included lesson plans from TeachersPayTeachers, Dan Meyers, Math Made Possible, Mr. Kraft Wikispaces, Kid Courses, and CCSS Math Tasks from the North Carolina Board of Ed. These resources gave us a broad view of the types of tasks being used for the purpose of teaching systems of equations. Some of the resources were focused primarily on building procedural fluency while others were focused on applications and conceptual understanding. We narrowed our research and studied two application tasks in particular: the Oreo Task (http://maccss.ncdpi.wikispaces.net/file/view/CCSSMathTasks-Grade8.pdf/460716114/CCSSMathTasks-Grade8.pdf) and the Solar Panel Task (https://spacemath.gsfc.nasa.gov/Modules/8Mod7Prob1.pdf). We decided against the solar panel task because of access to the materials and concerns that students wouldn't relate to the context. There were many variations of The Oreo Task to be found, each providing varying levels of structure for the students as well as several different properties of Oreos to study. We incorporated strategies we employ during Math Talks to engage students in discussion, facilitate mathematical discourse, and encourage struggling students. The problems we started with during our research were very structured and scaffolded. We strived to remove as much student support as possible to let them struggle with the math (much like a 3 Act Math Task).

9. Unit Plan

**This unit plan is unique in that our research lesson was at the very end of the school year. The class was revisiting a concept they had learned earlier in the year. It ended up being a "review mini unit."

Lesson	Learning goal(s) and tasks
1	Goal: Review Solving Systems of Equations. What are Systems? What are we trying to do with systems? What is a solution and what does it mean to s*olve* a system of equations? *How* do we solve a system of equations? Task 1: Solve a system of equations by graphing. Solve a system of equations by through substitution using the "Blob" method of solving systems. Solve a system of equations using the linear elimination method. Do an example with 4 pants and 3 shirts costs $177, 3 pants and 2 shirts costs $127.50. How much is a shirt?
2	**The research lesson:** Oreo Task
3	Goal: …Conceptual understanding of systems of equations and real world application of systems of equations and solving a system. What does the solution mean in the real world context? Task: …Make connections to the Oreo Task to the symbolic connections

10. Design of the Unit and Lesson

The students in this class are 8th grade math students in the "regular" track. There are students of all ability levels including very high (formerly in the advanced math track), average levels, and low ability. There are two students with IEPs. We will be in the last full week of school for the year at the time of this lesson. These students were previously introduced to Systems of Equations in February. Overall, it was a struggle for most. In the previous Illinois Learning Standards, teaching of systems of equations was done in high school. With the new Illinois Learning Standards Incorporating the Common Core, the topic of systems of equations is introduced in eighth grade. The students in this class are improving with linear graphing concepts, but systems have been more complicated for them. This lesson was designed with this information in mind. It will be an application of systems, in a fun and meaningful context for them. Math really is everywhere! Students are reviewing this concept for their final, to be administered a few days after this lesson. Students will have reviewed procedural methods to solve systems of equations a few days prior to the lesson.

This lesson will be administered to the students as inquiry. Students will be working in cooperative learning groups. A problem will be given to them that they will try to figure out (systems is one way to solve it; perhaps the most efficient way) on their own with minimal teacher guidance. We will try to determine if they will try to solve the problem using systems (or what methods were used and to what success), and we have built in this method for them to consider if they do not think of it on their own. Then, they will have to determine if systems is a practical and efficient method to use for the problem. What are the advantages to using systems? We scaffolded a systems solution that "another student" has used for their consideration. They will not be able to use any "non-math" methods to solve this problem. We want the students solving this on their own and explaining their methods and reasoning.

