IMMERSION
Dive into Math Modeling!

MATH MODELING IN THE ELEMENTARY GRADES THROUGH SCHOOL UNIVERSITY PARTNERSHIP

AMTE 2016 Irvine, California

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Purpose

In this presentation, we will share

① The design of the professional development and share the outcomes from the first year of a three year project of the school-university partnerships.

② The nature of the school- university partnership will be detailed with specific design decisions made to establish the critical infrastructure needed to guarantee a more sustainable professional development model.

③ Finally we will discuss the attributes of mathematical modeling and how it enhanced the teaching and learning of mathematics by bringing in the real world context to the teachers, students and learning environments.

Significance of our project

CCSS M STANDARD 4: Model with Math

- **Model with mathematics. From Standard 4 of CCSS-M**

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose. (NGACBP & CCSSO, 2010)

What does math modeling look like in the elementary grades?

Multiple meanings of *model*

How is modeling used in mathematics?

- Physical models (manipulatives)
- Mental/representational models (i.e.,diagrams)
- Modeling thinking (demonstration)

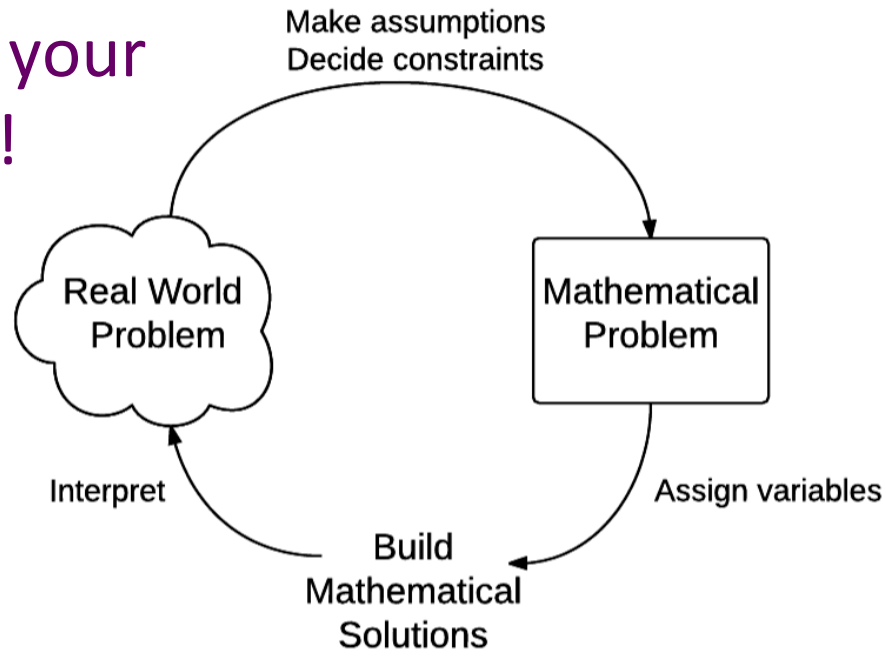
Our focus!

Mathematical modeling: a cyclic, open-ended, process of real-world problem posing and problem solving.

(English, 2003;

Mathematical Modeling

This is what your students do!



