

*The Mathematics Education into the 21<sup>st</sup> Century Project*  
*Universiti Teknologi Malaysia*  
*Reform, Revolution and Paradigm Shifts in Mathematics Education*  
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**Recruiting, Educating, and Retaining Teachers of Mathematics**

Madeleine J. Long

Hunter College, City University of New York

The Mathematics and Science Partnership in New York City

“We’ve arranged a civilization in which most critical elements---transportation, communications, and all other industries: agriculture, education, entertainment, and protecting the environment; and even the key democratic institution of voting---profoundly depend on science [mathematics] and technology. At the same time, to many citizens we kept illiterate. We might get away with it for awhile, but eventually this combustible mixture of ignorance and power is going to blow up in our faces.”<sup>1</sup>(Sagan)

Despite more than a decade of large-scale systems reform supported by the National Science Foundation (NSF), the United States Department of Education (DOE) mathematics and science education as we know it and practice it remains a model conceived at another time and for purposes derived largely from agrarian and early industrialized societies rather than for what Peter Drucker has often referred to as a “knowledge-based global” society. School calendars continue to be structured around the needs of these kinds of societies, and non-too-creative classroom organizations persist in reflecting a Dickensonian psychology where rows and rows of children sit passively behind screwed down desks, absorbing information in discrete bits, all-too-frequently from teachers whose content knowledge is far from adequate for the challenges at hand.

In this scenario, children and young adults from economically impoverished and minority families still lag well behind others in academic performance and achievement, especially at advanced levels of study. All too many teachers continue to doubt their ability and treat them to simplistic, incomplete, and often useless tidbits of information in place of important ideas and concepts. Having fun reigns supreme while challenges and thought-provoking problems are avoided to the same extent that some governments seem to avoid accountability and the pursuit of reason. “Race is the biggest reason the United States . . . is ruled by a political movement that is hostile to the idea of helping citizens in need...Who can honestly deny that race is a major reason America treats its poor more harshly than any other advanced country.”<sup>2</sup>

There are far too many critical, seemingly intransigent, problems that have and continue to plague PreK-20 education, especially the recruitment, education, and retention of teachers---and most are not even close to being resolved. Students of all ages, especially those from economically poor and historically underrepresented families, continue to experience difficulty learning mathematics. Many teachers, especially those in the elementary and middle school grades, suffer from a lack of fluency in the content they teach. Others, primarily high school and college faculty, appear unaware and lack understanding of how students learn and why they lack so many mathematics concepts and big ideas. Primary research remains removed from application in schools and classrooms. Bright young college students reject teaching careers. Affordable, viable, practical assessments fail to measure what it is that professionals consider important in the various disciplines. And too few concerned groups have learned how to work together in partnership to forge creative and responsive solutions to underlying problems.

The question of sustainable partnerships among secondary schools and institutions of higher education is highly visible in the United States. It is a high stakes issue in which the National Science Foundation and the United States Department of Education are heavily invested; each funds projects that develop plans to bring these two groups together. What remains unexamined are questions related to the purpose of the partnerships, the role each group is best able to assume, different forms such partnerships

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<sup>1</sup> C. Sagan, *New York Times Magazine*, 1993

<sup>2</sup> Paul Krugman, “Tragedy in Black and White,” *NY Times*, 9/18/05

might take, means of assessing results in terms of student learning, and issues related to sustainability, scale up, and transferability.

The plight of the elementary school teacher is another high stakes issue. In the United States and many other countries, the elementary school teacher is poorly educated in mathematics, disabled by mathematical concepts and, yet, needing to face students and teach them concepts related to numbers, shapes, measurements, unknowns, reasoning, prediction, graphing, and problem solving. This is not a new problem, yet attempts to deal with it have taken the same projectory for more than three decades: professional development offered by peers and/or university professors, “specialists” who teach only mathematics, and teacher coaches who are frequently less than a step ahead of those they coach. Actually there are a multiplicity of problems embedded within the larger one, the lack of knowledge on the part of the teacher and the failure of students to learn. Although there are likely multiple solutions as well, it is critical that any solution ensures that every student has the opportunity to learn mathematics from a knowledgeable and competent teacher.

