



Annual Report 2010-2011



MATHEMATICS
UA SCIENCE

Department of Mathematics, University of Arizona, Tucson, AZ 85721 • 520.626.6145 • ime.math.arizona.edu



Table of Contents

About the Institute	1
Ongoing Programs	2
Arizona Teacher Initiative (ATI)	2
Untangling KnotSS	2
Tucson Math Circle	3
Tucson Teachers' Circles	3
Graduate Students and Teachers Engaging in Mathematical Sciences (G-TEAMS)	4
The Intel Math Program	4
2010-2011 Events	
Knowledge of Mathematics for Teaching at the Secondary Level	6
Gearing Up for the Common Core State Standards in Mathematics	6
Mathematicians in Mathematics Education	7
2011-2012 Events	
The Ad Hoc Committee on Teachers as Professionals - Common Core Toolkit Authors Workshop I	7
Transition from High School to College	8
The Ad Hoc Committee on Teachers as Professionals - Common Core Toolkit Authors Workshop II	9
Featured Programs	10
People	14



About the Institute

Our Vision

The Institute was created in 2006 by William McCallum, Distinguished Professor of Mathematics at the University of Arizona. The principal mission of the Institute is to support local, national, and international projects in mathematics education, from kindergarten to college, that pay attention to both the mathematics and the students, have practical application to current needs, build on existing knowledge, and are grounded in the work of teachers.

The Need

Mathematics is crucial for innovation in science, technology and engineering, competitiveness in a global workforce, and informed participation in democratic government. Three decades of reports, from the Department of Education's *A Nation at Risk* (1983) to the National Academies' *Rising Above the Gathering Storm* (2006) offer ample evidence for the need to improve mathematics education in the United States.

Our Approach

The problems of mathematics education cannot be solved by one group alone. Taking its cue from pioneering collaborations of recent years, the Institute includes participants from communities that are sometimes worlds apart: mathematics departments, colleges of education, school systems, government agencies, business, and commercial and non-profit education organizations. It engages mathematicians, statisticians, scientists, education faculty, teachers, parents, business people, and policy makers in collaborative work in which each group plays a key role and for which each group takes responsibility.

Our Goal

Our long-term goal is to become a permanent, high-level institute that builds capacity for collaboration, stores institutional knowledge about collaboration, and influences professional cultures towards collaboration on a critical concern of our time: the mathematical education of our future scientists, engineers, workers, citizens and leaders.

Funding

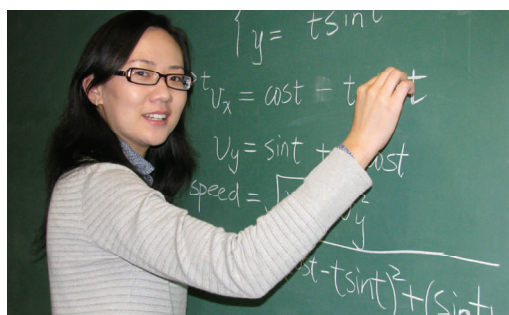
The Institute of Mathematics and Education is supported by funds from the University of Arizona Provost's Research Initiative Fund, the College of Science, and the College of Education; grants from the National Science Foundation, the Intel Foundation, the Brookhill Foundation, the Gates Foundation, and collaborative arrangements with other institutions. The Institute is seeking support from private foundations and donors in order to expand the range of its programs and help sponsor its ongoing activities. If you are interested in supporting the work of the Institute, please visit ime.math.arizona.edu/give/.

