



Institute for Mathematics and Education

Annual Report 2009 - 2010



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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, 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 Class of eight students have graduated with this degree in May 2010. The next three groups of students are currently working toward the degree, and we expect an additional 15 will finish by May 2011. 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 are Visiting in 2010-2011. The post-doctoral program is in its third year, and Dr. Ji Li, who has recently finished, is teaching in a Massachusetts college. Dr. Carolyn Wright will finish her third and final year in Summer 2011, and Dr. Cody Patterson has begun the program.



Untangling KnotSS

REBECCA MCGRAW, PI

The Untangling KnotSS (Knowledge for Teaching Secondary School) program is funded by a 3-year, \$788K National Science 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 is co-teaching mathematics and methods courses in Florida, and all team members are working on a book describing strategies for connecting mathematics and pedagogy in mathematics teacher preparation.

Tucson Math Circle

IBRAHIM FATKULLIN, ORGANIZER

The Tucson Math Circle, run and co-organized by mathematics professor Ibrahim Fatkullin and graduate students Matthew Thomas, David Love, Steven Rosenthal, Gleb Zhelezov, and Shane Passon, 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 2009-10 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' Circle

VIRGINIA BOHME, CAROLINE WRIGHT, ORGANIZERS

The Tucson Teachers' Circles bring together both teachers and university faculty members who meet one evening a month to engage in problem solving related to the night's theme. Any 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 ensure as they enjoy a catered dinner and have opportunities to share classroom experiences, best practices, and challenges. Participants earn recertification credits for their involvement.

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

Intel Math is an 80-hour professional development course in mathematics content for K-8 teachers. The program was adapted from the Vermont Math Initiative developed by Dr. Ken Gross. The course is collaboratively taught by a practicing mathematician and a mathematics educator. One of the goals of Intel Math is that teacher participants deepen their own understanding of math through problem-solving.

Intel Math “is designed to close the gap between insufficient mathematics training of elementary school teachers and the demands of the contemporary mathematics classroom” (Kenneth Gross, on VMI) and places emphasis on deepening the teacher participants’ understanding of core K-8 mathematics concepts.





2009-2010 Events

2009 State of Education

SEPTEMBER 15, 2009

Sponsored by the Institute for Better Education and hosted by the Tucson Chamber of Commerce, a luncheon and Education Expo themed “Opportunities to Revolutionize Education: Best Practices In Our Own Community.” The Institute showcased successful programs to help the local community learn more about our work in mathematics education.

Math League Contest

DECEMBER 10, 2009

Hosted by the University of Arizona Mathematics Department with tests provided by mathleague.org, this exciting day of competition featured four events and four opportunities to qualify for Arizona’s fourth annual State High School Math Championship. Students who scored high enough at the December 10th contest were invited to compete at the state championship on April 24th. The contest was held in the University of Arizona Math Building, room 501.

Mapping the Calculus Curriculum Workshop

MARCH 27 - 28, 2010

This workshop was the follow-up to the Mapping the Calculus Curriculum workshop in 2009 and produced pamphlets to guide instructors dealing with a variety of issues associated with the learning of calculus.

The following themes were addressed at the workshop, and articles produced by the participants can be found at ime.math.arizona.edu/2009-10/0327_workshop.

- Mapping the Ap / College Calculus Transition
- Cultivating Symbol Sense in Your Calculus Class
- The Fundamental Theorem of Calculus
- Limits
- Problem Solving
- Rates of Change

Mathematicians in Mathematics Education (MIME)

APRIL 25 - 27, 2010

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.



This workshop oriented mathematicians on key issues: the core mathematics of K–12, the mathematical knowledge of teachers, the nature of the educational system, the profusion of standards documents, the variety of curricula, and mathematics education research. A particular focus of the 2010 workshop was the Common Core Math Standards.

The workshop was aimed at the general audience of university mathematicians and graduate students in mathematical sciences who wish to become involved in helping solve the problems in mathematics education.



2010-2011 Events

Progressions Workshop

OCTOBER 23 - 24, 2010

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 childrens' 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 particularly knotty areas of the mathematics.

The goal of this workshop is to organize the writing of final versions of the progressions documents for the K–12 Common Core State Standards. The work will be undertaken by members of the original workteam of the progressions and also by prominent mathematicians, educators, and teachers not involved in the initial writing. The involvement of the latter group will be important in extending ownership of the Common Core State Standards to a wider group of practitioners than initially had a stake in the them. The final product will be a document that includes a 10-20 pages for each of the 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 inservice, 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.

Knowledge of Mathematics for Teaching at the Secondary Level

CO-SPONSORED BY FOCUS ON MATHEMATICS

MARCH 24-26, 2011

What knowledge of mathematics do expert teachers use in their work? While this question has been studied at the elementary level, there is less work at the secondary level. Participants in the workshop will consider the following questions:

- 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?



