HTM: Planning & Memorializing Template
MATH LESSON STUDY

Developed by Catherine Lewis and Shelley Friedkin (Mills College) and the San Francisco Unified School District's QTEA Team, 2017

I. RESEARCH LESSON OVERVIEW

School Name: Gary and Jerri-Ann Jacobs High Tech Middle
Lesson Study Team Members: Kathryn Pond Waters, *Sarah Strong, Cate Challen, Aurmon Harchegani, Curtis Taylor, Leandra Fernandez, Kristin Komatsubara, Katerina Milvidskaia*
Title of Research Lesson: Evaluating exponents **Date of Research lesson:** March 5th **Grade Level:** 8th grade **Instructor's Name:** Kathryn Pond Waters
Essential elements for effective Lesson Study 1. A clear research purpose 2. Kyouzai kenkyuu (examination of curricula, standards, and progressions) 3. A written research proposal 4. A live research lesson and discussion 5. Knowledgeable others 6. Sharing of results Lesson Study Alliance; *Helping teachers work together to improve teaching & learning; http://www.LSAlliance.org*
INSTRUCTIONS: *This template is designed to help you record your ideas as you work on designing a research lesson within its unit context. Red text explains the contents of each section or provides an example and can be deleted. Gray background provides information. The rest (green and blue background) is intended to be filled in by the lesson study team. For examples of completed plans, video and links to examples of student journals, board use, questioning strategies, etc., see the Teaching Through Problem-solving website http://lessonresearch.net/ttp/index.html*

II. RESEARCH CONCEPTION MAP

(copy directly from Designing Your Research Question and ToA)

MAP OF RESEARCH CONCEPTION

School Vision Statement or Educational Goals (including school math goals)

Ideal Profile of Students

- Asking questions to gain a better understanding
- Sharing ideas whether they are right or wrong.
- Listening to one another, hearing their ideas and using them to elevate their own ideas.
- A variety of students regularly sharing to further the class's thinking on the problem

RESEARCH QUESTION

How can we create a classroom environment in which being lost, making mistakes, and questioning for understanding are seen as a normal part of doing math?

Actual Profile of Students

Preconception about what it means to be good at math

- Fear seems to be a core driver of all of these things, based on student perceptions (reinforced by plenty of adults!!) of what it means to be "smart" or "good at math".
- Students may be fearful of appearing to lack competence in front of each other, and their teachers.
- Mistakes are not currently seen as "smart" or important for learning.

Students don't trust that if they draw it, think about it, they will actually come up with an idea … Relatedly, students go 'blank' or just don't have tools for things to tinker with to find a strategy that might get them started.

Students don't yet have the language to articulate their current understanding and dilemma.

"You don't know what you don't know" hard to ask a question when you are truly lost.

THEORY OF ACTION

If we use well constructed problems, anticipate student thinking/problem solving strategies, focus our lessons on student discussion, and use 'why' questions to push students to articulate their understanding, then we will create a class culture where students will feel more comfortable sharing their mathematical ideas with each other and deepen their mathematical understanding.

METRICS TO MEASURE PROGRESS

Tally

What our student shares (and how often) - questions, ideas, connections off of other' s comments

Exit Ticket

- "How can you convince someone that 4^{-2} is a fraction (if you don't have a calculator)?"
- "How comfortable did you feel sharing your mathematical ideas (with peers or class)?

III. UNIT ANALYSIS

This section includes the goals of the unit and a brief description of the lessons in the unit, so the reader can understand the lesson's role within the unit context.

Unit Name: Exquisite Patterns (Exploring the nature of Exponents)

General Flow of the Unit:

brief (2-3 sentence?) description of content and sequence of unit. For example, "this unit begins with...then moves to...then closes by…"):

This unit builds upon students' existing knowledge in three major ways. It extends: students' understanding of mathematical notation and exponents, their ability to transform and operate on expressions, and the kinds of problems that they are able to solve.