Solutions might involve assigning teachers to classes differently, employing expertise from outside the profession, and selecting and using technology wisely and efficiently. These solutions, in turn, are likely to involve a host of related changes such as scheduling classes differently, instituting differential pay scales, redefining full time teaching, designing and building schools differently, developing diverse partnerships that are real and ensuring that each partner has something to give, something to gain, and something to risk. Perhaps most important is the fact that the universe of possible solutions is likely to contain ideas and approaches that are unique and heretofore unknown. Some might exist individually, awaiting a synergistic combination of elements that has not yet occurred.

Consider, for the larger picture, the juxtaposition of plodding, sleepy, inefficient approaches to education with the continuous and sometimes furious explosion of knowledge especially scientific knowledge, and technological advances found in the worlds of research and industry. At this conference, a group of scholars and practitioners with diverse skills and backgrounds, and the ability to think outside the box, have the opportunity to turn themselves loose on important mathematics education problems; to frame the issues clearly; design future research projects that can be pursued by conference attendees between now and next year’s meeting; and develop case studies that help illustrate solutions.

Amidst this backdrop of critical problems that have eluded useful solutions for decades, myths and misconceptions about various facets of teaching and learning---some the product of so-called reform mathematics--- persist, and hinder progress. Since teaching, learning, and organizational strategies play important roles in the design of teacher education programs, a number of examples of myths that plague thinking about and locating solutions to the education of teachers follow. Hopefully, some of these myths will spark participants as they engage in presentations and conversations relevant to recruiting, educating, and retaining mathematics teachers.

### **I. The Learning Myth**

- Learning must be fun---and fun excludes challenging intellectual work.
- Constructing knowledge is always the best way to proceed.
- Standards-based curriculum/good teachers/programs/funds “solve” most educational problems
- Lectures induce passive learning.
- Efficiency, speed, task completion, and correctness are not important.
- TV time is necessarily non-productive for learning.
- Transfer occurs automatically or not at all.

### **II. The Myth of the Learner**

- Age makes learning harder.
- Children learn particular concepts/ facts at the same age and with the same speed.
- Smart people are smart all the time.

- Everybody can succeed at everything equally well.
- All children can learn---in spite of conditions.
- Boundaries and limits interfere with creative and critical thinking.
- Competition impedes learning.
- Developmental stages of elementary school children require the self-contained classroom.
- Not all parents care about their children.

### III. Myths Related to Organizational Issues

- Pre-K-12 formal learning must occur 10 months a year.
- All classes must be scheduled 5 days a week.
- All required subject matter must be taught all the time.
- Small classes are always better than large classes.
- Classes are best organized around like age groups.
- Classes are best organized around discrete subject matters.
- Learning is limited to formal education.

### IV. Teacher/Teacher Education Myths

- If all students can learn, all teachers can teach.
- Deep content knowledge is unnecessary for those teaching early elementary grades.
- Teachers necessarily teach as they have been taught.
- Differentiating content for perspective researchers and teachers waters down content for teachers.
- Partnerships between college and PreK-12 teachers will benefit student learning.

The process of recruiting, educating, and retaining teachers is made more difficult by the existence of myths such as these. Recognition that certain strongly held and long held beliefs are actually myths or dogma is an important step in introducing the scientific process to the study of education and development of good teacher education programs. Learning how to recognize and debunk myths can lead to development of a culture of inquiry, investigation, and analysis where the insights and changes that result are tested, reformulated, retested, implemented, and, when appropriate, scaled up. Hopefully, participants will hold, in retrievable places, many of the more damaging of these myths, and reconsider them as papers are presented and discussions and critiques ensue.

The balance of this paper, a prelude to the study group, focuses on the issues of recruiting teachers and developing partnerships, and result from studies that are part of an NSF-funded project at Hunter College of the City University of New York (CUNY). As the reader and conference participants confront them, awareness of related myths should help to trigger a different way of thinking about and analyzing them.