11. Research lesson

Steps, Learning Activities Teacher's Questions and Expected Student Reactions	Teacher Support	Assessment
Introduction: On the board when students walk in: "How do you eat an oreo?" Play students the Oreo commercial: https://www.youtube.com/watch?v=cYnLDxf9S0Y	Have Internet ready cued to the oreo commercial. Have the oreo cookies for each group. Single serving packs for each group with 6 original cookies and 3 double stuff cookies. Allow the students a minute to answer the question of how they eat an oreo after watching the video.	Are the students actively engaged and interested in the context?
Posing the Task Board: "My ideal would be a triple double. What would be the nutritional information of a triple double?" 	Provide the cookies with the nutritional information included. A triple double consists of three wafers and two single stuffing. Ask the students do a Think, Ink, Pair, Share. Give one minute to think about their strategy of how they are going to do this. Write their ideas down for one minute. Talk to their group for a minute. Ask the students to state any assumptions that they made during their discussion with their group.	Do students understand the task? Do they have an idea of where to start? Are students eager to solve the problem?

Anticipated student responses	*(All times where we see calories mentioned, students may look at a different nutritional fact.)*	Are students able to tackle the problem?
S1: Why can't I look on the nutritional information of that box?	T1: This is a Ms. Felt's cookie. We don't have it with us.	At what points do students struggle?
S2: It's a cookie and two/thirds. I figured how much was in one cookie, then divided it by the three parts (two wafers and a stuffing) and then the triple double has five parts. (or some other direct ratio of 1 and a half, etc).	T2: No. How many stuffings are included? How many wafers? Are they proportional? Does a cup of carrots and a cup of ice cream have the same amount of calories.	With questioning does S2 recognize why this can't be proportional?
S3: I don't have any idea where to start.	T3: Can we look at just the calories? How do they relate to the cookies? (If more is needed, specifically ask them how many calories per wafer and how many calories per stuffing)	
S4a: Well, I know that one original cookie is 1/6th of the package, so I can divide the calories by 6 and get it for one cookie. For the double stuff just divide by 3.	T4: Great. What can you do from there? (If necessary, so how much is in one wafer and one stuffing?)	How much prompting is needed to get student S4a to continue on to the rest of the problem?
S4b (correct but not using a system): Well, I know 2 wafers and 1 stuffing is 53.3 And I know 2 wafers and 2 stuffings is 73.3. Then it's only one stuffing different, so a regular stuffing would be 20	T4b: Great, keep going, figure out how much is in the triple double. If finished: How could you write this symbolically?	
S5: (correct) well, since we did systems yesterday, this is kind of like that problem.		How are students interacting within the group, especially if the people in their group are solving it more than one

12w + 6 s =320 6w + 6s = 220 S5a: (correct) so I do elimination and subtract and get 6w=100 calories and then substitute back S5b: (correct) 6s = 220-6w, so I can put that in the other equation for 6s. S5c: (correct) If I solve the equation for w (or s), I get w=220/6-s S5d: students have a system but make procedural errors. S6: Recognize it as a system, but incorrectly create the system, such as 6w+12s=220 for double stuff S7: Used one of the previous methods to find that a stuffing is 20 calories and a wafer is 16 ⅔ calories and found that a triple double would be 2(20)+3(16 ⅔)= 90 (Depending on rounding, the students could end up a little more or less than this).	T5d: Check your work within the original cookies. T6: Sketch a picture of the number of cookies with wafers and stuffing in the box. (If need be, let them open the actual package.)	way? How do the different skill levels within a group affect the dynamic of the discussion? Did students solve this in an unexpected way?

