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IMPLEMENTATION OF THE MATH AND SCIENCE PARTNERSHIP PROGRAM: VIEWS FROM THE FIELD

HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH

COMMITTEE ON SCIENCE

HOUSE OF REPRESENTATIVES

ONE HUNDRED EIGHTH CONGRESS

FIRST SESSION

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IMPLEMENTATION OF THE MATH AND SCIENCE PARTNERSHIP PROGRAM: VIEWS FROM THE FIELD

THURSDAY, OCTOBER 30, 2003

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH,
COMMITTEE ON SCIENCE,
Washington, DC.

The Subcommittee met, pursuant to call, at 12:33 p.m., in Room 2325 of the Rayburn House Office Building, Hon. Nick Smith [Chairman of the Subcommittee] presiding.

RESEARCH SUBCOMMITTEE
COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

Implementation of the Math and Science Partnership Program: Views from the Field

Thursday, October 30, 2003
12:00 PM
2325 Rayburn House Office Building

Witness List

Dr. Osman Yasar
Principal Investigator for the Targeted MSP grant at SUNY-Brockport

Mr. Ed Chi
Science Teacher, Brighton School District, New York

Mr. Jeff Mikols
Math Teacher, Rochester City School District, New York

Dr. Susana Navarro
Principal Investigator for the Comprehensive MSP grant at the University of Texas, El Paso

Dr. Joan Ferrini-Mundy
Principal Investigator for the Comprehensive MSP grant at Michigan State University

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HEARING CHARTER

SUBCOMMITTEE ON RESEARCH
COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

Implementation of the Math and Science Partnership Program: Views From the Field

THURSDAY, OCTOBER 30, 2003
12:00 P.M.—2:00 P.M.
2325 RAYBURN HOUSE OFFICE BUILDING

1. Purpose

On Thursday, October 30, the Subcommittee on Research of the House Science Committee will hold a hearing to discuss the implementation of the Math Science Partnership (MSP) Program at the National Science Foundation (NSF). The MSP Program, part of President Bush's No Child Left Behind initiative, was authorized by the House in last year's NSF Authorization Act, which was signed into law in December. The program provides grants to partnerships of universities and school districts (and sometimes businesses) to improve K–12 math and science education. This hearing will be the Congress's first look at how this major new initiative is working.

2. Witnesses

- **Dr. Osman Yasar (Oz-mon Yash-ar), lead researcher for the Targeted MSP award at the State University of New York (SUNY) Brockport.** Dr. Yasar is a professor and chair of the computational science department at SUNY College at Brockport. He established the first undergraduate program in computational science in the United States and, prior to SUNY, he was a staff scientist at the Center for Computational Sciences at the Oak Ridge National Laboratory.
- **Mr. Ed Chi (Chee), Science Teacher at Brighton School District in New York.** Mr. Chi teaches science to 7th and 8th grade students at Twelve Corners Middle School in Rochester, New York. Twelve Corners Middle School is the sole institution educating students in grades 6–8 in the Brighton School District.
- **Mr. Jeff Mikols, Math Teacher, at Rochester City School District in New York.** Mr. Mikols has been a teacher with the Rochester City School District since 1993, and he has taught courses ranging from pre-algebra to AP calculus. Currently, Mr. Mikols is the Secondary Mathematics Lead Teacher, which makes him responsible for providing professional development to other secondary school math teachers. Mr. Mikols received his B.A. in Mathematics and Master of Science in Mathematics Education from SUNY–Geneseo, and he is currently enrolled in a Certificate for Advanced Study in School Administration.
- **Dr. Susana Navarro (Nav-ARR-o), lead researcher for the Comprehensive MSP award at the University of Texas at El Paso (UTEP).** Dr. Navarro is the founder and the head of the El Paso Collaborative for Academic Excellence, a city-wide effort to improve the academic achievement of El Pasoans. Prior to the Collaborative, Dr. Navarro served as National Director of Research and Policy Analysis of the Mexican American Legal Defense and Education Fund and Executive Director of the Achievement Council. She graduated from the University of Texas–El Paso with a degree in political science and she continued her graduate studies at Sanford University, where she ultimately earned her Ph.D. in educational psychology.
- **Dr. Joan Ferrini-Mundy (Fer-RINI-Mun-dy), lead researcher for the comprehensive MSP grant at Michigan State University.** Dr. Ferrini-

Mundy is Associate Dean for Science and Math Education in the College of Natural Science at Michigan State University, where she is also a Professor of Mathematics and Teacher Education. Prior to joining Michigan State, Dr. Ferrini-Mundy co-founded the SummerMath Program for Teachers at Mount Holyoke College and she has been the principal investigator of several research and teacher education grants. She also has served as a Visiting Scientists at NSF's Teacher Enhancement Program and as Director of the Mathematical Sciences Education Board at the National Research Council.

3. Overarching Questions

The hearing will address the following overarching questions:

- How will awardees ensure that participants—mathematicians, scientists and engineers from higher education as well as K–12 teachers and administrators—are active in the program, drawing on the expertise of all partners? What role, if any, will businesses or non-profit organizations play in the partnership?
- How will awardees provide meaningful, high quality training for pre-service and in-service teachers? How will this close the gap between the research findings on the way students learn and actual classroom practice? How will improvements in teacher content knowledge and pedagogy be assessed?
- How will reform efforts align with each State's challenging math and science standards and accountability measures? What sort of in-depth, quantitative evaluation will be conducted? And how will the results be disseminated?
- Are the awards a sufficient size to develop and test new education reform models? How will the partnerships coordinate with State educational agencies to foster and sustain the reform effort after the award period expires?

4. Brief Overview

- For decades, educators and policy-makers have seen statistics that demonstrate a lackluster performance of U.S. students in math and science. Results from the National Assessment of Educational Progress show that a majority of U.S. students score below "proficient" in math and science, and the Third International Math and Science Study highlight our problems relative to other countries (see below).
- In response, Congress enacted two bills—the *National Science Foundation Authorization Act of 2002* and the *No Child Left Behind Act of 2001*—and created Math and Science Partnership Programs at the Department of Education and the National Science Foundation.
- These partnerships were to work together, with the National Science Foundation supporting model programs that create partnerships between the departments of math, science and engineering at colleges and universities with school districts to improve math and science proficiency for K–12 math and science teachers and students. The Department of Education was tasked with bringing the reform efforts to scale with grants to States and school districts.
- The annual authorization for the Department of Education partnership program is $450 million for Fiscal Year (FY) 2002 and such sums for the next five fiscal years. The FY 2002 appropriation was $12.5, but the FY 2003 appropriation grew to $100.3 million. The authorization for the National Science Foundation partnership program is $200 million for FY 2003, $300 million for FY 2004, and $400 million for FY 2005. The FY 2002 appropriation was $150 million and the FY 2003 appropriation was $127.5 million. The President has requested $12.5 million and $200 million in FY 2004 for the Department of Education and National Science Foundation partnership programs respectively.

5. Background

As part of the *National Science Foundation Authorization Act of 2002* (P.L. 107–368), the Congress established the Math and Science Partnership Program in response to President Bush's challenge to leave no child behind in education. Underlying this effort was data that showed that U.S. eighth and twelfth graders did not do well either by our own measurements or by international standards.

Student Achievement in Math and Science

The most recent results of the National Assessment of Educational Progress (NAEP) show that the trend for student achievement is generally up over the last 30 years, yet large numbers of U.S. students demonstrate a mastery of only rudi-

mentary mathematics. In fact, 31 percent of 4th graders, 34 percent of 8th graders and 35 percent of 12th graders scored below "basic." Students in the basic category cannot demonstrate even partial mastery of the material that is appropriate for their age group, with, for instance, few 4th graders even knowing how many fourths make up a whole.

These low levels of achievement are more likely among minority groups and among children from low-income backgrounds. In the 2000 NAEP, 68 percent of African American 8th graders scored below basic in math compared to 23 percent of white students. And the achievement gap in NAEP math scores between white and black students and between white and Hispanic students has remained relatively unchanged since 1990.

On the Third International Mathematics and Science Study (TIMSS), an assessment that evaluates the math and science performance of 4th, 8th and 12th grade students from 42 different countries, U.S. performance relative to other nations declined with increased schooling. While U.S. children scored above average in elementary school, those in 12th grade—including our most advanced students—ranked among the lowest of all participating countries, outperformed by nearly every industrialized nation and ahead of only Cyprus and South Africa.

These scores are disappointing and the reasons for them are complex. Yet one thing is certain—U.S. students are not getting a math and science education that will allow them to learn to their greatest ability. And their lessons neither engage nor challenge them. As a result, unacceptably low numbers of students are motivated to enroll in physics or chemistry and only 20–25 percent of graduating high school seniors have completed enough mathematics to be ready to study science or engineering. Because students who require remedial education are less likely to consider majors that require prerequisite classes in math, such as those in the physical, engineering and computer sciences, lack of preparation at the high school level clearly plays a role in many students' decisions to choose a major other than those in science, mathematics, engineering or technology. It is therefore no surprise that science and engineering degrees as a percentage of the population of 24 year olds have remained virtually constant at 5–6 percent. Within this group, women and minorities are seriously under-represented.

Legislation

Raising student achievement is the focus of No Child Left Behind, an initiative by President Bush to fundamentally reform K–12 education. As part of this five-year effort, Math and Science Partnerships Programs seek to unite the activities of higher education, school systems and business in support of improved math and science proficiency for K–12 students and teachers. This is in large part a response to national concerns regarding too many teachers teaching out of field, too few students taking advanced course work and too few schools offering challenging curricula.

Ultimately, two programs were created. The first established a competitive, merit-based grant program at the National Science Foundation (NSF), as part of the *NSF Authorization Act of 2002* (P.L. 107–368). As enacted, this program would award grants to partnerships between institutions of higher education and one or more school districts to improve math and science education. Funds would be used to develop innovative reform programs that, if proven successful, would be the key to large-scale reform at the State level. The second was housed at the Department of Education and was created by the *No Child Left Behind Act of 2001* (P.L. 107–110).

Although similarly titled, the programs were created to be complementary to—not duplicative of—each other. Specifically, NSF was to fund innovative programs to develop and test new models of education reform, thereby remedying a lack of knowledge about math and science research, while the Department of Education would broadly implement and disseminate new teaching materials, curricula and training programs. In so doing, the Education Secretary was required to consult and coordinate with the NSF Director.

NSF's Math and Science Partnership Program

NSF's Math and Science Partnership (MSP) Program competitively awards grants to institutions of higher education, or other eligible nonprofits, and their partners—one or more school districts—to improve K–12 math and science education. In particular, the MSP Program must have the active participation of a math, science, or engineering department (as opposed to the education department) at the college or university, and the collaborations must be well-grounded in sound educational practices. Funds are required to be used for activities that improve K–12 math and science education, consistent with State standards, which may include:

- recruiting and preparing students for careers in K–12 math and science teaching,

- offering professional development for math and science teachers;
- offering pre-service and in-service programs to help math and science teachers use technology more effectively;
- developing distance learning for teachers and students;
- developing a cadre of master teachers;
- offering teacher preparation and certification programs for people who want to switch careers and begin teaching;
- developing tools to evaluate MSP activities;
- developing/adapting K–12 math and science curricular materials that incorporate contemporary research on the science of learning;
- developing initiatives to increase and sustain the number, quality and diversity of pre-K–12 teachers of math and science, particularly in under-served areas;
- using professionals to help recruit and train math and science teachers;
- developing or offering enrichment programs for students;
- providing research opportunities for students and teachers; and
- bringing scientists, engineers and other professionals to the classroom.

NSF supports two types of partnerships—Comprehensive and Targeted. Comprehensive projects are funded for a five-year period for up to $7 million annually, depending on the scope of the project. These projects are intended to implement change in mathematics and/or science education practices in both institutions of higher education and in schools and school districts to result in improved student achievement across the K–12 continuum. Targeted projects focus on improved K–12 student achievement in a narrower grade range or a disciplinary focus in mathematics and/or science and are funded for up to $2.5 million a year for up to five years. In addition, the MSP Program funds Research, Evaluation and Technical Assistance (RETA) projects, which provide large-scale research and evaluation capacity and assist Comprehensive and Targeted awardees in the implementation and evaluation of their work.

The first competitions for MSP were held in FY 2002, for which $160 million was appropriated, and resulted in seven Comprehensive awards, 17 Targeted awards and 12 RETA awards. More recently, on October 2, NSF announced the award of $216.3 million in funding for the second year of the MSP Program, with five Comprehensive awards, seven Targeted awards, and 10 RETA awards.

Education

The MSP Program at the Department of Education, which is authorized by Title II, Part B of the No Child Left Behind Act, requires partnerships to include a State educational agency, the engineering, math, or science department of an institution of higher education and a high-need school district. Partners are required to use their grants for one or more specific activities. Among them are the following:

- professional development to improve math and science teachers' subject knowledge;
- activities to promote strong teaching skills;
- math and science summer workshops;
- recruitment of math, science or engineering majors to teaching through signing and performance incentives;
- stipends for alternative certification and scholarships for advanced course work;
- development or redesign of more rigorous standards aligned math and science curricula;
- distance learning programs for math and science teachers; and
- opportunities for math and science teachers to have contact with working mathematicians, scientists and engineers.

Unlike the NSF program, where funds are awarded competitively, the MSP Program at the Department of Education turns into a formula program to States when the amount appropriated exceeds $100 million. In FY 2002, $12.5 million was appropriated for this program, but, in FY 2003, the appropriations hit the trigger ($100.3 million) and the funds were allocated to the States by the program's need-based formula.

6. Award Abstracts on the MSPs run by Hearing Witnesses (verbatim, as provided to NSF)

Promoting Rigorous Outcomes in Mathematics/Science Education (PROM/SE)—(Michigan State)

Award Number: 0314866

Start Date: September 1, 2003

Expires: August 31, 2008 (Estimated)

Expected Total Amount: $35,000,000.00 (Estimated)

Investigator: Joan Ferrini—jferrini@msu.edu (Principal Investigator)

Sponsor: Michigan State University, East Lansing, MI 48824

NSF Program: MSP—Comprehensive Awards

Promoting Rigorous Outcomes in Mathematics and Science Education (PROM/SE) is a five-year effort by a joint partnership between Michigan State University (MSU) and five consortia of school districts in Michigan and Ohio. The consortia includes three Intermediate School Districts in Michigan, Ingham, Calhoun, and St. Clair County, and two consortia in Ohio, the High AIMS Consortium and the SMART Consortium. The sixty-nine districts represent the broad range of social, economic, and cultural characteristics found in the United States as a whole being situated in large urban cities (Cleveland and Cincinnati) and their suburbs, in medium size cities with large minority populations such as Lansing, and in very rural areas such as those in St. Clair and Calhoun Counties.

The Partnership utilizes a unique combination of research and practice. Detailed data from all students and teachers using instruments from the Third International Mathematics and Science Study (TIMMS) is gathered. On the basis of these data Action Teams of mathematicians, scientists, teacher educators and K–12 personnel collaborate to develop more focused and challenging content standards, align standards with instructional materials and improve mathematics and science teaching. Evidence-based and content focused professional development improves the subject matter knowledge of over 4,500 teachers of mathematics and science. Associates for mathematics and for science are fully prepared and engaged in the complex work of helping undertake substantial reform in all 715 schools. The mathematics and science opportunities for approximately 400,000 students improve and tracking disappears in all schools by 2006.

Eight hundred pre-service students participate and MSU reforms the preparation of future teachers through revision of pre-service education courses and programs. Partner sites mirror the diversity of the Nation as a whole and the prototype is exportable and replicable on a larger scale.

El Paso Math and Science Partnership

Award Number: 0227124

Start Date: October 1, 2002

Expires: September 30, 2007 (Estimated)

Expected Total Amount: $29,319,178 (Estimated)

Investigator: Susana Navarro—navarro@utep.edu (Principal Investigator)

Sponsor: U. of Texas–El Paso, University Ave. at Hawthorne, El Paso, TX 79968

NSF Program: MSP—Comprehensive Awards

The El Paso Math and Science Partnership (El Paso MSP) includes the three urban school districts that encompass El Paso, nine rural school districts in El Paso and Hudspeth counties, the University of Texas at El Paso (UTEP), El Paso Community College, the Region 19 Education Service Center, and El Paso area civic, business and community organizations and leaders.

The El Paso MSP is aimed at improving student achievement in mathematics and science among all students, at all pre-K–12 levels, and at reducing the achievement gap among groups of students. The goals of the partnership include:

- fully engaging university and community college leadership and mathematics, science, engineering and education faculty in working toward significantly improved K–12 math/science student achievement;

- ensuring the number, quality and diversity of K–12 teachers of mathematics and science across partner schools, particularly schools with the greatest needs;
- building the capacity of area districts and schools to provide the highest quality curriculum, instruction and assessment, and to ensure the highest level achievement in mathematics and science for every student;
- ensuring the K–16 alignment of mathematics and science curriculum, instruction and assessment, to ensure that students graduating from area high schools are prepared to enroll and be successful in mathematics, science and engineering courses at UTEP and El Paso Community College; and prioritizing research on educational reform and pre-K–16 partnerships.

SUNY–Brockport College and Rochester City (SCOLLARCITY) Math and Science Partnership: Integrative Technology Tools for Pre-service and Inservice Teacher Education

Award Number: 0226962

Start Date: January 1, 2003

Expires: December 31, 2007 (Estimated)

Expected Total Amount: $3,385,448 (Estimated)

Investigator: Osman Yasar (Principal Investigator)

Sponsor: SUNY–Brockport, Brockport, NY 14420

NSF Program: MSP—Targeted Awards

Abstract

The project is proposed by a partnership between SUNY–Brockport, Rochester City School District (RCSD) third largest in New York State with the lowest achievement scores and Brighton Central School District (BCSD) with similar gaps among under-represented groups yet with one of the highest overall achievement rates in the State. Additional partners are the Shodor Foundation and The Krell Institute. The primary goal for the partnership is to improve student outcomes in mathematics and science in grades 7–12 by creating a multi-agency approach for the recruitment and professional development of mathematics and science teachers. A Computational Mathematics Science and Technology (CMST) approach to learning science is employed in which students and teacher are engaged in fieldwork, laboratory experiments, mathematical modeling, computer simulation and visualization.

CMST employs math models to describe physical phenomena therefore bringing a new perspective about the usefulness of math as a tool in real life. The method is designed to make science and mathematics concepts more easily comprehensible. A Challenge program incorporating CMST is providing tools and motivation for 200, grades 7–12 students, under the supervision of participating teachers. The approach in addition to teaching science concepts is designed to promote teamwork, collaboration and new strategies for problem solving. A component of the comprehensive professional development program for mathematics and science teachers is a four-week summer institute each year serving a total of 240 teachers. In addition there is a Master's degree program for 30 teachers. Pre-service education programs at SUNY–Brockport are being revised and new courses are to be introduced to assure an improvement in the quality quantity and diversity of the new teacher workforce.

7. Questions for Witnesses

Dr. Yasar

- How will you ensure that participants—mathematicians, scientists and engineers from higher education as well as K–12 teachers and administrators—remain active in the program? What role, if any, will the Shodor Foundation and the Krell Institute play in the partnership and in continuing the reforms after the award period expires?
- What type of professional development will your partnership provide? How will you accommodate the unique professional development needs of individual schools, especially since they vary widely in terms of student achievement? How will improvements in teacher content knowledge and pedagogy be assessed?
- Is your award a sufficient size to develop and test your education reform model and achieve your partnership goals?

- What sort of in-depth, quantitative evaluation will be conducted? And how will the results of this evaluation be disseminated?

Dr. Ferrini-Mundy

- How will you ensure that participants—mathematicians, scientists and engineers from higher education as well as K–12 teachers and administrators—remain active in the program? How will you tailor your program to the unique needs of the sixty-nine participating school districts?
- What type of professional development will your partnership provide for pre-service and in-service teachers? How will you engage the nearly 4,500 teachers of math and science, all at different levels of ability and knowledge, in your reform efforts? How will improvements in teacher content knowledge and pedagogy be assessed?
- Is your award a sufficient size to develop and test your education reform models and achieve your partnership goals? How will the partnerships coordinate with State educational agencies to foster and sustain the reform effort after the award period expires?

Dr. Navarro

- How will you ensure that participants—mathematicians, scientists and engineers from higher education as well as K–12 teachers and administrators—remain active in the program? What role, if any, will businesses and non-profit organizations play in the partnership?
- What type of professional development will your partnership provide for pre-service and in-service teachers? How will improvements in teacher content knowledge and pedagogy be assessed?
- Is your award a sufficient size to develop and test your education reform models and achieve your partnership goals? How will the partnerships coordinate with State educational agencies to foster and sustain the reform effort after the award period expires?

Mr. Chi and Mr. Mikols

- How has the SUNY–Brockport MSP Project helped teachers and administrators understand and embrace the need to teach to high quality, standards-based math and science? Based on what you know—and have experienced to date—are the participating schools getting closer to providing high quality math and science education for all students?
- How have the professional development opportunities provided by the MSP Project been different from other teacher training programs in terms of content, duration and intensity?
- What do you believe is the greatest barrier to bringing the latest and best research on math and science education into the classroom? Based on what you know, is teacher practice in the classroom changing?
- Based on your experience, how do we recruit and retain the best math and science teachers? How has the MSP Project addressed—or failed to address—these issues?

Chairman SMITH. The Subcommittee on Research will come to order. I want to welcome everybody here today. I apologize for the delay in the starting time.

As a farmer, I use the analogy that our meeting today is a little bit about protecting our seed corn. What we are after, especially in this post-9/11 era, is a situation where we are going to have to be a little less dependent on students from other countries coming into our university systems to do our research. NSF reports that almost half of our research is still being done by foreign students who, through new regulations, are now under a little greater pressure to leave our country after they finish their postgraduate or graduate work.

Last year, during the consideration of legislation to authorize the Math and Science Partnership Program, I asked our witnesses to consider the following question: if education, especially in the early years, is more the lighting of a fire, an interest, rather than filling a container with knowledge, when is the fire lit? And several of the witnesses said probably between four years old and six or seven years old. To get that kind of an interest early on and then the follow-up question, of course, is how do you kindle that fire to keep it going through the rest of high school and through college?