The workshop will be of interest to teachers, mathematicians, and educators. One outcome will be a research agenda to study these and related questions.

Mathematicians in Mathematics Education (MIME)

APRIL 23-35, 2011

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.

This workshop will orient mathematicians on 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 of this year’s workshop will be orienting mathematicians to undertake productive work supporting assessment, professional development, and curriculum work around the Common Core Math Standards.

The workshop is aimed at the general audience of university mathematicians who wish to become involved in helping solve the problems in mathematics education.

The Illustrative Mathematics Project: Problems and Tasks for the Common Core Standards

TBA, 2011

The Common Core State Standards for Mathematics define the skills, understandings and practices we intend our children to learn as they progress through their schooling. As states develop assessments, curricula, and professional development based on the standards, and as teachers use them in the classroom, they will benefit from examples of student tasks that develop and assess those skills, understandings and practices. This project will develop a complete set of such tasks for each standard, ranging from easy to difficult, and from simple illustrations of single standards to complex tasks spanning many standards.

The purpose of the project is to guide the work of states, assessment consortia, and testing companies by illustrating the range and types of mathematical work that students will experience in a faithful implementation of the standards. The process of selecting and reviewing tasks will pay attention both to what is known about how students think and to mathematical structure. A complete set of task will provide a reference map for assessment, curriculum design, and professional development.



Featured Programs

Tucson Teachers Circles

GINNY BOHME, FACILITATOR

CARRIE WRIGHT, FACILITATOR

THE HISTORY OF TEACHERS' CIRCLES

The first Teachers' Circle was started by dedicated mathematics educators in the Bay Area at the American Institute of Mathematics in 2006. Math Teachers' Circles are similar in style to Math Circles for students, but are intended for teachers and provide an opportunity for teachers to enrich their own knowledge and experience of mathematics while engaging in a professional support network of teachers and mathematicians.

Teachers often become involved for a variety of reasons; to connect with other local math teachers, to renew their excitement about mathematics while gaining confidence in mathematics, and to acquire new ideas for their classroom.

TUCSON TEACHERS' CIRCLES

The Tucson Teachers' Circle at the University of Arizona was founded in the summer of 2007, with 61 participants, as one of seven satellite communities. In the beginning, the initiative targeted only middle school mathematics teachers. A separate high school Teachers' Circle was established in February 2009.

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

In 2009–2010 school year, the Middle School Teachers'



I loved the math circle. I was able to use what I learned immediately, and being able to talk teaching strategies with other middle school math teachers made me feel better about what I am doing in my classroom. I will be back next year!

--Participant Teacher





The week after the Teacher's Circle I use at least one activity that promotes open ended problem solving. Teacher's Circle has assisted me in creating better questions for students to guide performance.
--Participant Teacher

Circle served 37 educators from 22 schools. The High School Teachers' Circle served 36 educators from 14 schools. Themes have included exploratory mathematics problems, historical methods for multiplying large numbers, reasoning with statistical measures, surprising occurrences of the golden ratio, logic games, and using combinatorics to solve non-routine problems. Presenters at the Tucson Teachers' Circles include Cynthia Anhalt, Tom Banchoff, Chris Bergevin, Ginny Bohme, Nate Carlson, Jen Eli, Phil Grizzard, Sarah Hoffman, Ji Li, Joceline Lega, Dan Madden, Walter Piegorsch, Susan Norton-Scott, and Fred Stevenson.



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), 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 promotion and the development of quality assurance measures. To assist in this process, the IM&E hired Aubrey Neihaus as Program Manager. A web page 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 Mathematical Association of America (MAA) and the Arizona Department of Education (ADE) to



I am far and away a better math teacher than I could possibly have been otherwise.
—Participant Teacher





*I can teach students on their level
instead of teaching to the middle of
the class.*
—Participant Teacher

hold two separate four-day Instructor Trainings in June 2010. The first took place in Washington DC at the MAA Carriage House, the second at the ADE building in Phoenix. Thirty-one mathematicians and mathematics educators were trained as Intel Math Instructors, and are ready to deliver the course in 2010-2011.

We anticipate that in 2010-2011, Intel Math will be delivered to 34 cohorts spanning seven states. New states for 2010-11 include New Mexico, Pennsylvania, and Illinois. The program is expected to reach a projected 750 teachers by spring 2011. Partners for these courses include the Massachusetts Department of Education, the Arizona Department of Education, the MAA, the Silicon Valley Leadership Group, the Illinois Math Science Partnership, the Pennsylvania Math Science Partnership, and Georgian Court University.



People

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 Teresa Stovall, Program Coordinator
 Aubrey Neihaus, Intel Math Program Manager

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 2009-2010

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