1. **Recruiting Prospective Teachers:** Many school districts, especially large urban ones, have experienced teacher shortages in mathematics for more than two decades, a shortage recently exacerbated by factors such as the small-class movement and job competition from other areas where compensation is higher and conditions more professional. At the elementary school level, the replacement of an arithmetic-only curriculum with those that focus on mathematics has added to the recruitment difficulties. In order to alter the situation, and provide every student with mathematics teachers who understand content and how to teach it, many myths must give way. We must recognize and learn how to maximize the reality that learning takes place all day, every day through many different venues, and with the participation of many different kinds of messengers, including but not limited to classroom teachers. Within the classroom it may be time to look at a reorganization of teaching assignments, rescheduling of curriculum areas, and new ways to group student in order to maximize the time children spend with knowledgeable teachers.

Recruitment cannot wait until college; it should begin informally, early in a student's life. The natural propensity of children to help others, coupled with an early interest in exploring the worlds around them can be employed to great advantage. In CUNY's Mathematics and Science Partnership Program

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(MSPinNYC), high school students are recruited as tutors and work side by side with college students as part of a program that works to improve student performance on high school regents examinations. The student tutors are introduced to the rewards of teaching careers early on and helped to understand what is involved in becoming teachers---an important form of recruitment.

Those recruiting students must understand and operate in light of the broader process of recruitment, education, and retention. For example, recruitment efforts ought to take into account the fact that there is room for more than one model of teacher and teaching. This means that experts can be engaged to teach particular courses on a part-time basis. Graduate students, college faculty, and professionals from related areas might serve as classroom consultants in particular content areas; older students can serve as formal tutors to younger students; technologies as sources and purveyors of knowledge can be engaged much more than is currently the case. Teachers can share full time teaching assignments. Teacher choice may be provided at the secondary school level regarding class size.

## **2. Developing Partnerships**

The belief that partnerships with colleges and universities and business and industry are critical to the improvement of Pre-K-12 schools stands poised to become dogma, but there still appears to be time to put the belief to the tests of practice, analysis, and research. The CUNY MSPinNYC is accomplishing this through a very interesting approach directed at high school students who have failed to pass New York State examinations (regents) in mathematics, chemistry, and biology. Teaching Research Teams (TRTs) composed of college and high school faculty and high school and undergraduate tutors are selected and trained over the course of a semester prior to serving as instructors for the failing students. Students attend classes for a period of almost six weeks during which time various methods and approaches to content are experimented with in an environment characterized by public teaching, critical analysis, and reformulation. College and high school faculty learn, in process, about each other's skills and deficiencies and how to both employ the skills and minimize the deficiencies.

Dialogue among the various team members is, at first, self conscious and tentative, and "controlled" by an unstated desire to remain agreeable and likeable. Gradually personalities emerge, and differences become visible among the two groups. Uncertainty, arrogance, stress, impatience, and other traits begin to emerge but, along with them, there comes varying degrees of honesty, humility, visibility, and concern for the student. High school students do well, with an average of over 80% passing the very same examinations they failed two-three months earlier.

Meetings continue through the year as team members, project leadership, and evaluators attempt to deconstruct the process in order to determine just what factors made the most significant differences and how they are to be replicated. The question of the importance of collegial partnerships among high school and college teachers and their importance for student learning continues to be examined, a question of importance to high schools, teacher education programs, and funding agencies alike. Classrooms become laboratories for research and educational development in real time and under real conditions as teachers from all levels become increasingly comfortable with exposing their beliefs and practices to the scrutiny of others.

The value of other kinds of partnerships for the educational enterprise needs to be examined as well: partnerships with parents, business and industry, and community groups as well as those with funding organizations. Regarding the latter, it is not always clear that funds benefit the recipient. Think about some of the myths that have attached themselves to relationships between funding and success in educational enterprises! Which partnerships are critical? Which are really a victory of form over substance? What makes partnerships different from other types of cooperative efforts? What makes them work, or impedes their development? What is the role of partnerships in the recruitment, education, and retention of teachers?

It is hoped that this very brief look at factors involved in the education of teachers, and in the larger teaching and learning landscape, juxtaposed against a surround of myths and patently unequal treatment of some groups, will help move the Malaysia agenda forward.