Ongoing Programs

Arizona Teacher Initiative (ATI)

DANIEL MADDEN, PI

The Arizona Teacher Initiative is funded by a 5-year, \$4.8M National Science Foundation Math and Science Partnership grant (award no. 0634532) awarded to the IM&E in September of 2006. The Principal Investigator is Daniel Madden, the co-Principal Investigators are William McCallum and Rebecca McGraw of the Department of Mathematics in the College of Science, along with Erin Turner of the Department of Teaching and Teacher Education in the College of Education, and Margaret Shafer, assistant superintendent of the Tucson Unified School District. This grant has led to the development of a part-time 3 year Master's degree in Middle School Mathematics Leadership for current elementary-certified middle school mathematics teachers, a one-year full-time Math Specialist in Teacher Mentoring residential program for high school teachers, and a Postdoctoral Fellowship in Teacher Preparation for recent Ph.D.s in mathematics.



In 2009 The Arizona Board of Regents approved the new Master's degree program, and the first cohort of eight students graduated with this degree in May 2010. The second cohort graduated in May 2011 with ten students completing the degree program. The next three groups of students are currently working toward the degree, and we expect an additional 15 will finish by May 2012. So far 5 high school teachers have completed the pilot certificate program including Caroline Torres in 2009-2010, Ronald Hopley, Jason Dyer, and Margaret Janecki in 2010-2011, and Rosalynn Wolfe in 2011-2012. The post-doctoral program is in its third year, and Dr. Ji Li, our first candidate, is teaching in a Massachusetts college. Dr. Carolyn Wright will finish her fourth and final year in Summer 2012. Dr. Cody Patterson, who was the post-doc for 2010-2011 has left the position to join the University of Arizona Mathematics Department as an Academic Professional. He is currently an Assistant Director of the IM&E and the Director of the Center for Recruitment and Retention of Mathematics Teachers.

Untangling KnotSS

REBECCA MCGRAW, PI

The Untangling KnotSS (Knowledge for Teaching Secondary School) program is funded by a 3-year, \$788K National Science Foundation Discovery Research K-12 grant (award no. 0821996). The principal investigator is Rebecca McGraw. The program investigates the nature and processes of collaborative work between mathematicians and mathematics educators. The Untangling KnotSS program brings together teams of mathematicians and educators who co-teach courses aimed at building an integrated knowledge of mathematics content and pedagogy. The project documents different approaches to collaboration, along with the methods and practices associated with those collaborations, and student learning outcomes.

During 2009-2010, teams in Florida, Illinois, and Virginia co-taught mathematics and methods courses to future middle and high school teachers. All team members joined the KnoTSS PI and project staff at the IM&E in August 2009 for a 2-day meeting. The meeting focused on methods and models of collaboration, and methods for researching collaboration. During the 2010-2011 academic year, an additional team co-taught courses in Florida. Currently, project staff is working on data analysis and planning for dissemination of findings.

Tucson Math Circle

IBRAHIM FATKULLIN, ORGANIZER

The Tucson Math Circle, run and co-organized by mathematics Associate Professor Ibrahim Fatkullin and graduate students Matthew Thomas, David Love, Steven Rosenthal, Gleb Zhelezov, Shane Pason, Yuliya Gorlina, and Ian Goldstein, challenges pre-college students to sharpen their problem-solving skills in an informal setting. Student participants work on interesting problems and explore a



variety of mathematics topics together with faculty and graduate students from the University of Arizona. The goal is to share the excitement about mathematics and learn through engaging activities without formal tests and examinations.

The circle meets weekly during the Fall and Spring semesters, each academic year. In 2010-11 the Circle problems covered various topics in number theory, combinatorics, probability, geometry, and logic. The problems were primarily chosen to have a statement with a certain entertainment value to make them appear more interesting, engaging, and easier to comprehend, e.g., the famous problems of Königsberg bridges, Friends and Enemies, The Monty Hall problem, Prisoner's dilemma, and many others.

Tucson Teachers' Circles

VIRGINIA BOHME, CAROLINE WRIGHT, ORGANIZERS

The Tucson Teachers' Circles were founded in the Summer of 2007 with the idea to bring together both teachers and university faculty members to meet one evening a month to engage in problem solving related to the night's theme. Middle school and high school mathematics teachers who are interested in exploring engaging, accessible topics in mathematics and who strive to incorporate a problem solving approach in their classrooms are encouraged to participate. Participants gain access to a variety of resources, membership in a dynamic community of mathematics educators, and a renewed sense of appreciation for the fascinating world of mathematics. Rich mathematics discussions ensue as they enjoy a catered dinner and have opportunities to share classroom experiences, best practices, and challenges. Participants earn recertification credits for their involvement.