Students begin this exploration by noticing patterns in concrete examples (e.g. arriving at values of powers with negative exponents by extending the pattern in powers with decreasing positive exponents), they will also begin to reason in abstract terms. Students then take their expanded grasp on exponents to explore scientific notation.

Goals of the Unit ("Core Math"):

- Know and use the properties of exponents to simplify exponential expressions or write equivalent ones 8.EE.A.1
- Know the meaning of a number with a negative exponent and use it to simplify or evaluate expressions 8.EE.A.1
- Recognize that scientific notation is a convention for expressing very large and very small numbers and use it to express such numbers 8.EE.A.3
- Compare, estimate, and perform operations on quantities written in scientific notation, including those generated by calculators 8.EE.A.3, 8.EE.A.4 and recognize the merits of doing so
- Understand the meaning of "order of magnitude" and use it to compare quantities 8.EE.A.3
- Apply knowledge of properties of exponents and scientific notation to interpret data and solve problems 8.EE.A.4

Lessons within the Unit:

Add rows as needed to show all lessons in the unit; put an asterisk next to research lesson.

Lesson	Title, Learning Activities	Lamping in
1	From their past work students understand that sometimes we need to express quantities that involve lengthy numbers or repetitions, and that having efficient and agreed-upon methods for expressing these quantities is helpful. They recognize that the exponential notation simplifies repeated multiplication [6.EE.A.1]. This opening section activates what students already know about multiplicative situations and their mathematical expressions to prime them for the concepts in this unit. Students are reminded that mathematical expressions can help us convey quantitative changes, understand relationships, and solve problems. Students will see that the value of a number with a zero exponent can be determined by extending the pattern in any sequence of powers with integer exponents, e.g. $\mathbf{3^4} = 81$; $\mathbf{3^3} = 27$; $\mathbf{3^2} = 9$; $\mathbf{3^1} = 3$; $\mathbf{3^0} =$ ____.	Mathematical goal: The exponent describes the number of times the base is being multiplied or divided by itself. Multiplication and division are inverses of each other, thus increasing/decreasing the number of the exponent by 1 would be equivalent to multiplying or dividing by the base an additional time… This division by the base helps understand why when when we have a nonzero base to the power of 0 the result is 1 and why when we have integer bases with negative exponents the result is a fraction.

IV. BACKGROUND & RATIONALE ("Anticipate Student Responses")

*This section explains the flow of the unit and lessons in context of **your** students. What do students currently understand about this topic? What do they struggle with (based on past experience)? How will the lessons of the unit, including the research lesson, help them develop the understanding outlined in the unit goals?*

This unit builds upon students' existing knowledge in three major ways. It extends: students' understanding of mathematical notation and exponents, their ability to transform and operate on expressions, and the kinds of problems that they are able to solve.

By the time they reach Grade 8, students are aware of what exponential notation means. Here they use its definition to articulate some properties that always hold when power expressions are multiplied, divided, or raised to a power 8.EE.A.1. While they may begin this exploration by noticing patterns in concrete examples (e.g. arriving at values of powers with negative exponents by extending the pattern in powers with decreasing positive exponents), they will also begin to reason in abstract terms. They will use established facts or definitions and logic to arrive at new conclusions, and practice applying the new laws or properties on symbolic problems.

Students then take their expanded grasp on exponents to explore scientific notation. They learn that, just like other notations, the scientific notation is a convention established to make it simpler to denote and work with measurements, especially those involving very large or very small numbers 8.EE.A.3. The convention allows us to make sense of, estimate, and compare quantities that would otherwise be quite challenging or awkward to handle, and consequently to solve many kinds of problems –especially those related to the real world 8.EE.A.4.

The work here will also reinforce the idea that representation of quantities involves choices. In conveying measurements –especially those that are extremely large or small– the choice of units is essential, as it significantly affects how well a measurement would be understood, how accurate and precise we could get, and how useful it would be.

