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Mathematicians Playing a Role in Math Education: What We Learned at the IME/MIME Workshop

Anna Bargagliotti
Loyola Marymount University

Rama Chidambaram
Henry Ford Community College

Gizem Karaali
Pomona College

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By Anna Bargagliotti, Rama Chidambaram, and Gizem Karaali

In Hollywood, some actors are regularly cast as mean, others as sweet and endearing, and some typically play innocent big-eyed youths who inevitably succeed after awakening to the particular facts of life that their producer wants them to awaken to. It is unusual and difficult for actors to cross the bridge between different types on a regular basis. However, there are always exceptions to the rule.

In the seemingly unrelated world of academics, mathematics faculty may find themselves playing different roles. People with different skills and interests strive to balance their careers in ways that will be uniquely fulfilling to them. Many choose to play multiple roles within their research fields and within the mathematical community. However, some typecasting naturally happens in our midst as well, and switching roles becomes difficult. Who knew mathematicians and Hollywood celebrities had anything in common?

Typecasting among mathematicians is worth investigating. Looking at mathematics departments across the country we see mathematicians making many different choices. Some choose to dedicate most of their energy to the advancement of mathematics through research. This kind of role can come in many distinct flavors: undergraduate research, historical research, subject area specific research, etc. Others excel in classroom teaching and focus their energy on developing interesting coursework. Many dedicate themselves to innovate and improve the process of teaching mathematics. Recently, there has been an emergence of yet another group: a relatively small self-selected minority who successfully cross the bridge between mathematicians and mathematics educators called "mathematicians who also do mathematics education." This group's scholarly research bridges and enriches both fields.

This is a story told by three junior mathematicians who have not yet gone through the Sorting Hat, but are interested in playing many different roles in the mathematics community. Our tale reflects our experiences at the "Mathematicians in Mathematics Education" (MIME) workshop at the Institute of Mathematics Education (IME), University of Arizona, which we attended March 20–22, 2008.

Let us give some background and context: We were all intrigued by the MIME workshop announcement that promised to orient mathematicians to key issues of mathematics education. Each of us was convinced by the argument that "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." We found our separate ways to Tucson, AZ, hoping that, with some guidance, we too could find our own unique ways to contribute to the discussion and to work on current issues in mathematics education.

We were looking to make our first crossover. In graduate school, we were trained to be research mathematicians. We are of course grateful for our training and will continue to do research mathematics, but we would like also to have the chance to be involved with mathematics education research. We respect and admire the handful of mathematicians who have taken this path ahead of us, and want to follow in their footsteps. The philosophy of the workshop was precisely that this could be done: university mathematicians could contribute in meaningful ways to the work of mathematics educators while still maintaining their role as mathematicians.

Three prominent mathematicians and an accomplished mathematics educator organized the workshop. The participants were mathematicians at various stages of their careers. Many had dedicated years to several key issues related to mathematics education. Others, like the three of us, were mostly new to the conversation, but eager to get involved and ready to begin exploring the world of mathematics education.

We started with a working dinner in which everyone had the chance to meet informally. After dinner, we had the opportunity to listen to Roger Howe of Yale University, who has "worked diligently over the years to broaden and professionalize the involvement of a research mathematician in educational reform, to lead us towards the goal where involvement of mathematicians in education is viewed as a well-informed professional activity by mathematicians and educators alike," as the citation for his 2006 AMS Award for Distinguished Public Service says. Many mathematicians know him for his work in representation theory, and many others are familiar with his contributions to mathematics education. For us novices, his talk was inspiring, not only because of his reputation as a research mathematician, but also because his message was very compelling.

Howe gave us several simple examples of how to approach problem solving in the context of mathematics education. He discussed the difference between knowing the definition of number as a mathematician and actually coming up with a definition that an elementary school student can understand and use in a meaningful way. He also suggested specific ways a mathematician could become involved in mathematics education: collaborating in the development of various teacher preparation programs, designing professional development opportunities for teachers, writing about mathematics to provide motivation and insight to pre-service and in-service teachers, participating in various education-related program panels and committees of IES or NSF, reviewing or writing educational materials such as textbooks, being a consultant on education proposals (such as NSF curriculum change proposals), etc.

