Institute for Mathematics and Education

ANNUAL REPORT, 2006–2007

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Table of Contents

About the Institute 1

Ongoing Programs 2

- Arizona Teacher Initiative 2
- Making Connections 2
- Knowledge for Teaching Secondary School 3
- Math Circles 3

Events 2006–2007 4

- Institute Planning Retreats, October 13–14 and November 3–4, 2007 4
- Training for Parent Workshop Facilitators, February 10, 2007 4
- Workshop on Mathematics Courses for Teacher Education, March 1–4, 2007 4
- Learning Technologies and Mathematics Middle East Conference 5
- Visiting Scholars 5
- Theme for 2007-2008: Mathematics courses for teachers 5
- Theme for 2008-2009: Analysis of curriculum materials 5

People 6

About the Institute

What we do

The Institute supports 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.

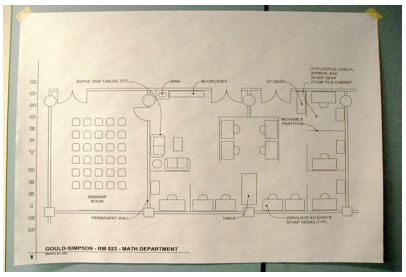
Our approach: collaboration

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.

Funding

Conference room

The old Chemistry Lab



Plans for renovating the old Chemistry Lab

The Institute 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; and collaborative arrangements with other institutions. In 2006–2007 the Institute also received additional funding from the University to renovate our quarters in the Gould-Simpson building. If you are interested in supporting the work of the Institute, please contact William McCallum at 520-440-1729 or ime@math.arizona.edu.

Ongoing Programs

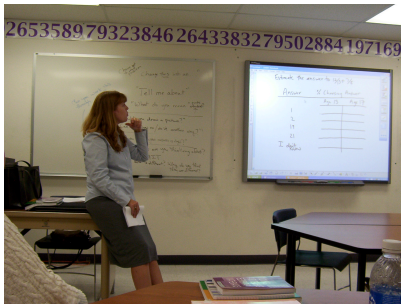
Arizona Teacher Initiative

In September 2006 the Institute was awarded a 5-year, $4.8M National Science Foundation Math and Science Partnership grant (award 0634532) to start the Arizona Teacher Initiative. The Principal Investigator is Daniel Madden, with co-Principal Investigators William McCallum and Rebecca McGraw of the Department of Mathematics in the College of Science, Erin Turner of the Department of Teaching & Teacher Education in the College of Education, and Roger Pfeiffer, superintendent of the Tucson Unified School District. The key activities are to develop a part-time 3-year Master's Degree in Middle School Mathematics Leadership for current elementary-certified middle school math teachers, a full-time one-year Certificate in Mathematics Teacher Mentoring for high school teachers, and a Postdoctoral Fellowship in Teacher Preparation for recent Ph.D.s in mathematics.

In 2006–07 the Institute initiated development and university approval of the degree programs, and recruited the first cohort of 11 middle school teachers, who started their Master's with a course on The Number Line in Summer 2007, taught by Daniel Madden. Pending approval of the Certificate program we recruited high school teachers Bruce MacMillan and Andrea Martin as adjunct instructors/Certificate candidates, and Ji Li from Brandeis University as our first post-doc.

Bill McCallum

The Master's students



Rebecca McGraw

Making Connections

The Making Connection project is funded by a 4-year, $300K National Science Foundation Distinguished Teaching Scholar (award no. 0525009, PI William McCallum). It aims to establish a model for collaboration between mathematicians, educators, and teachers, centered around analysis of student work on algebra problems.

The project brings together mathematicians, educators, and teachers in regional teams at a summer workshop to undertake a joint analysis of school algebra problems and student work, which has been collected during the preceding semester by the teacher participants. The summer workshop is a laboratory for developing a model for collaboration between these three groups by focusing on concrete examples. Each team uses the workshop to develop instructional materials and collaborative activities in their own regions.

In 2006 teams from Arizona, Georgia, and Montana studied work of middle school students on algebra, and in 2007 teams from Arizona, California, and Illinois studied work of elementary school students on algebraic thinking.

Knowledge for Teaching Secondary School

Modeled on the Mathematical Sciences Research Institute's Elementary Mathematics Project, this initiative of co-director Rebecca McGraw investigates the nature and processes of collaborative work between mathematicians and educators on identifying the mathematical knowledge necessary for teaching secondary school mathematics and how it develops.

Teams of mathematicians and educators co-teach courses aimed at building integrated knowledge of mathematics content and pedagogy. The project documents approaches to collaboration, methods and practices associated with collaborations, and student learning associated with them. Through analysis of the nature and processes of collaboration, and the interactions between content and pedagogy, the project generates critical knowledge about what teachers need to know for teaching secondary school mathematics and how that knowledge can be developed, and about methods and models of productive cross-disciplinary collaboration.

During the 2006–2007 academic year, William McCallum and Rebecca McGraw team-taught two courses in the mathematics department's math education major, Math 407, Synthesis of Mathematical Concepts, and Math 406A, Curriculum & Assessment in Secondary School Mathematics. Their interactions were documented by audio interviews by graduate student Wieke De Boer.

We are currently seeking NSF funding for a national expansion of this project.

Math Circles

This initiative of co-director David Savitt aims to set up math circles for gifted high school students in the Tucson area, and teacher circles for local teachers. During the 2006–07 academic year we held discussions with a local organizer of math competitions who was going to lead the math circles for students. He relocated for domestic reasons, so we are now seeking a replacement from among the math department faculty. We also sent a team to a workshop on teacher circles at the American Institute for Mathematics in Palo Alto, and they setting up a teacher circle for the 2007–08 academic year.

