

Mathematical Modeling with Elementary School Students

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Critical Questions in K-5

Why model in K-5?

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What are the tasks of teaching when engaging elementary students in mathematical modeling?

How should opportunities for modeling in grades K-5 be constructed and carried out?

Claims about Modeling in K-5

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- *Younger and simpler* approach to teaching modeling doesn't hold in K-5
- Focus should be on mathematical discourse and cooperative group work rather than *tasks*

Claim One

Modeling provides an opportunity (even for very young students) to examine complex and ambiguous issues from a mathematical point of view. It can empower students.

Mathematical modeling

Engages students in inquiry, empirical investigations, and complex judgements.

It requires an articulation of underlying values.

Empowering students with mathematical modeling

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.

Questions young students ask

What is best?

What is fair?

Powerful tool for justice

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“Statistics, data analysis, and modeling offer the unique opportunity to address real world problems that affect students in their communities”

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.

Bliss, Fowler, & Galluzzo (2014)

Why model?

Why should this mathematical perspective be included in *elementary* schools?

Modeling in schools

- Mathematical literacy
- Promotes productive dispositions
- Deep, integrated understanding

Example: What is the best meal for a community lunch?

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This is complex and ambiguous, and they are using mathematical and statistical tools to tackle it.

Claim Two

The most important part of modeling in K-5 is mathematical problem posing.

Modeling in schools

Mathematical modeling is an open process.

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

Openness

Modeling problems are open because the student decides what and how to pose a mathematical problem.

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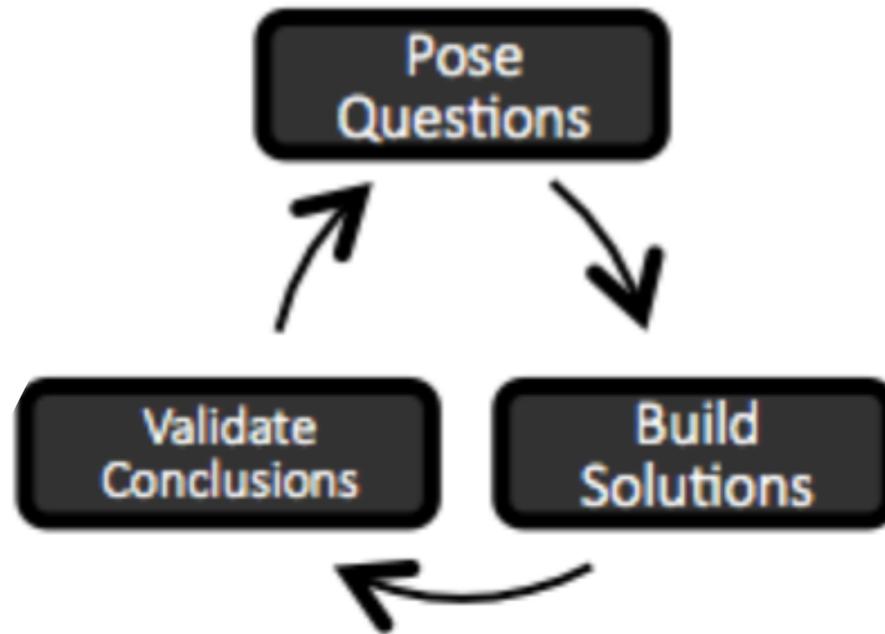
Teachers' struggle: Once the mathematical problem is posed, does the method of solution have to be open?

Ideally students decide when they are done with the model – but young students lose interest sometimes.