The next morning, renowned mathemat-

ics educator Deborah Ball led us through the present landscape of mathematics education in the US. Following her lead, we embarked on a discussion about mathematical subject knowledge and Mathematical Knowledge for Teaching (MKT). Pretty soon we discovered that MKT is not just about knowing mathematics, but also includes everything teachers do to support student learning: lesson planning, choosing the right examples, asking good questions that lead to classroom discussions, assessing student work, etc. Each of these tasks involves pedagogical skill as well as a considerable amount of mathematical proficiency, skills of mathematical reasoning and communication, and fluency with examples and terms.

To illustrate this point we watched a video of students in an elementary school classroom. Students in the video were discussing which fraction is larger: 4/4 or 4/8. While watching the class discussion, our task as mathematicians was to observe the mathematics in a child's explanation. After an hour of deliberations, we had filled up a large whiteboard with mathematical ideas such as the knowledge of unit measure, relationship between divisor and dividend, equivalence classes, etc. In the end, this turned out to be a surprisingly challenging and undeniably exhilarating experience. We enjoyed our task and came to appreciate the nuances and subtleties involved in identifying mathematical ideas in a child's work.

That afternoon, Hyman Bass encouraged us to think about how to help school students understand the meaning of a standard procedural algorithm used in performing mathematical operations. Our task was to use pictures and manipulatives to represent the standard procedures such as borrowing and carrying used to add, subtract, multiply, and divide in a way elementary school students could understand. This again proved to be challenging for a group of approximately twenty PhDs in mathematics.

In their presentations, Bass and Ball illustrated to us the large amount of mathematical reasoning and skill that is needed to develop the necessary knowledge base for teachers. They emphasized that this is an area of education that mathematicians are qualified to comment on, provided they develop a keen sense of observation and listening to identify the problems involved in teaching. Collaborating with educators, we discovered, mathematicians could use their knowledge about mathematics to develop more effective ways to teach teachers.

At the end of the day we were assigned homework! We were asked to examine and critique the treatment of the concept of a function in various algebra textbooks. We were given sample materials from three textbooks and were asked to review them overnight so that we could continue the discussion.

The action-packed day ended with a fantastic dinner at William McCallum's house. As the beauty of the southwestern sunset came upon us, many informal conversations about mathematics education took place. For example, one of us chatted with Deborah Ball about education as a research field and more specifically about questions like: What should being a "mathematician who also does mathematics education work" really mean? How can this be defined in terms of scholarship? What is the relevant research component? How can this research be incorporated into the more traditional research portfolio of an academic mathematician? Who is the audience interested in this type of research? Discussing these types of questions with Deborah Ball, Hyman Bass, and William McCallum provided interesting perspectives about this vast territory, which remains largely uncharted. We felt lucky to be at this workshop and be led through this geography by these pioneers.

On Saturday morning at 8:30 am McCallum, a 2005 NSF distinguished teaching scholar award winner and director of IME, initiated a discussion on developing a framework for evaluating school textbooks. We learned to give constructive criticism to the authors in order to ensure correct mathematics is being taught throughout all grades. In addition, we also had a chance to view some state high school curriculum standards, which touched on issues mentioned in Deborah Ball's discussion of the landscape of mathematics education in the US. The workshop ended after a discussion regarding our future work as mathematicians in mathematics education.

We left Tucson full of excitement, hope, and promise that in the future we would be able to cross the bridge between mathematicians and math educators doing scholarly research in both fields. It was clear to us that doing research in mathematics education is engaging, challenging, and requires skills substantially different from just knowing and successfully teaching mathematics at the university level. We also learned that with a lot of motivation and keen sense of observation and listening, we could make significant contributions to the field of mathematics education.

With mathematics educators like Deborah Ball and mathematicians like Hyman Bass, Roger Howe, and William McCallum, paving the way to make this transition possible, we believe crossing over should be a lot easier for mathematicians than for Hollywood actors. However, in order for the work of a mathematician in mathematics education to be regarded as valuable research, the end product must meet the scholarly standards in two fields: mathematics and mathematics education. Clearly, this is no small task. How it can be done is an open question that we are eager to attempt to answer.

For information on IME, check out: http://ime.math.arizona.edu. For an introduction to MKT see: Ball, D. L., Hill, H.C, & Bass, H., "Knowing mathematics for teaching: Who knows mathematics well enough to teach third grade, and how can we decide?" *American Educator*, Fall 2005, pp.14–22, 43–46; also available online at Deborah Ball's home page at http://www-personal.umich.edu/~dball/.

Anna Bargagliotti is assistant professor of mathematics at the University of Memphis. Rama Chidambaram is assistant professor of mathematics at the University of Michigan-Dearborn. Gizem Karaali is assistant professor of mathematics at Pomona College.