Comparing and Discussing S2 (recognizing why it can't be proportional.) S5: 5d (students recognize the system, but know their answer isn't exactly working) 5c (get's correct answer but has to deal with a lot of fractions.) 5b (also substitution like 5c, but deals with fewer fractions) 5a (elimination is what this problem is "setup" for.) S4a: providing the idea of doing it using reasoning without symbolic algebra. S4b: completes the reasoning method.	Have a fake version of S2 available if the students in any one class do not do this method. Make sure the students understand why this is not a proportional relationship. Have a fake version of S5a available if the students in any one class do not do this method. Have a fake version of S4b available if the students in any one class do not do this method. Have a fake version of the algebraic representation of S4b ready to have students step through and explain the steps. S4b equations: 12w+6s=320 Divide by 6 cookies 2w+s=53.33333 (calories in 1 original cookie) 6w+6s=220 Divide by 3 cookies 2w+2s=73.33333 (calories in 1 doublestuff) 2w+2s=73.33333 (calories in 1 doublestuff) 2w+s=53.33333 (calories in 1 original cookie) _____ s=20 (find difference tells me one stuffing) Or: 2w+2s-(2w+s)=73.33-53.333 (find difference), s=20 2w+20=53.333 2w=33.333 w=16.667	Do students recognize why a certain solution is incorrect, or appreciate the merits of one solution over another? Are students supportive, listening, and able to question their classmates to push either their own or others' thinking?

Summing up If we wrote an equation about one of our cookies, how would the equation have changed if we were talking about two cookies, or two packs of cookies? Why are we "allowed" to do the steps in elimination and how do the steps in the cookie problem help us to understand that? In what other situations would this method be useful?	Discuss these questions with the class if time. If no time, ask students to write a summary of these in their journals for homework and wrap up the following day.	Does the summary accurately represent the students' view of the lesson?

12. Evaluation

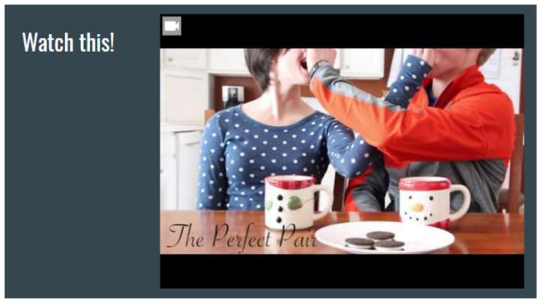
a) Did the lesson successfully promote student-to-student discussion?

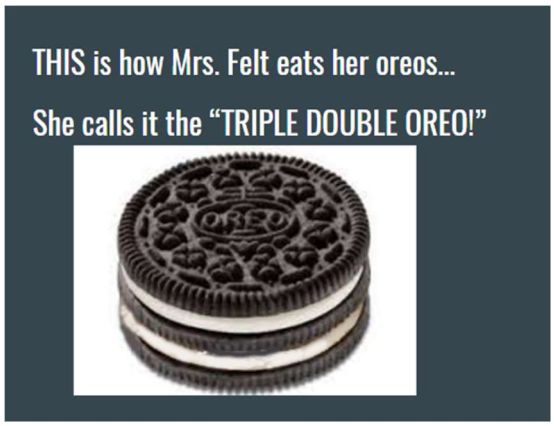
b) Did students recognize the need for a system of equations?

c) If students did not use systems of equations, did they recognize the connections after?

d) Did students stay actively engaged during the lesson?

13. Board Plan





How many calories are in a "triple double?"

Show all your work on the post-it chart paper.

14. Reflection

Before the research lesson, one of the team members taught a beginning version of the lesson:

When students first walked in the classroom, I had a picture of "How do you eat your Oreo." I then showed the Oreo commercial to the students. They thought that they were going to be just answering how they ate their Oreo and maybe finding some area for how much they ate. When I posed the question how many calories would a triple double have in it, they jumped right in. None of the students started with systems of equations, but started with finding how much calories are in one cookie. I had several students who started this way. By the end of the hour, I had a few students who were able to find the calories in the wafer and the stuffing by finding the difference.

- Suggestion at end have the students put all the posters up and have the students look at the connections between them and think about the differences.
- Add questions for the teacher to ask the students to get them thinking without directing them too much.