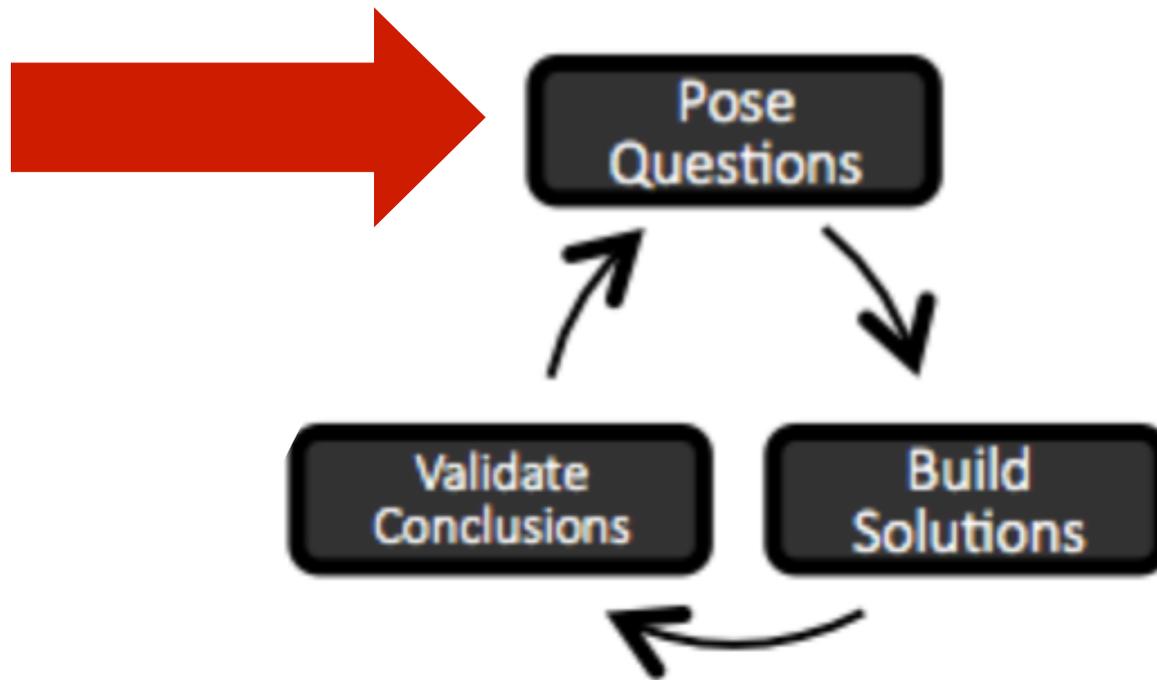
What experiences

Should K-5 students have in order to enable them to model in middle school, high school, and beyond?

A modeling cycle



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Posing is most important

Schools give students more opportunities to use multiple solution strategies than 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.

Claim Three

Smaller and simpler isn't a useful way to consider how to approach modeling in K-5.

Smaller and simpler?



The nature of primary students and primary schools



The nature of primary students and primary schools



Developing literacy. Developing numeracy. Developing social awareness (“best” means *my* favorite).

