Mathematical Modeling in Elementary Grades: Outreach Activities from the Immersion Program

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JOINT MATHEMATICS MEETINGS
SIAM MINISYMPOSIUM ON K-8 APPLIED MATHEMATICS OUTREACH ACTIVITIES
Research Partners

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IMMERSION is a research and professional development program investigating mathematical modeling in the elementary grades, funded by NSF STEM-C 1441024
Professional Development

• Three sites, each with 24 participants, led by a partnership between university mathematics faculty and lead teachers from the district.

• Five day summer PD focusing on teachers as mathematical modelers (mornings) and teaching mathematical modeling in elementary grades (afternoons).

• Follow-up fall semester “teacher study groups” were facilitated by university faculty or lead teachers and supported teachers’ enactment of mathematical modeling lessons.

• Classrooms from kindergarten through fifth grade
Professional Development

- Engages teachers as modelers
- Examines the teaching modeling framework
- Supports teachers in implementing modeling with students in grades K-5
### A glance at the week

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Open-endedness &amp; Defining Modeling</strong></td>
<td><strong>Mathematical Problem Posing &amp; Developing</strong></td>
<td><strong>Creativity and Choices &amp; Enacting</strong></td>
<td><strong>Revising &amp; Revisiting</strong></td>
<td><strong>Teacher Study Groups &amp; Differentiation</strong></td>
</tr>
</tbody>
</table>
What is modeling?

A *mathematical model* is a representation of a system or scenario that is used to gain qualitative and/or quantitative understanding of some real-world problems and to predict future behavior.

**Modeling** is the process of creating these models. In elementary classrooms, students use mathematical tools to represent, understand, and solve real-world problems.
Mathematical Modeling

Real World Problem

- Make assumptions
- Decide constraints

Mathematical Problem

- Assign variables

Interpret

Build Mathematical Solutions
Elementary students modeling

When students use their mathematical tools to make a decision, prediction, or solution about a real world situation.
What is special about mathematical modeling in schools?

Mathematical modeling does not prescribe processes to students. It asks them to create.
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Mathematical modeling involves translating “real-world” situations to and from mathematical world.

Mathematical modeling requires the modeler to make value judgments. The worth of the model is determined by its usefulness in addressing real world situations, not by the teacher or curriculum.
Complex and ambiguous

Mathematical modeling engages students in inquiry, empirical investigations, and complex judgments about how mathematics helps us understand phenomena in the world.
Modeling in schools

Mathematical modeling is an open-ended process.

- Open in how the modeler defines the mathematical problem
- Open in the solution method
- Open in the final solution
Opportunities

The *cyclic* nature of modeling, its reliance on *open-ended* problem *posing*, and a focus on problems *without a single* correct answer provide a rich learning environment for students.
Modeling and open-endedness

Not all open-ended problems are modeling problems.
Where is the most important “open”?

We give students more opportunities to use multiple solution strategies than we give them opportunities to define their own mathematical problem.
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In prioritizing where to spend the time on openness with modeling, I’d choose openness in problem posing, because it’s a characterizing feature in modeling.
Mathematical Modeling in 1st grade

- Real World Problem
- Make assumptions
  - Decide constraints
- Interpret
- Build Mathematical Solutions
- Assign variables
- Mathematical Problem
How many bags of candy do we need for our party?

• Question was framed with a story about having candy for trick-or-treaters and need to know how many will be needed for the class.

• Since candy was purchased for trick-or-treaters each group had one bag.

• Teachers chose not to identify fairness as the priority – they posed the question to students as “how many” and let the students determine what was important.
Counting by 2’s

Separate into groups of 20
Amount needs to be fair. Students determined fair amount.

How many bags of candy?

Told teacher how many to buy. Teachers purchased candy for party.

Counted pieces in one bag. Separated by color, counted by 2's, grouped by 5, grouped by 20

How many bags of candy if everyone gets 5 pieces?

Are colors important?
What to do with leftover candy?
5th grade task

What’s the best field trip for our class?

The assistant superintendent wanted a way to evaluate all field trip proposals – created a client video asking for a model.
## Ways to assess ‘Safe’, ‘Fun’, ‘Educational’ and ‘Affordable’

<table>
<thead>
<tr>
<th>5 Stars</th>
<th>4 Stars</th>
<th>3 Stars</th>
<th>2 Stars</th>
<th>1 Star</th>
</tr>
</thead>
<tbody>
<tr>
<td>Really fun (a blast)</td>
<td>Fun (really fun)</td>
<td>Kind of fun</td>
<td>Not so fun</td>
<td>Not fun (a rip)</td>
</tr>
<tr>
<td>Fun for everyone</td>
<td>Fun for almost everyone</td>
<td>Fun for half the people</td>
<td>Fun for not many</td>
<td>Fun for almost none</td>
</tr>
<tr>
<td>Kids are smiling</td>
<td>Most people smiling</td>
<td>Half of the people smiling</td>
<td>Drowsy eyes</td>
<td>No smiles</td>
</tr>
<tr>
<td>Interesting</td>
<td>Most people interested</td>
<td>Okay experience</td>
<td>Kind of bad experiences</td>
<td>Nothing to do</td>
</tr>
<tr>
<td>Lots of laughing</td>
<td>Talking</td>
<td>Happy</td>
<td>Talking about math</td>
<td>Have to be silent</td>
</tr>
<tr>
<td>Lots of movement</td>
<td>Happy</td>
<td>Talking</td>
<td>Standing</td>
<td>Falling asleep</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Listening</td>
<td>Boring</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No movement</td>
</tr>
</tbody>
</table>
Model Validation

First model:
F + E + S + A

Problem – boring field trips got high scores

Final model:
3F + 2E + S + A
Our (initial) challenge

How do we, as teacher educators, describe and support teaching practices that give students the best chance of engaging in mathematical modeling?
(Carlson, Wickstrom, Burroughs, & Fulton, 2016)
Modeling is Important and Worthwhile

- Young children can engage in the practice of mathematical modeling.
- Teachers learn and exercise ambitious teaching practices while engaging with students in mathematical modeling.