Events 2006–2007

Institute Planning Retreats, October 13–14 and November 3–4, 2007

National leaders in mathematics and education gathered in October and November to guide the future work of the Institute. Out of these discussions we identified themes for the next 2 years, described on page 5.

Participants in the October 13–14 retreat at the Westward Look Resort were Carol Bender (University of Arizona), Marilyn Carlson (Arizona State University), Marta Civil (University of Arizona), Carl Cowen (IUPUI), Al Cuoco (EDC), Veronika Furst (University of Arizona), James Glimm (Stony Brook University), Tom Kennedy (University of Arizona), Cathy Kessel (AWM), David Mumford (Brown University), Ken Ono (University of Wisconsin), Michael Pearson (MAA), Mark Saul (Templeton Foundation), Bonnie Saunders (University of Illinois), Richard Schaar (Texas Instruments), Alan Schoenfeld (University of California, Berkeley), Glenn Stevens (Boston University), Fred Stevenson (University of Arizona), Pat Thompson (Arizona State University), Philippe Tondeur (University of Illinois).

Participants in the November 3–4 retreat at the La Paloma Resort were Richard Askey (University of Wisconsin), Deborah Ball (University of Michigan), Tom Banchoff (Brown University), Hyman Bass (University of Michigan), Sybilla Beckman (University of Georgia), Nicholas Ercolani (University of Arizona), Phillip Griffiths (Institute for Advanced Study), Roger Howe (Yale University), Jeremy Kilpatrick (University of Georgia), Joceline Lega (University of Arizona), Jim Lewis (University of Nebraska), Katrina Mangin (University of Arizona), Jim Milgram (Stanford University), Richard Scheaffer (University of Florida), Joe Watkins (University of Arizona), Hung-Hsi Wu (University of California, Berkeley).

Training for Parent Workshop Facilitators, February 10, 2007

The Institute hosted a workshop for teachers from Hohokam Middle School in Tucson Unified School District to run math workshops for parents.

Workshop on Mathematics Courses for Teacher Education, March 1–4, 2007

Virginia Bastable from the Preparing Virginia's Mathematics Specialists project

UA's Dan Madden and Virginia Bohme at the March workshop on teacher education

Ryota Matsuura, Glenn Stevens, and Sarah Sword from Focus on Math

Participants in this workshop were teams of mathematicians and educators from universities interested in implementing content courses for school teachers. Workshop leaders were representatives of Math Science Partnerships and Centers for Teaching and Learning around the country, who presented models and worked with participant teams to develop plans for their home institutions. 40 participants from around the country listened to presentations from the Center for the Mathematics Education of Latinos/as, University of Arizona; Connecting Middle School and College Mathematics Project ([CM]^2), University of Missouri; Focus on Math, Boston University; Math in the Middle, University of Nebraska; Oregon Mathematics Leadership Institute, Portland State University; Preparing Vir-

ginia's Mathematics Specialists, University of Virginia; and Project Pathways, Arizona State University. A full report by Mark Saul of the Templeton Foundation is available at the IME website, ime.math.arizona.edu.

Learning Technologies and Mathematics Middle East Conference

March 31–April 1, 2007. This conference was a joint effort by the Institute and the Department of Mathematics and Statistics at Sultan Qaboos University. It brought together 144 educators and experts in learning technology from the Middle East, Europe, Asia, and North America to share their views on the best ways to prepare university students for a world driven by technological innovations.

Visiting Scholars

March 9–16. We had two visiting scholars supported by the University's Research Initiative Funds: Roger Howe, a mathematicians from Yale University, and Deborah Schifter, a mathematics educator from EDC in Cambridge, Massachusetts, visited for a week in March to help the Institute develop the concept for the Mathematicians in Mathematics Education workshops, to be piloted in 2007–08.

Theme for 2007-2008: Mathematics courses for teachers

Possible projects include:

- study and dissemination of models of teacher preparation and professional development in mathematics,
- design of graduate programs for teachers, taking a fresh approach to teacher knowledge by bringing teachers, mathematicians, and mathematics educators to do mathematics together with a focus on topics from the school curriculum,
- creation of materials to address challenging topic areas for elementary and middle school mathematics teachers.

Theme for 2008-2009: Analysis of curriculum materials

Joint analysis of curriculum materials, from both this and other countries, provides for a common reference point among different points of view, and affords opportunities to discuss longitudinal concerns in curriculum and assessment. Possible projects include:

- study of topics in the mathematics curriculum, producing essays that explore key features of the various treatments of these topics, and provide justification for key topics,
- development of a library of scanned curricula on a password protected web site, suitable for collaborative examination,
- analysis of lesson plans and classroom teaching (live or on video) in order to examine students' opportunity to grapple meaningfully with powerful mathematical ideas.

People

Staff

William McCallum, Director
Rebecca McGraw, Assistant Director
David Savitt, Assistant Director (2006–07)
Joceline Lega, Assistant Director (2007-08)
Robin Zenger, Program Coordinator

Planning Group

Deborah Hughes Hallett (chair), Professor of Mathematics, University of Arizona and Adjunct Professor of Public Policy, Kennedy School of Government, Harvard University

Deborah Loewenberg Ball, Dean of the School of Education and William H. Payne Collegiate Professor, University of Michigan

Hyman Bass, Roger Lyndon Collegiate Professor of Mathematics and Professor of Mathematics Education, University of Michigan

Al Cuoco, Senior Scientist and Director of the Center for Mathematics Education, EDC

Roger Howe, Professor of Mathematics, Yale University

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