

Common Core Standards Emphasize Problem Solving

Michael Flick and Debbie Kuchey, Xavier University

2009 Contest Results

The OCTM's 2010 *State Tournament of Mathematics* took place on February 27, 2010. Now is the time to start assembling a team to represent your school in competition for 2011! The 2010 team results are summarized in Table 1. Information about the 2011 State Tournament of Mathematics can be found at <http://www.octmtournament.org>. Overall results from the 2010 *State Tournament of Mathematics* are summarized in Table 1.

Table 1 2010 Overall *State Tournament of Mathematics* Results

Rank	School	Score
1	Sycamore High School	149
2	Dublin Jerome High School	139
	Lakota West High School	139
4	Copley High School	134
5	Seven Hills Upper School	133
	William Mason High School	133
7	Dublin Coffman High School	129
	Western Reserve Academy	129
9	Columbus Academy High School	127
10	Hawken Upper School	125
	Revere High School	125
	St. Xavier High School	125
13	Thomas Worthington High School	122
14	Dublin Scioto High School	120
15	Athens High School	118
	Olmsted Falls High School	118
	Strongsville High School	118
18	Brecksville-Broadview Heights High School	117
	Upper Arlington High School	117
20	Walnut Hills High School	114
21	Cincinnati Country Day School	113
22	Lincoln High School	111

Problem Solving and The Common Core Standards

The purpose of mathematics competitions is to spark student interest in mathematics while enhancing problem solving ability. Contest content is very much dictated by the content standards we use in our classrooms. On June 2, 2010, the *National Governors Association Center for Best Practices* and the *Council of Chief State School Officers* released the *Common Core State Standards* for English-language Arts and Mathematics. Governors and chief state school officers in 48 states, 2 territories and the District of Columbia worked on the development of these *Common Core State Standards*. The released standards considered nearly 10,000 public comments and the standards in other top performing countries. Var-

ious stakeholders were involved in the development of these standards, including content experts, teachers, school administrators, state personnel and parents. The standards were designed to establish clear and consistent goals for learning that will prepare our nations' students for success in college and work.

According to Steve Paine, West Virginia State Superintendent of Schools, "The Common Core State Standards provide a consistent clear understanding of what students are expected to learn, so teachers and parents have a roadmap for what they need to do to help them. Further, these standards provide appropriate benchmarks for all students, regardless of where they live and allow states to more effectively help all students to succeed" (News Release, 2010). Paine sees the common framework as an opportunity for states to "share best practices" with fellow superintendents across the nation.

Ten days after the release of the *Common Core Standards*, June 12, 2010, the state of Ohio adopted the *Common Core Standards*. Districts across the state are deciding the best way to implement the standards in all Ohio classrooms.

Implications of the Core

What does this mean for the mathematics classroom and the content of future mathematics contests? The mathematics standards were designed to replace state curricula which were "a mile wide and an inch deep," with a curriculum characterized by having greater focus and coherence. According to the Key Points found on the Common Core Standards Initiative website, "the standards stress not only procedural skill but also conceptual understanding, to make sure students are learning and absorbing the critical information they need to succeed at higher levels rather than the current practices by which many students learn enough to get by on the next test, but forget it shortly thereafter, only to review again the following year" (Key Points, 2010).

According to the Key Points, "the K-5 standards were designed to provide students with a solid foundation in whole numbers, addition, subtraction, multiplication, division, fractions and decimals" (2010). Then, "having built a strong foundation in grades K-5, students can do hands on learning in geometry, algebra and probability and statistics in the later grades" (Key Points, 2010). "The middle school standards are robust and provide a coherent and rich preparation for high school mathematics" (Key Points, 2010). "Students who have completed 7th grade and mastered the content and skills through the 7th grade will be well-prepared for algebra in grade 8" (Key Points, 2010). Finally "the high school standards call on students to practice applying mathematical ways of thinking to real world issues and challenges; they prepare students to think and reason mathematically" (Key Points, 2010).

Features of the Common Core Standards

The *Common Core State Mathematical Standards* consist of two components: (1) the Standards for Mathematical Practice and (2) the Standards for Mathematical Content. The mathematics standards include eight standards for mathematical practice. These standards incorporate the National Council of Teachers of Mathematics process standards combined with the National Research Council's report *Adding it Up* proficiency standards. The eight Standards for Mathematical Practice follow.