- All of the kids first found out how much was in one original cookie and one double stuff cookie. Then most the kids tried to do proportional and then half the kids moved away from that to subtract to find the cream.
- Most of the kids had the stuffing and the wafer had the same amount of calories.
- Group dynamics - that some kids took over and some groups worked collaboratively. How could we get more to the collaborative side.
- Kathy noted that the students were very engaged by the video and the context.
- Needed more connection to the systems of equations. Have the students find another nutritional information as an exit slip or homework. (Would students see the efficiency of the systems of equations and choose to solve with it.)
- Assumptions that students made guided their work, but many of them didn't realize how their assumptions were affecting the problem. (Even as small as rounding).
- 1 ⅔ vs 1.5 as most common answer change.
- The confusion between single stuffing and double stuffing in the triple double.
- One group was able to get to systems with minimal prompting.
- Wrap up could have been more structured (time was an element), but one group did say they are going first, and they had the correct answer.
- A use of a timer might have helped the lesson with a stopping point for the students.

Student Reflections from the Research Lesson on Entrance Tickets the Following Day:

1. They did not like the extra teachers in the room but understood why they were there

2. They loved the oreos and figuring out how many calories were in the triple double oreo.

3. They loved the different ways to solve problems and loved seeing that you could use different ways to solve this problem too.

4. They liked working with their peers in groups to solve the problem. They were not sure they could have done it on their own. They liked sharing ideas and using other's ideas to get more ideas of their own.

5. They liked the video.

6. They liked the lesson and especially liked seeing at the end that systems could be used so easily to solve this problem.

7. They realized how to "make a complex problem simple."

8. They would have liked to have had one teacher per group if there were so many teachers here.

9. They wanted more clues

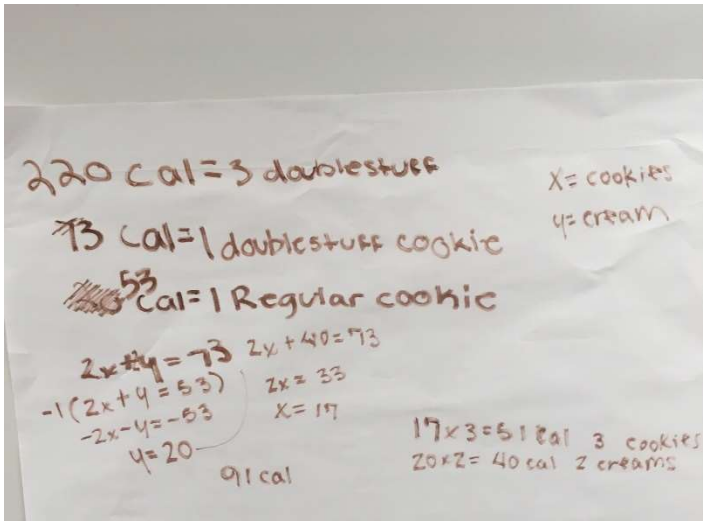
10. They liked how some people completely changed their attitudes and how they reacted to each other to solve the problem.

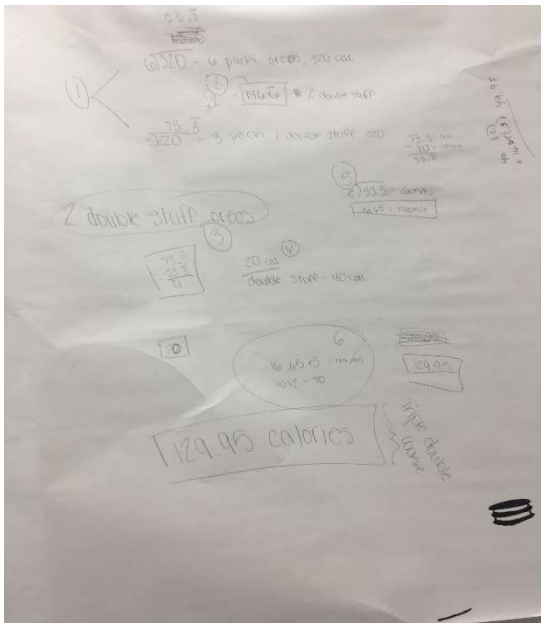
11. The "math was simple if you looked at it and didn't overthink it" (from a member of the group who didn't solve the problem).

