The Mathematical Sciences Research Institute (MSRI)

The Mathematical Sciences Research Institute (MSRI) is one of the world's preeminent centers for collaborative research in mathematics. Since 1982, MSRI's topic-focused programs have brought together emerging and leading minds in mathematics, in an environment that promotes creativity and the interchange of ideas. Over 1,500 mathematical scientists spend time at MSRI's Berkeley, California-based headquarters each year. MSRI is known around the world for the quality and reach of its programs and its leadership in basic research, and also in mathematics education and in the public understanding of mathematics.

The Institute for Advanced Study (IAS)

The Institute for Advanced Study, founded in 1930 as an independent institution in Princeton, New Jersey, is one of the world's leading centers for basic research in the sciences and humanities, where the permanent faculty and visiting scholars have the freedom to pursue some of the deepest theoretical questions without pressure for immediate outcomes. Its reach has been multiplied many times over through the more than 7,000 scholars who have influenced entire fields of study as well as the work and minds of colleagues and students.
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Inspiring Teachers

Mr. Kelley taught me to think like a mathematician—to seek out structural similarities between seemingly different mathematical systems, and to take delight in finding the hidden meaning that resides in formulas. The mathematics that I do now is far removed from what we did at Wilmington High, but the methods I learned there have served me well for over 50 years.

—Former Massachusetts Teacher

Mathematics is an essential tool whether students go on to build houses, heal patients, design cars, run start-ups, sign loans, or pursue myriad careers. Mathematics is also inspiring when students are challenged to experiment, discover surprising patterns, uncover subtle connections between seemingly different phenomena, and find precise ways to describe insights.

While the work of inspiring students falls to teachers, a big question remains. Who is working to inspire teachers?
Nationwide, a growing number of high-quality leadership oriented professional development programs are connecting teachers with inspiring mathematics. These programs seek to create systems to reward and strengthen excellence in teaching. They also respond to teachers’ deep desire to:

- Continue to explore complex ideas and engage in experimentation and discovery.
- Learn new strategies to ensure students excel and develop high level thinking skills.
- Participate in a stimulating professional community focused on inspiring students mathematically.

To illustrate what we mean by “leadership oriented professional development,” we have selected four programs to highlight as examples. All four programs have profound respect for teachers, and all of them connect teachers to inspiring mathematics. We conclude with an overview of the elements that make these programs so effective.

When we’ve tried everything else, and it hasn’t moved the needle (or has moved the needle only as long as an external finger was on the scale), perhaps we will finally invest more seriously in our teachers, and in leadership from within the teaching profession itself.

—Herb Clemens
Former director of Park City Mathematics Institute

Photo used with permission of PCMI
The heart of MfA is its programming—done with and often by teachers themselves. It provides an exciting and stimulating mix of multi-session Professional Learning Teams (PLTs, co-led by teachers), mini-courses (taught by university scholars or expert teachers), and workshops. In the most recent year, there were 44 PLTs, 35 mini-courses, and 42 single-session workshops. These draw well over 5,000 registrations from our 800 teachers, who explore both new advances in the field and controversies in pedagogy—from the (biochemical) deconstruction of your favorite sandwich to the role of teachers in education research.

—John Ewing
President of Math for America

The fundamental mission of Math for America (MfA) is to make teaching a viable, rewarding, and respected career choice for the best minds in science and mathematics.

- **It starts with outstanding teachers.** MfA Master Teachers have a deep understanding of their students, and they are experts on their content and authorities on the craft of teaching.

- **The magic is in the community.** Outstanding teachers inspire and motivate one another. They learn from each other and share ideas. They insist on excellence from their colleagues and themselves. MfA provides extensive opportunities for learning together.

- **Extraordinary teachers then stay in the classroom.** By becoming Master Teachers, participants find opportunities for leadership and growth as educators, which means they can enjoy dynamic, interesting, and challenging careers without ever leaving the classroom.

- **Great teachers are always learning.** MfA provides teachers with extensive opportunities to improve continually in three areas: their depth of content knowledge, their expertise in the craft of teaching, and their ability to know and teach to the strengths of every student in their classrooms.

The Math for America model is strength based; the program builds rather than repairs. The aim is not to fix what is broken but to reward what works, to reinforce it, and to hold it up as a model. Math for America creates a professional community, gives teachers freedom and respect, and changes attitudes about teachers and the profession of teaching.

http://www.mathforamerica.org/home
PROMYS for Teachers

The central goal of PROMYS for Teachers is to promote a culture of exploration in secondary mathematics classrooms. PROMYS is offered jointly through Boston University and Education Development Center, Inc., and supporters include the National Science Foundation and Boston University.

- **Teachers think deeply of simple things.** No special background is needed, but the PROMYS content is challenging enough to sustain the interest of the most mathematically sophisticated participants. Numerical observations made in early problem sets are enriched and extended in later sets so that participants acquire firsthand experience of unraveling deep and significant truths out of simple ideas.

- **Teachers experience authentic mathematics.** While the material on which teachers work is not at the forefront of research, the personal engagement, the methods, habits of mind, and styles of work they develop are exactly those of research mathematicians.

- **Teachers provide PROMYS-like experiences for their students.** Teachers bring the core principle of PROMYS—i.e., the “experience first” approach to learning mathematics—to their classrooms. PROMYS provides opportunities for teachers to share strategies for implementation with each other.

- **A mathematical community sustains learning.** Intellectually and socially, the mathematical community at PROMYS is central to its transformative effect upon participants. Through collaboration, workshops, lectures, and online interaction, this network remains a deeply valued personal resource years, in some cases decades, after teachers first participated in PROMYS.

