Common Core State Standards
Getting Mathematicians Involved

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Lessons learned from working with Mathematicians who teach K-12 teachers

Project PROMPT (Professors Rethinking Options in Mathematics for Prospective Teachers)

PMET (Preparing Mathematicians to Educate Teachers)

1.Mathematicians who prepare teachers need time for

* Experiencing mathematics which grows out of involvement with tools and techniques used in K-12 classrooms.

* Critically examining math activities or curriculum used in K-12 classrooms.

* Transferring insights gained from the experiences and examinations described above to discussions about content and pedagogy in courses for prospective teachers.

2. Prospective teachers deserve to

* learn significant mathematics
* experience mathematically rich activities (with connections to the classroom)
* construct an accurate and significant framework for the disciplines of mathematics and mathematics education
* practice distinguishing mathematical concepts from computational details
* polish communication skills in mathematics
* gain skills for assessing the mathematical value of classroom activities and assignments.

3. Courses for prospective teachers tend to improve when

* faculty are informed of changes in K-12 education
* motivated to meet the academic needs of prospective teachers
* involved in an ongoing dialogue with colleagues

Three topics in the CCSS content standards that are new or receive greater emphasis in the K-12 curriculum:

Grade 3: Understand a fraction as a number on the number line; represent factions on a number line diagram

Grade 8: An emphasis on transformation geometry

High School: An emphasis on Mathematical Modeling

Fractions on a number line: Current use of the number line is mostly to look at multiples of positive numbers.

From the Grade 3 CCSS:

Represent a fraction 1/b on a number line diagram by defining the interval from 0 to 1 as the whole and partitioning it into b equal parts.

Recognize that each part has size 1/b and that the endpoint of the part based at 0 locates the number 1/b on the number line.

Represent a fraction a/b on a number line diagram by marking off a lengths 1/b from 0. Recognize that the resulting interval has size a/b and that its endpoint locates the number a/b on the number line.

From the CCSS Grade 8:

Understand congruence and similarity using physical models, transparencies, or geometry software.

* 1. Verify experimentally the properties of rotations, reflections, and translations:

a. Lines are taken to lines, and line segments to line segments of the same length.

b. Angles are taken to angles of the same measure.

c. Parallel lines are taken to parallel lines.

* 2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.

* 3. Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.

* 4. Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.

From CCSS High School:

Modeling links classroom mathematics and statistics to everyday life, work, and decision-making. Modeling is the process of choosing and using appropriate mathematics and statistics to analyze empirical situations, to understand them better, and to improve decisions. Quantities and their relationships in physical, economic, public policy, social, and everyday situations can be modeled using mathematical and statistical methods. When making mathematical models, technology is valuable for varying assumptions, exploring consequences, and comparing predictions with data.

One of the insights provided by mathematical modeling is that essentially the same mathematical or statistical structure can sometimes model seemingly different situations. Models can also shed light on the mathematical structures themselves, for example, as when a model of bacterial growth makes more vivid the explosive growth of the exponential function.

The basic modeling cycle … involves

(1) identifying variables in the situation and selecting those that represent essential features

(2) formulating a model by creating and selecting geometric, graphical, tabular, algebraic, or statistical representations that describe relationships between the variables

(3) analyzing and performing operations on these relationships to draw conclusions

(4) interpreting the results of the mathematics in terms of the original situation

(5) validating the conclusions by comparing them with the situation, and then either improving the model or, if it is acceptable

(6) reporting on the conclusions and the reasoning behind them. Choices, assumptions, and approximations are present throughout this cycle.

In descriptive modeling, a model simply describes the phenomena or summarizes them in a compact form. Graphs of observations are a familiar descriptive model—for example, graphs of global temperature and atmospheric CO2 over time.

Analytic modeling seeks to explain data on the basis of deeper theoretical ideas, albeit with parameters that are empirically based; for example, exponential growth of bacterial colonies (until cut-off mechanisms such as pollution or starvation intervene) follows from a constant reproduction rate. Functions are an important tool for analyzing such problems.

Graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry software are powerful tools that can be used to model purely mathematical phenomena (e.g., the behavior of polynomials) as well as physical phenomena.

Modeling Standards

Modeling is best interpreted not as a collection of isolated topics but rather in relation to other standards. Making mathematical models is a Standard for Mathematical Practice, and specific modeling standards appear throughout the high school standards indicated by a star symbol (★).