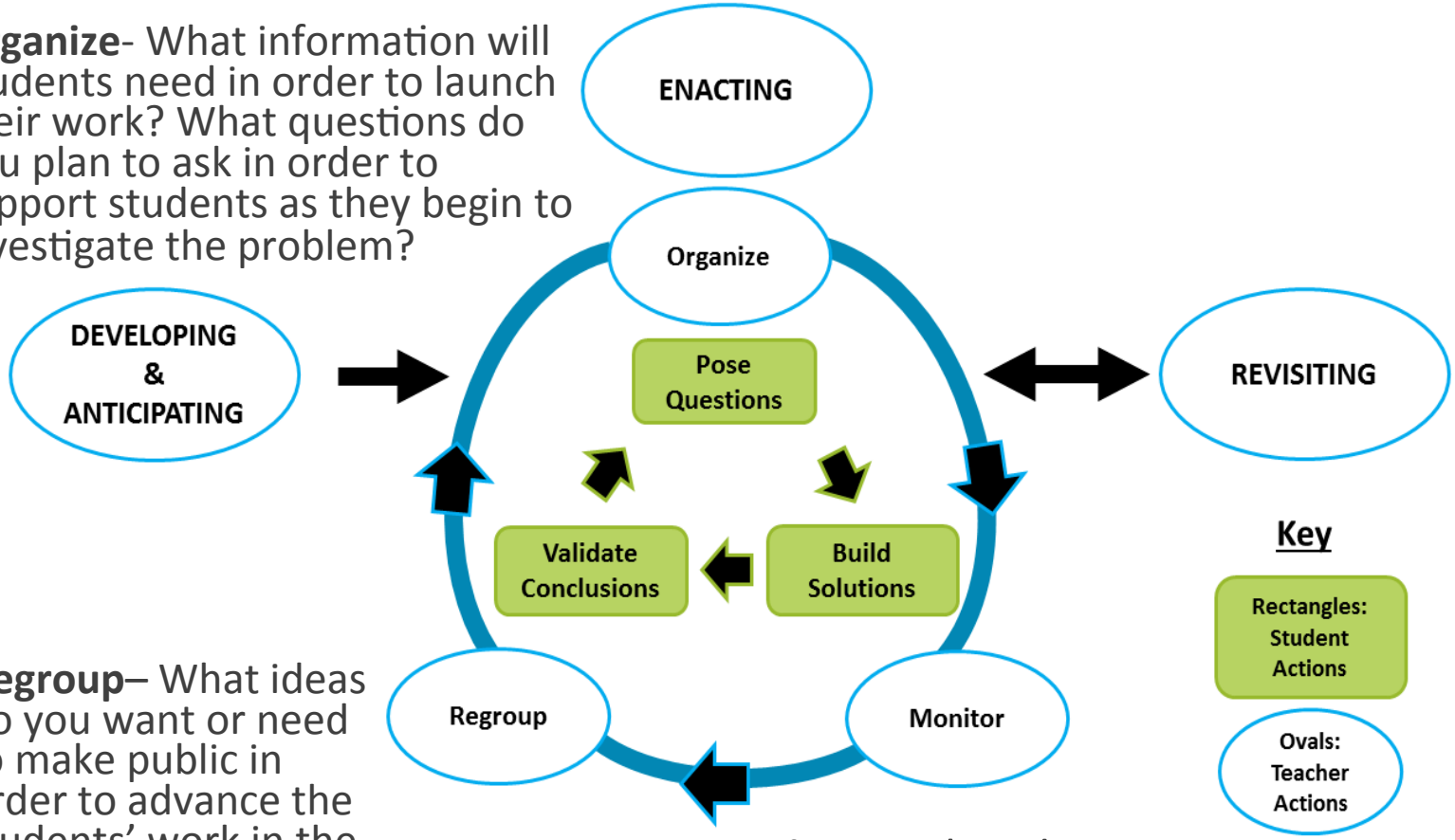
In our work with teachers as co-designers, we focused on the…

Facilitation and Assessment

Activity	Questions
Pose open modeling problem	What is the real-world problem? Who cares about the answer?
Make Assumptions/Choose Constraints	What ways might you limit the problem? What information do you need?
Pose Mathematical Problem	What math ideas and tools will you use?
Define Variables	What quantities change and what stays the same?
Build Mathematical Solutions	Did you do the math correctly? Did you explain what you did so others can understand?
Interpret/Validate	How accurate is your answer? How do you know?
Revise	What can you change to make your model more accurate or useful?

Immersing Teachers in Mathematical Modeling as Co-designers through TSG and Lesson Study

Organize- What information will students need in order to launch their work? What questions do you plan to ask in order to support students as they begin to investigate the problem?



Regroup– What ideas do you want or need to make public in order to advance the students' work in the modeling cycle?

Monitor– What do you want to see and hear from students as they begin to make progress on the task? How will you keep track of what you see and hear?

School-University Partnership (SUP)

PARTNERING WITH KNOWLEDGEABLE LEADERS FROM WITHIN

Bozeman and MSU Partnership Institute 1
This SUP had an ongoing PD and teacher preparation program relationship.
A former "teacher in residence" in the department of mathematical sciences, and current 5th grade teacher, joined the project at its inception as a teacher leader; a second grade teacher who had participated in a **coaching partnership** with the university was invited to be a second teacher leader.