The joys of exploration and discovery can be experienced by secondary school students and teachers in ways that are not all that different from what a seasoned mathematics researcher experiences. Moreover, teachers who have such experiences in their backgrounds are better prepared to encourage independent inquiry among their own students. Reports from former PROMYS teachers confirm that all students benefit from this kind of instruction.

[http://www.promys.org/pft](http://www.promys.org/pft)

The best thing that PROMYS has done for me is that it’s allowed me a way to guide the students to finding solutions on their own and persevering on their own by guiding them with questions and giving them strategies as opposed to giving them the answers. . . . I want them to be self-sufficient.

—Sarah Meloni
PROMYS participant, Framingham High School

**Date launched:** 1991

**Location:**
Boston University
Education Development Center, Inc.

**Format:** Six week summer immersion, school year workshops
The goals of the Teacher Leadership Program at the Park City Mathematics Institute (PCMI), an outreach program of the Institute for Advanced Study, are to deepen teacher expertise by giving them opportunities to continue to learn and do mathematics, analyze and refine classroom practice, and become resources to colleagues and the teaching profession as a whole.

- **Mathematics is at the core.** Teachers work on intricately sequenced problems that provide participants with an opportunity for authentic mathematical discovery. Through this experience, participants develop habits for doing mathematics, deepening their intuition, sense-making, and reasoning skills.

- **Teachers reflect on practice.** Teacher leaders, all of whom are former participants in the program, lead courses for reflecting on practice. These use artifacts of practice such as videos, journal articles, student work, and research findings to challenge perspectives and stimulate conversation.

- **Teachers develop new perspectives on teaching.** As the participants think about teaching after stimulating engagement with mathematics, they begin to realize what shapes their learning and thus, the learning of their students.

- **Mathematical cross-pollination happens.** Elementary and secondary teachers learn from each other about the nuances of teaching and learning mathematics. Moreover, the teacher participants are a vibrant part of a larger community of mathematical scholars at PCMI, and take part in an unusual opportunity for K–12 teachers to cross-train and interact with mathematical researchers and educators.

PCMI teachers gain a new perspective about the work of teaching and develop their potential for contributing in meaningful ways to the field.

http://www.parkcitymath.org/
NebraskaMATH

NebraskaMATH is a statewide partnership with more than 700 teacher leaders, centered at the University of Nebraska-Lincoln. The partnership educates and supports Nebraska’s PK–12 students and teachers at critical junctures, with the goal of improving achievement in mathematics for all students and narrowing achievement gaps of at-risk populations.

- **Mathematics is for everyone.** NebraskaMATH programs provide experiences that strengthen teachers’ mathematical understanding and their capacity to teach with conceptual development and multiple strategies. The partnership particularly emphasizes strategies for teaching diverse learners in high-need schools. Teachers are armed with the mathematical and pedagogical knowledge needed to improve mathematics achievement for all students.

- **NebraskaMATH has reach.** NebraskaMATH has more than 100 PK-12 school district and post-secondary partners across the state of Nebraska; NebraskaMATH has further increased accessibility with high quality online and regional courses for teachers. Targeted programs meet the needs of teachers of all grade bands, PK-12.

- **Innovation creates communities of lifelong learners.** For example, conferences and four Math Teacher Circles across the state of Nebraska bring secondary teachers and mathematicians together for problem solving and socializing.

- **Federal investment catalyzes private, local, and state investment.** NebraskaMATH, seeded with generous funds from the National Science Foundation, has been so valuable to Nebraska communities that the program has received over $6M in private foundation funds as well as $1M in funding from Lincoln Public Schools.

NebraskaMATH increases teachers’ confidence about mathematics and the teaching of mathematics, and prepares them to actively engage all students in learning mathematics.

http://scimath.unl.edu/nebraskamath/

The importance of a teacher in the classroom is much more than simply exposing students to new mathematical material. I feel the most important [role] of a math teacher, or any other teacher for that matter, is to teach students how to become lifelong learners.

—Tony Hoffman
NebraskaMATH participant, Crofton High School
Summary of Guiding Principles

- **Teachers have opportunities to do authentic mathematics.**
  Teachers conduct mathematical experiments, look for patterns, make conjectures, and uncover underlying structures and connections, discuss ideas and are naturally led to justify and defend their claims. These experiences reinforce the notion that mathematics is about more than just formulas and theorems— it's also about the kinds of thinking that goes into developing those formulas and theorems.

- **Teachers experience mathematics as a student does.**
  We hear this over and over from participants. It's extremely difficult for an adult, comfortable in that part of the discipline covered in this or that curriculum, to recall the struggles and the confusion that come when one is first learning a mathematical topic. These experiences accentuate the value of struggle in learning mathematics.
• **Teachers provide authentic mathematical experiences for their students.**
  Teachers connect their mathematical experiences to their work in the classroom. They learn strategies for providing students with opportunities to experiment, conjecture, and discover; for teasing out the germs of insights that are often implicit in hunches and conjectures; and for bringing coherence to school mathematics as a whole.

• **Teachers become leaders in their profession.**
  Across all these programs, participating teachers have opportunities to take on leadership roles. Formal leadership roles include facilitating workshops in these programs; informal roles include giving presentations and becoming resources for other teachers.

• **Teachers build communities.**
  Watching teachers work in one of these programs, you see that they quickly form collaborative groups—not in any formal sense but as ways to help each other with the mathematics. These groups extend long beyond the life of the programs—teachers continue to learn from each other, both about mathematics and how to teach it.

Through these experiences, teachers refine their capacity to inspire by being inspired. They are inspired by the mathematical explorations in which they engage; they are inspired by the discoveries that they make; and they are inspired by the community of other inspirational teachers. When teachers bring this inspiration to their own classrooms, they ignite a spark of mathematical excellence in their students.