The Tucson Teachers' Circles have been well-attended over the years by teachers. As one of the most successful of the satellite Teachers' Circles communities, the Tucson Teachers' Circles are being stud-

ied by the American Institute for Mathematics. The variety of willing, inspiring, mathematician presenters has been an excellent enticement for teachers to attend.

Graduate Students and Teachers Engaging in Mathematical Sciences (G-TEAMS)



JOCELINE LEGA, PI

G-TEAMS (Graduate Students and Teachers Engaging in Mathematical Sciences) is a 5-year, \$2.95M, NSF-funded Graduate STEM (Science, Technology, Engineering, and Mathematics) fellows in K-12 Education program that pairs University of Arizona graduate students in the mathematical sciences with K-12 teachers and their students. The program provides an innovative and dynamic opportunity for graduate students and teachers to collaborate on the development of novel, rigorous, and relevant material for K-12 mathematics courses. Run by the Institute for Mathematics and Education and the Department of Mathematics at the University of Arizona, G-TEAMS builds on a long-standing relationship between these two units and schools in the Tucson area. Fellows are recruited from the graduate programs in Mathematics, the interdisciplinary programs in Applied Mathematics and in Statistics, as well as other mathematical sciences graduate programs at the University of Arizona. They work with high school teachers on the development of new course materials, on ways to promote algebraic thinking in K-8 grades, and on strategies to facilitate transitions between elementary, middle, and high school.

G-TEAMS promotes STEM disciplines to underrepresented K-12 student populations and fosters a synergistic relationship among fellows, teachers, and K-12 students. Fellows learn to communicate mathematical ideas to diverse audiences, implement a range of teaching techniques, and increase their understanding of K-12 educational issues. Teacher partners are involved in professional development workshops and appreciate how mathematical concepts may be applied to a variety of situations. By interacting with individuals who are planning a career in the mathematical sciences, K-12 students learn about the wide variety of possibilities offered by STEM disciplines.

The Intel® Math Program

JOCELINE LEGA, PI

AUBREY NEIHAUS, PROGRAM MANAGER

THE HISTORY OF THE INTEL® MATH PROGRAM

The Intel Math Program was adapted from the Vermont Math Initiative (VMI), developed by Dr. Ken Gross. It consists of eighty hours of professional development for K–8 teachers in mathematics. The course provides teacher participants the opportunity to dive deep into the content of the K–8 mathematics curriculum through problem solving. The sequencing of the problem sets offers many opportunities to make connections across mathematics, both horizontally and vertically.

The program was piloted by the Intel Foundation in Massachusetts, California, New Jersey, and Arizona. In December 2009, the IM&E became the National Training Agency (NTA) for the program, taking on the responsibility to manage the program nationally.

IM&E AS THE NATIONAL TRAINING AGENCY

As the National Training Agency (NTA), IM&E is tasked with continuing to scale the program nationally through the promotion and the development of quality assurance measures. To assist in this process, the IM&E hired Aubrey Neihaus as Program Manager. A web site was developed to establish a web-presence for the program. Protocols and policies were formalized for the selection, training, certification, and observation of Intel Math Instructors. Additionally, Intel Math was featured in plenary sessions at the 2010 regional Math Science Partnership conferences in Washington DC, San Diego, and New Orleans. These activities positioned the IM&E to facilitate the national scaling of Intel Math.

To increase the number of Intel Math Instructors, the NTA partnered with the Arizona Department of Education and the New Hampshire Department of Education to hold two separate four-day Instructor Trainings. The first was held at the ADE building in Phoenix, in January 2011. The second was held in Concord, in July 2011. Twenty-six mathematicians and mathematics educators were trained as Intel Math Instructors, and are ready to deliver the course in 2011-2012.