The results from the most recent Third International Math and Science Study, the TIMSS study, as well as evidence all around us, demonstrate, I think in very stark terms, the need to improve math and science achievement for all students. Our witnesses today are experts in that area. We look forward to your suggestions and ideas as we move ahead, and the situation is that while U.S. students are nearly first in the world in science, and above the international average in mathematics in grade four, this leadership or predominance is short-lived. In fact, the longer U.S. students are in school, the farther they fall behind. By twelfth grade, U.S. students rank among the lowest of all participating countries, and ahead of only two countries, Cyprus and South Africa.

In response to this data, President Bush proposed the Math and Science Partnership. We moved ahead legislatively to put that into action. We have had it for the fiscal years '02 and '03. Now, we are moving into '04. Through its awardees, the Math and Science Partnership Program also seeks to address, in a comprehensive manner, the weaknesses in U.S. math and science education. While recognizing that there is no one factor that makes all the difference, we do know that kids can't learn what their teachers don't truly understand. We also know that too many standards lack the necessary academic rigor, or they maybe exist in name only, having not yet been linked with assessments and professional development and curricula and classroom practice.

Our goal here today is not to, I think, point a finger of blame at anybody. Our goal is to join the search for solutions and to underscore two fundamental truths: that all children can learn, and that no child should be denied the math and science spark that is so important in our new technological age.

Today, I am especially pleased to welcome true experts in education reform, teachers and educators and implementers of our new Math and Science Partnership Program, and as you can imagine, my colleagues and I spend a lot of time talking about you, but per-

haps too little time listening to you. It is such an important endeavor, and so crucial to the economic success of the United States.

As we look at other countries that are copying our ways of producing, trying to be as efficient as we are, what is going to keep us at the cutting edge, it would seem to me, is the math and the science and the evolving research of developing new products that people want to buy, and developing the kind of methods to produce those products that allow us to be efficient and competitive with, ultimately, the price we sell the product for.

In conclusion, let me thank you again for being here, and before we get to our witnesses, I would call on Representative Eddie Bernice Johnson. She took us down to Texas last year to study a similar situation of how we do a better job moving ahead in math and science, so Representative.

[The prepared statement of Chairman Smith follows:]

PREPARED STATEMENT OF CHAIRMAN NICK SMITH

I want to welcome everyone here for what I hope will be a series of hearings on the Math and Science Partnership Program and the implementation of the *National Science Foundation Authorization Act of 2002* generally.

Last year, during the consideration of legislation to authorize the Math and Science Partnership Program, I asked our witnesses to consider the following question: if education is more the lighting of a fire than the filling of a container, when is that fire lit for math and science and what keeps it burning?

They all had different answers. Some said third grade. Others said kindergarten. And still others said pre-school. Yet they all agreed that our greatest failure—and our greatest challenge—was that too many children failed to experience the spark at all. As a result, too few pursued math and science education.

Results from the most recent Third International Math and Science Study (TIMSS)—as well as evidence all around us—demonstrate in stark terms the need to improve math and science achievement for all students. While U.S. students are nearly first in the world in science and above the international average in mathematics in grade four, this predominance is short-lived. In fact, the longer U.S. students are in school, the farther they fall. By 12th grade, U.S. students rank among the lowest of all participating countries and ahead of only Cyprus and South Africa.

In response to this data, President Bush proposed the Math and Science Partnership Program as part of his comprehensive No Child Left Behind reform initiative. This program was created to support partnerships between colleges and universities and elementary and secondary schools but it also sought to challenge long held practices and to support innovative projects in math and science.

Through its awardees, the Math and Science Partnership Program also seeks to address in a comprehensive manner the weaknesses in U.S. math and science education. While recognizing that there is no one factor that makes all the difference, we do know that kids can't learn what their teachers don't truly understand. We also know that too many standards lack the necessary academic rigor or they exist in name only, having not yet been linked with assessments, professional development, curricula, and classroom practice.

Yet, our goal here today is not to point the finger of blame. Our goal is to join in the search for solutions and to underscore two fundamental truths—that all children can learn and that no child should be denied the math and science spark that will carry them through their formal education and into the world of work.

Today, I am especially pleased to welcome true experts in education reform—teachers and education researchers. As you can imagine, my colleagues and I spend a lot of time talking about you, but perhaps too little time listening to you. So it is indeed a great honor to have you here to explain how you are using the Math and Science Partnership funds to light the spark of interest and improve the achievement of all students.

I would also be interested to know how we can encourage even more businesses and private organizations—perhaps through recognition or awards—to join in these partnerships and help extend our reach to more students and teachers. I know I speak for the entire subcommittee when I say that we look forward to your testimony.

In just a moment, I will proceed with introductions but I will first recognize Ranking Member Johnson for whatever statement she may wish to make.

Ms. JOHNSON. Thank you very much. Mr. Chairman, I am pleased to join you in welcoming our witnesses today to this initial hearing on the implementation of the National Science Foundation's Math and Science Partnership Program. I especially would like to thank Dr. Susana Navarro, who is leading the El Paso Math and Science Partnership, for appearing today. Her project involves several urban and rural school districts, and has an important goal of working to reduce the achievement gap often seen by disadvantaged students.

During the last Congress, the Science Committee examined in some depth the question of how to improve science, math and technology education for all students in the Nation's schools. We looked at such issues, at improving teacher training and professional development, developing more effective curriculum, making use of education technologies and stimulating greater student interest in science.

The Committee's inquiries led to legislation whose centerpiece was the Math and Science Partnership Program. I had been trying to pass it for years. The program—I was the wrong party—the program was subsequently enacted as part of the National Science Foundation Authorization Act last year.

The key components of the partnerships program, in my view, are to obtain a serious commitment of time and effort from science, math and engineering faculty at the participating institutions, to institute changes at all the participating institutions that will lead to lasting educational improvement and to assure that the program has built-in and effective mechanisms to assess program outcomes.

Today, we will hear from some awardees from the Math and Science Partnership Program. I hope we will learn how they form their partnerships and get a sense of the level and engagement of the participants from academia and the schools. I am also interested in the kinds of educational activities that the partnerships will focus on, and to what extent they are guided by research findings on human development and learning.

While I am pleased to see that a few minority serving institutions have been able to participate as partners in the Math and Science Programs, three historically black universities, Tuskegee, Fayetteville State and Lincoln University, the Northwest Indian College and the University of Puerto Rico, which are not African-American, of course, I am quite disappointed that no minority serving institutions have been granted an award as a lead partner, and this is particularly disturbing, considering the roles of HBCUs and other minority serving institutions play among institutions of higher education to increase this nation's supply of math and science teachers in the minority communities.

Finally, I would like to welcome any recommendations from the panel on ways to strengthen the National Science Foundation's partnerships program, including any suggestions for improving the administration of the program.

Again, Mr. Chairman, I want to thank you for calling this hearing and thank our witnesses for appearing before the Subcommittee today, and I look forward to discussion. If there is any-

one in the house from the number one science and engineering high school in the country, which is in my district, I would like to acknowledge them. Thank you.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Mr. Chairman, I am pleased to join you in welcoming our witnesses today to this initial hearing on the implementation of the National Science Foundation's Math and Science Partnership Program.

I especially would like to thank Dr. Susana Navarro, who is leading the El Paso Math and Science Partnership, for appearing today. Her project involves several urban and rural school districts and has an important goal of working to reduce the achievement gap often seen for disadvantaged students.

During the last Congress, the Science Committee examined at some depth the question of how to improve science, math and technology education for all students in the Nation's schools. We looked at such issues as improving teacher training and professional development, developing more effective curriculum, making use of educational technologies, and stimulating greater student interest in science.

The Committee's inquiries led to legislation whose centerpiece was the Math and Science Partnerships Program. The Program was subsequently enacted as part of the NSF Authorization Act last year.

The key components of the partnerships program, in my view, are to obtain a serious commitment of time and effort from science, math and engineering faculty at the participating institutions, to institute changes at all of the participating institutions that will lead to lasting educational improvements, and to assure that the program has built-in and effective mechanisms to assess program outcomes.

Today, we will hear from some awardees from the Math and Science Partnership Program. I hope we will learn how they formed their partnerships and get a sense of the level of engagement of the participants from academia and the schools. I am also interested in the kinds of educational activities the partnerships will focus on and to what extent they are guided by research findings on human development and learning.

While I am pleased to see that a few Minority Serving Institutions (MSIs) have been able to participate as partners in the Math and Science Program (three Historically Black Universities, Tuskegee, Fayetteville State and Lincoln Universities, Northwest Indian College and the University of Puerto Rico), I am quite disappointed that no MSIs has been granted an award as a Lead Partner. This is particularly disturbing considering the roles HBCUs and other MSIs play among institutions of higher education in increasing this nation's supply of math and science teachers in our minority communities.

Finally, I would welcome any recommendations from the panel on ways to strengthen the NSF partnerships program, including any suggestions for improvements in the administration of the program.

Mr. Chairman, I want to thank you for calling this hearing and thank our witnesses for appearing before the Subcommittee today. I look forward to our discussion.

The prepared statement of Ms. Jackson Lee follows:]

PREPARED STATEMENT OF REPRESENTATIVE SHEILA JACKSON LEE

Mr. Chairman,

Thank you for calling this important hearing on the National Science Foundation's Math and Science Partnership (MSP). Every program we design here in the Science Committee, every initiative we fund at NASA or at the DOE or elsewhere, will be critically dependent on having qualified scientists and engineers to fill the tech jobs of the future. All of our great plans could be pipe dreams if we don't make the appropriate investment in our children. That investment could pay huge dividends in the future, if we help give kids the skills in math and science that will place them on the cutting edge in their careers to come.

Unfortunately, we have not been making the right investments, and it shows. For decades, American children have been performing poorly in science and math when compared to their international counterparts, or when measured against American standards. Across the board, about one third of kids cannot even score the "basic" level on standardized tests. It seems that a large proportion of our children *are*

being left behind. Those children from low-income families, or minority groups are especially at risk.

This poor performance does not bode well for the future of our scientific endeavors or our high-tech economy. That is why the Congress moved in 2002 to establish the MSP in the NSF Authorization Act of 2002. The program will provide grants to enable collaborative efforts amongst schools, universities, colleges, and the private sector to improve the experiences of K–12 children in science and math. This program is meant to compliment the *No Child Left Behind Act of 2001.*

Now that we have had a year or so to let this program work, I think it is an excellent time to get some input on how things are going at the ground level. Unfortunately, the Congress has not yet fully funded these programs. In fact, for FY 2003, MSP was funded at a level just a bit more than half of its authorized level. So, it probably has not yet had much of an effect. However, hopefully we can get some indications of challenges and pitfalls from the field that will enable us to tune the program, or maybe motivate appropriators to fund this program fully in the future.

I thank the panelists for taking the time out of their busy schedules to share their experiences with us today. I especially welcome the teachers. Your classrooms are where the rubber hits the road. I look forward to your testimony.

Thank you.

Chairman SMITH. Thank you, and just a moment. Allow me to introduce our great witnesses today.

Dr. Ferrini-Mundy is the lead researcher for the Comprehensive MSP grant at Michigan State University. Dr. Ferrini-Mundy is Associate Dean for Science and Math Education in the College of Natural Science at Michigan State University, where she is also a professor of mathematics and teacher of education. Prior to joining Michigan State, Dr. Ferrini-Mundy co-founded the SummerMath Program for Teachers at Mount Holyoke College and she has been the principal investigator of several research and teacher education grants, both at Michigan State University and the University of New Hampshire. She also has served as a visiting scientist at NSF's Teacher Enhancement Program.

Dr. Osman Yasar is lead researcher for the Targeted MSP award at the State University of New York at the SUNY–Brockport. Dr. Yasar is a professor and Chair of the Computational Science Department at SUNY College at Brockport. He established the first undergraduate program in computational science in the United States and prior to SUNY, he was a staff scientist at the Center for Computational Sciences at the Oak Ridge National Laboratory.

Mr. Ed Chi, science teacher at Brighton School District in New York. Mr. Chi teaches science to seventh and eighth grade students at Twelve Corners Middle School in Rochester, New York. Twelve Corners Middle School is the sole institution educating students in grades six to eight in the Brighton School District, so we will look forward to a person on the ground on your suggestions of dealing with students.

Mr. Jeffrey Mikols is a math teacher, Rochester City School District in New York. Mr. Mikols has been a teacher with the Rochester School District since 1993, and he has taught courses ranging from pre-algebra to AP calculus. Currently, Mr. Mikols is the secondary mathematics lead teacher, which makes him responsible for providing professional development to other secondary school math teachers, and Mr. Mikols received his B.A. in mathematics and master of science in mathematics education from SUNY in Geneseo and—is that right, Geneseo?

Mr. CHI. Geneseo.

Chairman SMITH. Geneseo. And he is currently enrolled in the certificate for advanced study in the school administration.

Dr. Susan Navarro, lead researcher for the Comprehensive MSP award at the University of Texas at El Paso. Dr. Navarro is the founder and head of the El Paso Collaborative for Academic Excellence, a city-wide effort to improve the academic achievement of El Paso students. Dr. Navarro has served as National Director of Research and Policy Analysis of the Mexican-American Legal Defense and Educational Fund, and Dr. Navarro, we appreciate you being here. You also graduated from the University of Texas in El Paso with a degree in political science. And again, thank you all for being here and for sharing some of your thoughts with us, and Dr. Yasar, we are asking you to proceed with your first testimony.

STATEMENT OF DR. OSMAN YASAR, PRINCIPAL INVESTIGATOR FOR THE TARGETED MSP GRANT AT SUNY–BROCKPORT

Dr. YASAR. Mr. Chairman, distinguished Members of the Committee, I am honored to be here. Thank you for inviting me. I was born in Turkey, so I went through a different public school system. I came here for a graduate education, and several things that—bring me into this project, certainly one is that I have a child in the school system at Brighton, 13 years old, whose interest in science may be slipping away, so I am really interested in helping her school and herself.

Another effort that I have been involved with is, as you said, in the Department of Computational Science, one of a kind in the country. This is a unique way of approaching mathematics, science and computing, in an integrated way. We have great results at the college level, and the idea of taking that to K–12 to raise the interest of students was very interesting, and I thank the NSF and the review panels for allowing us this opportunity to work on this.

I might report right away that our project has been very successful in terms of creating enthusiasm in teachers and students. I am sure you will be hearing from Mr. Mikols and Mr. Chi about their experience. This project involves SUNY College and two school districts, an urban school district and a suburban school district. This is a pretty common pattern in the country. Rochester, with 35,000 students and Brighton, with 3,000 students.

Rochester has been experiencing very low achievement rates, as low as 11 percent in eighth grade mathematics, so there is a definite need there. Brighton's role here is not only to benefit from our unique methodology, using technology, but also to give to the partnership through its experience and so on.

We also have two national organizations, Shodor Education Foundation and Krell Institute. I have colored them on my presentation. Their role is to bring to us their experience from the national level, as well as help us disseminate the result.

Texas Instruments is part of this partnership. We use their specialists, training specialists. The Xerox Corporation's role is to offer internships to our students, both in high school and at the college level, and then to disseminate our results in the local community, we work with the Monroe County School Boards Association and New York State Education Department. We have partnered with

another NSF MSP project, the Council of Chief State Schools Officers, to use their evaluation instrumentation.

And now, recently, we have been invited to work with another partnership program under NSF named PACI (Partnerships for Advanced Computational Infrastructure). I believe this is also reviewed under this committee.

Mr. Chairman, this partnership project is not only partnership in school districts and colleges. Certainly, the goal is to improve student achievement and interest, both at the public schools and colleges, and as you may see in other projects in this program, raising quality and quantity of teachers is the key here.

Another partnership that goes on under this umbrella is the partnership of mathematics and science as topics. And this, I believe, is our approach. We have taken an integrated approach to mathematics and science, in a way, to present the mathematics and technology in a context of applications. This, we believe, raises student interest and so on.

Our way to achieve this goal is certainly to offer professional development to teachers and faculty members in the college through training and mentoring, through support, including technology scholarships and stipends, and through team approaches and peer networking.

From students' point of view, teachers with new pedagogies, using technology in an integrated approach, as well as scholarships, is a way that our team has chosen to attack this problem.

In the past year, we held a summer institute that brought together 56 teachers from two school districts, and the training brought together math and science and technology teachers. All of them were subject to the same material. All of them had a chance to work together to see how useful mathematics is in the context of applications and so on. Again, our approach is well documented in the testimony here. We believe this offers a layered approach and inquiry-based approach, some of the things that are very new for a project like ours.

Under professional development, we have an education component and a challenging component to make sure the needs of many schools and individuals are also addressed here. I will be skipping to my last slide here to sum up. The results of our training so far have been evaluated by independent consultants, and 100 percent of teachers have rated this very successful, and they want to come back the next year. This is an ongoing training and education opportunity for teachers as well as students. We are very hopeful that the dissemination of this project and the lessons learned here will help others in the country as well.

[The prepared statement of Dr. Yasar follows:]

CONGRESSIONAL TESTIMONY

OCTOBER 30, 2003

SUNY Brockport College and Rochester City (SCOLLARCITY) Math and Science Partnership (NSF EHR-0226962)

Principal Investigator: Osman Yasar (Tel/FAX: 585-395-2595/5020)
Independent Evaluator: Linda Reid (Tel: 585-256-2024)

Core Partners:

- **SUNY Brockport (College)**
- **Rochester City School District (RCSD)**
- **Brighton Central School District (BCSD)**

Supporting Partners:

- **Shodor Education Foundation**
- **The Krell Institute**
- **Texas Instruments**
- **Xerox Corporation**
- **Research Foundation of SUNY**
- **Monroe County School Boards Association**
- **The Council of Chief State Schools Officers**

I. PARTICIPANTS

SUNY Brockport College:
Dr. Osman Ya ar- Principal Inve tigator and Chair of the Computational Science Dept.
Dr. Timothy J. Flanagan- Provo t and Vice Pre ident of Academic Affair
Sue Baroca - Project Coordinator
Amanda Duncan- Project Secretary
Gerry Moon- Technology Speciali t
Dr. Leigh Little- Faculty and Work hop Coordinator at Computational Science Dept.
Dr. Robert Tuzun- Faculty and Scholar hip Coordinator at Computational Science Dept.
Dr. K. Raj- Faculty and Recruitment Coordinator at Computer Science Department
Dr. Jo e Maliekal- Faculty and Technology Coordinator at Earth Science Department
Dr. Mark Heitz- Faculty and Indu try Coordinator at Chemi try Department
Dr. Mohammed Tahar- Faculty and Challenge Coordinator at Phy ic Department
Dr. Dawn Jone - Faculty and Web Coordinator at Mathematic Department
Dr. Peter Verone i- Faculty and Internal Evaluator at Education Department
Dr. Bet y Balzano- NCATE Accreditation Coordinator at Education Department
Dr. Richard Mancu o- Faculty and Chairper on of Phy ic Department
Dr. Tom Kallen- Faculty Chairper on of Chemi try Department
Dr. Charle Sommer- Faculty Chairper on of Mathematic Department
Debra Dilker – Secretary at Computational Science Department
Dr. Michael Fox, Vice Provo t, Co-Chair of the Strategic Plan
Dr. Su an Stite -Doe – Dean of Graduate School
Dr. Stuart Appelle, Dean, School of Letter and Science
Dr. Michael Maggiotto, Former Dean of School of Letter and Science
Julian Ortiz – Admi ion Speciali t, Graduate School
Bernie Valento – Director of Undergraduate Admi ion
Adrienne Collier – Affirmative Action Office
Dr. Kenneth O' Brien – Faculty Senate Pre ident
Peter Dowe, Jenice Stewart – Regi tration and Record
Nick Ma cari – Media Relation (New Relea e)
Terry Baker, Mark Gardner - Brockport Auxiliary Service Corporation (catering event)
Brian Volkmar, Anne Par on , Mary Jo Orzech – Information Technology Service

Teacher Candidate (Undergraduate Student):
Laura Merkl, Davi Joki, Scott Koch, Gerald Moon, Chri tina Ol ow ky
Teacher Candidate (Graduate Student): Maria Roman

Research Foundation of SUNY
Sylvia Tortora, Sandy Mo her, Laura Merkl – College at Brockport
Dr. Guven Yalcinta , Vice Pre ident, Technology Tran fer – Headquarter at Albany

SUNY Central Administration
Kate Van Arnam, A i tant Vice Provo t, Program Review and Planning, SUNY, Albany

Rochester City School District (RCSD):
Dr. Manual Rivera - Superintendent
Michael Robinson and David Silver- Deputy Superintendents
Margaret Crowley-Director of Mathematics Instruction, Co-Director of CMST Institute
Tim Cliby-Managing Director of Instructional Technology
Dr. Paul Helberg – Technology Specialist and Consultant
Rebecca Boyle – Mentoring Coordinator
Jeff Mikols-Lead Teacher for Secondary Mathematics, CMST Project Coordinator at RCSD
Mike Christmen, Andy MacGowan, Nicole Crocker - Research Data Collection

School Principals Participating from RCSD:
High Schools:
Marilynn Patterson-Grant (Wilson Magnet School)
Kathleen Lamb (East High School)
Kim Dyce (Franklin High School)
Dan Drmacich (School Without Walls, SWW)
Clinton Strickland (Edison Tech)
Jerome Watts (Lofton Academy)
High School and Middle School:
Dominic Bona (School of the Arts, SOTA)
Joseph Munno (Marshall High School)
Middle Schools:
Dr. Andrew Ray (James Madison School of Excellence, JMSE)
Linda Dianetti (Monroe Middle School)
Barbara Hasler (Frederick Douglass Middle School, FDMS)
Deborah Rider (Charlotte Middle School)
Donna Gattelaro-Andersen (Dr. Freddie Thomas Learning Center, FTLC)
Connie Wehner (Nathaniel Rochester Community School, NRCS)
Walter Milton, Jr. (Jefferson Middle School)
Pedro Manerio (Clinton Avenue Learning Center)

Teachers Participating from RCSD in 2003-2004 Academic Year:

First Name	Last Name	Teaching area	School/Grade
Ellery	Palma	Math	Charlotte 7/8
Paula	Coniglio-Gillies	Math	Charlotte 7/8
Margaret	Brazwell	Bio/Gen Science	East High 9-12
Lynn	Panton	Bio/Earth Sci/Gen Sci	East High 10
Steven	Colabufo	Math	East High 9-10
Paul	Geary	Chem/Bio	East High 9-12
Valerie	Huff	Math	East High 9-12
Brian	DiNitto	Math /Technology	East High 9-12
Allison	Leckinger	Math/Spec ed.	East High 9-12

Tanya	Wilson	Math/Spec ed.	Edison Tech 9-12
Jamie	Foos	Special Ed	Edison Tech 9-12
Lisa	Englert	Bio/Chem	FDMS 7/8
Daniel	Esler	Chem/Gen. Science	FDMS 7/8
Kenneth	Schultz	Ind. Arts/ Technology	FDMS 7/8
Tina	Thomas	Math	FDMS 7/8
Julia	Maloney	Science	FDMS 7/8
James	Phillips	Math	Franklin High 9
John	Goodwin	Math	Franklin High 9
Dion	Rahill	Math	Franklin High 9
Chioma	Owunwanne	Math	Franklin High 9/10
Mark	Chomyn	Earth Sci/Bio/Gen Sci	Franklin High 9-11
Uma	Mehta	Bio/Gen Science	Franklin High 9-12
Mary	Davey	Math/Technology	Franklin High 9-12
John	Zoller	Technology	Franklin High 9-12
Caroline	Rodriguez	Biology	Freddie Thomas 7/8
Michael	Baskin	Bus Tech	Freddie Thomas 7/8
Joann	Bell	Math	Freddie Thomas 7/8
Stephanie	Monk-George	Bio/ Gen. Science	JMSE 8
Bruce	Mellen	Math	JMSE 8
Natasha	Bell	Bio/Chem	Josh Lofton 9-12
Jacqueline	McClaney	Business/Technology	Josh Lofton 9-12
Yolanda	Wooten	Math	Josh Lofton 9-12
Tonette	Graham	Math	John Marshall 7/8
Raymond	Yeaton, Jr.	Chem/Bio/Physics	John Marshall 9-12
Colleen	O'Mara	Math	SOTA 8
Margarette	Douyon	Chem/Bio	SOTA 8-12
Jeffrey	Mikols	Math	SOTA 8-12
Karen	McCann	Biology	SWW 9-12
Kenneth	Steffen	Math/ English	SWW 9-12

Rose	Gulley	Math/Technology	Wilson Magnet 9-10
Sounthone	Vattana	Math/Technology	Wilson Magnet 9-11
Moneith	Burney	Special Ed Math	Wilson Magnet 9-11
Lisa	Dennison	Bio/GenSci/Technology	Wilson Magnet 9-12
Vanessa	Youmans	Math/Technology	Wilson Magnet 9-12
Michael	Meise	Math/Technology	Wilson Magnet 9-12
Darcy	Barrant	Math/Technology	Wilson Magnet 9-12
Peggy	Foos	Math/Technology	Wilson Magnet 9-12

Brighton Central School District (BCSD):
Dr. Henry J. Peris - Superintendent
Jeanne Strining -Assistant Superintendent for Instruction
Tom Hall-Vice Principal of Brighton High School, Project Coordinator at Brighton
Steven Whitman, Senior Physics Teacher at Brighton High School

School Principals Participating from BCSD:
Terence M. Quinn (Twelve Corners Middle School, TCMS)
William Maxwell (Brighton High School, BHS)

Teachers Participating from BCSD in 2003-2004 Academic Year:

First Name	Last Name	teaching area	School/grade
Dr. Lakshmi	Rao	Chemistry	BHS 9/11
Kimberle	Ward	Biology	BHS 9-12
Vincent	Vitale	Math	BHS 9-12
Keri	Rouse	Brighton/Math	TCMS 7/8
Jeffrey	McKinney	Brighton/Science	TCMS 7/8
Ed	Chi	Brighton/Science	TCMS 7/8

Brockport Central School District:
Jane Bowdler (High School Math Teacher)
Karthik Rajasethupathy (7th grade student)

Assignment of Faculty Advisors and Coaches to Schools at RCSD and BCSD:

Faculty Advisor	District Coaches	Schools
Sue Barocas	Gerry Moon, Tanya Wilson Natasha Bell, Yolanda Wooten	Edison HS Lofton HS
Robert Tuzun	Ellery Palma Valerie Huff	Charlotte MS East HS
Leigh Little		

	Dan Esler Sounthone Vattana	Douglas MS Wilson Magnet HS
K. Raj	Christina Olsowsky Michael Meise	James Madison MS Wilson Magnet HS
Jose Maliekal	Vincent Vitale Ed Chi, Keri Rouse	Brighton HS Brighton MS
Dawn Jones	John Goodwin, Dion Rahil, Chioma Owunwanne	Franklin HS
Mark Heitz	Michael Baskin, Joann Bell Ken Steffen	Freddie Thomas LC School WW
M. Tahar	Ray Yeaton Steve Colabufo	Marshall HS East HS
Peter Veronesi	Colleen O'Mara	School of the Arts (SOTA)

Shodor Education Foundation: Dr. Garret Love (Instructor), Dr. Robert Panoff (Director)
Krell Institute: Barbara Helland (Technical Consultant, Associate Director)
Texas Instruments: Melody DeRosa (Technical Consultant),
Vince Doty (Training Specialist), Donna Roberts (Training Specialist)
Independent Evaluation Consultant: Linda Reid

The Council of Chief State Schools Officers:
Rolf Blank, Andra Williams, Carlise Greenfield
The American Institute of Research: Kwang Suk Yoon
Wisconsin Center for Education Research: Andy Porter, John Smithson

Other Collaborators and Consultants: Dr. Rubin Landau (Oregon State University), Dr. Greg Moses (Univ. Wisconsin-Madison), Y. Deng (SUNY Stony Brook)

1. Overview

The overall goal is to improve math and science education at partnering institutions in the Rochester area. Our project builds upon a strong partnership between SUNY College at Brockport and two area school districts (Rochester City School Districts (RCSD) and Brighton Central School District (BCSD)). Each partner has different needs, yet recognizes that it needs others as part of the solution. School districts demand better teachers from higher education institutions in order to answer the demand by area colleges for better students. Our project involves: 1) a college that is the largest producer (26%) of all bachelor's degrees in the area, but is facing dramatic decreases in math and science enrollments, 2) an urban school district (RCSD) with a large student population (35,000), a large minority population (84%), achievement rates as low as 11% and gaps as wide as 50 percentage points in state math exams,

and 3) a suburban school district (BCSD) with higher achievement rates (79%) but facing persistent gaps among groups of different socioeconomic status, ethnic, gender, and grade levels. SUNY Brockport will play a central role in promoting a new approach to math and science education, providing better teachers to the Rochester area, and sharing outcomes and findings of this study with other local, regional, and national school districts and colleges. The two school districts with different achievement data and goals can benefit from the college as well as from each other. Outside reviewers of our project believe that this urban-suburban model could result in new lessons for a national implementation.

Our project also builds upon a partnership between math, science, and technology subject areas, departments, and their faculties in each partnering institution. Enabled by computational technology and use of mathematical modeling to solve real-world problems, we are able to implement an integrated approach to math and science education. We have formed a multi-institutional and multi-departmental Institute to coordinate project activities. The Institute is co-managed by the college, RCSD and BCSD; facilitating involvement of key people in all partnering institutions through open decision-making and a shared vision, which played a key role in solidifying the partnership. Using an integrated technology approach to math and science education, SUNY Brockport draws strength from its well-qualified faculty, its unique computational science department (the only in the country), and its strong teacher preparation programs to fix a local problem with national ramifications. Experienced staff at BCSD, Texas Instruments, Shodor Education Foundation, and Krell Institute is also assisting the college. Partnering school districts might adapt proposed technology and instruction at different grades, thus creating a wide perspective and a diverse pool of teachers and students to adopt the proposed integrated approach. We all learn from each other and advance through example and interaction. Shodor and Krell have been an integral part of national development, training, and dissemination efforts. As members of NSF-funded projects, they organized and implemented training sessions for building a national reservoir of secondary math and science teachers to lead the nation in the use of technology in the classrooms. We are taking advantage of their previous experience while using their national stature to disseminate our findings and newly developed materials. Our partnership involves participation of regional and local industry such as Xerox to facilitate internships and industrial perspective for students, teacher candidates, and teachers in our project.

Specific Objectives:

1. To improve student outcomes in math and science at grades 7-12 at RCSD and BCSD through an integrated technology approach to math and science education.
2. To increase retention of high quality math, science, and technology (MST) teachers through professional development (summer workshops, coaching, and certification).
3. To increase the number of students majoring or seeking teacher certifications in MST programs at SUNY Brockport through scholarships and internships.
4. To strengthen relationship with the local industry such as Xerox Corporation through internships to MST students.
5. To foster collaboration with industry such as Texas Instruments through use of new instructional technology.
6. To foster collaboration with national programs and organizations such as Shodor and Krell, through dissemination, building evidence, and sharing results and training materials.

2. CMST Pedagogy

We use an *integrated approach* to math, science, and technology education. This new approach, namely computational (math, science, and technology) or abbreviated as CMST, uses math modeling and computer simulations to aid teaching, learning and studying math and science. The characteristics of the CMST approach include inquiry-based, project-based, and team-based instruction. CMST approach (pedagogy) takes the learner-centered or constructivist approach recommended by the national and state MST standards. There is evidence that technology applications can support higher-order thinking by engaging students in authentic, complex tasks within collaborative learning contexts. The literature contains evidence that education can be considerably improved by focusing on higher-order cognitive skills using project- and inquiry-based authentic learning, which is generally more effective than traditional didactic presentation in improving students' problem-solving skills. The CMST approach can even transform uninvolved, at-risk students into active and invested learners. CMST tools can be used to teach about a scientific topic via a series of student-controlled experiments and simulations without having the student know the mathematical and scientific details of the phenomenon under study. This simple framework allows one to introduce a topic and then move deeper with more mathematical tools after students gain a higher level of interest and knowledge. This motivational and layered aspect of technology is a principal reason that educators strive to master and apply it. This project works closely with outside consultants, including other NSF MSP projects, to gather more evidence that could contribute to a culture of evidence for MSP program and particularly the CMST approach.

3. Sustainability and Institutional Change

Active participation of faculty, teachers, and administrators in this project will be ensured in many ways, including institutional commitments and individuals' interests to be part of a larger community with experience of sharing of ideas and discovery of new and emerging technology in the sciences and mathematics. The institutional changes sought in this partnership will help sustain project activities beyond the duration of the award. In the first year of the project (2003), many activities and elements of this project were incorporated into new Strategic Plans by partnering institutions. The new institutional plans put partnerships, professional development, instructional *best practices*, and access to technology among high priorities. One of the milestones of this project, accreditation by NCATE (National Council for the Accreditation of Teacher Education) for SUNY Brockport's teacher preparation programs has just been accomplished. Input by teachers and administrators from partnering school districts has played an important role in the design of new changes and improvements in college's teacher programs. This partnership brought credibility and quality to teacher programs at SUNY Brockport, which led to issuance of accreditation. This will attract more students to the profession of teaching among college students at Brockport and it will lead to hiring of more of them by RCSD and BCSD, which will help sustain the partnership even after the award expires.

SUNY College at Brockport has established bachelor's and master's degree programs in computational science. New York State Education regulations require a master's degree for permanent teaching certification. Combination of degree programs in CMST and NCTAE accreditation of teacher programs will lead to higher enrollments for math and science programs at Brockport and it will help many RCSD and BCSD teachers obtain certifications. The College Senate and SUNY Administration are reviewing a five-year combined BS/MS degree program

submitted by the computational science department. RCSD has started a new tuition reimbursement program to encourage its math and science teachers to seek certification. About 60% of RCSD teachers do not have permanent certification. Knowledge of discovery of new and emerging technology in the sciences and mathematics in college's new CMST programs should be an attraction for many years to come for teachers and teacher candidates in their pursuit of a college education. Technology expansion targeted by all partnering institutions will generate a new learning environment that will survive much longer than the duration of the NSF award. For example, in support of this project, BCSD is giving laptop computers to all of its MST teachers. This not only will help enable current teachers but it will also set new standards which will be followed as an example for many years to come.

The partnership has formed a center (CMST Institute) to coordinate project activities. The Institute is co-managed through co-directors from each partner. Establishment of this center was to institutionalize the partnership so it can last beyond the duration of the award. The Institute's summer workshop has been registered as a credit-bearing college course. The center will continue to exist after the NSF funding expires. The school districts will continue to support teachers attending the activities of the center. We expect that there will be other school districts wishing to utilize the center's services. The Monroe County School Boards Association will assist us by facilitating communication among 20 districts in the area. School districts will use their own budgets as well as other local grants to both expand this project and continue its activities. During the period of NSF funding, there is support for teachers and instructors in the form of stipends, while the college charges no tuition and classroom facilities are available without charge. After NSF funding ceases, the summer institute will continue in the form of a college course, which will be counted towards master's level programs. School districts will continue to send teachers. RCSD will provide tuition support for its teachers while BCSD will continue to provide technology assistance to teachers (through laptops, calculators, and hand-held devices) to its MST teachers attending project activities beyond the award duration.

This project promotes a strong collaboration between higher education and school districts about infusing CMST-based pedagogies and tools into courses and curricula. In 2003, participating teachers and faculty have developed more than 100 lesson plans. Teachers have access to these lesson plans. The volume of lesson plans and ways to incorporate them into curriculum will increase in the next five years. A total of 5 courses in the college incorporated CMST tools in their content and syllabi. A new course has been registered to teach CMST tools to both undergraduates and graduate students at the college.

Partnership among MST faculty members at the college has been increased tremendously after the formation of the CMST Institute. The Institute offered training and laptops to more than 10 faculty members in its first year. Members meet among themselves and also with schoolteachers and coaches frequently. CMST faculty members have developed new joint proposals and articles within the past year. These collaborations have already laid a foundation for a long-term partnership among mathematicians and scientists in the college. The continued sense of community and ownership of the project has created a strong bond between schoolteachers and CMST faculty. Please see attached testimonies of faculty and teachers about this. The project leadership facilitated involvement of key people in all partnering institutions through open decision-making and a shared vision, which played a key role in solidifying the partnership.

Currently participating teachers have been told many times that they need to take proactive roles as full partners in this project. Even during the proposal development phase, our leadership was one of few that brought teachers to the MSP workshop in Washington. This culture is expected to last through presence of the CMST Institute, offering of summer workshops, school districts' tuition reimbursement program, and integration of CMST tools and pedagogy in courses and curricula at each institution. Dissemination of project results and team-based presentations by teachers, faculty, and administrators at national settings will enhance the sense of a regional and even national community. The Shodor Education Foundation and the Krell Institute will play an important role in bridging between our project participants and other colleges and school districts in the country. The repository of lesson plans and its dissemination through web and CD-based media will continue to link us with both Shodor and Krell.

3. Tools and Major Activities

- A multi-institutional center to coordinate meetings, project activities, and development of new courses and challenging curricula using technology-based pedagogy.
- A summer institute to provide training to teachers as part of professional development. Teachers will receive academic credits, a stipend, and technology tools to enable them to extend project activities in their classrooms and school districts.
- A yearlong mentoring program to offer professional development to participating teachers through coaches at school districts and faculty at the college.
- Pedagogically improved courses and challenging curricula at the college and in the school districts.
- Development and documentation of CMST training materials and lesson plans.
- A Scholarship opportunity for teachers and teacher candidates to pursue a BS or MS degree in computational science and technology.
- A project-based Challenge program to promote collaborative work among project teachers, their students at grades 7-12, and college faculty mentors.
- Reciprocal visits by faculty and teachers to classrooms at the college and school districts.
- Interaction between college faculty and schoolteachers from different districts.
- Dissemination of results and lesson plans to other teachers in the country.
- Testing of new uses for instructional technology (hand-held devices and calculators).
- Development and administration of evaluation instruments and surveys (web-based and paper-based) to measure student learning and teacher quality.
- Evaluation and analysis of progress and targeted benchmarks by outside consultants.

4. Professional Development

This project is based on the premise that, more than anything else, *improving teacher quality* will help improve student achievement across all groups. Our main implementation will be to train 145 middle and high school teachers as well as a limited number of teacher candidates and faculty members at the college. Under the coordination and organization of the multi-institutional CMST Institute, we offer four major activities as listed below, including a 4-week summer institute, a coaching program throughout the year, a scholarship program, and a project-based Challenge program for both students and teachers. Raising the quality of MST teachers is at the heart of our effort.

NATIONAL SCIENCE FOUNDATION (Award EHR-0226962) – Congressional Testimony

A. CMST SUMMER INSTITUTE

In summer 2003, we offered an introductory training workshop for MST teachers (grades 7-12). Starting in summer 2004, we will also offer an advanced workshop for teachers who want to further improve their content and pedagogy skills and those who want to develop a new course (elective or an AP course) in their schools. Ideally, we would like all teachers to go through both introductory and advanced workshops to maximize the impact on their classroom teaching and professional development. However, based on similar experience by the Shodor Foundation, we expect that only half of the teachers we serve the first time will choose to return for advanced training. The two-stage training, as illustrated in Table I, will help us prepare district mentors and coaches to become Lead Teachers in their school districts for years to come. We reached out to about 150 teachers in 2003 during our planning and informational meetings. The feedback from teachers and school administrators has been incorporated into the process of application and determination of benefits and responsibilities. Teacher feedback was also incorporated into the content, length, and time of the summer institute. We received more than 90 applications for a 50-seat summer institute.

The ultimate goal of this project is to improve student achievement; therefore we will weigh the needs of schools and student groups when selecting teachers. School administrators help us select teachers based on individual interest, need and desire for improvement as well as the need of their schools. We target a mix of experienced and new teachers to help both new teachers and to create strong leaders for training other district teachers. We also target a mix of middle and high school teachers, and a mix of math, science, and technology teachers as described below.

An important premise of this project is the integrated approach to math and science topics. We are promoting a partnership in teaching and learning both mathematics and science. The content of summer institutes will be relevant to grades 7-16 math and science curricula. CMST tools and approaches taught in the summer workshops can be applied to a variety of topics and levels, including freshmen at the college. There will be an advanced workshop for teachers and faculty members who want to further explore infusion of CMST tools into their teaching. The Rochester City School District has started a restructuring from schools with grades K-5, 6-8 and 9-12 to only K-6 and 7-12. Therefore, most of RCSD teachers attending our program will work in a combined learning setting as targeted here. Tailoring teacher professional development to needs of individual schools will be realized during the yearlong coaching activity, which is explained later. Each school will have 1-2 coaches and 1-2 designated CMST faculty advisors to help them implement acquired tools and knowledge into their classrooms. CMST faculty members and coaches will make several visits to classrooms for observation and assistance.

Based on feedback received from district administrators and schoolteachers, CMST Faculty members, and training specialists from Shodor Foundation and Texas Instruments, we registered the summer 2003 introductory workshop as a college course with 3 academic credits. The development of this course has necessitated weekly meetings by representatives and chairpersons from math, computer science, computational science, physics, biology, chemistry, earth sciences, and education departments at the college. Topics included:

- Computer and network training (use of laptops and educational software),
- Calculator training (TI-83 Plus) and its use in math and science courses,

- Math and Science modeling software tools (Excel, STELLA, AGENTSHEETS, and INTERACTIVE PHYSICS)
- Computational Science methodology (rate of change, numerical integration, and visualization of results),
- Data collection and analysis tools and experiments,
- Support for integration of technology into teaching (examples of lesson plans),
- Curriculum Support (i.e., Connected Math, Core Plus),
- Support for Curriculum Alignment with State Standards.

The table below reflects our strategy to cover as many new teachers as possible while allocating necessary resources to advanced training that would lead to new courses and challenging curricula and other institutional changes at core partners. This scheme would train 145 new **CMST Teachers**, including 70 **CMST Lead Teachers** who would receive advanced training. The advanced training will also be registered as a graduate-level course at Brockport. About half of the Lead Teachers are expected to become **CMST Coaches** to support CMST Teachers and Lead Teachers at their schools throughout the year. The **CMST Faculty** will mentor the CMST Coaches, Teachers, and Lead Teachers throughout the project. The project will offer technology support (laptops, calculators, software tools) to teachers attending the introductory workshop.

Table I: Two-stage professional development strategy and yearlong coaching activity timetable.

Activities & Support	Number of Teachers Receiving Service and Support per year					
	2003	2004	2005	2006	2007	**Total**
Summer Training	50 Intro	25 Intro 25 Adv	40 Intro 10 Adv	30 Intro 20 Adv	15 Adv	145 Intro 70 Adv
Coaching Support		50	25	40	30	145
Technology Support	Number of technology items per year					
	2003	2004	2005	2006	2007	**Total**
Laptops	50	25	40	30		145
Calculators	50	25	40	30		145

We aim to reach every math, science, and technology teacher within RCSD and BCSD; directly or through CMST Coaches, Teachers, and Lead Teachers. There are 252 math and science teachers at RCSD and 41 at BCSD. CMST Teachers will be required to pair up with at least one teacher in their district who will not be able to attend project activities directly. The district will use its professional development conference days to provide turnkey training for those teachers who did participate in the program to teachers who did not attend the program. Also, new teachers will receive training on the instructional methods during their monthly "new teacher in-services".

B. CMST COACHING

The coaches need to be aware of project expectations and CMST-related tools in order to be able to help other participating teachers in the school districts. The selection of 20 CMST

Coaches took place during the summer institute based on their performance and sustained interest in becoming a coach.