V. RESEARCH & KYOUZAIKEN KYUU ("Anticipate Student Responses")

This section describes what you learned from examining the SFUSD curriculum materials, additional curricula or reference sources, and Common Core State Standards and Progressions. What did you learn, and what are the implications for your research lesson?

We recommend exploring the following in relation to your lesson/unit content:

1) California Common Core State Standards for Math
2) California Mathematics Framework
3) Progressions Documents for CCSS-M
4) Math Misconceptions (book)
5) Elementary and Middle School Mathematics: Teaching Developmentally (book)
6) Principals to Action: Ensuring Mathematical Success for all (NCTM book)
7) 5 Practices for Orchestrating Productive Mathematical Discussions (NCTM book)

Relationship of the Unit to the Common Core State Standards (CCSS)

This section describes the relationship between learning in this unit and prior and subsequent learning, as laid out in CCSS. For each column, list standards (including the standard number).

Key Related Prior Learning (“Prior Supporting Mathematics”)	Learning in This Unit (“Current Essential Mathematics”)	Future Learning (“Future Mathematics”)
The concept of mathematical notation is a familiar one to students. From their elementary years they began to develop the awareness that a notation enables us to express quantities or perform operations in simpler, more precise, or more efficient ways. They learned, for instance, that a multiplication statement helps us express repeated addition, that a line over some numbers helps us indicate repeating decimals, that a variable can be used to express unknown values, etc. They have interacted with a particular notation –the exponent– in the preceding few years. In Grade 5, students use exponential	This unit builds upon students’ existing knowledge in three major ways. It extends: students’ understanding of mathematical notation and exponents, their ability to transform and operate on expressions, and the kinds of problems that they are able to solve. By the time they reach Grade 8, students are aware of what exponential notation means. Here they use its definition to articulate some properties that always hold when power expressions are multiplied, divided, or raised to a power 8.EE.A.1. While they may begin this	Students will encounter exponents again in studying square roots, irrational numbers, and the Pythagorean Theorem in the next unit, and in exploring the volumes of solid figures and cube roots in Unit 8.9. Exponents are integral to a substantial portion of the mathematics students will see beyond Grade 8. They will take what they develop in this unit to explore the laws of rational exponents, study polynomial and exponential functions, investigate roots and complex numbers, and make sense of logarithms.

notation to write whole-number powers of 10 [5.NBT.2]. In Grade 6, they expanded that understanding by using exponents to write repeated multiplication of other integers [6.EE.A.1]. In Grade 7, they encountered exponents in the formulas for the area of a circle and for the volume of prisms [7.G.B.4], [7.G.B.6].

Students have also explored the concept of equivalent expressions in a number of ways. They know that expressions can be transformed to achieve simplicity and clarity (e.g. fractions can be reduced), to show structure (e.g. an integer can be written as a product of its factors), or to enable us to better make sense of the quantities or relationships they represent. Transforming expressions often involves operations, which are also familiar to students. They have performed operations involving various kinds of expressions: decimals [5.NBT.B.7], [6.NS.B.3], rational numbers [7.NS.A.1], [7.NS.A.2], and variable expressions [6.EE.A.3], [7.EE.A.1].

exploration by noticing patterns in concrete examples (e.g. arriving at values of powers with negative exponents by extending the pattern in powers with decreasing positive exponents), they will also begin to reason in abstract terms. They will use established facts or definitions and logic to arrive at new conclusions, and practice applying the new laws or properties on symbolic problems.

Students then take their expanded grasp on exponents to explore scientific notation. They learn that, just like other notations, the scientific notation is a convention established to make it simpler to denote and work with measurements, especially those involving very large or very small numbers 8.EE.A.3. The convention allows us to make sense of, estimate, and compare quantities that would otherwise be quite challenging or awkward to handle, and consequently to solve many kinds of problems –especially those related to the real world 8.EE.A.4.