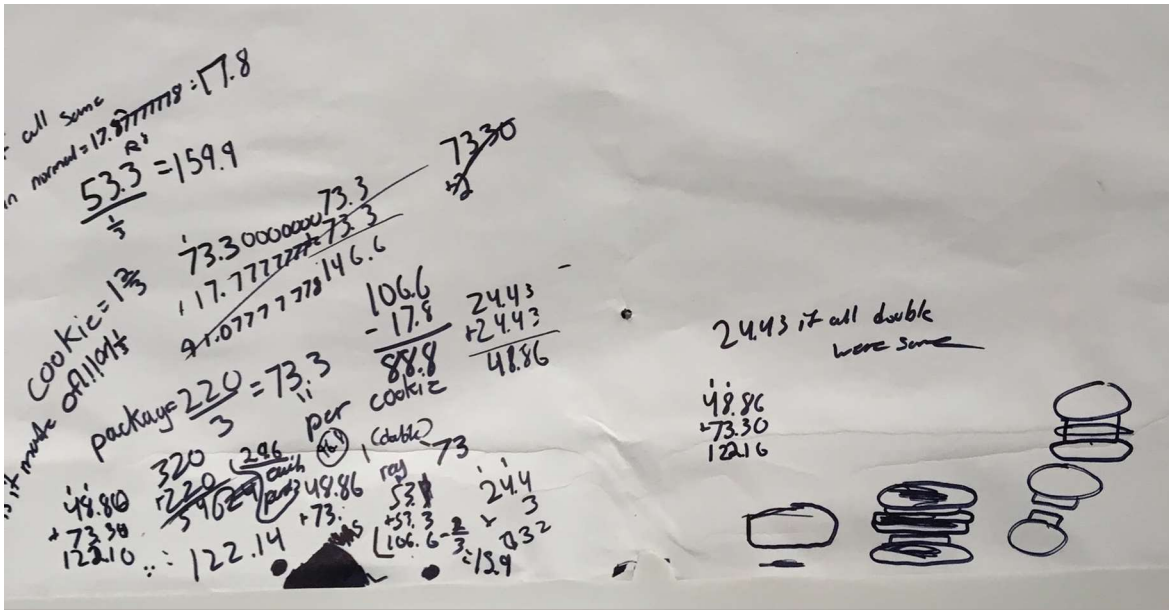
12. They liked the concept and the idea.

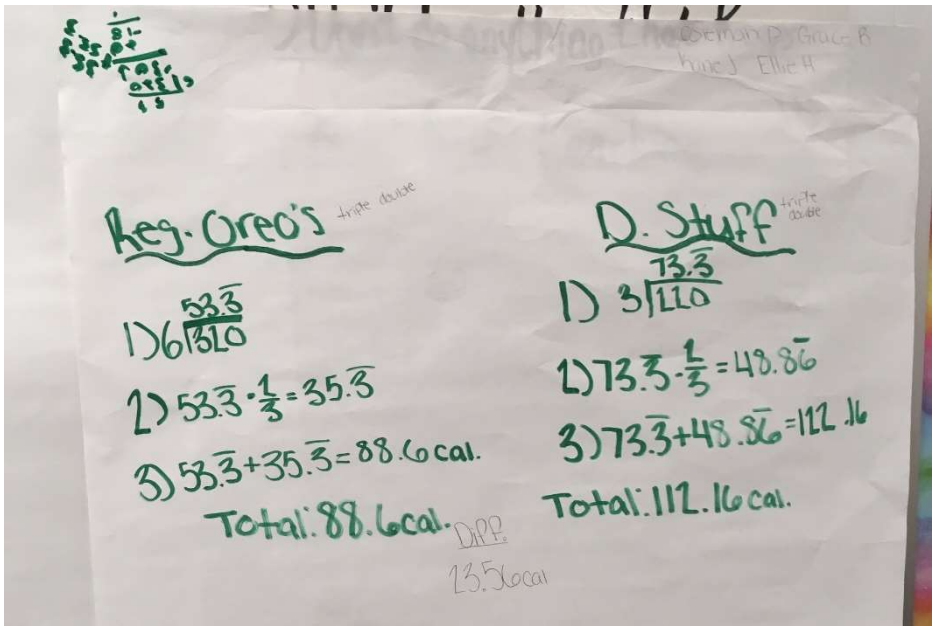
13. They liked the real life problem.