Pomona and HMC Partnership Institute 2
This SUP was a new professional development relationship. A small group of teacher-leaders **(one math specialist, one teacher on assignment, one (former elementary) current middle school teacher and one mathematics education professor** met with the PI from Harvey Mudd College monthly throughout the 2014-15 academic year to prepare for the summer PD.

FCPS and GMU Partnership Institute 3
This SUP was unique in that the district leaders and the university educators already had a multi-year professional development relationship through other state funded project. .
After discussing and **co-planning the partnership** project, the university educators and the district leaders realized that the **mathematical modeling project would align well with a new district wide initiative of problem-based learning and developing 21st century learners** that would focus on open-endedness problem-posing tasks because it would allow them to assess students 4Cs: collaboration, creativity, critical thinking and communication skills.

Research Questions

1) What were some noticeable change in teachers' attitudes towards mathematical modeling before and after targeted PD in mathematical modeling?

2) What aspects of teaching modeling to elementary students are challenging for teachers?

3) In what ways is modeling exhibited in elementary grades mathematics classrooms?

4) How does the school-university partnership enhance the professional development model and make teacher learning more sustainable and the impact on student learning more visible?

Participants and Context-

- 24 teachers
- Grades k-6

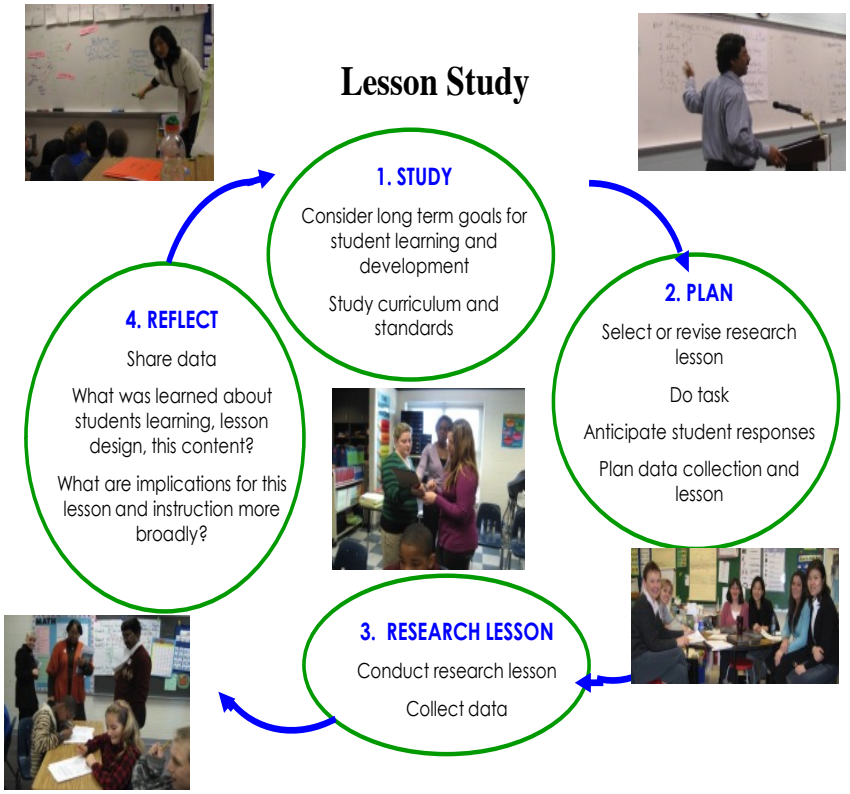
The goal of the project was to improve teachers' mathematics content knowledge and pedagogical strategies in modeling through University-school partnerships. Teacher leaders worked with university faculty to **co-plan** the professional development and teachers become **co-designers** of the mathematical modeling curriculum for the elementary classrooms.