The work here will also reinforce the idea that representation of quantities involves choices. In conveying measurements –especially those that are extremely large or small– the choice of units is essential, as it significantly affects how well a

	measurement would be understood, how accurate and precise we could get, and how useful it would be.	

Other learnings from studying curriculum materials, additional curricula, mathematical progressions and frameworks, and other resources

VI. GOALS FOR THE RESEARCH LESSON

We recommend utilizing the [SFUSD Dimensions for Teaching and Learning](#) to support development of your goals.

Brief description of the lesson selected:
The lesson is a modified version of a Youcubed task where students are given the opportunity to create axioms about positive integer exponents, to then apply to negative exponents. Students are asked specifically to reason about the expanded forms of negative exponents and bases to the power 0. They will critique each other's reasoning to agree upon a solution.

Lesson goals ("Core Math"):
What will students know, understand, or be able to do as a result of this lesson?
Include the STUDENT OUTCOME(S)/LEARNING GOALS or SUMMARY STATEMENT you hope to reach by the end of the lesson.

- Students will identify patterns and build on existing knowledge to construct an understanding of negative exponents.
- Students find value in collaboration and co-construction of knowledge
- Students will develop their mathematical reasoning skills by being skeptics

Mathematical goal:
The exponent describes the number of times the base is being multiplied or divided by itself. Multiplication and division are inverses of each other, thus increasing/decreasing the number of the exponent by 1 would be equivalent to multiplying or dividing by the base an additional time…
This division by the base helps understand why when we have a nonzero base to the power of 0 the result is 1 and why when we have integer bases with negative exponents the result is a fraction.

Goals related to our research question/theory of action: *How will this lesson facilitate student development related to our team or school Research Question and Theory of Action?* Students will be pushed to deepen their understanding of the situation by being skeptical of each other's ideas. The teacher will also model this by asking questions of why their ideas makes sense and how they relate to the given situation
Goals related to the pedagogical practices we are investigating (if different from above), such as whole-class discussion and mathematics journals: *What pedagogical practices are you investigating, and how? How will you assess progress or success? For example, if you are trying to build journal use, you might attach journal copies from your three selected students over the unit, and explain how you assess their quality.* ● Individual student think time to formulate ideas and questions ● Small group discussion to share ideas, answer questions, build on each other's ideas and formulate new conjectures ● Whole class discussion to help students develop their skills as skeptics, by sharing ideas, asking skeptical questions, visualizing their mathematics and making connections between equations and mathematical models ● Exit card summary to help students synthesize key mathematical messages

VII. LESSON DESIGN

Three Levels of Teaching *Japanese mathematics educators and teachers identify three levels of expertise of mathematics teaching:*	***Problem Solving*** ***(Standards and Focal Points, NCTM)***
Level 1: The teacher **can tell** students the important basic ideas of mathematics such as facts, concepts, and procedures. **Level 2:** The teacher **can explain** the meanings and reasons of the important basic ideas of mathematics in order for students to understand them.	Problem solving means engaging in a task for which the solution is not known in advance. Good problems give students the chance to solidify and extend their knowledge and to stimulate new learning. Most mathematical concepts can be introduced through problems based on familiar experiences coming from students' lives or from mathematical contexts.

Level 3: The teacher **can provide students with opportunities** to understand these basic ideas, and support their learning so that the students become independent learners. *(Sugiyama, Y. 2008, Trans. Takahashi, A., 2011a)* *Lesson Study Alliance: http://www.LSAlliance.org* *Helping teachers work together to improve teaching & learning*	Students need to develop a range of strategies for solving problems, such as using diagrams, looking for patterns, or trying special values or cases. *Lesson Study Alliance: http://www.LSAlliance.org* *Helping teachers work together to improve teaching & learning*

Explain why you have designed the lesson flow as shown in the next section. For example, what is your rationale for the selection and sequence of student responses? Incorporate what you learned from solving and discussing the mathematical task yourselves and anticipating student responses. Refer to the SFUSD Dimensions for Teaching and Learning which reference 3 dimensions critical to consider while planning: "Agency, Authority, and Identity"; "Access to the Content"; "Uses of Assessment". See also page 10 of the SFUSD Strategic Plan (TLTL) for further explanation of the Dimensions.