Goals of the CMST Coaching Activity

- Provide a follow-up mechanism for the summer institute training
- Provide support for team projects
- Help CMST Teachers with content, pedagogy, materials and strategies
- Provide a mechanism for interaction between CMST Teachers in their home districts
- Provide interaction between CMST Teachers and the CMST Faculty
- Provide interaction between CMST Teachers and Coaches from partnering districts
- Promote awareness of NCTM, NSTA, and NCATE standards
- Promote curriculum alignment with State standards
- Provide technical support to CMST teachers on hardware/software issues

Qualifications expected from CMST Coaches

- Attendance in CMST Summer Institute
- Ability and willingness to give time, energy, and support to teachers
- Tenure and permanent certification
- Experience with use of technology in the classroom
- Excellent content/grade level knowledge
- Demonstrated capacity for professional reflection
- Confidence to encourage the CMST teachers to take risks and grow
- Demonstrated instructional leadership within his/her discipline

C. CMST EDUCATION

Another activity to support professional development is a CMST-based formal education. The NY State requires completion of a master's degree for permanent certification. Sixty percent of RCSD and eleven percent of BCSD math and science teachers do not have a MS degree. Although this project cannot completely cure the problem, it will plant seeds of a long-term training program. Through a CMST Scholarship program, we will promote teaching profession among undergraduate students at the college, improve teacher quality, and increase the retention rate at partnering school districts. Additionally, RCSD will offer a tuition reimbursement program to support CMST-based education and certification for its teachers.

SUNY College at Brockport will provide a comprehensive CMST-based content training to in-service teachers and graduating seniors at the college. The interdisciplinary program at the college in *computational science* offers a CMST-based education at BS and MS levels to teachers and students from a variety of backgrounds. Students in this program combine basic CMST skills with a specialization in a content area of choice (math, science, or technology). A graduate of this program gains skills and background in multiple areas; thus becoming a very marketable teacher in school districts. Graduates of this program are now employed in both the high tech industry (i.e., Xerox, Kodak, Lockheed Martin) as well as the K-12 public schools in Rochester. Candidates would be recruited from RCSD and BCSD teachers as well as graduating seniors at the college who plan to become teachers.

D. CMST CHALLENGE

The CMST Challenge program will start after the summer workshop and will encompass the school year in which teams of students and teachers complete science projects. The makeup of the teams and their project topics will be determined after the summer training. We will create teams of two teachers and two students per teacher. Bringing MST teachers together on the same team will give a chance to integrate knowledge and expertise. Throughout the program, help and support will be given to the teams by the CMST Coaches and Faculty. CMST teachers will select students based on their GPA, prior coursework, computer experience, and desire to learn about science and computing. Although there will be differences (grade and background) among challenge students, we expect each selected student to be up to the challenge among their peers in their classrooms. CMST Teachers will be advised to ensure equity of all groups and full participation of underrepresented groups, particularly minority and female groups whose performance drop in middle and high schools has received regional and national attention. If the selection follows the statistical make-up of student population in each district along with the allocations given to each district, then this will ensure a just distribution that core partners have agreed upon.

During the Challenge experience, students will be engaged in simulations, problem solving, and inquiry- and project-based learning to stimulate their interest and learning. The activities will involve students in making decisions about their learning, thus empowering them to become more involved in the learning process. Connection in content will be made to urban situations that students can relate to. In addition to being an educational experience, the Challenge will be an avenue for competition, designed to encourage students to perform at the highest possible level. To encourage participation, projects will be placed in divisions according to mathematical background and grade level. For example, teams made up of students who have completed Algebra I will compete against similar teams. Participants at all levels will be able to attain many levels of recognition. Trophies will be awarded for teamwork, technical writing, presentation, creativity, innovation, modeling, code performance, and multimedia.

5. Evaluation Plan

The evaluation design will be both formative (process-oriented) and summative (results-oriented), employing naturalistic inquiry for capturing complex interactions, patterns of student/teacher learning and changes in teacher strategies and in student motivation, interest and achievement in math, science, and technology. The formative evaluation will examine usefulness and appropriateness of software tools, whether or not they need to be replaced as part of midcourse corrections. It will examine coaching activities to find out whether we need more coaches. The length of workshops and orientations as well as the selection criteria for teachers and students will be among parameters for midcourse corrections. We will survey teachers, students, and coaches and we will hold interviews. While it will rely on more traditional scientific inquiry for student outcomes, these measures will occur frequently to determine if the project is on target in meeting its' goals and objectives. To measure the impact of project activities on participating students, both quantitative and qualitative methodologies will be employed. Teachers will submit weekly logs to project management. Designated coaches will make classroom observation and provide input on a regular base. The project principals will work with district coaches to develop an annual Teacher Impact Survey (TIS) for grades 7-8 and 9-12.

First, descriptive statistical comparison of pre-and post-measures of academic achievement in math, science and integrated technologies will be compiled and maintained and reviewed on a frequent basis. A database will be constructed on the target population to enable longitudinal following for a 5-year period. Second, general attitude and motivation orientations as well as specific knowledge and attitudes will be assessed three times per year for program alignment and revisions.

The Advisory Board will meet in spring and summer to review the data and make recommendations to school principals and participants. A Memorandum of Agreement will be signed between the Research Foundation of SUNY, represented by the PI, and school districts, represented by school principals, to ensure that teachers participating in the proposed programs are adequately assisted, supervised, and monitored in their professional development. After summer institutes, a joint one-day workshop will be conducted by superintendents for school administrators (principals and assistant principals) to integrate our project's goals and expectations into the overall accountability measures for schools, mentoring coordinators, mentors, and teachers involved.

Outside consultants will be involved in project evaluation and advise us on statewide results. The records will be housed at the CMST Institute. The project will develop a web site for project members, teachers, students and for the public. An annual report will be prepared for NSF. The partnership will participate in the national analysis of the MSP program and in any further research activities requested by NSF. There will be a strong link to Centers for Learning and Teaching in the state. The achievement gaps will be released to the public by the NY State, and the schools will be held accountable at the county and state levels. The local newspapers and TV channels closely follow school reports, which will be a vehicle to raise public awareness about the new education initiative and NSF's role in it.

Both participating School Districts have in place a system for collecting and analyzing achievement data for all students and this current system will be utilized to disaggregate the data specifically for the targeted teachers and students. Further, this will offer the Districts an opportunity to compare the outcome data from all the intervention programs, including the target population, and to use this data to make the programmatic and policy changes necessary to meet the goals of this program.

Throughout the implementation of the project, participants will provide more personal forms of feedback regarding the activities and educational impact provided. Focus groups and district-designed tests will allow the staff to make the needed mid-course changes and revisions as the data and feedback indicate. The twin tasks of this evaluation are to assess the effectiveness of teacher training as well as the impact on student achievement in MST. For more information on our evaluation plan, please see the 5-year Strategic Plan.

6. Dissemination Plan

We have several regional and national mechanisms for dissemination, including the two supporting institutions (Shodor and Krell) that have been an integral part of national development, training, and dissemination efforts. As members of NSF-funded programs, Shodor

and Krell organized and implemented training sessions for building a national reservoir of MST teachers. In particular, Shodor targets undergraduate faculty at small universities, community colleges and minority-serving institutions. It will provide an instructor and mentor for the summer institute, thereby providing a direct link to other national and regional programs. Sharing instructional personnel will also provide a conduit for disseminating our successes to a nationally distributed audience, integrating and helping to standardize curriculum development at both levels.

We will also work with another partnership program supported by NSF, namely the Partnership for Advanced Computational Infrastructure (PACI). The PI was invited in March 2003 to give a talk at the All Hands Meeting Conference organized by the PACI-Education, Outreach, and Training (www.eot.org). EOT has offered to publicize and disseminate our project activities, lesson plans, and elements of CMST culture of evidence. The link to EOT puts us at the center of the national computational science community in a more visible way, which will contribute to building a more comprehensive culture of evidence. Participation in future NSF's MSP Learning Network events will also help disseminate our results.

Within the last several months, we have presented at several national conferences, including SIAM Computational Science and Engineering (http://www.siam.org/cse), and Supercomputing (http://www.supercomp.org) conferences. We will continue to play a role in these meetings, particularly in the Supercomputing Conference that has an Education Session devoted solely to training of K-12 teachers and undergraduate faculties in computational science. We plan to send at least two teams of CMST Faculty-Teacher-Student combination to present results in these conferences.

At the local level, we will work with the Monroe County School Boards Association to expand our activities to other school districts. They will assist us by facilitating communication among 20 districts in the area. The local media has shown great interest publicizing our project. Our project has been featured in Rochester Democrat and Chronicle, Brighton Post, and several TV and Radio Stations. We expect to promote our annual results through local media and newspapers at Rochester and through the SUNY Newsletter.

At the regional level, we have visibility at the Chancellor's Office at SUNY Central and at the Research Foundation of SUNY in Albany. We helped a sister institution (SUNY Fredonia) initiate a major effort to target scholarships and industrial internships for student in their MST fields. Our focus on CMST has led to establishment of a computational research center at SUNY Buffalo and planted seeds of a Computational Engineering program at SUNY New Paltz. The PI is an Adjunct Professor at SUNY Stony Brook and he plans to apply for SUNY funds to organize a Conversation in the Discipline workshop at which MSP-related findings can be shared with other SUNY schools. Finally, we will set up a web site for this project as early as the first year.

7. WORK PERFORMED

The SCOLLARCITY partnership was put on firmer grounds in 2003. There have been a few major changes since the award announcement. In response to reviewers' comments about reaching out to more math and science teachers, we increased our capacity from a total of 100 teachers to 145. A budget supplement has been requested from NSF.

There were structural changes at partnering institutions. RCSD hired a new Superintendent who then hired new directors of math and science programs. The project leadership facilitated involvement of key people in all partnering institutions through open decision-making and a shared vision, which played a key role in solidifying the partnership. A positive outcome of the leadership change at RCSD was creation of a new Strategic Plan that included innovative technology solutions and regional partnership with higher education that are core elements of this project. The new Plan puts professional development, instructional *best practices*, and access to technology among high priorities as well (A copy of the new RCSD Strategic Plan is available at www.rcsdk12.org). In 2003, a multi-institutional center was founded between SUNY Brockport, Rochester City and Brighton School Districts. The center (CMST Institute) is co-managed by a Director from the College and two Co-Directors from school districts.

The second major test for the partnership was the development and documentation of the 5-year Strategic Plan (S-Plan) and the 1st Year Implementation Plan (I-Plan). The partners held weekly, bi-weekly, and later monthly meetings leading to the submission of the Strategic Plan in July 2003. The location of discussion meetings (involving principals of the project) was alternated between the City, Brighton, and Brockport suburbs. The meetings included both administrative and technical people to sort out details of role and responsibilities of all participants, including teachers, coaches, faculty members, and institutions as well. CMST Co-Director from RCSD (Margaret Crowley) and Project Coordinator from BCSD (Tom Hall) played an excellent leadership role in their districts to talk to teachers and encourage them to attend informational meetings. Our Independent Evaluator (Linda Reid) has been a source of great advice and research data for mid-course corrections. The recruitment of teachers for the summer institute took a great deal of effort by all three partnering institutions, including more than 7 informational meetings, presentations, and communication. The input from teachers attending these sessions was used to adjust the content, length, location, and dates of the summer institute. Collaboration with another MSP partnership project (The Council of Chief State Schools Officers, American Research Institute, and Wisconsin Center for Education Research) helped us collect baseline data in April 2003 from all applicants (target group plus the control group) prior to our summer institute. This collaboration has provided us with evaluation instrumentation that could not have been created using our limited funds set aside for evaluation component.

The third major test was the delivery of pledged support (mostly release time) for principals. It has taken the project leadership and their institutions time and experimentation to accurately assess necessary institutional support. Initial estimates seem to hold and all partners have contributed in some form or another. The college and Rochester City School District provided tuition support and facilities. Brighton provided laptops for all of its MST teachers. The college provided facilities for summer training. Computer labs were upgraded at the college and school districts. Partners also contributed through staff time, though this is hard to measure. The college granted a course release for the CMST director in spring 2003 and it stands by its pledge

to do the same every semester for the duration of the project. CMST Faculty members were advised by the Dean to use their scholarship and personal time to contribute to the project. Thus far, support in the summer (via salary) and during academic year (via scholarship time and extra service) has adequately enabled delivery of essential services and maintained faculty engagement throughout the whole year. Teachers rated CMST faculty members 'excellent' for their knowledge and dedication to the project.

CMST Faculty spent a tremendous amount of time in spring 2003 on updating the content of the summer institute. Since this project involves use of technology tools, we need to be aware of latest tools in the field at all times. With Shodor's input, the project adapted new tools such as STELLA, AGENTSHEETS, and Interactive Physics to replace FORTRAN and MATLAB originally considered for summer training. In Spring 2003, with the help of Garrett Love from Shodor, a training session was organized for all CMST faculty members about these tools. A similar effort took place with the Texas Instruments. The content discussions involved CMST Faculty members, instructors from Shodor and Texas Instruments as well as project coordinators, school principals and teachers from the districts. We managed to register the summer institute as a credit-bearing course for teachers and students in teacher preparation programs at Brockport. The advanced version of the summer institute will be developed by Spring 2004 for the upcoming summer. We expect the same process, however, this time we will also involve the Krell Institute members who are specialized in topics more suitable for advanced training.

The 2003 Summer Institute was very successful. It took a great deal of teamwork to do it. Hiring of a Project Coordinator (Sue Barocas) early enough in the process (April 2003) brought fresh energy as well as perspective of a former math teacher into a college setting. She brings not only her knowledge of math but also her administrative experience (as director of math instruction) and connections to teachers. Hiring of a secretary (Amanda Duncan) the week before the Summer Institute made a great deal of difference. She is an Office Wizard and does things very quickly. We made mid-course corrections as we encountered problems, including registration of participants; space and air-conditioning issues; purchase of laptops, calculators, and software tools; cloning laptops and installation of software on college computer network; negotiations with vendors; organization of course materials, content of the course; management of office hours, weekly meetings by the Instructional Team; ceremonial gatherings, picnics, interviews with TV shows, Newspapers, and many other tasks. As reported by our Independent Evaluator in the next section on Quantitative Data, hundred percent of participants rated the summer institute as a success.

Maintaining of our success (achieved with the summer institute) in the months ahead will be our top priority as teachers and college faculty integrate the CMST tools and approach into their teaching. Implementation of the lesson plans developed during the summer and early fall will be crucial for improvements in student achievement to be reported at the end of this school year (9/03-6/04). Work on development of Student Impact Test (SIT) and Teacher Impact Survey (TIS) will begin by early 2004. Technology access at schools is an important issue and will be improved. We will hold monthly talks with teachers, coaches, and school principals about their needs. At the minimum, each CMST teacher should have a laptop and access to an LCD projector to be able to teach math and science topics using integrated approach through visual

representations and simulations. Details of activities such as coaching, turnkey training, and the CMST Challenge program will be worked out by the end of October. NCATE accreditation application by the college has received favorable recommendation. A combined BS/MS program in Computational Science has been designed and submitted to the College Faculty Senate for approval. School districts have started discussions on changes to curriculum maps and this process will take a considerable time to come to fruition. For additional information on upcoming activities and their projected timeline, please refer to the Implementation Plan for the 2nd year attached to this Annual Report.

ACTIVITIES AND FINDINGS

(Reported by the Independent Evaluator- Linda Reid)
The proposed activities the Project staff accomplished from January 2003 to September 2003 to achieve the first year goals (in the 1st Year Implementation Plan) are summarized below.

- Signed a Memorandum Of Agreement (MOA) by SUNY College at Brockport, Rochester City School District and Brighton Central School District.
- Established the Computational Math. Science, and Technology (CMST) Institute to coordinate project activities and develop and teach courses using a new pedagogy (integrating fieldwork, laboratory experiment, math modeling, computer simulation, and visualization). The CMST Institute is co-managed by three directors by core partners.
- Promoted elements of CMST approach at newly developed RCSD Strategic Plan
- Promoted elements of CMST approach at the College's new 5-year Strategic Plan under development.
- Signed subcontracts with Shodor Education Foundation. The subcontract with Krell Institute has been sent to the Research Foundation of SUNY for legal matters before it is submitted to Krell for signature.
- Signed a partnership agreement with Texas Instruments, which led to a saving of $14,000 for our project.
- Signed a partnership agreement with The Council of Chief State School Officers, which led to a saving of $17,775 as direct support (stipend and catering) for 70 teachers as well as travel support of $11,000 to project members to attend workshops on Building Evaluation Capacity. This relationship is expected to save our project hundreds of thousands of dollars that otherwise would have gone into development of evaluation instrumentation by our own staff.
- Established a partnership with IBM on educational technology support for K-12 teachers. The relationship led to a saving of $78,500 by our project.
- Established a partnership with MSC Software and High Performance Systems on educational technology software support. This relationship led to a saving of $5,900.
- Improved teacher preparation programs through application for NCATE accreditation. The process will continue with further feedback to the college about its programs.
- Improved teacher preparation programs through creation of a new in-service/pre-service course. This course infused CMST methodology and tools into a course that can be taken by all math, science, and technology teachers and teacher candidates. The Board of Study for Teaching Mathematics and Science approved the course content. The Dean signed off on it.

NATIONAL SCIENCE FOUNDATION (Award EHR-0226962) – Congressional Testimony

- Improved math and science education at the college by integrating CMST tools into 4 college courses, including CPS 101 Introduction to Computational Science, NAS 401/501 Computational Approaches to Math, Science, and Technology Education, ESC 350, Computational Methods in the Field Sciences, MTH 313 Mathematics for Elementary Teachers. More courses are expected to use CMST tools and approach in the 2003-2004 school year.
- Helped promote quality at SUNY Brockport. The College was upgraded from a Tier 3 ranking to a Tier 2 category as a result of increasing the percent (60%) of incoming freshman enrollment who have a high school average of 90 and/or SAT scores of at least 1200. This fall's jump from Tier 3 to Tier 2 marks the culmination of a multiyear effort by Brockport officials to attract a higher caliber student body. The option of offering a Computational Science program was a key factor in attracting students who scored high on SAT. Participation in the MSP Learning Network to exchange results and expertise with other granted projects has been consistent since the inception of the project.
- Reached to more than 150 MST teachers through informational meetings and presentations by college faculty visiting the school districts. About 90 applications were received and reviewed. School principals were involved in the reviewing and recommendation of all applying candidates. Offers were made to 56 teachers and 6 college students. Contracts were signed with teachers to manage the handling of resources and expectations of the summer institute as well as commitments to a mentoring activity after the training. Integration of CMST tools and pedagogy into teaching was made a requirement through two lesson plans.
- Implemented a 4-week summer institute providing training to 55 teachers as part of professional development. The institute included 6 college students, two of which were offered a teaching job by RCSD as a result of such training. All participants received academic 3 credits.
- Tuition support provided by the college for 6 SUNY Brockport students, 48 RCSD teachers and one administrator, and 6 BCSD teachers to take a summer course at Brockport. The project funds also offered tuition support to 7 students and 4 teachers in fall 2003.
- Tuition reimbursement provided by Rochester City School District to MST teachers taking courses or seeking MS degrees to obtain permanent certification at SUNY College at Brockport. Data will be collected in early 2004.
- IBM laptops were provided by Brighton Central School District to all of its MST teachers
- IBM laptop computers were provided by the project to 55 teachers and 10 instructional faculties. Also provided college-licensed education software tools and CMST-licensed new tools such as STELLA, AGENTSHEETS, and Interactive Physics.
- Texas Instruments TI-83+ graphing calculators were provided by the project to 55 teachers, 10 faculty members, and 6 teacher candidates and a middle school student (7th grader Karthik Rajasethupathy) who attended the whole summer institute. The middle school student did a demo at the graduation ceremony displaying his pool table model using the Interactive Physics. Teachers were stunned by student's success and pledged to promote similar successes in their own districts.
- Training was provided to 20 coaches who have been assigned to work with teachers from the summer institute during the school year. A schedule for bi-monthly meetings was developed. Dates are: 8/12, 10/08, 12/10 in 2003 and 2/10, 3/1, 4/6, and 5/10 in 2004.

- A List Server (ANGEL) has been set up to disseminate summer workshop materials, including 55 lesson plans developed by college faculty and participating teachers at the end of the workshop.
- A database (EXAMgen) of questions aligned with NY State MST student learning outcomes was made available at RCSD by district administration in support of our Strategic Plan goals.
- Began the initial stages of a Challenge program to serve students at grades 7-12. An Interactive Physics Day was organized on October 14, 2003. SUNY Brockport hosted more than 50 secondary school students and 5 physics teachers on its campus.
- Established a mentoring program at Brighton Central and Rochester City school districts to offer professional development to participating teachers. Hired 20 coaches at two districts.
- Established a schedule for mega meetings to bring together Brockport faculty, RCSD and BCSD teachers and coaches who attended the 2003 summer institute.
- Established an action plan and met with stakeholders to implement strategic plan of core partners for pedagogically improved courses at SUNY Brockport, RCSD, and BCSD.
- Steps to modify curriculum maps at partnering school districts have been initiated.
- A combined BS/MS program in Computational Science has been submitted to the College faculty Senate in fall 2003.
- Collected, adapted, and refined course materials from previous NSF and DOE programs with the help of Shodor Foundation for classroom teachers. Help by Krell will be sought in early 2004 for advanced training materials.
- Promoted the CMST pedagogy and curriculum via a journal paper to appear in SIAM Review (Vol. 45, No. 4) in November 2003. Credit to NSF MSP program will appear on the front page. SIAM is the primer society of Applied Mathematicians and Computational Scientists (ww.siam.org).
- Promoted CMST approach at several national conferences, including SIAM Conference on Computational Science and Engineering in February 2003 at San Diego. Also, attended MSP Learning Network Meeting in January 2003 at Washington, D.C.
- Invited to talk at All-Hand-Meeting by the NSF NPACI-EOT (www.npaci.edu/ahm2003/) in February 2003 at San Diego. The mission of the NSF-funded National Partnership (of more than 50 institutions) for Advanced Computational Infrastructure (NPACI) is to advance science by creating a ubiquitous, continuous, and pervasive national computational infrastructure.
- Invited to participate in NSF PACI Partnership meeting at NSF (Arlington, VA) on October 20-21, 2003 to discuss promoting CMST approach to a national audience. This might provide new resources to our project's dissemination effort.
- Promoted CMST Integrated Approach to math and Science Education at SUNY system. The PI was selected as a member of the University Senate Graduate Education and Research Policies Committee. He was subsequently appointed as the Senate Liaison to the Research Foundation of SUNY. He was invited to serve on a SUNY-wide Mathematics Education Task Force. Through his membership and appointment in these SUNY-wide committees, the PI has promoted NSF's MSP program and the CMST approach. He was also invited by the President of SUNY College at New Paltz to help initiate a Computational Engineering program.