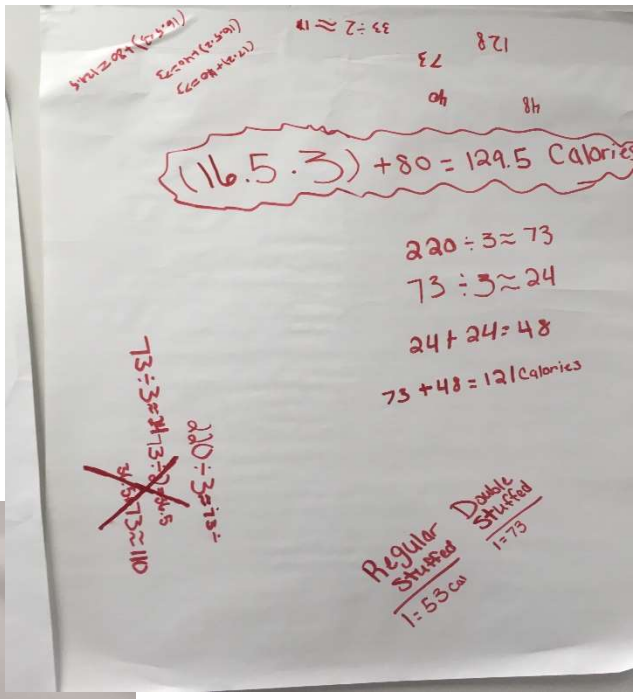
14. Some didn't like having to make their thinking into an equation.

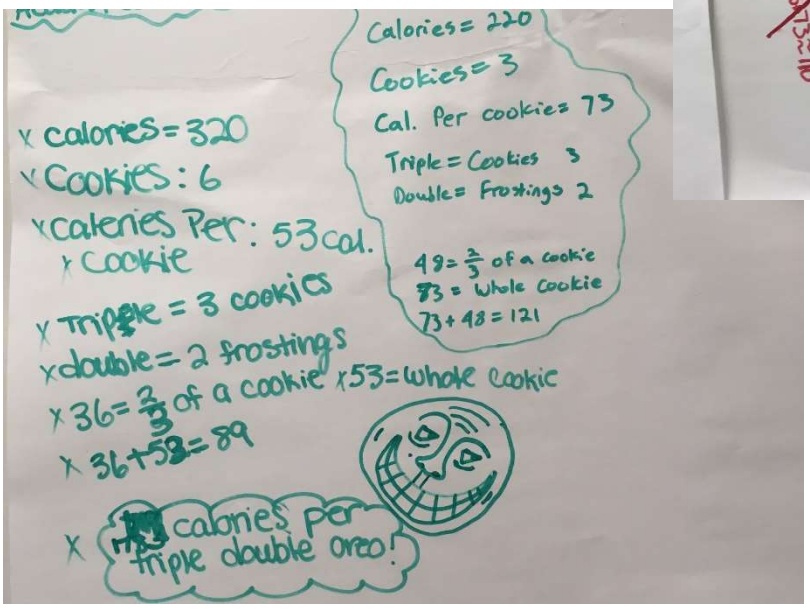












Lesson Study Pilot Post-Survey

We asked participants the following questions in our post-survey via Google Forms:

1. I have enjoyed the lesson study pilot. (scale 1-5, 5 being the greatest 1 being the least)
2. The lesson study pilot has affected the way I instruct. (scale 1-5)
3. Since I participated in the lesson study, my students have more effectively engaged in MP3. (scale 1-5)
4. The lesson study pilot has affected my collegial conversations. (scale 1-5)
5. Lesson study has made me a more reflective teacher. (scale 1-5)
6. How has your participation in the lesson study pilot benefited you? (open-ended)
7. What were the challenges of working on the lesson study pilot? (open-ended)
8. If we continue to offer virtual lesson study opportunities, what do you suggest we do the SAME next time? (open-ended)
9. If we continue to offer virtual lesson study opportunities, what do you suggest we do DIFFERENTLY next time? (open-ended)
10. Are you interested in being involved in another virtual lesson study? (Yes/No)
11. Are you interested in facilitating a virtual lesson study? (Yes/No)
12. If you were to facilitate a virtual lesson study, what support would you need from the content specialists? (open-ended)

Summary of post-survey responses:

One hundred percent of the participants expressed they enjoyed the lesson study pilot, it affected the way they instruct, and this experience has made them a more reflective teacher. All participants are also interested in participating in another lesson study. Seventy-one percent had students that more effectively engaged in Math Practice Standard #3 after participating in the lesson study. Eighty-six percent of participants felt that the lesson study positively affected their collegial conversations and would be interested in facilitating a future lesson study.

Not surprisingly, the challenges of working on the lesson study pilot included the use of technology and time management. One reviewer also shared that it was challenging because this was the first opportunity she had to collaborate with others. Participants liked meeting

weekly virtually and the use of GoogleDocs to collaborate asynchronously. Reviewers also commented on the benefit of meeting in person to observe the research lesson.

When participants were asked what support they would need as a future facilitator of lesson study, the responses varied from a lot of support to very little. Participants shared that it would be beneficial to have a Content Specialist available for guidance and to answer questions. Some participants shared that they would like to experience another lesson study before becoming a facilitator.

Here are some specific quotes on how lesson study benefited the participants:

- "Giving me new ways to think about teaching and mathematics."
- "Before this opportunity, I did not know this type of activity even existed. I have been able to form a network with teachers from across Illinois. I am working with a fellow teacher (from the study) on helping me to align my curriculum. It has also helped me to learn a new way to teach an old concept that I am going to use next year!"
- "We are all better by considering the ideas and perspectives of others. It has been very beneficial to share lesson ideas, tips, expectations, and experiences with other teachers, and to view my ideas and thoughts through their eyes. It is also helpful to learn how other teachers approach certain concepts to gain insight and learn other approaches to teaching. This will make me more effective and aware of other strategies when working with all students."
- "Reading the "Teaching Gap" has made me more conscious of how and what I am teaching. I participated, because I needed to collaborate with teachers. I was looking for strategies to help solve my main problem- students' lack of retention. This lesson study has provided me with insight as to why that is and a method to research and make effective changes."
- "The hope is that teachers will become more deliberate and intentional in their planning and more open to suggestions when the instruction they deliver does not result in TRUE student success. Conversations with my fellow coaches often focus on lesson and teacher preparedness. We have discussed doing lesson studies within my district, but it

has yet to go beyond conversation. My experience with this pilot has sparked interest from other coaches in the district."

Conclusion

We would like to express our gratitude to those who participated in our Pilot Lesson Study—Amanda Carson (Monmouth Roseville Junior High), Kathy Felt (Sherrard Junior High), Alfreida Jamison (Posen-Robbins School District 143.5), Laura Kaplan (Chicago Academy for the Arts), Kandace McCoy (Farrington Grade School), Nicole Rogers (Rosa Parks Middle School) and Rebecca Wattleworth (Warrensburg-Lathum High School). A special thanks to Sherrard Junior High, Kathy Felt, and her students for inviting us into your school and classroom to observe the delivery of our research lesson. It was remarkable that, even with a room full of "extra" adults in the classroom observing and recording data during the lesson, the students still behaved as they normally would.

We also wish to recognize Tom McDougal and Lesson Study Alliance for their support an guidance as we ventured into this pilot which, while breaking the rules of traditional lesson study, you were still willing to provide support and guidance.