Design of the PD-Mathematical Modeling Summer Institute

Monday	Tuesday	Wednesday	Thursday	Friday
Open-endedness & Defining Modeling	Mathematical Problem Posing & Developing	Creativity and Choices & Enacting	Revising & Revisiting	Teacher Study Groups & Differentiation

Design of the PD-Mathematical Modeling Fall Follow-up

LESSON STUDY & TEACHER STUDY GROUPS



Data Sources & Analysis

Design-Based Implementation Research methodology, DBIR (Fishman, Penuel, Allen, Cheng, & Sabelli, 2013) to examine the design of our professional development and to study and enhance our design through feedback from our iterative implementation cycles.

To begin analyzing the themes, we used the document analysis technique using teachers' individual reflections and exit passes, transcripts of the Lesson Study debriefs and symposium presentations and the researcher memos. We systematically analyzed the data by developing initial codes and used the method of axial coding to find categories in such a way that drew emerging themes (Miles & Huberman, 1994).

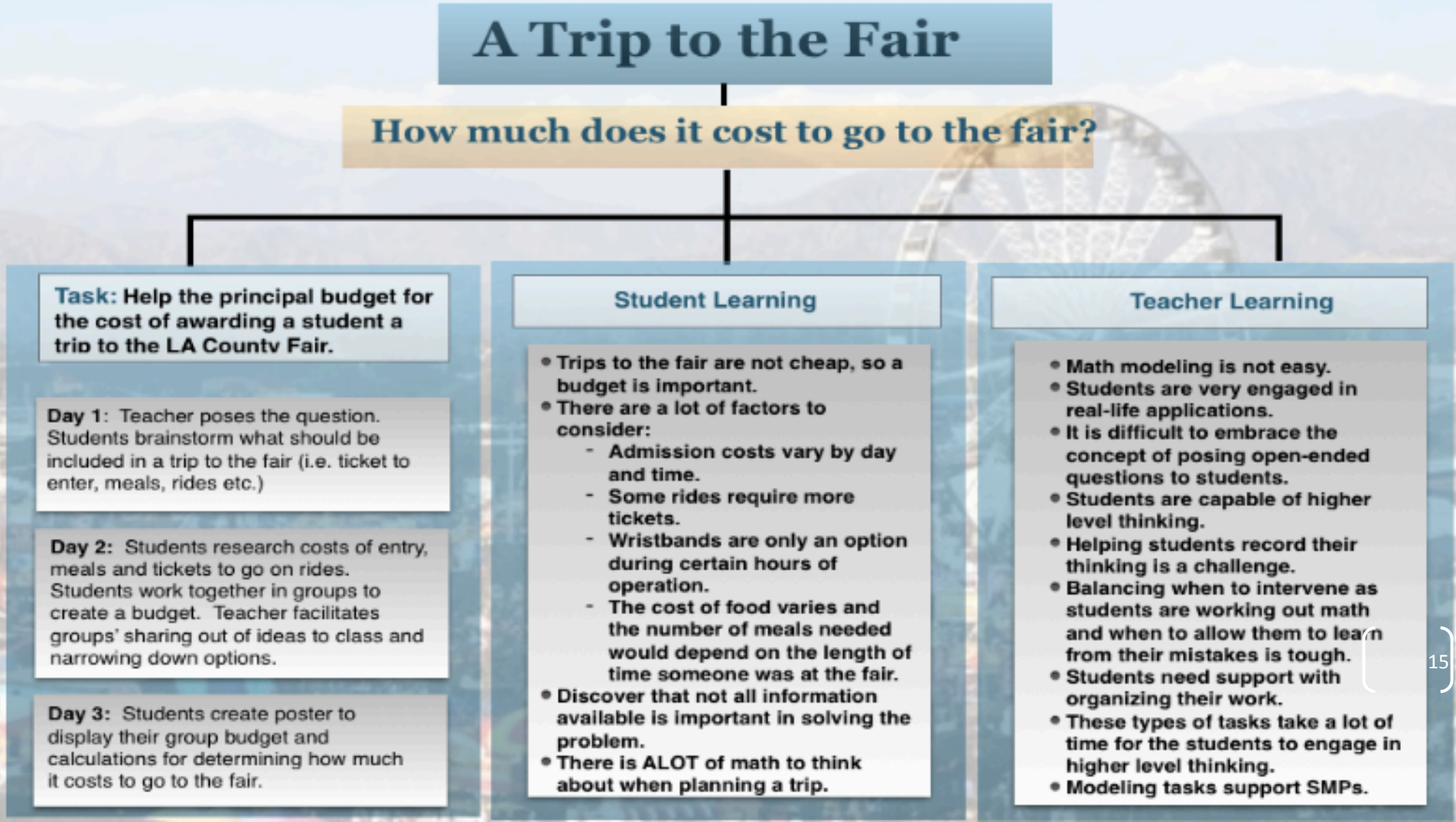
Dedoose, an internet-based data management tool (Dedoose Version 6.2.7) was used to code and analyze the data