We anticipate that in 2011-2012, Intel Math will be delivered to 38 cohorts spanning eight states. New states for 2011-12 include New Hampshire and Connecticut. The program is expected to reach a projected 970 teachers by spring 2012. Partners for these courses include the Arizona Department of Education, the Massachusetts Department of Education, the New Hampshire Department of Education, the Connecticut Department of Education, the Illinois Math Science Partnership, the Pennsylvania Math Science Partnership, the Worcester Catholic Diocese, and the Silicon Valley Leadership Group.



2010-2011 Events

Knowledge of Mathematics for Teaching at the Secondary Level (co-sponsored with Focus on Mathematics)

MARCH 24–26, 2011

This work shop was attended by teachers, mathematicians, and educators to look at questions centering around the knowledge teachers use at the secondary level. Questions studied included: What knowledge of mathematics do expert teachers use in their work? What is knowledge of mathematics for teaching at the secondary level? What mathematical habits of mind support effective teaching? How can we assess teachers' mathematical habits of mind? What areas and types of knowledge facilitate effective implementation of the Common Core State Standards? How do we help prospective and practicing secondary teachers develop knowledge of mathematics for teaching?

Gearing Up for the Common Core State Standards in Mathematics (co-sponsored by the Center for Science, Mathematics & Computer Education and the Institute for Research on Mathematics and Science Education)

APRIL 1–3, 2011

Participants in the workshop discussed the areas of the Common Core State Standards for Mathematics that should be the initial target for professional development as states gear up to implement them. They studied tasks and problems that have been written to illustrate the Common Core's goal of raising standards through focus on a few critical areas, mathematical coherence across grade levels, and an emphasis on conceptual understanding. Participants used these tasks as a tool for engaging in conversations about content areas where the Standards require a step up in professional development, and areas that should be de-emphasized.

Participants presented their findings and discussed the appropriate initial focus of PD materials supporting the Standards at the elementary, middle, and high school grade levels. They identified existing materials that meet some of the needs and areas where additional materials are needed.

The report may be downloaded from

http://commoncoretools.files.wordpress.com/2011/12/2011_12_06_gearing_up.pdf

Mathematicians in Mathematics Education (MIME)

APRIL 23–25, 2011

The workshop, aimed at the general audience of university mathematicians who wish to become involved in helping solve the problems in mathematics education, oriented mathematicians on the following key issues: the core mathematics of K–12, the mathematical knowledge of teachers, the nature of the educational system, the variety of curricula, and mathematics education research.

A particular focus this year was directing mathematicians to undertake productive work supporting assessment, professional development, and curriculum work around the Common Core State Standards in mathematics as the demand is increasing for mathematicians who can constructively contribute to work in mathematics education, such as standards development, validation of tests, curriculum design, textbook review, and the preparation and professional development of teachers.

2011-2012 Events

The Ad Hoc Committee on Teachers as Professionals - Common Core Toolkit Authors Workshop I

SEPTEMBER 17, 2011

The Common Core State Standards in mathematics were built on progressions: narrative documents describing the progression of a topic across a number of grade levels, informed both by research on children's cognitive development and by the logical structure of mathematics. Progressions explain why standards are sequenced the way they are, point out cognitive difficulties and pedagogical solutions, and give more detail on particularly knotty areas of the mathematics.

The goal of this workshop was to organize the writing of final versions of the progressions documents for the K–12 Common Core State Standards. The work was undertaken by members of the original work team of the progressions and also by prominent mathematicians, educators, and teachers not involved in the initial writing. The final product is a document that includes a 10-20 pages for each of twelve progressions.