Rationale for *Agency, Authority, and Identity*:
What choices did you make in your lesson design to foster student agency and authority, and to be responsive to student identity? Why?
We chose a problem that would allow students to use mathematical reasoning to support different solutions. The prompt is open enough to encourage students to develop their own reasoning, and then critique each other's reasoning to identify a correct solution. Students are encouraged to explain why things work, rather than just relying on rules to determine correct answers.

Rationale for *Access to the Content:*
- Students have seen exponents before, but are unlikely to be familiar with
- Additional access is provided for learners to think about visual representations of exponents, not just algebraic or numerical ideas.
- Students are given the opportunity to engage in productive struggle, individually, in small groups and as a class. By building on a warm up activity where basic principles of positive exponents are discussed, all students should have an opportunity to access the problem.

What choices did you make in your lesson design to ensure access to the content for all students? Why?
- The chosen task is designed to review previous understanding around positive exponents, while giving students the chance to grapple with how those principles might apply to negative exponents.
- The task provides opportunities for students to use mathematical reasoning to come up with possible solutions. By discussing

those solutions as a class, students have the opportunity to critique the reasoning and make sense of their solutions. ● The cognitive demand is largely on students throughout this lesson - the primary role of the teacher is to push student thinking by modeling skeptical questioning and requiring students to explain and justify their thinking. ● To ensure comprehension, a warm up activity is structured similarly to the main task for the lesson. This should give all students the chance to understand terms like “exponential notation”, “expanded form” and value. The prompt will be shared with students verbally, in written form and restated by other students. The prompt itself is brief and uses instructional-level appropriate language.
Rationale for *Uses of Assessment*: *What choices did you make in your lesson design about the use of formative and summative assessment? Why?* ● Questioning & student presentations will be used as a formative assessment . This will allow us to know how students are making meaning of the mathematics. Additionally, an exit card to restate a main discussion point for the day

VIII. FLOW OF THE RESEARCH LESSON

These sections are just a guide. “Anticipated student responses,” however, should always be included.			
Components of the TTP Lesson Structure	**Steps, Learning Activities, Teacher’s Questions and Expected Student Reactions** *Shows the major events and flow of the lesson.*	**Teacher’s Support/ Questioning** *Shows additional moves, questions, or statements that the teacher may need to make to support students.*	**Points of Evaluation** *Identifies what the teacher should look for to determine whether to proceed, and what observers should look for to determine the effectiveness of the lesson.*
LAUNCH: Introduction (Hook)	*Students engage immediately in a warm up activity. They are asked to complete a table showing the expanded form and value of three different exponents.*	The teacher gives students time to work alone, followed by a brief amount pair-share time. The teacher then just scribes ideas as the students share them, being careful to write just what she hears	*Students share their ideas and agree as a class to the conventions of positive exponents. The goal os for students to see and agree that exponents determine how many times the base number is multiplied by itself. This axiom will then be used during the main task of the lesson.*