Data Sources & Analysis

Data sources:

- Exit passes from Summer session on MM
- Teacher Study Groups and Lesson Study artifacts (facilitator memos)
- Final symposium powerpoint presentation and debriefs

Harvey Mudd College & Pomona District



Montana State University & Bozeman District

First-Grade Modeling

Task 1: What is the one carnival game we should tell the PAC to keep next year?

When: September

Mathematics content: Voting/tallying, graphing

Modeling content: defining best; convincing the PAC president we know which is best

What we learned about teaching: How long is too long. Even the carnival is abstract to first graders. We didn't need to frontload to engage students in modeling, but we had to scaffold.

Task 2: How many bags of candy do we need for our class harvest party?

When: October

Mathematics content: counting, repeated addition, guess and check, sorting, grouping, equal shares

Modeling content: determining how many pieces of candy each student should get. Fair.

What we learned about teaching: using manipulatives was more engaging,

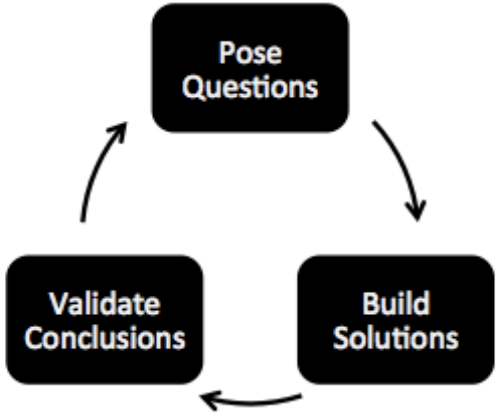
George Mason University & Fairfax County Public School

- **FOOD FOR THOUGHT-Fighting Hunger**
- **ELABORATE: Build Solutions-Service Project**

The problem was posed:

"How can you help eliminate hunger in our local community?"

Then the students brainstormed possible solutions, and used research, as needed.



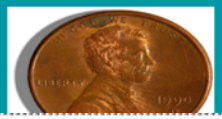
FACTS/MATH!!!!!!!!!!

Student presentations for the Fight Hunger MM project

After finding out that 1 in 5 kids are hungry we found the population of Reston which is 58,404 as of 2010. After dividing that by 5 which is about 16610. That is the number of people that go hungry. In a classroom with 30 kids, about 6 would be hungry. Once we get the food we will use division to divide the food evenly.We want to make a difference by feeding as many of these kids as possible.

Pennies Go A Long Way

A cent a day keeps the hunger away!!!!!!



THIS IS AN EXAMPLE OF A FLYER!

Hey 3rd Grade!
Did you know that 1 in 5 kids go hungry? But you can help! We are asking your grade for:

Canned Soup!

Thank you for your support! Love Mrs. Rossbach's class

How Many People Don't Know Where Their Next Meal Is Coming From?

There are about 1:5 children in Virginia who don't know where their next meal is coming from. These children are all around you. Just because they're hungry doesn't mean that they have to be homeless.

These people it's not just childr
but it's their family. If you and f
other friends are around a tabl
that means that one of you cou
possibly not know where your
meal is coming from.

Results

1) What were some noticeable change in teachers' attitudes towards mathematical modeling before and after targeted PD in mathematical modeling?