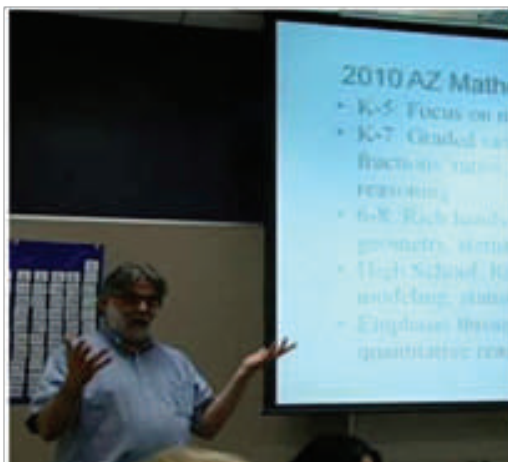
The target audience of this product is curriculum developers wishing to understand the deep structures of the standards and implement them faithfully; mathematicians and educators who teach teachers, both pre-service and in-service, and help them develop their mathematical knowledge and practice in the classroom; and mathematically knowledgeable teachers wishing to get a deeper understanding of the standards.

Transition from High School to College

NOVEMBER 4-5, 2011

This two day workshop was sponsored by Research Corp, the Center for Recruitment and Retention of Mathematics Teachers, and the Institute for Mathematics & Education. It featured a hands-on exploration of the transition from high school to college, from the perspective of teaching and learning mathematics. In particular, the following questions were considered:

- What is the mathematics assessed in the UA placement exam?
- What does the exam look like?
- What online learning tools are available to students and teachers?
- What happens after UA placement?
- What types of problems and problem-solving strategies are UA pre-calculus students expected to master?
- What does a UA pre-calculus final exam look like?
- What are best-practices for supporting students' transition from high school to college, both before and after this transition?



The Ad Hoc Committee on Teachers as Professionals - Common Core Toolkit Authors Workshop II

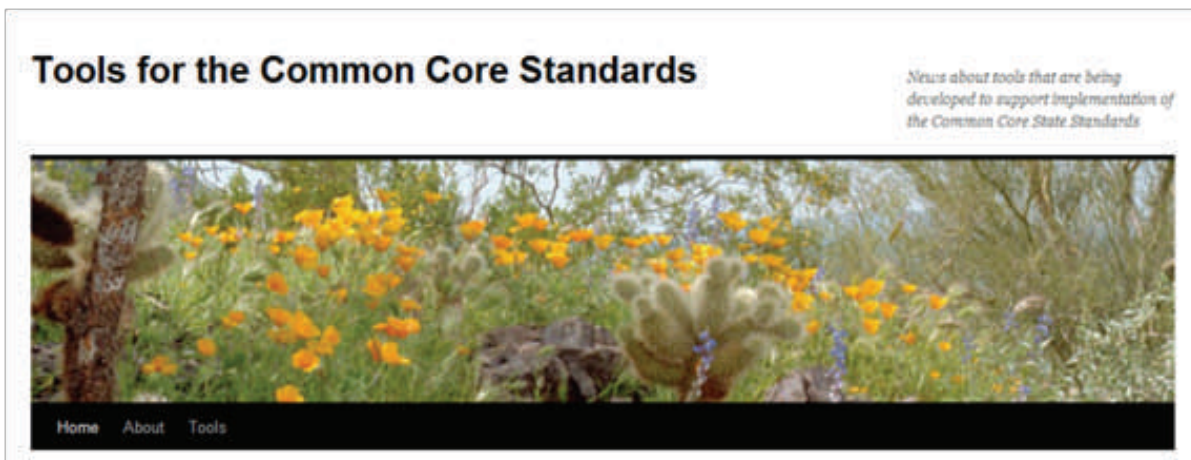
DECEMBER 10, 2011

This workshop reviewed activities created by the elementary author team, giving feedback to these activities, and brainstorming ways that they can be adjusted to a middle school audience. These activities will become part of the Common Core Toolkit, a professional development day made by teachers, facilitated by teachers, for a target audience of teachers. This nationwide effort aims to support the work of teachers trying to implement the Common Core State Standards in Mathematics in their classrooms.