LAUNCH: Posing the Task	*Read the task out loud with the picture on the screen but no words.* You guys did a great job recalling how exponents work! What if we extended our exponents into negative numbers? How could we use the ideas we generated during our warm up to make sense of negative exponents? *Read the task again, this time with the text on the screen. Encourage students to complete all parts of the table, being able to explain their mathematical thinking to others.* *Ask students to retell the objective to one another in pairs.* *Invite 2 students to retell the objective to the whole class.* *Invite clarifying questions from the class.*	Teacher ensures that students understand the prompt.	*Clarifying questions and restatements.*
EXPLORE: Independent Work & Anticipated Student Responses **("Monitor, Select, Sequence")**	*Task is distributed and students enter into a 5 minute independent think time.* *Possible responses:* ● *See anticipatory planning document.*	Teacher gives students the chance to explore the task individually, before having students discuss in groups. For students/groups who seem stuck, teacher might encourage them to try drawing out visuals for positive exponents, or using what we agreed in the warm up to think about other parts of the table. Students might also need to be pushed to write the expanded form for 3^0	*Students who are stuck* *Students who are able to fill out the values, but are struggling with the visuals.* *Students who are able to write values, but can't explain them with an expanded form.*
EXPLORE: Partner/ Group Work?	*Questions to push student thinking:* *How would you explain your mathematical thinking to someone else?* "If your reasoning goes back to "because my teacher told me so", that means you don't really know" (if they echo some rule) "Do you see the logic in their thinking?	*See above*	*What will indicate that students are benefiting from partner/group work/talk?* *Convincing each other of different ways of thinking*

	"I also have reasons to be skeptical because…" "If students get the right answer in the table what would 3^0 look like in expanded form? "How does your logic connect to what we agreed during our warm up?"		
CONNECT: Neriage: "Kneading" Discussion (to Compare Solutions and Draw Out Key Mathematics)	*Push students to decide:* *"Which argument was most convincing and why?"*	*What are the ideas to focus on during the discussion? Which student responses are essential to the discussion, and in what sequence will they be presented? What will students notice? What will be done if essential ideas don't emerge from students? What questions and teacher moves will help students notice, explain, understand?*	*What will indicate that students are benefiting from the discussion?*
SUMMARIZE: Summing up		*What prompts for discussion or journal-writing will help students summarize what they learned? Assessment activity, if any.*	*What comments or work will reveal student thinking and any changes in it?*
SUMMARIZE: Reflection	*Students will be given a few minutes to respond to an exit question to determine the success of the mathematical and culture goals for the day.*	*What prompts for discussion or journal-writing will reveal authentic student thinking and reflection?*	*What reflections or comments will reveal student learning or student experience?*

IX. BOARD PLAN

A board diagram shows how work on the board will be organized to support the lesson flow above. Conducting a mock-up lesson (with adults) and creating a board diagram can provide a chance for your team to think through the drama of the lesson–what students will

say and do (monitor) and how and why students' thinking will change over the lesson (select and sequence) - and plan the board accordingly. For a board plan template and examples, see http://lessonresearch.net/ttp/boardorganization.html
A blank copy of the table will be on the board and students from different tables will be invited to put their table's ideas up for discussion. The order of presentations is laid out in the anticipatory planning document.

X. EVIDENCE/DATA TO COLLECT OR OBSERVE

What data will help you determine what students learned and are able to do as a result of your lesson? *What data will help you assess student progress toward the lesson goals and your research question?* *What data will help you assess student experience (interest, safety, agency, confidence, etc.) throughout the lesson?* *(Consider student work, student responses and conversation, patterns of participation, student journals, student engagement, etc.)*
Exit card: ○ **How can you convince someone that 4^{-2} is a fraction (if you don't have a calculator)?** ○ **How comfortable do you feel sharing your mathematical ideas (with peers or class)? Scale of 1-4.** **Data collection at tables for individual students:** [Possible data collection sheet]() ● Coding system for tracking participation in group - Q (question), S (shared idea), B (built on idea), C (challenge another student / disagree) (can we add one for extra/throw away comment) ● General comments about the subculture of the group

XI. NOTES OR SCRIPTING FROM THE PUBLIC RESEARCH LESSON

Participants:

Note-taker:

Pre-Lesson Discussion Notes:

Scripting

- What is your **research question** and **theory of action**? Why did your team choose this focus? Why is this focus important to student learning and/or student experience at this site?
- What is the **context and rationale** for this research lesson? Why is it important and relevant for students? How is it connected to the **research question** and **theory of action**?
- What are your specific **student learning objectives** and **intended student learning outcomes**? What are you hoping or expecting students to **do or say**?
- What is the **new student learning** in this lesson?
- How will you **assess student learning**?
- How will you **assess progress** toward your **theory of action**?

