

## Growing Mathematicians

Update on investment in the K-12 mathematics program



# Context

## Massachusetts Math State Frameworks

### Content

Identification of discreet math skills to be taught at each grade level.

### Mathematical Practices

A standardized PreK-12 set of skills associated with developing the “Habits of Mind” of a mathematician. These skill stay the same year after year but grow in their application to more complex mathematical problems.

The educators in the Shrewsbury Public Schools have been working to both align to the Massachusetts State Frameworks and to also ensure our students are ready for the more abstract problem solving demands of the work and college environments. The district has primarily addressed the changes in content through a K-8 purchase of materials that are well aligned with the new state standards. The selected materials were also seen as strong anchors for the Mathematical Practices. However, the teaching of these practices is a very complicated task and requires sustained focus and attention to do well. This report specifically outlines on some of the work occurring in our schools with these practices as we focus on growing our students into strong mathematicians.

For a review of the Principles of Mathematical Practice please refer to the Illustrative Mathematics site using the following link: <https://www.illustrativemathematics.org/practice-standards>

## Problem Solving and Communication (Grades K - 4)

Starting in the 2014-15 school year and continuing to the present, the Elementary Instructional Coaches have been working in collaboration with elementary teachers to develop an assessment that helps to document student growth in problem solving and to identify instructional teaching steps for each phase of of as student’s development. Assessment questions and student exemplars are being developed for each grade level for use across the entire district. In each of the assessments, students are asked to solve one problem on their own, and then to solve a second problem but also to look at another hypothetical solution to another problem and to critique the reasoning and accuracy of the work.

Please see below for language from the current *draft* of a rubric designed to score the 4th grade problem solving questions

Construct Measured	Score Point 4	Score Point 3	Score Point 2	Score Point 1
Accuracy		I solved the problem correctly.		I did not solve problem correctly.
Strategy	I solved the problem using an efficient strategy.	I solved the problem using an appropriate strategy that matches how I got the answer.	I solved the problem using an incorrect strategy.	I did not show a strategy.
Model	I modeled the problem using a clear and/or labeled drawing or diagram, chart, graph, or equation.	I modeled the problem using a drawing or diagram, chart, graph, or equation that represents the problem.	I attempted to model the problem using a drawing, chart, graph, or equation.	I did not model the problem.
Score	<b>Advanced</b> 11	<b>Proficient</b> 10 9 8	<b>Needs Improvement</b> 7 6 5	<b>Warning</b> 4 3

	Construct Measured	Score Point 4	Score Point 3	Score Point 2	Score Point 1
Student ability to solve the problem themselves	Accuracy		I solved the problem correctly.		I did not solve the problem correctly.
	Strategy	I solved the problem using an efficient strategy.	I solved the problem using an appropriate strategy that matches how I got my answer.	I solved the problem using an incorrect strategy.	I did not show a strategy.
	Model	I modeled the problem using a clear and/or labeled drawing or diagram, chart, graph, or equation.	I modeled the problem using a drawing or diagram, chart, graph, or equation that represents the problem.	I attempted to model the problem using a drawing, chart, graph, or equation.	I did not model the problem.
Score		<b>Advanced</b> 11	<b>Proficient</b> 10 9 8	<b>Needs Improvement</b> 7 6 5	<b>Warning</b> 4 3
Student ability to identify and explain the math error	Identification of Math Error		I correctly identified the math error.		I did not correctly identify the math error.
	Explanation for Correcting Error	My explanation for correcting the math error is correct and very clear and addresses the error made.	My explanation for correcting the math error is correct and reasonably clear and addresses the error made.	Some parts of my explanation for correcting the math error are incorrect, unclear or missing.	My explanation for correcting the math error is incorrect, missing or all parts are unclear.
Score		<b>Advanced</b> 7	<b>Proficient</b> 6 5	<b>Needs Improvement</b> 4 3	<b>Warning</b> 2

## Problem Solving and Communication (Grades 5 - 8)

Teachers place a strong emphasis on problem solving and communication in math at the middle level. Students are instructed and assessed in these areas during each unit. Over the past few years, the math department at Oak Middle School has developed explicit lessons and rubrics to help students improve their written communication in math. The term "SO C<sup>4</sup>" represents the criteria used at OMS to identify an appropriately communicated written response to a math task. The resources and strategies developed at OMS promote rigor and consistency across the math department.