The goals of the Toolkit are to help teachers:

- See structure in the standards: progressions, ties, streams, and pinnacle standards.
- Deeply explore the language used in the standards.
- Understand the Standards for Mathematical Practice and see ways to implement them in the classroom.
- Analyze classroom tasks for connections to the standards and see ways in which they can be adapted to the standards.

For each goal, a set of supporting materials and activities, a detailed facilitator's guide was developed. This meeting was focused on the activities and materials for Elementary and Middle School teachers.



Featured Programs

Center for Recruitment and Retention of Mathematics Teachers

CODY PATTERSON, DIRECTOR

SUE ADAMS, CO-DIRECTOR

ANN MODICA, CO-DIRECTOR

FRED STEVENSON, FOUNDER

THE HISTORY OF THE CENTER

The Center for Recruitment and Retention was founded in 2000 by Fred Stevenson, a professor of mathematics at the University of Arizona, with generous financial assistance from Ashby Lohse. Stevenson began the Center as a project to boost the morale of school mathematics teachers in Tucson and support them in their work.

Over the last ten years, the Center has evolved into a program that supports teachers across the K-12 spectrum and in all phases of their careers. The Center has forged partnerships with ten school districts in the Tucson area, three private schools, Pima Community College, and NAU Tucson.

The Tutoring in the Schools Program endeavors to recruit talented UA undergraduates into the teaching profession while providing classroom support for local teachers. Each semester, fifteen students work as tutors in local classrooms while taking a course on effective mathematics tutoring. Students who complete the program often report that the experience has heightened their interest in becoming mathematics teachers.

The Teacher Induction Program is a year-long mentoring program for first- and second-year mathematics teachers. Inductees are paired with experienced teacher coaches who observe their teaching and offer advice and moral support.

Participants also participate in monthly workshops in which they discuss key mathematical content, instructional practices, classroom management strategies, and other issues relevant to first-year teachers.

Teacher Workshops that focus on critical content areas are offered throughout the year for elementary, middle, and high school teachers. Workshops are taught by Bruce MacMillan, an award-winning teacher and professional developer, and by Cody Patterson. Workshops often discuss how teachers can incorporate technology and hands-on activities into their teaching and how teachers can design instruction for the new Common Core State Standards.



Cody Patterson

The Mathematics Educator Appreciation Day (MEAD) Conference is the largest conference for mathematics teachers in the state of Arizona. This annual conference, attended by over three hundred teachers each year, offers presentations on mathematical content, interactive lessons, applications of technology in the classroom, and ways of supporting special needs students and English language learners.

The Center is supported by financial partnerships with local school districts, private schools, and postsecondary institutions, the University of Arizona College of Science, publishing companies, and a number of generous individuals and foundations who wish to support the work of mathematics teachers in southern Arizona.



Common Core State Standards in Mathematics

The Common Core State Standards in Mathematics are a state led effort to share a common set of educational standards for K-12 mathematics across the US. Each state can individually choose whether to adopt the standards. Currently 45 states have adopted the mathematics standards providing an unprecedented opportunity as a nation to share best practices of instruction, professional development, and assessment across state lines. Drawing on the expertise of Common Core's chief author Bill McCallum, the IM&E has a number of projects aimed at supporting the implementation of the standards nationwide.

COMMON CORE PROJECTS AT THE IM&E

Common Core Toolkit

In collaboration with NCTM, NCSM, ASSM, AMTE, CBMS, Achieve, AFT, IAS/PCMI, MfA, NAGB, and NEA, the IM&E is directing a project to create professional development authored by teachers, facilitated by teachers, to a primary audience of teachers. Author groups for elementary, middle school, and high school activities are spread across the country, creating a professional development day that can be added to existing district or school level professional development.