Before-Fear of the Unknown

"How do you keep this real? Our **time** is so precious. How can we integrate other subjects/ standards, and have a greater impact than just in math?" (Summer Institute Fairfax Exit Pass)

"I am always ***anxious*** *of what this looks like in my class*." (Summer Institute Fairfax Exit Pass)

"Would like to see a "**bank**" of already open-ended questions." (Summer Institute Fairfax Exit Pass)

"Want better understanding of designing a task that **has enough math content** but doesn't become unmanageable in the doing." (Summer Institute Fairfax Exit Pass)

"What do I do if my students ask a **question** I can't answer?" (Summer Institute Fairfax Exit Pass)

Teachers have grade level concerns – concerns that the tasks **aren't relevant for their grades** and that they don't have examples for their grade level. "What can we incorporate at grade level modeling? (Need more examples)" Some teachers **have low confidence** in their own abilities in terms of being creative as well as facilitating modeling. "I am concerned that I **do not have the ability to facilitate a modeling task.**" Teachers are still grappling with giving their students enough help, **but allowing them freedom** without them becoming too constricted or too frustrated. "I want to give my class enough constraints to **begin without eliminating creativity**." (Summer Institute Day 3 Pomona Exit passes)

The most common question continues to be about balancing freedom with structure. Teachers worry that they **may over-support** students and which would make the task no longer a modeling task. "I am struggling to figure out how to make a problem mathematical without trying to control what the students are doing." Other teachers wonder about **differentiation and including students who are below grade level.** (Summer Institute Day 4 Bozeman teacher Exit Pass)

Results

RQ 1) What were some noticeable change in teachers' attitudes towards mathematical modeling before and after targeted PD in mathematical modeling?

After –Implementing lesson provided the "Proof of Concept"

"Trusting the process and the Students."
"Trusting students to find and use efficient strategies."
"Seeing students want to dig deeper."
"Student engaged in real life application."
"Modeling taks supports SMPs."
"Students are capable of higher level thinking."

Students are capable of higher level thinking

A

Results

RQ 2) What aspects of teaching modeling to elementary students are challenging for teachers?

Challenges for teachers

- It is difficult to embrace the concept of posing open-ended questions to students
- Helping students record their thinking is a challenge.
- Balancing when to intervene as students are working out math and when to allow them to learn from their mistake is tough.
- Students need support with organizing their work
- These types of tasks take a lot of time for the students to engage in higher level thinking.
- Math modeling is not easy! (Pomona TSG presentation reflection)

Challenges for teachers

- Conflict with current curriculum pacing guide
- Focusing on the mathematics
- Managing facilitation of students as they went through the MM processes

Fairfax Lesson study presentation reflection)

Challenges for teachers

One of the lesson became a STEM focused lesson-which did not focus primarily on the Math modeling process.

(Bozeman TSG presentation Memo)