Please find below the criteria used to assess students' problem solving and communication skills

Standard: Solves problems in real-world and mathematical contexts.

4	3	2	1
Thoroughly interprets scenarios; Accurately applies math skills to solve problems; Solutions show an in depth conceptual understanding	Thoroughly interprets most scenarios; Minor inaccuracies in math skills do not reflect conceptual misunderstanding; Solutions show a proficient conceptual understanding	Inconsistently interprets scenarios; Inaccuracies in math skills reflect some conceptual misunderstanding; Solutions show a limited conceptual understanding	Inaccurately or incompletely interprets scenarios; Inaccuracies in math skills reflect conceptual misunderstanding; Solutions show little or no conceptual understanding

Standard: Communicates mathematical thinking clearly and concisely.

4	3	2	1
Consistently uses appropriate forms of representation; Work is consistently and clearly organized; Accurately uses math vocabulary; Uses relevant and concise reasoning to support all ideas.	Uses appropriate forms of representation; Most work is clearly organized; Accurately uses some math vocabulary; Uses relevant reasoning to support most ideas.	Inconsistently uses appropriate forms of representation; Clear organization is lacking; Accurately uses limited math vocabulary; Support for a number of ideas is incomplete or contains errors in reasoning.	Rarely uses appropriate forms of representation; Work is unorganized; Math vocabulary is used inaccurately or is missing; Most ideas are unsupported or supported using irrelevant reasoning.

Please find below a consistent strategy used across Oak Middle School to support students in communicating their problem solving work

SO C<sup>4</sup> CHECKLIST: Supported, Organized, Correct, Complete, Clear, Concise

Correct  
Complete  
*Is the math right?*

Check for any mistakes in:  
your reasoning  
your calculations  
your representations  
your mathematical language  
Check that you have included all necessary parts.

Organized  
Supported  
*Is there a clear path of steps and reasons?*

Check that:  
the flow is logical  
you give the reader clear signposts to show where you are going  
you have backed up all claims

Clear  
Concise  
*Have you included enough but not too much?*

Ask yourself:  
Will the reader understand?  
Have I included appropriate mathematical language and representations (diagrams, tables, equations, graphs)?  
Do I keep my focus and stick to the info that is really helpful?

## **Problem Solving and Communication Application (Shrewsbury High School)**

SHS Mathematical Modeling and the HiMCM

Mathematical Modeling, a full-year course, is being offered for the first time at Shrewsbury High. This elective is an honors-level course offered to upper classmen taking AP-level math. The course offers students the opportunity to solve real-world problems - collaboratively and with the use of technology - using math learned both in the Modeling Course and math learned in prior years.

In November, the students in the Modeling Course competed in the HiMCM - the High School Mathematical Competition in Modeling. This is a 36-consecutive-

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hour competition where teams of four students solve a real-world problem using math. In this year's problem, students had to analyze crime statistics - specifically 11 thousand rows of crime data - to measure the relative safety of a city. Each group put forth a tremendous effort and produced a professional report that provided a well-thought-out solution to the problem. Please see the attached brochure for additional details on the HiMCM project.

**COMAP ANNOUNCES THE EIGHTEENTH ANNUAL  
HIGH SCHOOL MATHEMATICAL CONTEST IN MODELING®**

# **HIMCM®**

**October 30–November 16**



This contest offers students the opportunity to compete in a team setting using applied mathematics in the solving of real-world problems.

**Additional support provided by the National Council of Teachers of Mathematics (NCTM),  
the Mathematical Association of America (MAA),  
and the Institute for Operations Research and Management Sciences (INFORMS).**

## Dear Colleague:

I would like to invite your school's participation in COMAP's Eighteenth Annual High School Mathematical Contest in Modeling (HiMCM). The HiMCM is designed to provide students with an opportunity to work as a team in a contest that will stimulate and improve their mathematical problem-solving proficiency as well as develop their writing skills.

The competition takes place with teams consisting of up to, but no more than, four students working on a real-world problem in a consecutive thirty-six-hour period between October 30 – November 16, 2015. Teams are allowed to work on the contest problem at any local facility. Each team has a faculty advisor to guide them and submit their work. Papers are submitted to COMAP for judging by a panel of mathematics educators.