- News Releases and TV interviews were granted to local media during the opening ceremony of the CMST Institute. Occasional news releases are also being published in the Democrat and Chronicle, Brockport Post, and Brighton-Pittsford Post.

BENCHMARKS AND QUANTITATIVE DATA

The following sections are direct responses to questions and benchmarks in the Evaluation Section of the 1st Year Implementation Plan.

A. Partnership:

1. ***Did all partners agree upon a shared vision for SCOLARCITY Partnership?***
2. ***Did core partners define mutual goals, responsibility and accountability?***

The project documentation verifies that all partners did agree upon a shared vision at the inception of the project and this collaborative effort has continued throughout both the planning and implementation periods of this project (copy of Memorandum of Agreement is available).

This major effort did encounter significant shifts due to a notable change in staffing at the Rochester City School District. During the planning stages of the project the PI collaborated with the Superintendent and the Directors of Math, Science and Technology departments, as well as the Director of Academic Instruction. Midway in the process, after all agreements had been approved, the Superintendent left the position and was replaced by a new Superintendent. Further, the Directors of Math, Science and Technology retired from their positions due to an early incentive offered by New York State Education Department. Newly appointed staff filled these positions. Several of the building Principals who were originally recruited to participate in the Project also retired or were transferred. Additionally, the Chief Academic Officer was replaced during the same period.

Finally, in 2002-03 the District began implementing a plan for restructuring the system from a middle school (6-9) high school (9-12) configuration to a comprehensive 7-12 structure. All of these considerable changes have presented unique challenges to the implementation of the project. Despite these significant changes, the PI was successful in rebuilding new relationships with the new staff by fostering good communications, open decision-making and teamwork with the new players and stakeholders. According to information collected through staff interviews, new members believed that the project leadership, by involving and supporting people of different skills and backgrounds, was able to build on the enthusiasm of individuals and ensured broad participation. Further, the outcomes of the project are perceived as relevant to the stakeholders and matter to both teacher participants and district leadership.

3. ***Did the partnerships strengthen relationships with local industries? What evidence supports this?***

Promoting each partner's common goal, by taking advantage of the strategic alliances, and offering appropriate prices for technology tools strengthened partnerships with IBM and Texas Instruments. Teacher feedback to IBM and Texas Instruments regarding classroom application of their tools has been beneficial. The training of teachers by Texas Instruments staff received extremely positive responses from teachers and the teachers were satisfied with the access to T.I. staff in support in the use of graphing calculators from Texas Instruments.

In a reflective statement from Shodor Education Foundation's instructor, Dr. Garrett Love writes:

> I believe the Summer Institute was effective in exposing the participants to the basic concepts of computational science and modeling, and introduced a good variety of tools, thereby increasing the chances that participating teachers would be able to find a tool they were comfortable with and thus incorporate the technology into some aspect of the classroom.
>
> Currently the SCOLLARCITY project is quite regional in scope, although that is somewhat expected in the initial phases. The lead institution (SUNY Brockport) is obviously serving as a valuable resource for the Rochester area schools, but in order to extend the scope and impact of the project, it will be necessary to identify shareable outputs or potential outputs of the project (curricula, best practices, teacher leaders) and to establish how these and other resources (faculty and staff expertise, computational infrastructure, facilities) can be used to augment similar projects led by other institutions.
>
> In particular, it is of great interest to Shodor as to whether the model piloted this past summer – namely the introduction of computational science content and methods to a concentrated core group of faculty associated with an MSP – is an effective structure and approach for reaching both undergraduate and secondary classrooms, and whether Shodor can demonstrably serve as a resource for MSPs in general. Demonstrated effectiveness of our collaboration will lead to 'institutional change' in Shodor in the form of increased involvement with MSPs, perhaps as a stated objective.
>
> In addition, Shodor has extensive involvement with the Education, Outreach and Training arm of the National Partnership for Advanced Computational Infrastructure (NPACI). A key EOT-PACI project led by Shodor is the Computational Science Education Reference Desk (www.shodor.org/cserd), which serves as a repository for computational science materials and curricula generated by Shodor and various collaborators and partners. It is my expectation that curriculum generated by CMST faculty and perhaps even participant teachers will be submitted for publication, thus expanding the impact of the generated curriculum as well as the scope of the repository. I have high expectations that as this project matures it will generate resources in support of institutional change on a national scope.

4. *To what extent did the project foster collaboration with industry to enhance new instructional technology?*

Assessment of the technology tools by teachers was conducted during the CMST Summer Institute. The initial results have been shared with Texas Instruments and will be used by the company in revising and updating their tools and training material. Additional feedback will be collected from teachers throughout the project period to provide information to technology partners.

5. *In Year 1, to what degree did the partners promote the CMST Institute?*

To date, significant promotion occurred among partners through press releases, adequate release time for project staff and a high level of cooperation between partners. District partners encouraged teachers to enroll in the CMST Summer Institute and all partners worked together to overcome any barriers that arose in the implementation process. For example, the original plan of the Summer Institute's daily schedule was totally revised to accommodate teachers who had committed to teaching summer school in the mornings in Rochester. While the change presented some adaptation for faculty members, the process occurred swiftly and the needs of teachers, faculty and trainers were met. CMST staff, together with input from partners, has designed a new informational and recruitment brochure that will be disseminated in a variety of venues during the 2003-04 school year.

6. ***Was Project successful in establishing collaboration with the MSP longitudinal study and OCCSSO by April of Year One?***

The CMST Project is actively involved in a partnership study with another MSP (RETA) project. Staff is working with Rolf Blank from Council of Chief State School Officers as a participant in their study of professional development in mathematics and science instruction. Surveys have been administered and PDA Activity Logs have been set up. A total of five CMST staff has attended the MSP Conferences and Evaluation Workshops during this project year. Approximately six CMST staff will also be attending a two-day MSP workshop in Baltimore on October 16 and 17 2003.

B. Teacher Preparation:

1. ***In project year 1, 100% of the 50 available spaces in the CMST Summer Institute will be filled by teachers by May 15 2003***

The CMST Summer Institute recruitment effort was 100% successful; enrollment goals were met and exceeded. Eighty-eight (88) teachers applied for participation in the CMST Project, a total of 56 teachers were accepted. Both urban and suburban enrollment objectives were met.

2. ***Ten (10) faculty from SUNY Brockport, 2 veteran instructors from BCSD/RCSD will participate in the training of 50 teachers per year***

The 10 Brockport faculty participated fully in the four-week training of 56 teachers include:

- Computational Science (Yasar, Tuzun, Little)
- Mathematics (Jones)
- Computer Science (Raj)
- Physics (Tahar, Mancuso)
- Chemistry (Heitz)
- Earth Sciences (Maliekal)
- Education (Veronesi)

A veteran science and technology teacher from Brighton School District (Steve Whitman) also participated in the training.

The instructor from Rochester City School was unable to schedule training due to conflicting job responsibilities and was replaced with a newly retired Math teacher from the RCSD (S. Barocas) who previously taught Mathematics at the Monroe Community College.

Teachers were surveyed with a 49-question survey at the end of the Summer Institute and 25 exit interviews were conducted between July 28 and July 31, 2003. The results were used to answer questions # 3 through #9 below. (See Survey Results in Appendices)

3. Did participants feel their time was well spent?
100% of the participants rated their experience as beneficial (42%) to very beneficial (57%). 70% of the Math teachers rated the Institute as very beneficial. 100% of the participants stated that they would recommend the program to other teachers.

4. Did the materials make sense? Will they be useful?
76% of the teachers found the materials to be extremely useful and the other 24% stated that the materials were somewhat helpful.

Teachers recommended that for next year's Summer Institute, CD's be created with specific modeling applications for classroom use. Middle school teachers recommended that more materials for middle school teachers be added. Science teachers suggested seeing more science. Because of the integrated approach to math and science (through use of technology), all of the teachers are asked to learn beyond their own specialty. The CMST Institute needs to insist on asking math teachers to learn more science and asking science teachers to learn more mathematics and technology. The research shows that no textbooks/workbooks exist for the K-12 educator in the area of computational science or in any of the companion disciplines. CMST faculty and presenters spent significant time and effort researching and assembling materials, which they believed, would be helpful for the 7-12 grade teachers. One of the tertiary benefits of this project is that through their collaborative work in the CMST project, faculty and teachers have already begun creating lesson plans and assessment tools for classroom use. Throughout the five years of the project the development of these curricular tools and materials will provide a usable body of working materials for teachers in the area of computational science for the classroom.

5. Was faculty knowledgeable and helpful?
The Instructional Team (Brockport Faculty, District Teachers, TI Training Specialists, and Shodor Training Specialist) was rated by teachers in a survey by our Internal Evaluator (Veronesi) as being very successful (>4.5 on a scale of 5). In his own words, Dr. Peter Veronesi (a Science Educator at the Education Department) states:

> "From my observation and professional judgment, I feel that the goals of the CMST summer Institute were accomplished and that the event came off as a smashing success! Teachers where engaged and challenged during the entire time.
>
> It is quite evident that ALL CMST instructors are *very* committed to the success of the entire program. CMST faculties want to see the teachers/participants succeed with their students as they begin to infuse the learned technologies in their classrooms. This particular group of instructors is extremely committed- they feel ownership in the Institute. And, it seems likely from the comments of

the final survey that a great majority of the teacher participants were looking forward to implementing the various technologies and strategies."

Additional surveys by External Evaluator (Reid) also showed that overall teachers expressed high satisfaction with the faculty. Teacher Survey results showed that participating teachers from the Summer Institute ranked 80% of the CMST faculty as excellent to very good in Knowledge in the subject matter. 71% believed that they had "very good" access to faculty throughout the four-week sessions and 29% said access was "good". One participant, a science teacher, said access was fair.

In exit interviews participants expressed high satisfaction with faculty and believed that all faculty members were extremely helpful in supporting participants' learning efforts and activities. Teacher ranking of faculty was highest by the less experienced teachers. (100% of the teachers with less than 15 years experience not only ranked faculty as extremely knowledgeable and helpful but also were very enthusiastic about their satisfaction in exit interviews. Examples of teacher comments from the survey include:

- "The Institute was very good"
- "Instructors could not have been humanly better!"
- "I originally thought about quitting the program because the pace was so fast, but the professors were so accommodating and truly put everyone at ease. The entire staff was excellent; they made everyone feel competent. Faculty readily stayed later to help trouble shoot problems."
- "I feel that we accomplished a ton, in the short amount of time we had. This is a credit to the instructors and organizers."
- "I thank all the instructors for their dedication and interest."
- "There was not one member of the faculty and staff that was not helpful, patient and willing to go the extra mile."
- "This course exceeded my expectations. We are very grateful to the staff of CMST for the opportunity and the wealth of information that was generated. They were very eager to show us what they know. We are just so indebted to you all. Please continue to do this every summer to get more teachers on board. This is a very rare opportunity and as pioneers, we will do our best to promote this in our schools."

Individual rankings of faculty were shared with PI and Project Co-Directors as well as faculty. Individual faculty members are using the evaluations to improve their teaching for the next session.

6. Did teachers acquire the intended knowledge and skills?

While the input from the teachers indicated they believed they definitely acquired the knowledge needed to implement the CMST approach in their classrooms, they were less confident about their level of skills in applications in their classrooms. 36% definitely felt prepared to apply modeling in their classroom this September, whereas 41% were "probably" prepared", 16% were unsure and 7% did not feel prepared. Interview data further revealed that teachers explained that their lack of confidence was due to their need for additional manipulation and experience with these new tools in the classroom. The PI and the CMST Technology Coordinators (Maliekal and Little) have been made aware of this. At a minimum,

teachers must be able to have a laptop (provided by the project) and an LCD projector to display results and experiments on the screen. Ideally, students should have access to computers and CMST tools to learn from their own experience with simulations. School districts are improving the student/computer ratio.

At the outset of the Summer Institute, faculty surveyed teachers to determine their level of competency in technology in order to assess at what level instruction should be focused. Interestingly, faculty reported that teacher's perception of their proficiency was much higher than what faculty actually observed teacher's skills to be.

Teachers recommended that the Summer Institute be expanded by one week in order to give them additional time in "hands-on" use of the tools and applications for the classrooms. Program participants will be providing staff with monthly information via the PDA Activity Logs and weekly via Teacher Activity Logs on ANGEL regarding their actual use of the knowledge and skills they learned in the CMST Summer Institute.

Coaches and faculty mentors will be available to teachers throughout the school year to support classroom implementation of CMST approaches. Through classroom observation and teacher input, coaches and mentors will be assessing the extent and scope of the model applications and teacher use of technology tools for individual instructional support for teachers as well as for programmatic changes in the design of the CMST program. Program planners, as well, are reviewing the recommendations by teachers regarding the strengths and weaknesses of the Summer Institute in order to make modifications and improvement for next years' summer program.

7. What percent of the participants completed the Summer Institute?

The Summer Institute was highly successful in it's objective in retaining 60 of 61 participants. Of those 60: 6 were SUNY Brockport students; 6 were teachers from Brighton Central District; 48 were teachers and one administrator from RCSD; and one teacher and one middle school student from Brockport School District. One RCSD teacher dropped out after the first week due to a family emergency and not related to his satisfaction with or performance in the CMST Institute.

All 60 participants successfully completed their assignments and maintained the rigorous attendance requirements. Approximately one third of the teachers also taught summer school at their District in the morning and drove 45 minutes from the city to Brockport to attend the CMST training sessions. District reports from previous education related workshops held during the past four summers show an average of at least a 10% non-completion rate. Teacher commitment to completion of the Summer Institute was exceptionally high. Teachers who were teaching summer school in their district reported that they already started using in the summer school what they learned the week before in the Summer Institute. This shows a quick turn around time and an unusual excitement among participants.

8. Did teachers receive adequate coaching/mentoring support?

The assignment of Coaches to teachers has been completed on schedule. Orientation meetings with Coaches occurred on August 12, 2003. Coaches have been trained in classroom

observation techniques and On-line Logs have been created to monitor input from both the teachers and the coaches. A mega meeting will be held on October 8, 2003, which will include CMST faculty, Coaches, and Teachers. The coaching activity will be assessed on an ongoing basis throughout the school year and results will be recorded in December 2003 and June of 2004. They will be reported in 2004.

9. How many Brockport teacher candidates with CMST-training were hired by partnering school districts?

Three teacher candidates (Gerry Moon, Chris Olsowsky, Maria Roman) with CMST training were hired by the Rochester City School District; a graduate student in the Teacher Education Program, a master's student and undergraduate student (and a substitute teacher) in computational science department was hired as a permanent Math teacher by the same district.

10. Were the needs of urban participants different than suburban teachers?

There was no statistical difference between the group responses, except in two areas.

- Suburban teachers did not find the technology tools to be an incentive for their participation. They found the quality of training and the uniqueness of the CMST tools interesting. The Brighton Central School District had already committed to providing all the 7-12 grade MST teachers with laptop computers this school year in support of our project. Further, the purchase of graphing calculators by both parents and the Brighton District is also expected to occur this year. The Rochester City School teachers, on the other hand, were very motivated by the offering of these laptops. Most believed that without these technology tools many of the teachers would not have been able to participate in the Summer Institute. Urban teachers stated they did not think the majority of their students would have the financial support to purchase graphing calculators nor did they anticipate that their school would be able to purchase the number needed.
- Five of the six suburban teachers did not anticipate any barriers in their school that would prevent them from fully implementing the CMST approach in their classrooms, whereas all of the urban teachers anticipated some or many barriers in their schools.

C. Curriculum and Classroom Impact:

Current records show that three of the 6 SUNY students were hired by the RCSD; of the six teachers from Brighton, four returned to teaching in Brighton, one (Jeff McKinney) was promoted to an administrative position at Greece Arcadia middle school, and one (Kimberle Ward) accepted an administrative job, as a vice principal at Corning high school (NY). The two teachers who took administrative positions at suburbs of Rochester have submitted proposals to continue promoting CMST approach and help recruit students for Brockport's MST programs.

Of the 48 Rochester City School District teachers, forty-five returned to the classroom; one teacher moved out of the area, two were granted sabbaticals and one was promoted to Lead Mathematics Teacher position (while still teaching). CMST Project staff is working with the two participants who have relocated to new school districts in an effort to explore the possibilities of rolling out the CMST methodology at these new locations. The two teachers on sabbatical are doing research on the CMST pedagogy, are serving as Coaches at their schools and intend to offer CMST training for teachers within the district in 2003-04. The teacher who

was promoted to Lead Mathematics teacher (Jeff Mikols) is working directly under the supervision of the RCSD's Director of Mathematics/CMST Co-Director. In his new position he will be providing CMST training and support for the district math teachers as CMST project Coordinator at his district.

Of the 6 SUNY Brockport students, three were offered positions at RCSD, therefore making up for teachers who took sabbaticals and leaves.

The teacher from Brockport High School (Jade Bowdler) returned to teaching. She is an excellent teacher and is expected to disseminate the CMST approach into her school district. Along with two Brighton teachers who took positions at Greece and Corning, these three teachers are expected to continue their CMST promotional activity beyond the original two districts. As planned, this project is expected to promote CMST approach at other school districts within the Monroe County School Districts Association (MCSDA). The executive director of MCSDA, Jody Siegel, is an Advisory Board member of our project from the beginning.

Teachers have just begun teaching classes. They have agreed to use the PDA Logs and this objective will be assessed as the data becomes available. Preliminary response to using the reporting logs created by CMST on ANGEL during the month of September is averaging about 50% of the CMST teachers. It is anticipated that this will increase in October. Of those teachers who have recorded activities and observations in the online Logs, the information is providing a wealth of teacher input and is expected to be a valuable tool for project assessment and teacher information.

Following are testimonies of 3 teachers from RCSD and BCSD, who have started implementing CMST tools and approach in their classrooms and districts.

Jeffrey Mikols (RCSD –High School Math Teacher):

"I have had the opportunity to be a participant in the CMST Program at the State University of New York College at Brockport. As a participant in the MSP Project, I received four weeks of intensive training in technology, with the intent of applying this to classroom lesson planning. We were trained on the Texas Instruments TI-83+ graphing calculator, STELLA, AgentSheets, and Interactive Physics. I had the opportunity to apply this training to writing lesson plans that incorporate the use of technology. As the Secondary Mathematics Lead Teacher of the Rochester City School District, I have begun to train teachers to implement technology and promote change in the mathematics classroom.

The SUNY-Brockport MSP Project has helped teachers and administrators by providing training in technology based approaches to mathematics and science lessons. Technology has made it possible to change the way teachers approach mathematics and science to make lessons that are exciting to students and relevant to their interests. New York State Educational Standards specifically target the use of technology as methods of communication and information gathering systems. In the Rochester City School District, I have made it a priority to begin training building specialists on the TI-83+ graphing

calculator so they can train the teachers in their individual buildings. We have trained these specialists in lessons from eighth grade curriculum up to eleventh grade curriculum. The earlier our students are proficient with graphing calculators, the more they will benefit from them as move through high school curriculum. Teachers that participated in the CMST Summer Program are using the training they received and are beginning to implement this training into their classroom and producing high quality lessons. This is a primary step in improving math and science education in our schools.

The professional development provided by the MSP Project has been different than other professional development I have received on many levels. The MSP Project provides teachers with direct training on specific methods to change mathematics and science teaching. Teachers were trained on the technology and then asked to reflect and implement what they learned in planning classroom lessons. The Summer Institute was well staffed with knowledgeable professors. Questions pertaining to the programs we were trained on were answered efficiently yet thoroughly. The training went very fast at times, but there was support available. The MSP Project provides ongoing training during the school year with the expectation that teachers trained are going to continue using the training they received throughout the school year. There are regular checkpoints of accountability in place to ensure that teachers are doing this. The participating teachers have each been assigned a coach to provide help where necessary. This ongoing training and accountability are essential for any professional development to have a lasting effect on the way teachers conduct their practice.

I believe that the greatest barrier in implementing the latest and best research into the classroom is teachers not changing their practice. This failure to change practice is partially because of lack of training or awareness of alternative methods, but also because teachers do not admit the need to change is necessary. The MSP Project is good model to approach this problem. It has provided teachers with the necessary training and subsequent support to facilitate change in classroom practice. As teachers implement technology into their lessons, and students learn more and enjoy mathematics and science more, it is my belief that other teachers who are reluctant to change their practice will take notice of the improved student outcomes and want to change as well. I have begun trying to implement this change in approach with building specialists in my district. The specialists have been very eager to be trained on the TI-83+ graphing calculator, so the potential for change at their individual buildings is a reality. I have seen teachers in classrooms beginning to implement graphing calculators into their lessons, and they are realizing the benefits of using them.

The best way to recruit high quality mathematics and science teachers is create students that love to learn these subjects. If high school students enjoy learning these subjects and see the relevance in their lives that these subjects have, there is a better chance that these students will consider teaching these subjects as a career. There must be exciting opportunities for students to experience technology and real life application in mathematics and science. The MSP Project has tremendous potential to foster this type of interest. Many students have a natural interest in technology and how it is applied. Recently, the MSP Project hosted an Interactive Physics Day where students from

Rochester City Schools and Brighton Central schools received the opportunity to see how technology relates to Physics. I believe the MSP Project could make more inroads into the individual schools by presenting demonstrations for students to participate in. The benefits of teaching mathematics and science must be "advertised" more effectively and earlier in the students' high school career. Teaching must be made a first choice, not a career to fall back on."

Michael Baskin (RCSD- Middle School Math Teacher)

At Dr. Freddie Thomas High School the MSP is closely aligned to the districts initiative to change the teaching culture from teacher centered to student centered. Within the framework of this model is a structured classroom that creates independent learners with guidance and coaching from the teacher/facilitator. Each class is structured around an America's Choice classroom with Rituals and Routines, an Opening, Mini-lesson, Independent learning/exploration, and closing. While we are getting closer to providing high quality education to all students, our biggest obstacle is overcoming student disciplinary issues.