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.

3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

The Standards for Mathematical Practice describe how students should engage in mathematics content throughout the K -12 curriculum. The Standards for Mathematical Content consist of a “balanced combination of procedure and understanding” of mathematical content. Content expectations using the verb “understand” will require the integration of the mathematical practice standards. By integrating content with practice standards students should no longer rely on procedures too heavily. Students should be able to “represent problems coherently, justify conclusions, apply the mathematics to practical situations, use technology mindfully to work with mathematics, explain the mathematics accurately to other students, step back for an overview, or deviate from a known procedure to find a shortcut. In short a lack of understanding effectively prevents a student from engaging in the mathematical practices.” The following problem provides an opportunity for students to engage in such mathematical practices:

The DNA of bacterium *Bacillus amoris* 9 (causing love) is a sequence, each term of which is one of 2005 genes. No three consecutive terms may include the same gene twice, and no three distinct genes can reappear in the same order. That is, if distinct genes a , β , and γ occur in that order (with or without any number of genes in between), the order $a, \dots, \beta, \dots, \gamma$ cannot occur again. Prove that this DNA is at most 12,032 long. (Taken from the 2005 sample problems for the twenty-second Colorado Mathematical Olympiad; created by Alexander Soifer.)

If these *Common Core State Standards* are to be obtained by all students, problem solving must permeate the mathematics classroom. The incorporation of real world engaging problem solving in mathematical classrooms will make the task of developing or discovering problems to challenge future math team participants even more difficult.

Resources for Rich Problems

The following six websites are excellent resources for contest problems or problems that will enrich the mathematics classroom and assist in bringing the *Common Core State Mathematics Standards* to life.

Wild About Math: <http://wildaboutmath.com/math-contest-problem-web-links>

The website *Wild About Math* lists 43 Math Contest Problem Links which offer released problems from previous contest and provide excellent practice for students preparing for Math Contests.

Math League Contests: <http://www.mathleague.com/contests.htm>

The Annual Math League Contests website has sample contest problems for grades 4 through 8, Algebra 1 and High School Students.

American Mathematics Competition: <http://amc.maa.org/index.shtml>

The American Mathematics Competition website offers practice worksheets in the teacher's manual.

University of Tennessee Contests: http://sunsite.utk.edu/math_archives/.http/contests/

The University of Tennessee has a Mathematics Contests, Competitions and Problem Sets link contains mathematics contests, competitions, mathematics problems, archives of problems, and information about problem resources for all levels from early childhood through graduate level.

USA Mathematical Talent Search: http://www.usamts.org/Problems/U_ProblemsPast.php

The USA Mathematical Talent Search website has past problems and solutions for the last eleven years.

The Math Forum: <http://mathforum.org/pow/other.html>

The Math Forum @ Drexel features a Problem and Puzzles link that offers the current problems of the week, the problems of the week library, write math with the forum, and other real world applications and puzzles for elementary through college level. For complete access a fee is involved.

References

Common Core State Standards Initiative. (June 2, 2010). National governors association and state education chiefs launch common state academic standards. In Recent News. Retrieved August 4, 2010, from <http://www.corestandards.org/articles/8-national-governors-association-and-state-education-chiefs-launch-common-state-academic-standards>.

Common Core State Standards Initiative. In Key Points in Mathematics. Retrieved August 4, 2010 from <http://www.corestandards.org/about-the-standards/key-points-in-mathematics>.



DEBORA KUCHEY served as a Teacher Leader in the Kentucky Middle Grades Mathematics Teacher Network for several years. She is currently the College Representative for the Greater Cincinnati Council of Teachers of Mathematics. Dr. Kuchey is an Associate Professor in Early and Middle Childhood Mathematics Education at Xavier University.



MICHAEL FLICK Michael Flick, Ph.D., has served the Ohio Council of Teachers of Mathematics as State Contest Coordinator for over 25 years. He has received numerous teaching awards and honors. Dr. Flick is Professor, Director of the Center For Excellence In Education, and Chair of the Department of Secondary and Special Education at Xavier University.