It was difficult as an observer to stay out of "teacher-mode." Most participants shared that, more than once, they wanted to jump in and help a student or groups. Letting the students struggle and reason through the mathematics was a very explicit part of the lesson plan. The team discussed at length the fact that we, as educators, jump in and rescue students too soon and too often. Authentic learning occurs during the moments the students are struggling with the mathematics. Observing this first-hand was enlightening for many of the participants especially as they saw students arrive at a correct solution independently after several minutes of struggle.

During the research phase of our pilot, kyozai-kenkyu, team members found multiple tasks that used oreo cookies to solve systems of equations. The Cookie Calorie Conundrum from the North Carolina Department of Public Instruction's Lessons for Learning was referenced repeatedly (http://maccss.ncdpi.wikispaces.net/file/view/CCSSMathTasks-Grade8.pdf/614409221/CCSSMathTasks-Grade8.pdf). The team members kept commenting on the possibility of high student engagement due to the use of food, but we weren't all convinced that the task would lead to a deeper conceptual understanding. Over the course of several

meetings, the only resemblance that remained was the use of the cookies. The cited lesson was stripped of its considerable scaffolding. All that was left was the packaging information and a new central question: "How many calories are in a triple-double Oreo?" The Cookie Calorie Conundrum lesson led all students down the same solution path, whereas the research lesson allowed students to use whatever mathematical reasoning seemed logical to them. Students had opportunities to fail, revise their thinking, and try again. They shared their work with each other and critiqued each other's reasoning. The outcome was an authentic, meaningful learning experience that barely resembled the lesson that inspired it.

In the future, we hope to increase the presence of The Teaching Gap as a reflective tool throughout the process. In our pilot, every participant was mailed a copy and was assigned to read chapter 6 which we discussed during a virtual meeting. After that, participants read the book on their own time. The participants enjoyed the book and claimed it positively affected their teaching practice and how they planned for student learning. To capitalize on the quality of the resource, a portion of each meeting will be devoted to a book study discussion of a reading assignment.

In the pilot, the content specialists played the part of both participant and facilitator. In the future, the content specialists will help with facilitation and fulfill the role of knowledgeable other, but will not be an active participant the planning of the research lesson. This will allow for unbiased feedback and more traditional role of final commentator in the post-lesson discussion. This also allows participants to have full ownership of the research lesson.

In the future participants need better focus on blackboard planning—"bansho." Bansho is the planned management of student solutions to the main task. How will the student work be displayed to facilitate discourse and allow for students to make connections? This display should be semi-permanent, perhaps using chart paper or large sticky notes. This ongoing display of student work allows students to reflect on their work and make connections to future learning. Because the participants in the pilot did not completely understand the concept of bansho, an explicit board plan was not thoroughly developed. We all had a slightly different idea of how the student work was going to be shared during the delivery of the lesson. As a

result, it could have been a more meaningful experience had we been more intentional with those details.

Lesson Study, whether virtual or traditional, proves to be a highly effective form of professional learning. Participants develop skills that improve their daily practice—from planning quality instruction to developing collegial collaboration techniques. Participants are highly engaged and a quality product results from the process that can then be shared with other educators.

The long-term goal of virtual lesson study is for participants to take lesson study back to their districts and repeat the process (or a variation that works for them). Teachers will grow more attuned to the important details of their daily planning and instruction and become more reflective. Administrators and support staff will become more familiar with what quality student learning looks like and what it takes to plan for those quality learning experiences.

Resources

Common Core State Standards Initiative (2010). Common Core State Standards for mathematics. http://www.corestandards.org/the-standards/mathematics.

Stigler, J., & Hiebert, J. (1999). The teaching gap: best ideas from the world's teachers for improving education in the classroom. New York: Free Press.

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https://www.nytimes.com/2014/07/27/magazine/why-do-americans-stink-at-math.html?_r=1

http://www.lessonresearch.net/publications/whatWorksCReview.pdf

http://www.lessonresearch.net/IESAbstract10.pdf