The MSP is not just based in theory. It is practical "real-world" examples of how the math/science/technology concepts look and feel in a real application. It combines the elements of differentiated instruction and multiple intelligences and seeks to engage the student. While it is very intense, I feel the coaches' network and the continued MSP faculty support encourages success in the classroom. Kids want to know how to make the theory real for them and give it meaning. The MSP is aligned to this orientation.

The greatest barriers to bringing the latest research in math and science to the classroom at the RCSD is the lack of available technology. With numerous cutbacks we lack the people to write grants to obtain the technology we need from graphing calculators to computers.

Teacher practice is changing and will continue to slowly change if we can create a learning environment in the classroom. So far the lack of meaningful consequences for behavioral issues is significantly impeding teacher's ability to create a learning environment in their classrooms.

The enthusiasm shared by the first cohort will entice others to partake in the program. This is the best form of promotion/advertising for new participants in the program. Additionally a brief demonstration of the tools and resources and capabilities the program offers should seal the deal. In the immediate future unless your moving forward with your education by continuing the learn you will become one of the uneducated.

The MSP Project is engaging. It asks us to tear down the boxes that may have restricted our thinking in the past and step outside our comfort zones much as we expect from our own students."

Ed Chi (BCSD- Middle School Science Teacher)

"The CMST program has made plans to speak to and collaborate with participating teachers and their administrators. Their goal is to share the CMST mission statement with these administrators

and seek ways to support the efforts of the CMST teachers and coaches. At Twelve Corners we have taken steps to load modeling software onto school networks and share activities and knowledge with faculty at department meetings. The students in my classes have expressed great interest in receiving training on modeling software and creating opportunities to allow them to take charge of their learning.

About the summer workshop: The content was technologically intensive yet practical. We could see ways to integrate them into our own programs. There was a constant theme of interdisciplinary approaches to these activities. They made every attempt to include math, science and technology into every aspect of the training. This was no small feat.
Most professional development workshops end when the presenters and facilitators hand out evaluation forms. The CMST has kept their promise to continue the collaboration well beyond the end of the summer program. We communicate via weekly teacher's logs and coach's logs. There have been invaluable meetings where we have offered feedback and suggestions on ways to make the program more effective. I feel as though I am partly responsible for shaping the CMST program not just participating in it. Perhaps it is because this is a young program in Brockport or because the people are confident enough in their own area of expertise to listen to others. Whatever the reason I feel a true sense of collegiality here.

About barriers: For myself thus far the greatest barrier has been the lack of technology available in the schools. This can stifle the efforts of the teacher to incorporate meaningful activities in the classroom. If it was not for the talents of the CMST faculty I would be unable to provide my students with the ability to explore the connections between science, math and technology in my classroom in a meaningful way.

About incentives: Good pay incentives; access to technology plus the support to get it into the hands of students and use it effectively in the classrooms attracts good teachers and keeps them. I will admit that the pay, technology, and support incentives provided by the CMST program drew me in, and has meet and exceed my expectations."

E. Sustainability and Institutional Change

1. ***What steps are being taken in Year 1 to integrate the CMST pedagogy into math and science education at SUNY Brockport?***

Analysis of CMST faculty reports indicates that individual faculty has begun incorporating CMST pedagogy into their classes in a variety of ways. The following excerpts from summaries by faculty show the range and depth of faculty approaches for incorporation in 2003-04. Of the faculty that participated in the CMST Summer Institute, two have been promoted with SUNY Brockport College and their teaching responsibilities have changed significantly. Jose Maliekal has been promoted to the Associate Dean position. He was CMST Coordinator for Institutional Change and we believe his new position will be supportive of his CMST role. The other member (Raj) has been promoted to the Director of Master's in Liberal Studies program, which draws many teachers from the community to higher education at Brockport. Dr. Raj was the

CMST Coordinator for Recruitment and his new position will also be supportive of his CMST role.

Computational Science Department Faculty member:
"All courses in the Computational Science department make extensive use of computational technology to perform modeling and simulation. Besides general purpose tools such as Fortran and C/C++ compilers and Matlab, the courses I teach include use special purpose software packages such as:

- Fire!, distributed by Shodor, used in CPS304 (Simulation and Modeling).
- SIMPROCESS, distributed by CACI, used in CPS304 and CPS633 (Dynamical Modeling).

I plan on adding AgentSheets to CPS304 and CPS633; and Stella to CPS304 and perhaps CPS632 (Deterministic Dynamical Systems)."

Mathematics Department Faculty member:
"I have been using Excel for many years in my courses, where appropriate. I have also been using some of the JAVA applets on the Project Interactive site, especially in my Math for Elementary Teachers classes. I think these applets are very well done and are a wonderful addition to my class. There were a few applets that were introduced to me (such as fire) that I had not used before and I plan to use that in my Math for Elementary Teachers II when we talk about probability.

Three of the tools, Stella, Agent Sheets and Interactive Physics, were new to me, and I found them to be quite interesting. Although I personally enjoyed learning about Stella, I do not see using in my classroom that much. I do think that I can construct models in Agent sheets that would be useful in my class. I am teaching MTH 605 Problem Solving and I plan to use both Stella and Agent Sheets in the class.

If I were teaching calculus, I would definitely use Interactive physics as well, but the courses I am currently teaching do not directly lend themselves to this software.

I have used graphing calculators for many years in all of my classes and will continue to do so. Although I considered myself an expert in the use of the calculators, I did learn a few new tricks that I found to be very useful. I mostly use the graphing calculators in classes such as Calculus, Business Calculus, Finite Math, and Pre-calculus. I look forward to using some of the new applications in my other classes. For example, there is an application called Cabri Junior, which is a tool for doing geometric constructions and calculations. I really look forward to exploring the possibility of using this in my MTH 314, math for Elementary Teachers II and MTH 432/532 College Geometry.

I also plan to offer some training for the Faculty in my Department. I think the faculty would benefit tremendously from tools we introduced to this campus. It is my hope that this training will allow the Departments of mathematics and Computational Science to work more closely on curricular development and perhaps even some cross-teaching of courses in the two departments."

Chemistry Department Faculty Member:

"The primary tool used in courses at this point is Microsoft Excel. In the future, Agentsheets will be incorporated into courses to model probabilistic events that occur in separation sciences."

Physics Department Faculty Member:
"I have used LabView and Excel in my laboratory classes, particularly, College Physics Labs, for the past three years, in fact I initiated implemented its use. In these labs the experiments are set-up on bench tops and data is collected from transducers through a data acquisition board well suited for LabView. The data analysis is carried out using Excel, for graphing least squares fitting, etc. This will continue with the addition of different experiments and their rotation.

Excel has been used for one dimension kinematics and projectile motions. The equations of motion have been specific solutions and are easily entered with formula available with Excel. These equations are used to generate data, which can be used to generate graphs of position, velocity and acceleration as functions of time. These graphs are a powerful way of correlating derivatives to slopes and thus instantaneous velocities and accelerations.

I plan to use interactive physics in my college physics as a tool for visualization and during problem solving sessions. The actual word problems can be set up using interactive physics and stepped through, in parallel with my own narration. Once set up properly a problem can be stepped through providing a visualization and even numerical solution to a word problem. This can provide a check for solving the problem analytically and thus build the student's confidence."

Computational Science Department Faculty member:
"For the courses I currently have, the main tools being used are FORTRAN and C/C++. Two of these courses (CPS 303 and CPS 602) are high performance computing courses that rely heavily on parallel computing. As most high performance computing environments are UNIX/LINUX based, introduction of CMST tools requires creativity. I have found that for CPS 303, there are many opportunities to use the tools (particularly Agent Sheets) as motivation and description of parallel programming assignments. Using Agent Sheets will provide a concrete, visual description of the programming goal. In CPS 602, there are many tools arising that will prove useful. Currently, we make use of the Partial Differential Equation Toolbox for MATLAB. This tool makes the numerical solution of highly complex systems of partial differential equations very easy and accessibly to anyone. MATLAB is purely a serial programming environment, but there are open source tools that work in a similar manner for parallel environments. These include The Portable, Extensible Toolkit for Scientific Computation (PETSc) , PHAML (Parallel Hierarchal Algebraic Multilevel solver), PARMS (Parallel Algebraic Recursive Multigrid Solver).

My other course (CPS 201) concentrates on learning FORTRAN 90. This subject matter is critical to the future success of a student in our program and it is important to have this course remain so in order to assure that students be successful. However, as in CPS 303, the tools can be used as motivation for why certain types of programming tools are needed and can be used to provide concrete descriptions of programming assignments. "

Earth Science Department Faculty member:
"Prior to the Summer Institute, I attended a weeklong training session, which enabled me to learn about three software packages, Agent Sheet, Interactive Physics, and Stella. The CMST training is enabling me to use Stella to demonstrate principles of Earth System modeling in ESC 350, Computational Methods in the Field Sciences. This is a required course for students seeking teacher certification in Earth Sciences. In fact, I have added Earth System modeling as a new topic in ESC 350.

Based on my observations of teachers participating in the Summer Institute, I have observed that schoolteachers are very eager to learn the CMST pedagogy. Their enthusiasm to incorporate modeling and simulation activities into their teaching is very high. An impediment against incorporating new technology is time and resource constraints. One solution might be to make the format of the Summer Institute to resemble that of a Workshop. My experience also tells me that one-on-one (or in small groups) interaction is enabling schoolteachers to learn new technology skills.

In some school buildings, teachers do not have access to adequate technology. Teachers also face time constraints. In addition, a person teaching a class that is directly related to a state-mandated examination, the school district and parents expect them to focus almost exclusively on test. This stifles innovation. Proving already developed lesson-plans might increase teachers' ability to integrate technology into their classrooms."

During the first year of the project, further efforts to include the CMST model are reflected in the college's Strategic Planning committee report submitted to the President by Vice Provost Michael Fox and his Committee, including the Center for Excellence in Learning & Teaching (CELT) Advisory Committee. Two CMST faculties are members of this Committee, which has been examining the question "How can faculty enable students to be better learners?" The CMST model is one of the critical vehicles for addressing this plan, which is summarized below.

2. *Is there evidence that CMST pedagogy is being reviewed for efficacy by national organizations? What is the result?*
An article titled "Elements of Computational Science and Engineering" has been submitted by the PI and accepted for publication in Journal SIAM Review (Vol. 45, No:4). The article has gone through a rigorous review for the past year. It makes direct references to the CMST pedagogy. It is expected to serve as a foundation for national CMST models.

The PI was invited to talk about CMST approach and NSF's MSP program at national conferences. A network of 300 people from SIAM and an audience of 100 people from NSF's NPACI (www.npaci.edu) partnership listened. As a result, he has been invited to take part in the next round of NSF's NPACI Partnership to promote CMST at a national level. He will be at NSF on October 21 to discuss a partnership with the NPACI-EOT institutions.

Regionally, the PI has been promoting CMST at SUNY level. He has been given important opportunities to talk about CMST. SUNY College at New Paltz has invited him to give a talk on October 15 to their campus faculty, which could lead to establishment of a Computational

Engineering program at New Paltz. These efforts all provide opportunity for review of the CMST approach.

3. *To what degree, district-wide technology tools were available to students and teachers for CMST applications?*

Project Co-Directors, together with Tim Cliby, Director of Instructional Technology at the Rochester City School District, are currently assessing what technology tools are available to the CMST teachers for the 2003-04 school year. On a district-wide basis, this objective will be measured at a later date during the project year. PI and Project Directors have met with the Technology Directors of both Districts to review their long term Technology Plans. The initial survey results, interviews and input from staff and teachers indicate that within the urban district this may be the most complex aspect of the project's implementation plan. Availability and access to technology and software at some urban school sites is good. For example, Wilson Magnet High School (1,000 students) has a Computer Science Program that offers state-of-the-art technology in many of the school's classrooms. Also, at East High School (2,000 students) the classrooms are equipped with full sets of graphing calculators which teachers and students have access to all day, every day. However, at the other participating schools, the technology access is less clear. Within the City School District, computer distribution between Labs, classroom computers and mobile laptops is in varying stages of phase-in and network wiring to accommodate for maintenance of bandwidth is also in flux. Reports show that the district is committed to moving from an aging analog WAN connection by modem to LAN-WAN connections providing digital access but this process is slow due the size of the district, the aging structure of some schools and the overall financial constraints of the district.

The Brighton School District has one high school and one middle school and adequate financial support to provide teachers and classrooms with consistent access to technology tools. Brighton has provided all 7-12 grade teachers with laptop computers and because family income levels (and educational levels) are significantly higher than the urban district, student's parents are more able to provide graphing calculators for them. At the RCSD, where the poverty rate is roughly 80%, families are less likely to provide their children with graphing calculators and the district does not have the funds to equip all classrooms with a full set of graphing calculators.

CMST Project Directors see this situation as both a challenge and an opportunity. All partnerships are exploring different options for approaching the problem and this information will be collected and reported as the project implements strategies to overcome this obstacle.

SUNY COLLEGE & ROCHESTER CITY MATH and SCIENCE PARTNERSHIP

CORE PARTNERS:	WITNESS:	JOB/TITLE
SUNY College at Brockport	Osman Yaşar, PI	Prof. of Computational Science
Rochester City School District:	Jeffrey Mikols	High School Math Teacher
Brighton Central School District:	Ed Chi	Middle School Science Teacher

SUPPORTING PARTNERS:

Shodor Education Foundation	Krell Institute
Texas Instruments	Xerox Corporation
Monroe County School Boards Association	NY State Education Department
The Council of Chief State Schools Officers	The American Institute of Research

Partnership for Advanced Computational Infrastructure-Education,Outreach,Training

GOAL OF THE PARTNERSHIP:

-INCREASE STUDENT INTEREST AND ACHIEVEMENT IN MATH AND SCIENCE AT GRADES 7-12 and COLLEGE (BS, MS)

-INCREASE QUALITY AND QUANTITY OF STUDENTS SEEKING EDUCATION or CERTIFICATION in MATH, SCIENCE, and TECHNOLOGY (MST) FIELDS

-IMPROVE QUALITY AND RETENTION OF MST TEACHERS & COLLEGE FACULTY

WAYS TO ACHIEVE OUR GOAL:

FACULTY AND TEACHERS

-TRAINING and MENTORING
-SUPPORT (technology, stipend, scholarships)
-TEAM APPROACH and PEER NETWORKING
-NEW PEDAGOGIES AND TOOLS

STUDENTS

-NEW PEDAGOGY AND TOOLS BY TEACHER
-LAYERED APPROACH TO LEARNING
-INTEGRATED APPROACH TO MATH & SCI
-SCHOLARSHIPS
-TEAM PROJECTS & LEARNING VIA PEERS
-MENTORING BY TEACHERS & FACULTY

INTEGRATED (computational technology) APPROACH TO MATH & SCIENCE EDUCATION at Grades 7-12 and College:

Summer Training and Mentoring During the School Year

30 Math
20 Science
5 Tech

Teachers

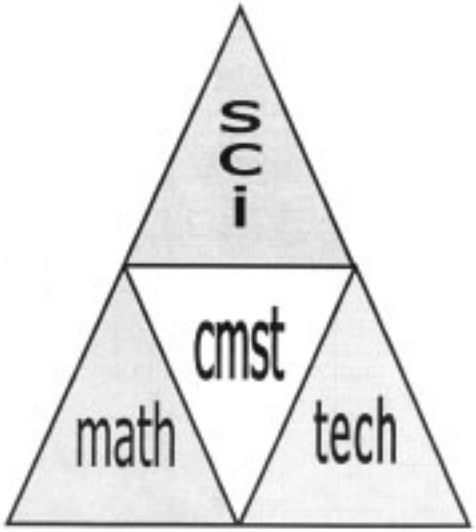
12 MST Faculty

20 Coaches

100 Students

COMPUTATIONAL MATH, SCIENCE, AND TECHNOLOGY (CMST) PEDAGOGY:

Layered Approach
Project-based Approach
Team-based Approach
Constructivist Approach
Inquiry-based Approach



Points of Interest:

-Partnership and Sustainability
-Design of Professional Development
    -CMST Summer Training (2-level)
    -CMST Coaching
    -CMST Education
    -CMST Challenge
-Needs of Individual Schools & Teachers
-Integration of CMST tools & approach into courses
-Assessing Impact on Teachers & Students
-Award Size & Number of Teachers
-Evaluation Plan & Mid-course Corrections

2003 CMST SUMMER INSTITUTE

(July 7-August 1)

-4 weeks of professional development
-Introductory-level training on:
CMST pedagogy
CMST tools such as TI-83+ calculator, Excel, STELLA, AGENTSHEETS, AND INTERACTIVE PHYSICS

2003 CMST SUMMER INSTITUTE

-56 MST Teachers, 6 Teacher Candidates, and 12 College Faculty
-Provided laptops and TI-83+ calculators to participants
-Provided software tools to all participants
-Instructional Team included college faculty, experienced teachers, and training specialists from Texas Instruments and Shodor Education Foundation

CMST Faculty and Coaches

2003 CMST SUMMER INSTITUTE

- 100 Lesson Plans were developed to integrate CMST pedagogy and tools into curriculum and classroom instruction in math and science
- Teams were formed in each of the 15 schools and across different schools to continue their joint undertaking
- 20 Coaches were assigned to participating 56 teachers, half of which is expected to apply for advanced training in 2004

A Team of MST Teachers from Wilson Magnet School

FUTURE OF CMST

-1st Annual Report submitted to NSF
-More teachers and faculty will be trained
-Independent Evaluator rated this project "the best" among all she evaluated since 1978
-Teacher Survey shows 100% satisfaction
-Web-site to be launched to disseminate lesson plans and results
-Impact in the classroom is to be evaluated
-Partnership to be expanded within NY State and nationally

OŞMAN YAŞAR
State University of New York, College at Brockport, NY 14420
Tel/FAX: (585) 395-2595/5020, http://www.cps.brockport.edu

AREA OF PROFESSION: Computational {Math, Science, and Technology}

EDUCATION:

- **University of Wisconsin-Madison/USA**
  - **Ph.D.** *Engineering Physics* 1986-1989
  - **M.Ş.** *Computer Science* 1988-1989
  - **M.Ş.** *Nuclear Engineering* 1986-1988
- **Hacettepe University-Ankara/TURKEY**
  - **M.Ş.** *Physics* 1980-1982
  - **B.Ş.** *Engineering Physics* 1976-1980

PROFESSIONAL EXPERIENCE:

- **State University of New York, Brockport**

2002 – Present	Director, CMST Institute
2002 – Present	Project Director, National Science Foundation, SCOLLARCITY MSP
1998 – Present	Professor and Chair, Department of Computational Science
2001 – Present	Chair, Faculty Senate Graduate Curriculum and Research Policies
2001 – Present	Member, Faculty Senate Executive Committee
2001 – Present	Member, Academic Priorities Committee
2001 – Present	Member, Strategic Planning Committee
2000 – Present	Senator, Faculty Senate
2000 – 2001	Member, Faculty Senate Budget and Resources Committee

Accomplishments: Founded the first undergraduate degree program in the United States in the area of Computational Science (1998). Developed undergraduate and graduate curricula, tenure guidelines, and student learning outcomes in an interdisciplinary field. Recruited 60 students and graduated 20 of them within 3 years. Issued the first B.S. degrees in computational science in the country. Designed and developed 18 new courses. Hired new faculty members and issued the first tenure in this field. Founded the Institute for Computational Math, Science, and Technology. Received two million dollar supercomputer equipment donations from Intel and Silicon Graphics. Collaborating with local industry Xerox and Kodak. Received support from members of the U.S. Congress. Received recognition from Chancellor of SUNY. Established a partnership with local public schools (Rochester City and Brighton Central) and obtained federal funds from the government in support of math and science education. Serving as the PI for an NSF grant ($3.4 million), which carries tuition scholarships for 80 master's students, training and laptops for 240 secondary school teachers, a challenge program for students, professional development for college faculty, and salaries for professors in more than 7 departments. Served as member for another NSF grant ($275 K), which carried 40 BMACS scholarships in Mathematics, Computer Science, and Computational Science programs. Received research awards from the U.S. Department of Energy to perform summer research at the National Energy Technology Lab (Morgantown/Pittsburgh) and Oak Ridge National Laboratory (TN). Carried research with General Motors and Cummins Engine Company to model spark ignition as part of engine combustion software. Edited a Special Issue of *J. Parallel*

Computing. Founded a software company (OYSOFT) and received two grants from U.S. Navy and one from Lockheed to support OYSOFT. Served as the President of High Performance Users Group and organized a national conference for its members, which included well-known researchers, educators, and government agencies.

- **Oak Ridge National Laboratory, United States Department of Energy**

  1998 – 2001 Senior Scientist, Engineering Technology Division (on sabbatical)
  1997 – 1998 Director, Computational Center for Industrial Innovation
  1994 – 1998 Consultant, Computational Center for Industrial Innovation
  1994 – 1998 Staff Scientist, Center for Computational Sciences

  Accomplishments: Helped scientists (in many disciplines) with their computational research. Founded a new research group in computational engine modeling. Developed the first distributed-memory parallel version of the engine code KIVA3. Teamed with Brookhaven National Lab and SUNY-Stony Book on development of molecular dynamics simulation software and helped break a world-record by simulating one billion particles on a 1024-node Intel supercomputer at ORNL. Assisted SUNY-Stony Brook and BNL with purchase of a 128-node Intel Paragon supercomputer. Participated in the USCAR and the Partnership for New Generation Vehicles (PNGV) initiatives, which involved Three Big Automakers (Chrysler, GM, Ford) and several major national labs of the U.S. Department of Energy. Developed a new ignition computer model to help design new spark plugs. Signed cooperative research and development agreements (CRADA) with General Motors and Cummins Engine Company. Served as the President of the Intel Supercomputer Users Group (ISUG). Founded the High Performance Computing Users Group. Organized 3 national conferences and published a Special Issue of *J. Computers and Mathematics*. Represented ORNL in the DOE-Strategic Simulation Initiative, which led to the President's IT^2 Initiative. Served as a consultant and later as director for Computational Center for Industrial Innovation (CCII) at ORNL. Took a long-term sabbatical as a member of the Engineering Technology Division to form the computational science program at SUNY Brockport. Continued summer research at ORNL for the Engineering Technology Division. Published research articles.