Illustrative Mathematics Project

The Illustrative Mathematics Project, funded by the Bill and Melinda Gates Foundation, seeks to illustrate the standards using sample tasks. Over the course of the year the website has gone live with tasks illustrating specific standards at each grade level. Tasks go through a rigorous screening process before they are posted on the website, including reviews by at least one mathematician, at least one classroom expert, and a reviewer who can evaluate the task based on the collection of tasks representing each standard.

Intel Math

The Intel Math program was adapted from the Vermont Math Initiative as eighty hours of mathematics instruction for K – 8 teachers wanting to delve into their content area. Intel math is a nationally scaled program delivering professional development. The Intel Math program will continue to be increasingly aligned to the Common Core standards in terms of mathematical content covered by the program.

Introductory Videos from the Authors

The Hunt Institute has produced a collection of videos with the authors speaking about main points within the standards. The videos include guiding principles of how the standards were produced and descriptions of the authors' thinking in progressions across grade levels.

Orientation to the Common Core Professional Development

Due to the urgent need for Common Core professional development, the IM&E is producing professional development activities to orient teachers to the new standards. These activities will be rolled out initially in the Tucson area as well as online at Bill McCallum's blog.

PARCC Assessment Consortium

The IM&E is part of a group of institutes partnering to advise the PARCC assessment consortium, one of two assessment consortia working on common assessments for the standards. Members on the IM&E are working with teams of education and mathematics professionals to develop models which will lead to the types of tasks used on the assessment.

Professional Development Videos

Stemming from professional development with the Tucson Unified School District, the IM&E has produced a collection of videos for lower elementary teachers which provide an overview of the Common Core, as well as explain the Standards of Mathematical Practice.

Progressions Documents

The Common Core was written from a set of documents that traced different topics across grade levels, tracking their progression through the grades. The documents are being revised to reflect the final version of the Common Core. Current revisions are available both on the IM&E website as well as from the blog described below. The Progressions Documents are the most accurate description of how topics flow through the different grade levels and what is different about their coverage in each grade.

Tools for the Common Core Blog

As a primary author of the Common Core, Bill McCallum keeps a blog about emerging tools that can be used in the implementation of the standards. His blog (commoncoretools.wordpress.com) has links to the Illustrative Mathematics Project as well as the Progressions Documents and new tools and activities to understand the Common Core State Standards.



People

Staff

Joceline Lega, Director
 Rebecca McGraw, Assistant Director
 Cody Patterson, Assistant Director
 Teresa Stovall, Program Coordinator
 Aubrey Neihaus, Intel Math Program Manager
 Ellen Whitesides, Director, Common Core
 Projects

Planning Group

Deborah Hughes Hallet, Chair, University
 of Arizona and Harvard University
 Deborah Loewenberg Ball, University of
 Michigan
 Hyman Bass, University of Michigan
 Al Cuoco, Center for Mathematics Education
 Roger Howe, Yale University

Advisory Board

William McCallum, Chair, University of Arizona
 Richard Askey, University of Wisconsin
 Deborah Loewenberg Ball, University of Michigan
 Hyman Bass, University of Michigan
 Sybilla Beckman Kazez, University of Georgia
 Herbert Clemens, The Ohio State University
 Al Cuoco, Education Development Center
 Francis "Skip" Fennell, McDaniel College
 Roger Howe, Yale University
 Deborah Hughes Hallett, University of Arizona and
 Harvard University
 Cathy Kessel, Mathematics Education Consultant
 Jeremy Kilpatrick, University of Georgia
 James Lewis, University of Nebraska
 Ron Marx, University of Arizona
 Joaquin Ruiz, University of Arizona
 Paul Sally, University of Chicago
 William Schmidt, Michigan State University
 Alan Schoenfeld, University of California, Berkeley
 Glenn Stevens, Boston University
 Hung-Hsi Wu, University of California, Berkeley

Sponsors

University of Arizona:
 Provost's Research Initiative Fund, College of
 Science, and College of Education

National Agencies:
 National Science Foundation

Private Foundations and Donors:
 Intel Foundation
 Brookhill Foundation
 Gates Foundation