Analysis:
Questions/Wonderings about the *Research Question* and *Theory of Action:*

Questions/Wonderings about the lesson design:

Teacher Reflection (initial thoughts and reactions):

Scripting

Evidence Share-out (data collected during research lesson):

Scripting

Summary of evidence collected:

Post-Lesson Discussion/Debrief Notes:

Scripting

I. **Student Learning & Thinking:** What have we learned about our students, the content, and instruction? Were the lesson goals and learning targets met? How did the lesson design enable student learning and illuminate student thinking? Was new learning embraced and did students engage in productive struggle? Were students engaged and hooked? What might we have done differently?

II. **Research Question & Theory of Action:** What have we learned about our research question and our theory of action? What implications does this have on our next steps? Do we need to revise our theory of action?

III. **Next Steps:** What are our strategic next steps as a team?

Analysis:
Questions or themes that guided the conversation:

Questions or themes for future discussions:

Expert Commentary Notes: Scripting (of expert commentary and of discussion afterwards): Summary of key points:

XII. SUMMARY OF LEARNING

(To be completed AFTER the research lesson)

Summary of learning from the Post-Lesson Discussion & Expert Commentary We recommend having each member of the lesson study team complete this reflection individually (see template below), before meeting as a team to discuss collectively. Summarize your learnings below after discussing:
What we learned about the mathematical topic / "Core Math" (including the CCSS-M standards and mathematical practices). What we learned about how to teach this content, how our students learn this content, and use of the curriculum to support the content. Include what you would change in the lesson if you were to re-teach whole-class or to small-groups. ***What will we change in our teaching practice as a result?*** Mathematical goal: - Students worked hard to defend a pattern - but weren't connecting it to the whole table. Helped the teacher to figure out the gap. - Seeing the repeated division is very challenging, especially when students aren't attending to the first part of the table - Students were "backward fitting" a pattern to fit the way in which they filled out their table, instead of identifying a pattern first, then extending it. - If students had calculators, would they have questioned their thinking more?

- Takes a lot of convincing for students to see negative exponent does not give a negative number
- Potential to double huddle $3^0=1$ to give students a chance to be more skeptical of their initial thoughts.

What we learned about our research question and theory of action. What we learned about the instructional practices and productive habits intended to support our research question and theory of action, such as whole-class discussion, mathematics journals, etc. ***What will we change in our teaching practice as a result?***

Implications for our next lesson study cycle (for example: topics to investigate, modifications of our theory of action, modifications of the lesson study process, how we worked together and communicated as a team, vulnerability and courage to teach publicly, etc.) ***What will we change within our team's lesson study cycle as a result?***

Details For Next Time…

- Spanish translation for invite
- Spanish translation during the event?
- Signs on the GSE door that the event is occurring
- Decision about using microphones with students upfront. Let them know beforehand.
- Another teachers tests the lesson with their students and the team observes.
- The data piece still feels fuzzy to me and unsatisfying.

Structure of lesson

- Two different strategies (instead of three)
- What happens when nobody comes up with the division pattern? Did filling up the first part help last years group understand the positive exponents and create a link to the negative?
- Include a statement "a negative exponent means you have to…." Then participants and students could use it as a reference point to focus the questions/conversations
- Describe what happens to the value and the expanded form as a first step for the positive exponents

- For negatives - what are the things we might hear students saying that we can hook & press on: “losing a three each time”
- How to keep (or develop further) the restate + clarify section - but keep it quick.
- Some work on how to construct viable arguments - how can we encourage them to be skeptics of themselves
- Here is what I think you’re saying “...” then check to see if class agrees.
- “Can you use this teams strategy to do 3^-4?” (and use a double huddle so team can think more deeply about their argument.
- Have students read the problem to each other.
- Show just the first positive exponent part and ask students what they think about it.