The nature of primary students and primary schools



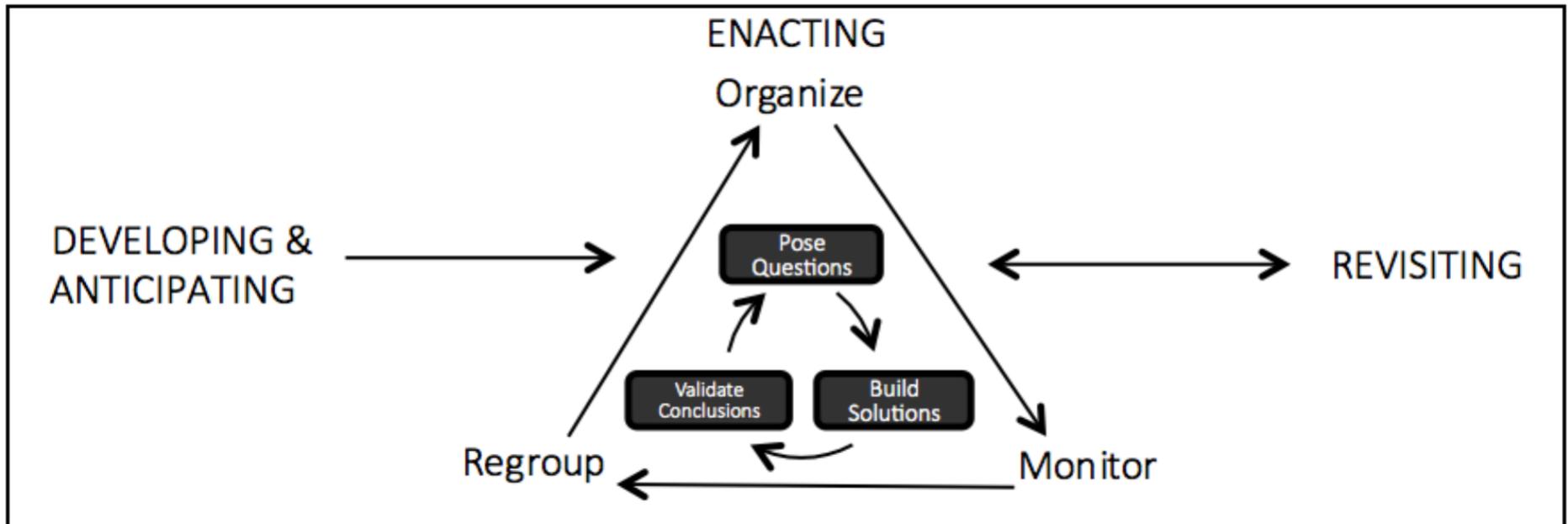
Developing literacy. Developing numeracy. Developing social awareness (“best” means *my* favorite).
Varying attention spans, skills, mathematical and social maturity.

Teaching Modeling Framework

To model with elementary students, we propose three teaching phases:

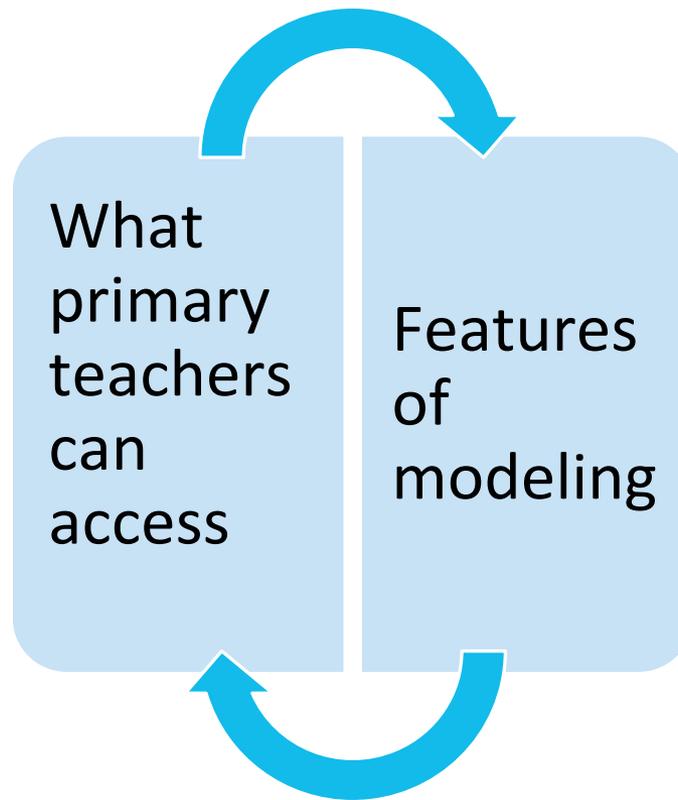
- developing the modeling activity
- enacting the modeling cycle
- revisiting ideas