- **University of Wisconsin-Madison, College of Engineering**

  1993 – 1994 Manager and Staff Scientist, Computational Engineering Laboratory
  1991 – 1994 Manager and Staff Scientist, Center for Parallel Computing in Engineering
  1990 – 1991 Research Associate (Postdoctoral Fellow), Fusion Technology Institute
  1986 – 1990 Research Assistant, Fusion Technology Institute (20 hours/week)

  Accomplishments: Modified a radiation dose code (DKR) to run 100 times faster (1987) at San Diego Supercomputer Center. Developed Monte-Carlo codes for vector supercomputers and adapted the radiation dose code DKR to work with Monte-Carlo Neutral Particles (MCNP) and other particle transport codes from Los Alamos National Laboratory. Developed an adaptive-grid methodology for solving conservation laws on a finite-difference mesh (1988). Developed a combined plasma and radiation hydrodynamics code (1989) to assist Inertial Confinement Fusion devices at Sandia National Laboratories. Founded a new supercomputer center and received support from Intel to develop an engine-modeling code for Intel supercomputers (1990). Served as manager, scientist, and system administrator. Developed the first supercomputer version of engine modeling code KIVA-II; advised thesis work for 10 Ph.D. and 5 M.S. students from civil, chemical, nuclear,

mechanical, and engineering physics departments; served as member of Board of Executives for Intel Supercomputer Users Group; developed lectures and workshops for faculty and students on parallel computing (1990-1994). Regularly attended workshops at Argonne National Laboratory and San Diego Supercomputer Center. Founded a company (SuperTech) to sell supercomputers to Turkey and was granted distributorship by Intel (1993). Published research articles.

- **İnönö University-Malatya/TURKEY**
  1982 - 1985 Faculty Member and Teaching Staff, Physics Department
  Accomplishments: Designed and taught courses in College Physics, Nuclear Physics, Electromagnetism, Solid State Physics, and Electronics

- **Hacettepe University-Ankara/TURKEY**
  1980 - 1982 Teaching Staff, Physics Department, Hacettepe University/Turkey
  Accomplishments: Assisted with the Electronics Laboratory courses. Developed documentation and tutorials

SUMMER POSITIONS:

- **U.S. Department of Energy, USA** (3 months duration)

2001 Summer	Scientist, National Energy Technology Laboratory-Morgantown, WV
2000 Summer	Scientist, National Energy Technology Laboratory-Pittsburgh, PA
1999 Summer	Scientist, Oak Ridge National Laboratory, Knoxville, TN

- **Higher Education Institutions, TURKEY**

2002 Summer	Visiting Professor, Istanbul Technical University
1998 Summer	Visiting Professor, Middle East Technical University, Ankara
1998 Summer	Consultant, Turkish National Science Foundation
1998 Fall	Consultant, Istanbul Technical University

OTHER PROFESSIONAL EXPERIENCE:

1995 - Present	Adjunct Professor, Applied Math and Statistics, SUNY - Stony Brook
2001 - Present	Consultant, The Krell Institute, Ames, IA, 50010 (www.krellinst.org)
1998 - 2000	Consultant, Lockheed Martin Energy Research Corporation
1999 - 2000	Consultant, Naval Surface Warfare Center at Carderock
1992 - 1993	Consultant, Computer Center, Ege University/Turkey
1992 - 1993	Consultant, Kernforschungszentrum, Karlsruhe/Germany

COURSE & CURRICULUM DEVELOPMENT EXPERIENCE:

The following courses were developed for undergraduate students:
▫ Intro to Computational Science ▫ Computational Tools I and II ▫ High Performance Computing ▫ Simulations and Modeling ▫ Scientific Visualization ▫ Applied and Computational Math ▫ Intro to Computational Physics ▫ Intro to Computational Fluid Dynamics ▫ Intro to Computational Chemistry ▫ Intro to Computational Biology ▫ Computational Finance ▫ Embedded Computing ▫

GRADUATE STUDENT MENTORING:

20 Students (Advisor to 5 Ph.D., Co-Advisor to 5 Ph.D., Advisor to 15 M.S.); 5 NSF/DOE Scholars

POSTDOC ADVISING:

3 Postdocs at Oak Ridge National Laboratory (1994 - 1998)

LEADERSHIP EXPERIENCE:

1994 – Present	Various positions in Professional Societies (SIAM, SCS)
1997 - 2000	Founder/Chairman, High Performance Computing Users (HPCU) Group
1995 - 1997	President, Board of Directors, Intel Supercomputer Users' Group (ISUG)
1993 - Present	Executive Member, Board of Directors, Intel Supercomputer Users' Group

PUBLISHING EXPERIENCE:

- Editor, Special Issue of *Computers and Mathematics* (Vol. **35** (7), 1998)
- Editor, Special Issues of J. *Parallel Computing* (Vol. **27** (1), 2001)
- Publication Manager, *ISUG Newsletter,* (1993-1995)

ENTREPRENEURSHIP EXPERIENCE:

2001	One (1) Patent Pending, U.S. Patent and Trademark Office
1999 -	Chairman/Founder, OYSOFT
1992 - 1993	Director of Technology, SuperTech (Intel Supercomputer Distributorship in Turkey)

CONFERENCE ORGANIZATION EXPERIENCE:

2001 – Present	Organizing Committee, International Conference on Computational Science
1993 – Present	Program Committee, SCS High Performance Computing Symposium
2000	Session Chair, SIAM Conference on Computational Science and Eng
1999	General Chair, HPC Users Group Conference at SUNY Stony Brook
1995 - 1997	Chair, ISUG Annual Conferences
1993 - 1995	Member of Scientific Computing Advisory Committee, ACM

INDUSTRIAL COLLABORATIONS:

1998 - 2002	Research and Education Collaboration, Xerox Corporation, Webster, NY
1998 - 2002	Research and Education Collaboration, Eastman Kodak, Rochester, NY
1996 - 1998	Principal Investigator for CRADA Agreement with General Motors R & D Center
1996 - 1998	Principal Investigator for CRADA Agreement with the Cummins Engine Company

RESEARCH PRODUCTIVITY:

60 Publications, 2 Special Issues (Ed.), 42 Invited Presentations, 15 News Articles,
5 Posters, 11 Computer Software (Industrial) Codes

RESEARCH AREA:

Parallel Computing, Engine Combustion Modeling, Ignition Dynamics,
Plasma and Radiation Hydrodynamics

GRANTS EXPERIENCE:

SCOLLARCITY Math & Science Partnership (PI)	NSF	01/03 – 12/07, $3.4 M
BMACS Scholarship (Co-PI)	NSF	08/01 - 08/03, $273 K
Diesel Engine Simulations (PI)	U.S. Navy	10/99 - 09/01, $65 K
Spark Ignition Modeling (PI)	Lockheed Martin	11/98 - 10/00, $100 K
Acquisition of 4-node SGI Onyx2 (PI)	SGI/SUNY	07/98 - 09/01, $150 K
Acquisition of 16-node Intel Paragon (PI)	Intel (donation)	06/98 - 09/00, $400 K
Acquisition of 128-node Intel Paragon (Co-PI)	SUNY/Intel	03/96 - 09/00, $2.0 M
Spark Ignition Modeling-SIDI Engines (PI)	DOE/General Motors	10/97 - 10/98, $100 K
Spark Ignition Modeling-Nat Gas Engines (PI)	DOE/Cummins	01/96 - 09/99, $600 K

Engine Modeling on Intel Paragons (PI)	DOE/ORNL	06/95 - 09/97, $100 K
Particle Dynamics on Intel Paragons (PI)	DOE/ORNL	06/94 - 09/95, $100 K
Innovation in Parallel Comp Education (Co-I)	Intel/SUNY	07/94 - 07/96, $200 K
Parallel Sparse Matrix Library (Co-I)	Intel/UW-Madison	01/91 - 01/94, $100 K
KIVA Engine Modeling on iPSC/860 (PI)	Intel/UW-Madison	01/91 - 01/93, $100 K
Acquisition of 16-node Intel iPSC/860 (Co-I)	Intel/UW-Madison	01/91 - 01/94, $300 K

- Reviewer for NSF Grants (Information Technology Research, Math and Science Partnership)
- Reviewer for many computational journals, Society of Automotive Engineers Transactions, Society of Applied and Industrial Mathematics journals, Numerical Heat Transfer

SELECTED PUBLICATIONS:

1. O. Yaşar, "A New Ignition Model for Spark-Ignited Engine Simulationş," *J. Parallel Computing*, **27** (1), 179 (2001)
2. O. Yaşar, *et al.*, "A New Perşpective on Computational Science Education," *IEEE Comp. in Sci &Eng* **5** (2), 2000
3. O. Yaşar, "A Scalable Algorithm for Chemically Reactive Flowş," *Computers and Mathematics*, **35** (7), 1998.
4. O. Yaşar, "Computational Engine Modeling," *ORNL Review*, **30**, No. 3 & 4 (1997).
5. Y. Deng, *et al.*, "Molecular Dynamicş on MIMD Computerş," *Applied Math Letters*, **8** (3), 37-41 (1995)
6. O. Yaşar, G. Moşeş, "Explicit Adaptive Grid Radiation Magneto-hydrodynamicş," *Comp. Phys*, **100** (38), (1992).
7. O. Yaşar, G. Moşeş, "R-MHD Computer Code," *Comp. Phys. Comm.*, **69**, 439 (1992).

REFERENCES:

1. Dr. Gregory A. Moşeş, Profeşşor, Department of Engineering Phyşicş, Univerşity of Wişconşin-Madişon, WI 53706. Tel: (608) 265-6567, moşeş@engr.wişc.edu
2. Dr. M. Guven Yalcintaş, Vice Preşident, Reşearch Foundation of The State Univerşity of New York, Albany, NY 12201, Tel: (518) 434-7167, guven.yalcintaş@rfşuny.org.
3. Dr. Yuefan Deng, Profeşşor, Department of Applied Mathematicş, SUNY-Stony Brook, NY, 11794, Tel: (631) 632-8614, deng@amş.şunyşb.edu.
4. Dr. Rubin H Landau, Profeşşor of Phyşicş, Director, Computational Phyş Program, Oregon State Univerşity, Corvalliş OR 97331 USA, Tel: 541-737-1693, rubin@phyşicş.orşt.edu
5. J. T. Thomaş, Intel Corporation, Portland, OR, jt.thomaş@intel.com
6. Dr. Harv Periş, Superintendent, Brighton Central School Diştrict, Harv_Periş@bcşd.org
7. Margaret Crowley, Director of Math Program, Rocheşter City School Diştrict, Margaret.Crowley@rcşdk12.org
8. Dr. Ed Oliver, Aşşociate Director, Office of Science, U.S. Department of Energy, ed.oliver@şcience.doe.gov, Tel: (301) 903-7486
9. Dr. Thomaş Zacharia, Aşşociate Director, Oak Ridge National Laboratory, Oak Ridge, TN 37831, zac@ornl.gov

October 30, 2003

The Honorable Nick Smith
Chairman, Research Subcommittee
2320 Rayburn Office Building
Washington, DC 20515

Dear Congressman Smith:

Thank you for the invitation to testify before the U.S. House of Representatives Science Committee, Subcommittee on Research on October 30 for the hearing entitled *Implementation of the Math and Science Partnership Program: Views from the Field.* In accordance with the Rules Governing Testimony, this letter serves as formal notice of the Federal funding I currently receive in support of my research.

- Amount: $30,000; Award#: EHR-0226962, Agency: NSF, 2003

Sincerely,

Osman Yasar

Chairman SMITH. I am going to proceed the way you are arranged in my book, so Mr. Mikols, if you would—if you're comfortable in going next.

Mr. MIKOLS. Sure. Okay. Again, I asked the——

Chairman SMITH. Actually, I see Mr. Chi is ahead of you in my book.

Mr. MIKOLS. Oh.

Chairman SMITH. So it is not your turn.

Mr. MIKOLS. Oh. Then I will—let me turn mine off.

Mr. CHI. There we go.

Chairman SMITH. Mr. Chi, excuse me, please.

STATEMENT OF ED CHI, SCIENCE TEACHER, BRIGHTON SCHOOL DISTRICT, NEW YORK

Mr. CHI. That is not a problem, Chairman. First, I would like to thank everyone on the Committee for the invitation to come and speak.

And I first would like to begin with talking about why the MSP program is a necessary program. First, it is truly interdisciplinary. Through it, I have learned, and I have also shown my students, that no subject is an island. I often hear in my class that—they see, they are beginning to see connections between science and math and technology. And it often astounds them, because I guess in the past, they have seen each subject treated as an individual, and not together in a group, so this is one of their first opportunities to see all these different disciplines coming together in one activity.

Also, it is truly interdisciplinary in the fact that it incorporates math and technology into the science classroom. We are using math and we are using technology to do science in our classrooms, and I often hear my students say "Wow, this class is getting to be more like a math class than a science class." They are often checking to see if they are in the right room. So, I think that is testimony in itself that the program is working.

Another reason why this is a necessary program is because it is truly unique. I have attended many programs for professional development, and very few have really put together teachers that are in fact helping to shape the program as well. There is a youthful energy to everyone in the program, because we are—we feel as though we are on the cutting edge, and that is inspiring us and that is motivating us, and we are bringing that into the classroom as well.

Also, there is long-term continuous collaboration going on. Oftentimes, the second workshop is done, we get a little handout rating the workshop, but there has not been a clear cutoff point for this program. It is continuous. There is continuous collaboration going on between teachers in the classrooms and professors at the college, and amongst teachers between districts. And we also feel that the program and its administrators are invested in us. We feel as though we are—I hate to put it this way, but we feel as though we are star players in this program, and we definitely appreciate that.

Secondly, how is the MSP program achieving its goals? We are collaborating with teachers. Teachers are talking to each other. There is open conversation going on. We are not just isolated in our

own classrooms any more. They have also helped us to develop meaningful lesson plans. We have been able to overcome our initial fear of technology being incorporated into the classroom. They are exposing us and forcing us to be adventurous with our teaching styles. We have also been able to hone existing skills, any prior knowledge or any existing skills. We are able to advance and also we are able to share this with fellow colleagues. There is collaboration with administrators. There are plans to have a get together to discuss our mission statement with administrators all over the districts that are involved.

Also, we are getting students excited and interested, and ultimately, that is what we want. The simulation programs and the modeling programs have put them in charge. They are in charge of their own learning. They are beginning to—they are the creators of their learning, and they are pulling the strings, and by taking us, by that I mean the teachers, by taking us out of the driver's seat and putting them into it, they are beginning to own their education. They are—because they are so inspired—they go beyond where we would typically bring them.

There are, of course, some barriers to achieving our goals. There is always administration who aren't always as supportive as they could be, in terms of valuing technology and seeing it as an important component of education. Then there are also teachers who feel as though they themselves are not savvy enough to take on the responsibility and take on the skills that are required to teach technology and incorporate it into the science and math classroom, but the program is slowly but surely taking teachers who are savvy and teachers who are willing to take risks, and bringing them into the school, so that they can inspire students, and at the same time, because we have inspired students, other teachers are curious as to what we are doing to inspire students, and therefore, that is sort of a contagious atmosphere where other teachers can take some of that fear away and dive into the technology as well.

And that is really all I have to say for today. Thank you.

[The prepared statement of Mr. Chi follows:]

PREPARED STATEMENT OF ED CHI

How has the SUNY–Brockport MSP Project helped teachers and administrators understand and embrace the need to teach to high quality, standards-based math and science? Based on what you know—and have experienced to date—are the participating schools getting closer to providing high quality math and science education for all students?

The CMST program has made plans to speak to and collaborate with participating teachers and their administrators. Their goal is to share the CMST mission statement with these administrators and seek ways to support the efforts of the CMST teachers and coaches. At Twelve Corners we have taken steps to load modeling software onto school networks and share activities and knowledge with faculty at department meetings. The students in my classes have expressed great interest in receiving training on modeling software and creating opportunities to allow them to take charge of their learning.

How have the professional development opportunities provided by the MSP Project been different from other teacher training programs in terms of content, duration and intensity?

The content was technologically intensive yet practical. We could see ways to integrate them into our own programs. There was a constant theme of interdisciplinary approaches to these activities. They made every attempt to include math, science and technology into every aspect of the training. This was no small feat.

Most professional development workshops end when the presenters and facilitators hand out evaluation forms. The CMST has kept their promise to continue the collaboration well beyond the end of the summer program. We communicate via weekly teacher's logs and coach's logs. There have been invaluable meetings where we have offered feedback and suggestions on ways to make the program more effective. I feel as though I am partly responsible for shaping the CMST program not just participating in it. Perhaps it is because this is a young program in Brockport or because the people are confident enough in their own area of expertise to listen to others. Whatever the reason I feel a true sense of collegiality here.

What do you believe is the greatest barrier to bringing the latest and best research on math and science education into the classroom? Based on what you know, is teacher practice in the classroom changing?

For myself thus far the greatest barrier has been the lack of technology available in the schools. This can stifle the efforts of the teacher to incorporate meaningful activities in the classroom. If it was not for the talents of the CMST faculty I would be unable to provide my students with the ability to explore the connections between science, math and technology in my classroom in a meaningful way.

Based on your experience, how do we recruit and retain the best math and science teachers? How has the MSP Project addressed—or failed to address—these issues?

Good pay incentives, access to technology plus the support to get it into the hands of students and use it effectively in the classrooms attracts good teachers and keeps them. I will admit that the pay, technology, and support incentives provided by the CMST program drew me in, and has meet and exceed my expectations.

BIOGRAPHY FOR ED CHI

Ed Chi teaches science to 7th and 8th grade students at Twelve Corners Middle School in Rochester, New York. Twelve Corners Middle School is the sole institution educating students in grades 6–8 in the Brighton School District.

November 4, 2003

Honorable Nick Smith
Chairman, Research Subcommittee
2320 Rayburn Office Building
Washington, DC 20515

Dear Congressman Smith:

Thank you for the invitation to testify before the U.S. House of Representatives Science Committee, Subcommittee on Research on October 30 for the hearing entitled *Implementation of the Math and Science Partnership Program: Views from the Field.* In accordance with the Rules Governing Testimony, this letter serves as formal notice of the Federal funding I currently receive in support of my research.

Amount: $2,000 (stipend plus laptop)
Grant Number: EHR-0226962
Agency: NSF
Title: SCOLLARCITY MSP
Fiscal Year: 2003

Sincerely,

Ed Chi

Chairman SMITH. Mr. Chi, very good, thank you. Mr. Mikols.

STATEMENT OF JEFFREY M. MIKOLS, MATH TEACHER, ROCHESTER CITY SCHOOL DISTRICT, NEW YORK

Mr. MIKOLS. Again, I would like to thank this committee for inviting me to speak and give testimony about what it is that we have experienced. And in my role as a lead teacher in the Rochester City School District, I am in a unique—I have a unique opportunity to promote change, and as you, Mr. Smith, mentioned with the TIMSS Report, the concern that we have as to how the United States is doing is something I share within our own district. Our district, right now, as Dr. Yasar has mentioned, is not a high performing district right now, and it is a burden that we all carry, and we realize that the need for change is extremely important.

And technology is one of the mechanisms we can use to change the way that teachers are approaching math and science. Technology, for many kids, in and of itself, is very, very interesting to them. I have two young sons at home, and just get them a Game Boy and they are clicking away, and they have a great time with that. But perhaps more importantly, what technology does is it facilitates investing in topics of student interest. They find something that they are interested in, and the use of technology lets them gather information, draw conclusions, verify conclusions in a way that is much quicker than we have ever been able to do before, so this use of technology is very appropriate.

Technology has made it possible to change the way teachers approach math and science, and they can make lessons that are exciting and relevant to student interest. That is the key thing. Teachers can teach what they think is important, but until it gets down to the point where students are pursuing things that are directly relevant to them and interesting to them, they are not going to achieve to where we want them to be achieving.

In my role, I do conduct quite a bit of professional development, and having been trained in the Summer Institute, and also having some prior experience with graphing calculators, we have made that a priority in our district, that all schools should have teachers that are competent in using these tools with their students. Additionally, there were other tools that we used in the CMST [computational math, science, and technology] program, such as STELLA, AgentSheets, Excel, and a lot of these tools are things that are so applicable to what students would find interesting, and still cover the types of mathematical and scientific content that are required in standards.

In our district, as I mentioned, we are low achieving, but making teachers aware that these avenues are available, and that change is necessary, this is one of the first steps that we can make toward improving math and science education in our district.

The CMST program, under the MSP project, has offered some excellent opportunities in terms of professional development. The Summer Institute was extremely well-staffed with knowledgeable professors, and a lot of us went in not knowing how to use a lot of the tools that were being used, and we were provided with very quick feedback that was extremely helpful.

The MSP project also provides ongoing training during the school year, with the expectation that teachers trained are going to continue using the training. That is extremely important, because when you talk about implementing professional development effectively, if there is no follow-up to that professional development, it is rare that that change is going to have any kind of long-lasting effect. And so there are regular checkpoints along the way to make sure that teachers who were trained in this program are continuing to work in the things that they were trained in and having direct implementation into the classroom lessons that they are preparing.

Some of the barriers that I would like to discuss, one of them is perhaps financial. It is not the greatest barrier, because I think there are—through the availability of grants and other types of monies, the types of tools that we use can be available for students. I think the greatest barrier is, perhaps, the lack of willingness for

teachers to change their practice. We were discussing over lunch that many times, teachers feel uncomfortable in changing their practice and John Dewey used a term called cognitive dissonance, which mentioned that until people feel uncomfortable, real learning doesn't occur. Once they feel uncomfortable and feel the need to take on something, to do something about that discomfort, then people will pursue that and learn something from it. Teachers may be very, very reluctant to work in these different kinds of changes that we are asking them to, but in a sense, that discomfort is a good sign, because they realize that they need to do something different, so it is very important that they are pursuing those things.

In terms of recruiting the best teachers, and I know I am getting very close to running out of time, so I want to make this one last point, in terms of recruiting the best possible teachers, we need to reach our students early and we need to make them lovers of mathematics and science at an early age, and if we can do that, the likelihood that they are going to pursue a career in math and science teaching I think goes up.

