

AMS Special Session in Louisville, KY on The Work of Mathematicians and Mathematics Departments in Mathematics Education

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and

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The Focus on Mathematics (FoM) Professional Teacher Academy

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The FoM Teacher Academy is a Collaboration of

- ▶ Education Development Center, Inc. (EDC)
- ▶ Math for America Boston (MfAB)

in support of a community of mathematical practice that engages

- ▶ teachers and
- ▶ mathematicians

working together to close the gap between school mathematics and mathematics as a scientific discipline.

This is work in progress . . .

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over the past 23 years . . .

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and still going strong!

A community of mathematical practice that has been evolving for almost 25 years.

- ▶ A Targeted Math and Science Partnership (MSP)
 - ▶ established in 2003
 - ▶ with funding by the National Science Foundation
- ▶ Rooted in *PROMYS for Teachers*, initiated in 1989
- ▶ Phase II research beginning in 2009
- ▶ DRK12 project to develop measures of secondary teachers' algebraic habits of mind

Dedicated to improving mathematics education by building a corps of outstanding teachers and leaders.

- ▶ Recognize and support excellence
 - ▶ Fellowships and salary supplements
- ▶ Develop and support teachers as leaders of their profession
- ▶ Focus on inputs rather than outputs
 - ▶ great teachers
 - ▶ excellent curricula
 - ▶ well-structured school environments
 - ▶ not narrowly defined outputs such as test scores
- ▶ Outstanding teachers serve as role models
 - ▶ for other teachers
 - ▶ for those who might consider teaching as a profession

Working closely with MfA headquarters in New York City.

Massachusetts STEM Master Teacher Corps (MSMTC)

Beginning with mathematics, our ultimate goal is to advance STEM teaching and learning across the Commonwealth of Massachusetts by

- ▶ recognizing and rewarding our best and brightest STEM teachers, and
- ▶ providing them with opportunities to advance and improve their own profession.

The FoM Academy will be a professional school

- ▶ for **and by** practicing mathematics teachers
- ▶ providing graduate level courses
- ▶ and authentic mathematical experiences
- ▶ tailored to profession-specific mathematics used by secondary teachers in their work

Distinctive Features

- ▶ Depth over Breath
 - ▶ Focus on one aspect of improving education
- ▶ Focus on Mathematics
 - ▶ Everything we do revolves around mathematics
- ▶ Capacity building
 - ▶ **Teachers drive their own professional development**
- ▶ Community building
 - ▶ Mathematicians, teachers, and education researchers work and learn together

Work to Date: *Focus on Mathematics Programs*

The FoM partnership has established

- ▶ Study Groups
- ▶ Seminars and colloquia
- ▶ A new graduate degree program
 - ▶ Master of Mathematics for Teaching (MMT)
- ▶ Summer Institutes
- ▶ Mathematics fairs and Mathematics Expo for students
- ▶ Research collaboratives
- ▶ Evaluation and case studies
- ▶ Teachers in leadership roles throughout

Expert mathematics teachers

- ▶ Know mathematics as a **Scholar**:
 - ▶ its major results, its history of ideas, its connections to pre-college mathematics
- ▶ Know mathematics as an **Educator**:
 - ▶ how mathematical ideas develop in learners, algebra and arithmetic, geometry, analysis.
- ▶ Know mathematics as a **Mathematician**:
 - ▶ have deep experience of the doing of mathematics
 - ▶ grappling with problems, becoming completely absorbed in mathematical activity for a sustained period of time
- ▶ Know mathematics as a **Teacher**:
 - ▶ mathematics that is specific to the teaching profession
 - ▶ the craft of task design and the “mining” of student ideas

Distinctive is the FoM Academy's focus on the third of these

Knowing Mathematics as a Mathematician

- ▶ Examining the whole mathematical enterprise
 - ▶ as a coherent body of knowledge
 - ▶ as a way of thinking and inquiring about the world we live in
- ▶ Having *deep experience of the doing of mathematics* – e.g.
 - ▶ grappling with problems
 - ▶ building intuition
 - ▶ developing theories
 - ▶ becoming completely absorbed in mathematical activity for a sustained period of time

Experience first:

It has been observed in every human activity experience comes first, and as this experience grows the need for communication motivates the development of language. Sadly enough, in our classroom practice we place language first and experience second. We worry about what we should say in order to help the students understand. By this we mean to provide the effect of experience through the use of suitably chosen words. Not unexpectedly, the effect is at best a very pale image of the real thing.

Arnold Ross

Authentic Mathematical Experience

- ▶ Teachers and mathematicians experiencing mathematics together
 - ▶ as a collaborative activity
 - ▶ alongside students
 - ▶ as an empirical science
 - ▶ as exploration
- ▶ Key Features
 - ▶ emphasis on learning and problem-solving
 - ▶ depth over breadth
 - ▶ strengthening *mathematical habits of mind*

Typical features of an immersion experience

- ▶ Immersion in new ideas
- ▶ Necessity for open communication
- ▶ Acquiring taste for hard problems
- ▶ The central role of experience
 - ▶ empirical basis of mathematical knowledge
 - ▶ personal experience as guide for exploration
- ▶ Learning good judgement in recognizing significant ideas
- ▶ Sharing ideas with others
 - ▶ in writing
 - ▶ in seminars
- ▶ Questioning answers
- ▶ Low threshold – high ceiling

The PROMYS community

- ▶ First year participants
 - ▶ 60 high school students
 - ▶ 23 teachers
- ▶ Returning participants
 - ▶ 23 high school students
 - ▶ 12 teachers
- ▶ Counselors
 - ▶ 22 undergraduates
 - ▶ 9 teacher alumni and 4 graduate students
- ▶ Faculty
 - ▶ 7 mathematicians (for seminars)
 - ▶ 6 mathematicians (as outside research mentors)

Mathematical Habits of Mind

- ▶ **Acquiring experience**
 - ▶ numerical experimentation and alert observation
 - ▶ mathematics as an empirical science
 - ▶ practice – enhancing skills
 - ▶ inductive reasoning – building intuition and sense-making
- ▶ **Use of language**
 - ▶ precision
 - ▶ asking good questions, formulating conjectures
 - ▶ reasoning – proofs and disproofs
- ▶ **Review**
 - ▶ identifying important ideas
 - ▶ making sense of complex problems
 - ▶ looking for connections
- ▶ **Generalization**
 - ▶ broadening applicability
 - ▶ questioning answers

Final Remarks: Involvement of Mathematicians

- ▶ The number of “special” mathematics teachers having significant talent and significant interest in mathematics is significantly higher than is commonly believed.
- ▶ Helping these teachers is work that mathematicians are uniquely prepared to do.
- ▶ The mathematical habits of mind required for excellence in teaching are similar to those required for excellence in research.
- ▶ Mathematicians benefit **AS MATHEMATICIANS** from engagement in issues of mathematics education.