Teachers' framework

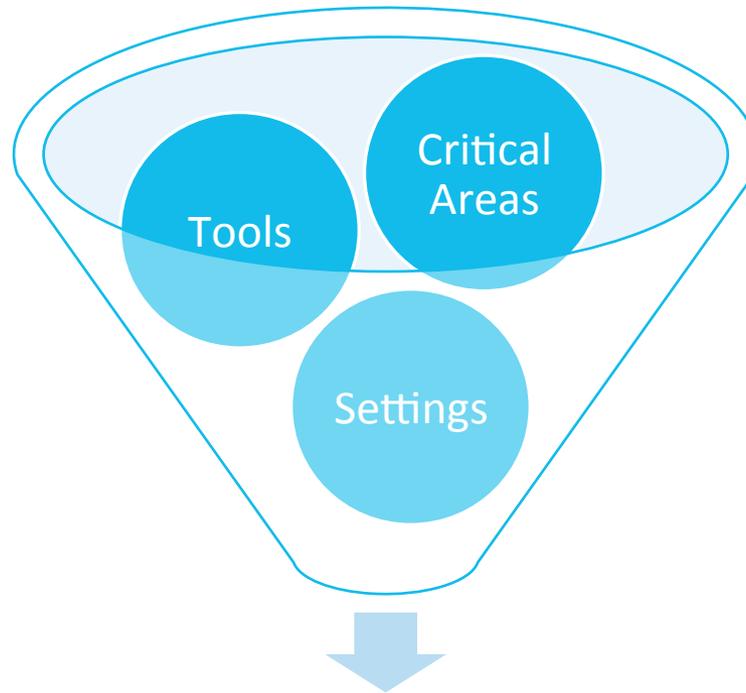


Carlson, M. A., Wickstrom, M. H., Burroughs, E. A., & Fulton, E. W. (2016). A Case for Mathematical Modeling in the Elementary Classroom. In C. R. Hirsch (Ed.), *Annual perspectives in mathematics education 2016: Mathematical modeling and modeling mathematics* (pp. 121–129). Reston, VA: National Council of Teachers of Mathematics

Teaching Modeling to Young Students



Teachers' inputs



A Modeling Experience for Students

For example, Kindergarten



Critical Mathematical Areas

- Representing, relating, and operating on whole numbers, initially with sets of objects.
- Describing their physical world using geometric ideas.
- Identifying and naming basic 2-D shapes.
- Using basic shapes and reasoning to represent objects in their environment and construct more complex shapes.