Results

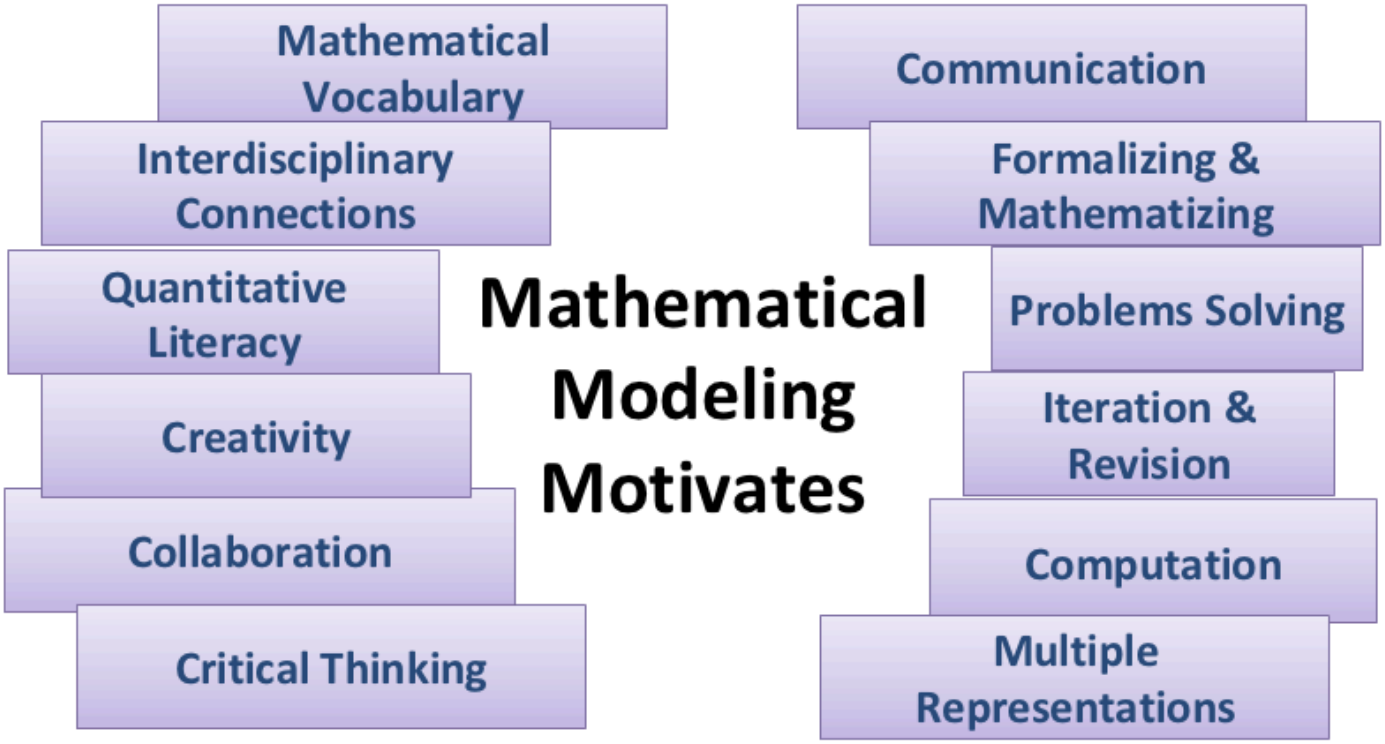
Mathematizing

RQ 3) In what ways is modeling exhibited in elementary grades mathematics classrooms?

"Group three really were looking at the numbers of people in Fairfax County. And, so, we had the number of one in five in the United States, so they had to research how many kids are in our county. ***If it's one in five, how many of them are hungry?*** *So they were looking at that and* ***how much it costs a family to feed their kids****. And then group four they were focused on the income like of families and single moms, and* ***how much should she make in order to provide for the family based on grocery costs****. Group five explored average family size and how much money would be left over each month to buy food.. So they really all sort* ***of went in different directions****, which was fine with me. And as they worked they found what worked, what didn't, how they could tweak things, and we really worked on this for several days in a row."*

Connections to 21st century skills

Students engaged in mathematical modeling have to determine the important factors to consider in the situation, as well as mathematical operations to be applied as they continue **to refine, justify, and show their thinking.** The children not only have to create a model for the situation, but they also have to collect new data and apply their model to that data. Throughout this process they are learning how to collaborate in a small group to reach a common goal.



Teachers Discovered that Students can Learn *without Direct Instruction.*

One of the greatest concerns that the teachers had initially was that modeling process would take too much of their instructional time. They were worried that with this time investment on mathematical modeling, the teachers would not be able to cover all the content objectives. One of the biggest "return on investment" was the content that was covered in the classroom during mathematical modeling. In fact, content was brought about without the direct instruction of the teachers, for instance students first experience working with proportional reasoning without prior direct instruction.

Student Engagement and Attitude towards Math.
Student engagement as a result of mathematical modeling was one of the other topics shared at the Symposium. Teachers found that though the MM process was messy for them, it was engaging for the students. They found that **students begged for, "Just five or ten more minutes,"** to work on mathematics and regularly asked when they would have class time to work on the project. This type of mathematics also impacted student disposition towards mathematics. One teacher notes that mathematical modeling is a natural process and the messiness comes from the teacher more so than the student. **'It's messy for us because we don't know what is going to happen, we have to do the anticipation and have to be flexible, the messy is from the teacher perspective but the messy is engaging for students…**.the messy is that they have so much choice which is engaging and motivating.' A participant remarked that at **a recent parent-teacher conference, a parent shared that their child had gone from hating mathematics the year before to currently loving mathematics. The shift was attributed to the mathematical modeling project in this teacher's classroom.**