I wish to encourage the teachers and students at your school to form a team or teams. More data is in this flyer, and further detailed information is online at [www.himcm.org](http://www.himcm.org). Teams must be registered by 2:00 pm EST on October 30, 2015. I look forward to your participation in this exciting and challenging adventure.

Best wishes,



William Fox  
Contest Director

The High School Mathematical Contest in Modeling is open to all secondary schools. This flyer presents an overview of the contest. Detailed information is available online at: [www.himcm.org](http://www.himcm.org)

**CONTEST FEES:** \$75 per team. Fees must be paid at online registration.

**Please register only the teams that will take part in the contest. Registration fees are not refundable.**

**Contest Date and Time:** The 2015 contest must be accomplished at a local facility, during a thirty-six-hour consecutive time period starting anytime after 3:01 pm EST on Friday, October 30 and ending at 8:00 pm EST on Monday, November 16, 2015.

Faculty advisors must ensure that no alterations of any form are made after the 8:00 pm cutoff. All papers must be emailed and received at COMAP by 9:00 pm EST on November 16, 2015.

**The Contest Materials:** The contest Website contains all the guidelines, requirements, registration, judging criteria, and suggested procedures for the submission of solution papers, including step-by-step instructions.

No materials will be available in any other form.

On Friday, October 30 at 3:00 pm EST, the contest problems will be posted on the contest Website.

**The Role of Advisors:** The advisor informs students about this competition and encourages the formation of teams.

Advisors guide and rehearse the team(s) prior to the beginning of the competition.

During the competition, students are expected to develop all of the substantive analysis without the help of others. Advisors ensure that students have access to computers and graphing calculators.

Advisors distribute guardian consent forms and have them signed prior to the contest.

**Registration of Teams:** All teams must register online on or before October 30, 2015 at 2:00 pm EST.

Each team may consist of up to four students who are enrolled in school at the time of the contest.

There is no limit to the number of teams an advisor can sponsor.

Team members do not need to be named at the time of registration, but they must be determined before the contest problems are read.

The Contest Problems: Teams will choose one of two modeling problems that will be posted on the Website at 3:00 pm EST on Friday, October 30, 2015.

Data, if needed, will be attached to the problem, or available on the Website.

Sample problems from other years are available online at: [www.himcm.org](http://www.himcm.org)

**The Report:** Participants may use all the technology available such as computers, libraries, software packages, Internet, or any other inanimate sources.

Problems are designed to be open-ended and are unlikely to have a unique solution.

Attention must be focused on clarity, analysis, and design of the solution. The narrative section of the solution papers must be typed and in English. Partial solutions are acceptable.

Each team is now required to submit an electronic copy of its solution paper by email to [solutions@comap.com](mailto:solutions@comap.com). The advisor or any team member may submit this email. Your email MUST be received at COMAP by the email submission deadline of 9:00 pm EST on November 16, 2015.

### **New for 2015**

- You are no longer required to mail a hard copy/print copy of your Solution Paper.
- You are required to mail a hard copy/print copy of the signed Control Sheet and the signed Parental/Guardian Authorization forms.
- Staple the Control Sheet on top of the Parental/Guardian Authorization forms and mail them to COMAP Inc.

Your teams Control Sheet and the signed Parental/Guardian Authorization forms must be printed, mailed and received by COMAP no later than 5:00 pm EST on Monday, November 30, 2015.

For detailed instructions please visit the HiMCM website at: [www.himcm.org](http://www.himcm.org)

**Results:** Judging will be completed in January, 2016.

The solutions will be recognized as Successful Participant, Honorable Mention, Meritorious, Finalist, National Finalist, or Outstanding.

The results will be posted on COMAP's Website after February 1, 2016.

Certificates and a press release will be mailed or emailed in February 2016.

All successful participants will receive a certificate.

Outstanding teams will have their solution papers (or their solution abstracts) published in *Consortium*. For detailed information on all of the above, please go to the HiMCM Website at: [www.himcm.org](http://www.himcm.org)

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The Consortium for Mathematics and Its Applications (COMAP) is dedicated to the improvement of mathematics education. COMAP publishes a wide variety of innovative curriculum materials including printed modules, computer software, and video programs.

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