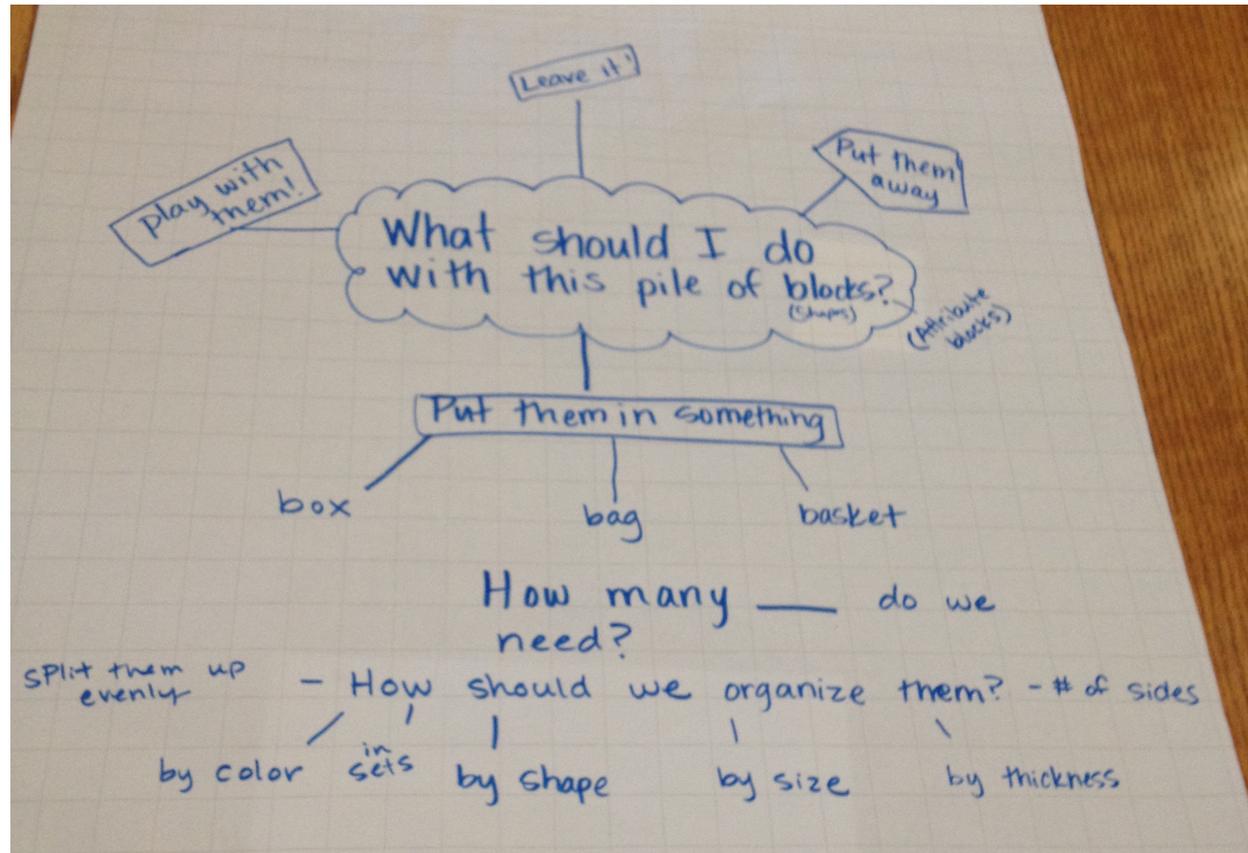
Tools (formal and informal)

- Drawing
- Writing numbers
- Showing joining and separating with sets of objects
- Writing addition and subtraction number sentences

Settings (interest and access)

- Classroom
- School
- Playground
- Giving and removing (“fair” situations)
- Gardening, building
- Imaginary play

Modeling in Kindergarten



Claim Four

Underlying assumption about teaching modeling is that teachers can and will facilitate **mathematical discourse** and facilitate **cooperative group** work.

Focusing only on modeling *tasks* misses these critical component of **teaching** modeling.

What does it look like to support modeling?

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- Attention to developing the skill of facilitating mathematical discourse.
- Attention to developing the skill of managing cooperative groups in mathematics.
- Encouraging teachers to focus on frequent problem posing opportunities (rather than infrequent full-blown tasks).

Caution: isolated resources

Focusing on modeling **tasks** puts curricular coherence in jeopardy.

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Focusing on modeling tasks puts curricular coherence in jeopardy.

“A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.”

-NCTM *PSSM*

NCTM President's Statement

“Curricular Coherence in the Age of Open Educational Resources”

(August 2016) Matt Larson, NCTM President



IMMERSION: Investigating Mathematical Modeling in Elementary Grades

Research Leaders



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Megan Wickstrom



Rachel Levy

Harvey Mudd College

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



Teachers' own experiences

Teachers have likely NOT engaged in mathematical modeling tasks either as teachers or as students.

Professional Development

- Engages teachers as modelers
- Focuses on developing skills that enable modeling
- Supports teachers in implementing modeling with students in grades K-5



Immersion teachers

- Continue to find modeling opportunities in their classrooms a year after their professional development experience is done.



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- Tackle bold problems (*What's the best way to address the problem of hunger?*)



Immersion teachers

- Continue to find modeling opportunities in their classrooms a year after their professional development experience is done.
- Tackle bold problems (*What's the best way to address the problem of hunger?*)
- Engage their students in important mathematics that holds student interest.

Thank you

Questions?

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