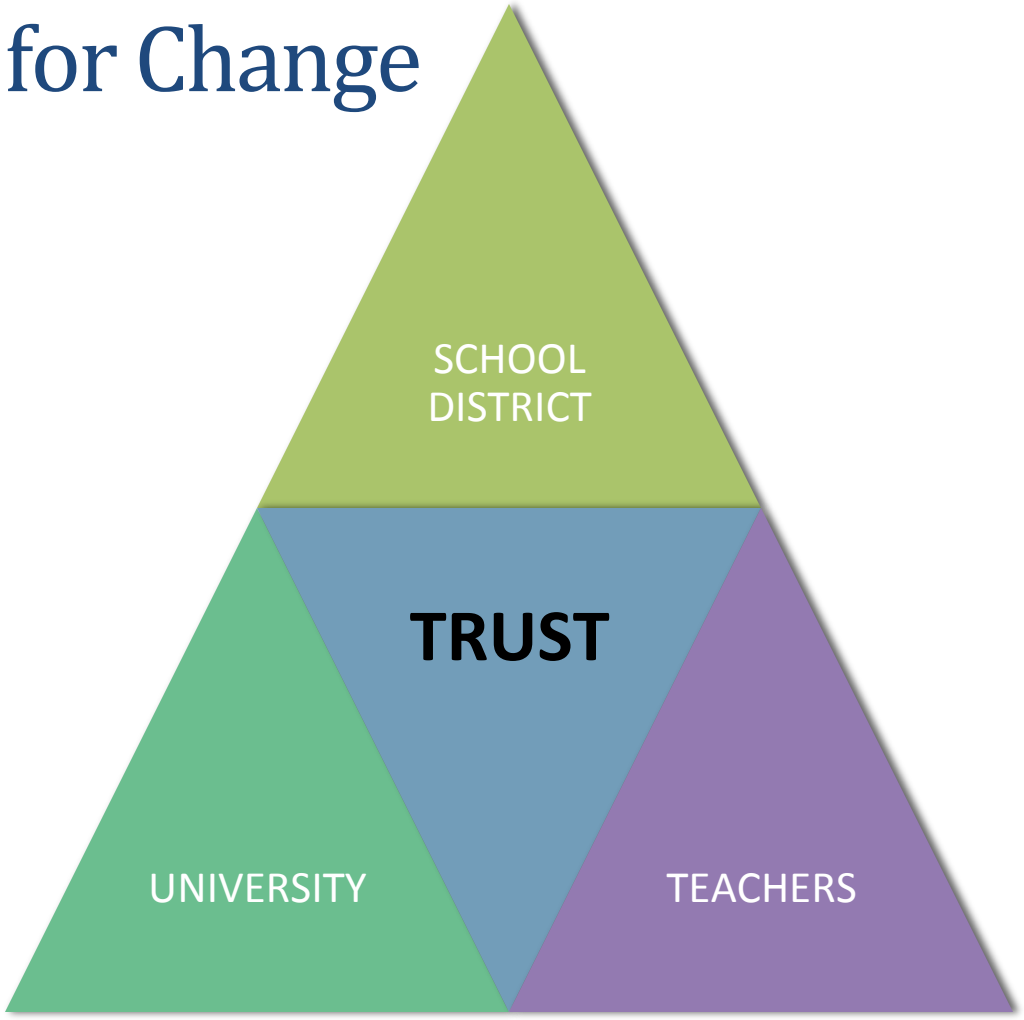
Results

RQ 4) How does the school-university partnership enhance the professional development model and make teacher learning more sustainable and the impact on student learning more visible?

By including school-university stakeholders such as the district leaders and the teacher participants in the research design, we were better able to make improvements in the design and make the innovation more feasible and scalable for sustainability.

Working with teacher participants and district leaders we gathered and interpreted evidence of effectiveness and areas of improvements to assist with our iterative cycle of design. In addition, having three professional development research sites, we wanted to know how and for whom and what support and resources are necessary to have a positive effect on learning.

School University Partnership- Networks that become the Catalyst for Change



School University Partnership- Networks that become the Catalyst for Change