Some things we did not anticipate and might plan differently next time:

- Have a clearer plan for what to do when no students come up with the correct solution - even practicing ahead of time
- Ensure that lead teacher has seen and feels confident doing the thing s/he is being asked to do!!
- Getting student input on task/lesson design
- Ensuring that students and teacher get a chance to try out any strategies that are likely to be in the lesson ahead of time.
- Predicting clarifying questions ahead of time, so teacher does not need to make key decisions in the moment. This could be a norm/cultural structure to work on with kids ahead of the day.

Potential ideas for next steps or revisions:

- An idea that came up in another class is…. $3^0=1$
- “I think I have a pretty good idea about your thinking from yesterday, but what I am not understanding yet how you are extending your pattern across the table for the values row”
- Focus students on the value row for finding patterns
- Presenting a sequence of 27, 9, 3…. And asking for the next 3 numbers in the sequence - then reconciling this with the work from today.

Katie is still thinking about different strategies for helping students to see the pattern, either through huddles, warm ups, different representation of the table etc. May want to consider structures/scaffolds for preparing arguments - for example a short list of skeptical questions - so that each student is preparing to present.
Implications for our school (for example: what we want to share with colleagues, implications for school professional development, implications for how math is structured and taught at this school, recommendations for our administration or ILT, etc.) ***What will we bring to our school as a result?***
Implications for our district (for example: recommendations to other schools, changes to the SFUSD curriculum ("Core Math"), type or frequency of support needed from central, recommendations to math department re: math content/practice, etc.) ***What will we bring to our district as a result?***
Next Steps. What do we plan to do differently? What will we do *short-term (immediate actions)* and *long-term (ongoing or future actions)* as a result of this lesson study cycle? Be specific.

Short term	Long Term
Takeaways: Leandra is excited to give this lesson Aurmon - More board space next time	

Katie - Focus more on discussion; appreciate the space to be honest Curtis - Thinking of questioning strategies to bring out ideas Libby - None of us will ever get it just right Kristin - Gratitude for this group and this opportunity Katerina - anticipate, anticipate, anticipate!! Daisy - thinking of questioning strategies. Such a special group!!! Cate - so grateful to Katie! Can anticipate and plan for 8 weeks and still things go in a different direction than we thought!	

End-of-Cycle Individual Reflection **Individual ID#________________**

Please post or distribute this page so that each team member has a copy and can write an individual response, and please include the individual responses with your video and artifacts from your lesson study cycle.

What we learned about the mathematical topic / "Core Math" (including the CCSS-M standards and mathematical practices). What we learned about how to teach this content, how our students learn this content, and use of the curriculum to support the content. Include what you would change in the lesson if you were to re-teach whole-class or to small-groups. ***What will we change in our teaching practice as a result?***

What we learned about our research question and theory of action. What we learned about the instructional practices and productive habits intended to support our research question and theory of action, such as whole-class discussion, mathematics journals, etc. ***What will we change in our teaching practice as a result?***

Implications for our next lesson study cycle (for example: topics to investigate, modifications of our theory of action, modifications of the lesson study process, how we worked together and communicated as a team, vulnerability and courage to teach publicly, etc.) ***What will we change within our team's lesson study cycle as a result?***

Implications for our school (for example: what we want to share with colleagues, implications for school professional development, implications for how math is structured and taught at this school, recommendations for our administration or ILT, etc.) ***What will we bring to our school as a result?***

Implications for our district (for example: recommendations to other schools, changes to the SFUSD curriculum ("Core Math"), type or frequency of support needed from central, recommendations to math department re: math content/practice, etc.) ***What will we bring to our district as a result?***

Next Steps. What do we plan to do differently? What will we do *short-term (immediate actions)* and *long-term (ongoing or future actions)* as a result of this lesson study cycle? Be specific.

Short-term	Long-term