[The prepared statement of Mr. Mikols follows:]

PREPARED STATEMENT OF JEFFREY M. MIKOLS

I have been a teacher for the Rochester City School District since 1993. I have a Bachelor of Arts in Mathematics and Master of Science in Mathematics Education from the State University of New York College at Geneseo. I am currently enrolled in a Certificate for Advanced Study in School Administration from the State University of New York College at Brockport. During my tenure with the Rochester City School District, I have had the opportunity to teach a wide range of courses from Pre-Algebra in the seventh grade to Advanced Placement Calculus to seniors. I am currently the Secondary Mathematics Lead Teacher. I am responsible for providing professional development to mathematics specialists assigned to each of our secondary buildings. These building specialists then provide this professional development to the teachers in their building. Additionally, I work in classrooms with teachers modeling, coaching, and serving as resource to them.

Testimony

I have had the opportunity to be a participant in the CMST Program at the State University of New York College at Brockport. As a participant in the MSP Project, I received four weeks of intensive training in technology, with the intent of applying this to classroom lesson planning. We were trained on the Texas Instruments TI–83+ graphing calculator, STELLA, AgentSheets, and Interactive Physics. I had the opportunity to apply this training to writing lesson plans that incorporate the use of technology. As the Secondary Mathematics Lead Teacher of the Rochester City School District, I have begun to train teachers to implement technology and promote change in the mathematics classroom.

The SUNY–Brockport MSP Project has helped teachers and administrators by providing training in technology based approaches to mathematics and science lessons. Technology has made it possible to change the way teachers approach mathematics and science to make lessons that are exciting to students and relevant to their interests. New York State Educational Standards specifically target the use of technology as methods of communication and information gathering systems. The natural curiosity of students concerning technology has enabled teachers to design and carry out lessons that involve an inquiry approach.

In the Rochester City School District, I have made it a priority to begin training building specialists on the TI–83+ graphing calculator so they can train the teachers in their individual buildings. We have trained these specialists in lessons from eighth grade curriculum up to eleventh grade curriculum. The earlier our students are proficient with graphing calculators, the more they will benefit from them as they move through the high school curriculum. Teachers that participated in the CMST Summer Program are beginning to implement training they received into their classroom and are producing high quality lessons. This is a primary step in improving math and science education in our schools.

The professional development provided by the MSP Project has been different than other professional development I have received on many levels. The MSP

Project provides teachers with direct training on specific methods to change mathematics and science teaching. Teachers were trained on the technology and then asked to reflect and implement what they learned in planning classroom lessons. The Summer Institute was well staffed with knowledgeable professors. Questions pertaining to the programs we were trained on were answered efficiently yet thoroughly. The training went very fast at times, but there was support available. The MSP Project provides ongoing training during the school year with the expectation that teachers trained are going to continue using the training they received throughout the school year. There are regular checkpoints of accountability in place to ensure that teachers are doing this. The participating teachers have each been assigned a coach to provide help where necessary. This ongoing training and accountability are essential for any professional development to have a lasting effect on the way teachers conduct their practice.

I believe that the greatest barrier in implementing the latest and best research into the classroom is teachers not changing their practice. This failure to change practice is partially because of lack of training and awareness of alternative methods, but also because teachers do not admit the need to change is necessary. The MSP Project is a good model to approach this problem. It has provided teachers with the necessary training and subsequent support to facilitate change in classroom practice. As teachers implement technology into their lessons, and students learn more and enjoy mathematics and science more, it is my belief that other teachers who are reluctant to change their practice will take notice of the improved student outcomes and want to change as well. I have begun trying to implement this change in approach with building specialists in my district. The specialists have been very eager to be trained on the TI–83+ graphing calculator, so the potential for change at their individual buildings is a reality. I have seen teachers in classrooms beginning to implement graphing calculators into their lessons, and they are realizing the benefits of using them.

The best way to recruit high quality mathematics and science teachers is to create students that love to learn these subjects. If high school students enjoy learning these subjects and see the relevance in their lives that these subjects have, there is a better chance that these students will consider teaching these subjects as a career. There must be exciting opportunities for students to experience technology and real life application in mathematics and science. The MSP Project has tremendous potential to foster this type of interest. Many students have a natural interest in technology and how it is applied. Recently, the MSP Project hosted an Interactive Physics Day where students from Rochester City Schools and Brighton Central schools received the opportunity to see how technology relates to Physics. I believe the MSP Project could make more inroads into the individual schools by presenting demonstrations for students to participate in. The benefits of teaching mathematics and science must be "advertised" more effectively and earlier in the students high school career. Teaching must be made a first choice, not a career to fall back on.

BIOGRAPHY FOR JEFFREY M. MIKOLS

I have been a teacher for the Rochester City School District since 1993. I have a Bachelor of Arts in Mathematics and Master of Science in Mathematics Education from the State University of New York College at Geneseo. I am currently enrolled in a Certificate for Advanced Study in School Administration from the State University of New York College at Brockport. During my tenure with the Rochester City School District, I have had the opportunity to teach a wide range of courses from Pre-Algebra in the seventh grade to Advanced Placement Calculus to seniors. I am currently the Secondary Mathematics Lead Teacher. I am responsible for providing professional development to mathematics specialists assigned to each of our secondary buildings. These building specialists then provide this professional development to the teachers in their building. Additionally, I work in classrooms with teachers modeling, coaching, and serving as resource to them.

November, 9 2003

The Honorable Nick Smith
Chairman, Research Subcommittee
2320 Rayburn Office Building
Washington, DC 20515

Dear Congressman Smith:

Thank you for the invitation to testify before the U.S. House of Representatives Science Committee, Subcommittee on Research on October 30 for the hearing entitled *Implementation of the Math and Science Partnership Program: Views from the Field.* In accordance with the Rules Governing Testimony, this letter serves as formal notice of the Federal funding I currently receive in support of my research.

- $800 stipend for participating in Summer Institute
- $1200, IBM Thinkpad Laptop
- $125, TI-83+ Silver Edition Graphing Calculator

All of these were received from the CMST Summer Institute from the State University College of New York at Brockport. If there is more information that you need, I will be happy to help.

Sincerely,

Jeffrey M. Mikols

Jeffrey M. Mikols

Chairman SMITH. Thank you. Dr. Navarro.

STATEMENT OF M. SUSANA NAVARRO, PRINCIPAL INVESTIGATOR FOR THE COMPREHENSIVE MSP GRANT AT THE UNIVERSITY OF TEXAS, EL PASO

Dr. NAVARRO. Mr. Chairman, Ranking Member Johnson and Members of the Committee, I am pleased to be here to share with you the work of the NSF-funded El Paso Math and Science Partnership.

Over the past decade, the NSF has been a valuable partner in supporting improved math and science instruction and achievement across the El Paso community. What the MSP now provides is an opportunity to bring together partners across our entire community, K–16, toward the shared development and implementation of high quality practices aimed at improving academic achievement among all students.

Over the last decade, the community of El Paso has distinguished itself as one that is deeply committed to ensuring academic success among all of our youngsters. Our strong focus on education in El Paso reflects the reality that there is so much at stake in ensuring that this growing, largely Hispanic community is able to create opportunities for its more than 700,000 citizens and over 155,000 students.

Currently, our per capita income lags behind both the State and the Nation, and the median household income ranks sixth lowest in the U.S. The overall educational attainment of our citizenry is low as well. Just 68 percent of the population aged 25 and older have earned a high school diploma and fewer than 16 percent of El Pasoans hold bachelors degrees or higher.

Against these tremendous odds, the El Paso community has demonstrated its commitment to high academic achievement and we have shown that we can do it. For example, the achievement gap of which Member Johnson spoke of, as measured by TAAS mathematics, is at its lowest point since El Paso's NSF-funded systemic reform efforts began in 1994. From a high that year of 21 points between Hispanic and white students and 27 points between African-American and white students, the gap has been reduced to 5.7 and 7.9 points respectively.

In addition, enrollment in college preparatory math and science courses, which we consider absolutely key, has increased significantly over the past year, with over three fourths of our students, of all of our students, now enrolled in algebra I, geometry, algebra II, biology and chemistry. This is a radical shift from what occurred——

Chairman SMITH. From one of the other, or all of them?

Dr. NAVARRO. All of our students, over three fourths of all of our students.

Chairman SMITH. I mean all of those courses, they are in one of those courses?

Dr. NAVARRO. That is right.

Most significantly, pass rates improved greatly over the past year. Notably in geometry, where 86 percent of students passed the course, and in chemistry, where 78 percent of students passed the course. These increases in enrollment and pass rates represent possibly the most important aspect of NSF-supported work in El Paso schools.

And yet, enormous challenges remain, particularly in fully preparing students for math and science success in college. We have made great strides K–12. It is ensuring that students are able to make that leap and be able to do well in college math and science. That is what we are very much focused on now.

Shared concerns about this and other challenges have brought together 12 El Paso area school districts with the El Paso Community College and the University of Texas at El Paso to focus on identifying strategies for ensuring the academic success of all of our youngsters. We are grateful that funding for the El Paso MSP will allow us to address these critically important problems.

The El Paso MSP is built around five key priorities. These include one, increasing and sustaining the quantity and quality of pre-K–12 math and science teachers, absolutely a burning issue for

us. Two, building the capacity of schools and districts to effectively support efforts to improve math and science instruction and achievement. Three, aligning curriculum instruction and assessment of math and science to ensure that what is taught reflects shared expectations for students from kindergarten through university. Four, promoting efforts to increase college going rates among El Paso area students, because if they don't go to college, they can't get degrees in math and science and then go and do research and other things with math and science. And five, conducting research that advances knowledge and understanding about the systemic improvement of math and science instruction. Strategies addressing each of these priorities focus on local needs, though many have relevance to communities across our country, which we hope will benefit from the lessons that we learn in MSP.

Let me quickly tell you about some of the lessons that we have learned in the over 13 months of implementing MSP so far. First, we have learned that this work absolutely must be done K–16, that is from kindergarten through university and beyond. Reforming K–12 will only work for the long-term if our teacher preparation programs and colleges and universities have themselves improved, if they, too, are focused on the best national content standards, if they are also aggressively working toward fully engaging students in the learning process. And given that teacher preparation encompasses the entire university, not just colleges of education, those that educate prospective teachers in the core subject areas, the colleges of science, the departments of mathematics, colleges of liberal arts, must also work toward improving teacher quality.

A second lesson learned is that partnerships must address the issue of K–16 curriculum alignment. What does that mean? It really means seamlessly linking what is taught at each point in the education continuum, from elementary, middle and high school, with what is expected and taught at community college and at university. The MSP Math and Science Alignment Project brings together K–12 teachers of math and science, as well as math faculty from community college and faculty from U. Tex. colleges of education, engineering and science.

A major goal of the initiative is to develop course outlines along with curriculum frameworks that will be implemented by teachers across the twelve districts. These outlines and frameworks provide clear and specific information about math and science content at each grade level that students must understand and be able to do, and the level of rigor at which they must be able to do them. This really takes standards to the next level, because standards are a great big mass of things that, while helpful, don't provide the direction to teachers that is needed in order for teachers to know what is most important, and the level at which students need to know that particular topic in mathematics or science. Our frameworks are helping to do that.

And the final lesson learned is that we have to provide a full and robust set of support and assistance mechanisms necessary for building school capacity. We do that by working with teachers. We also do that by working with faculty members, deans, superintendents and the like, but we put our greatest emphasis on teachers. In my written testimony, you can see the kinds of things that we

do with teachers, but I guess I want to close by just saying that what drives our work is our absolute belief in what students deserve, the importance of focusing on equity and partnerships.

We are delighted and very thankful to have this opportunity to do more of the work that we have been doing and to do it at a level that we have not done before, so thank you very much.

[The prepared statement of Dr. Navarro follows:]

PREPARED STATEMENT OF M. SUSANA NAVARRO

Greeting and Overview

Mr. Chairman, Ranking Member Johnson, and Members of the Committee, I am pleased to be here today to share with you the work of the National Science Foundation-supported El Paso Math/Science Partnership (MSP), and the opportunities that it provides for students across El Paso. Over the last decade, the National Science Foundation has been a valuable partner in supporting improved math and science instruction and achievement across the El Paso community. What the MSP now provides is an opportunity to bring together partners across the community, K–16, toward the shared development and implementation of high quality math and science content and instructional practices aimed at improving student achievement among all students.

Over the last decade, the community of El Paso has distinguished itself as one that is deeply committed to ensuring academic success among all students. In fact, education has come to be seen as a key element in improving the quality of life in our community, which is working very hard to turn around life chances for its large and growing population. Our strong focus on education in El Paso reflects the reality that there is much at stake in ensuring that this growing, largely Hispanic community is able to create opportunities for its 700,000 citizens. Currently, our per capita income lags behind both the State and the Nation, and the median household income ranks sixth lowest in the United States. The overall educational attainment of our citizenry is low as well. Just 68 percent of the population (aged 25 and older) has earned a high school diploma and fewer than 16 percent of El Pasoans hold a Bachelor's degree or higher.

Against these tremendous odds, the El Paso community has demonstrated its commitment to high academic achievement among all students. For example, the achievement gap, as measured by TAAS mathematics, is at its lowest point since El Paso's NSF-funded systemic reform efforts began in 1994. From a high that year of 21.2 percentage points between Hispanic and White students, and one of 26.7 points between African Americans and Whites, the gap has been reduced to 5.7 and 7.9 points respectively in 2002. In addition, enrollment in college preparatory math and science courses has increased significantly over the past year, with over three-fourths of all students across the MSP districts now taking Algebra I, Geometry, Algebra II, Biology and Chemistry. Most significantly, pass rates improved greatly over the past year—notably in Geometry (86 percent) and Chemistry (78 percent). These increases in enrollment and pass rates represent possibly the most important impact of NSF-supported work in El Paso schools.

And yet, enormous challenges remain, particularly in fully preparing students for math and science success in college. Shared concerns about this and other challenges has brought together 12 El Paso area school districts with the El Paso Community College and the University of Texas at El Paso to focus on identifying strategies for ensuring the academic success of our young people. We are grateful that funding for the El Paso MSP will allow us to address these critically important problems.

Key Components of the El Paso MSP

The El Paso Math/Science Partnership is built around five key priorities identified as critical to ensuring the academic achievement and opportunities for future success of El Paso area students. These include: one, increasing and sustaining the quantity and quality of pre-K–12 mathematics and science teachers; two, building the capacity of schools and districts to effectively support efforts to improve math and science instruction and achievement; three, aligning curriculum, instruction, and assessment of math and science education to ensure that what is taught reflects shared expectations for students from kindergarten through university; four, promoting efforts to increase college-going rates among El Paso area students; and five, conducting research that advances knowledge and understanding about the systemic improvement of mathematics and science instruction. Strategies addressing each of

these priorities focus on local needs, though many have relevance to communities across the Nation, which we hope will benefit from the lessons we learn in MSP.

Increasing and Sustaining the Quantity and Quality of Pre-K–12 Mathematics and Science Teachers

The first key element of the El Paso MSP addresses our efforts to increase and improve the quantity and quality of certified math and science teachers across our twelve partner districts. Strategies include roles for partners at UTEP, EPCC, the El Paso Collaborative for Academic Excellence, the Region 19 Educational Service Center, as well as participating districts, and range from increasing the number of fully certified math and science teachers, to providing intensive professional development to in-service teachers, to encouraging high school students to consider careers in math and science teaching.

Among the most notable accomplishments in the last year, are the enhancement of a Master of Arts in Teaching Mathematics (MATM) and the establishment of a Master of Arts in Teaching Science (MATS) program. Currently, 15 high school Mathematics teachers and 21 Science teachers are supported by the El Paso MSP and enrolled in courses leading to a Master's degree. In addition, a Pre-MAT program has been established to support prospective Master's participants who do not have the required prerequisites—most notably in college-level Calculus. Through the El Paso MSP, UTEP faculty have also developed a Physical Science degree plan for the MATS focusing on Physics and Chemistry.

Identifying and supporting prospective teachers is also taking place through promotion of alternative certification for prospective teachers with math and science backgrounds, high school teaching magnet programs and the recruitment of undergraduate engineering students into secondary math/science teaching.

Local concerns—that also reflect national trends—pertaining to support for new math and science teachers are being addressed through a newly established teacher induction program, into which new teachers have been enrolled and participate in an intensive two-year support program.

Intensive support for current teachers is being provided through MSP-supported Staff Developers—a highly qualified cadre of math and science master teachers—who provide professional development, sustained and connected over time, in teachers' classrooms. The focus of the Staff Developers' work includes support for teachers in covering topics and activities most central to improving the quality of their teaching.

Building School and District Capacity

The second key element of the El Paso MSP focuses on supporting the improvement of math and science instruction in pre-K–12 classrooms via leadership at the school and district levels, as well as support for increased parent engagement.

The MSP recognizes that a factor critical to implementing and sustaining standards-based instruction is the ability of school administrators to facilitate and actively support teacher efforts for improving teaching and learning. Principal Academies include attention to results-based reform efforts, data analysis, strategic planning, and content-focused coaching aimed at the successful implementation of the K–16 math and science curriculum frameworks. In addition, regular, ongoing meetings are held with superintendents and other district leaders to ensure coherence, consistency, ownership, and support for all MSP goals and activities.

Finally, the El Paso MSP recognizes the role of parents and the community in supporting math and science reform. Key efforts include monthly meetings for parent teams from area schools addressing the importance of high-level mathematics and science for preparation for higher education, and the role parents play in supporting greater student achievement. Parents' sessions also address State standards, and the rigors and demanding nature of the State assessment. Discussions also center on the expectations of students and implications of the "No Child Left Behind" Act. Community engagement through the El Paso MSP has also focused on preparation for higher education.

Aligning Curriculum, Instruction, and Assessment of Mathematics and Science Education

To support students in achieving higher levels of mathematical and scientific understanding in preparation for higher education, the El Paso MSP is working with mathematicians and scientists from UTEP and EPCC, along with pre-K–12 teachers, in developing high level mathematics and science curriculum course frameworks that will guide instruction and assessment at all levels. To date, frameworks have been developed in K–12 mathematics, Algebra I and Algebra II. This year, work is commencing with Geometry, and Chemistry and Physics.

The institutionalization of the curriculum frameworks will be carried out through the development and enactment of policies pertaining to the implementation of the frameworks across local districts, EPCC and UTEP. Also critical will be the alignment and integration of the frameworks with instruction provided by post-secondary educators, including math/science teacher faculty at both higher education institutions.

Increasing College-Going Rates

Along with the improvement of science and mathematics education, a priority of MSP is to ensure that increasing numbers of El Paso area students recognize the importance of a post-secondary education and early preparation for college. The fourth key element of the El Paso MSP focuses on: 1) increasing college-going rates through the THINK COLLEGE NOW Initiative; 2) increasing attention to the work of counselors in supporting students' preparation for higher education; and, 3) implementing the College of Engineering's Infinity Project—a curriculum for high school students that addresses concepts and skills related to engineering.

Implementing a Research Agenda that Advances Knowledge and Understanding about the Systemic Improvement of Mathematics and Science Instruction

The final key element in the El Paso MSP recognizes that research on the impact of MSP efforts informs critically important decisions about what works, where, and under what conditions. Priorities include the implementation of math/science field based research pedagogical laboratories, which are underway; research training for El Paso MSP Staff Developers and District Directors; and the awarding of small research grants to teachers.

Responses to Specific Questions

How will you ensure that participants—mathematicians, scientists, and engineers from higher education as well as K–12 teachers and administrators—remain active in the program? What role, if any, will businesses and non-profit organizations play in the partnership?

The involvement of El Paso MSP partners across higher education and pre-K–12 institutions, as well as in the business and non-profit community, is focused on building a long-term commitment toward shared goals for the students in the El Paso community. This commitment starts with the leadership at higher education institutions and school districts—many of whom play key roles in the El Paso MSP. Beyond the fulfillment of the priorities laid out, these leaders are focused on ways in which our partnership can sustain itself for the long term. The University of Texas at El Paso, for example, has committed to graduating more credentialed mathematics and science teachers and increasing the number of teachers holding math and science masters degrees. MSP districts, too, are committed to continue prioritizing and supporting mathematics and science education after MSP, including the use of district resources to support continued intensive professional development and acquisition of the best standards-based math and science materials. El Paso MSP partners, including business, community organizations and civic leaders, will continue to participate actively in promoting key MSP priorities, including making presentations to students, parents and community groups about the importance of math and science literacy and of going to college.

What type of professional development will your partnership provide for pre-service and in-service teachers? How will improvements in teacher content knowledge and pedagogy be assessed?

Professional development for both pre-service and in-service teachers will be provided to increase and sustain the quantity and quality of pre-K–12 mathematics and science teachers. Teachers' content knowledge will also be enhanced by the K–16 curriculum alignment frameworks that include expectations about what student should know and be able to do from kindergarten through higher education.

Assessing the impact of these efforts in supporting both teacher content knowledge and pedagogy will occur through a combination of strategies. Teachers receiving a Master's of Arts in Teaching either Mathematics or Science will be required to have attained Master's-level content knowledge in order to graduate. At the same time, prospective teachers coming to the profession through alternative certification and engineering backgrounds will be expected to have mastered their content knowledge in order to proceed with their certification. The familiarity of both pre-service and in-service teachers with the rigorous content addressed in the frameworks, and its integration into classroom practices will also be measured. Classroom teacher observation protocols and surveys, for example, will provide a guide for

formative evaluation of teachers' progress in implementing the content addressed in the frameworks.

Is your award a sufficient size to develop and test your education reform models and achieve your partnership goals? How will the partnership coordinate with State educational agencies to foster and sustain the reform effort after the award period expires?

The support we have received from the National Science Foundation has been extremely beneficial in allowing us to develop and refine our reform models from which longer-term implementation and sustainability can be built. This work is an enormously costly proposition. Over the past 20 years, we have seen first-hand that making the transformations expected through the partnership are expensive and take significant time. What has been so valuable is the significant NSF investment in promoting the value of our pre-K–16 partnerships and those in other communities. This leadership and attention to our work has also allowed the El Paso MSP to more effectively leverage resources from our own community.

Though we do not directly coordinate our efforts with the Texas Educational Agency, we continue to share products and lessons from the work of the El Paso MSP. One key example, will be the broader dissemination of the mathematics and science curriculum frameworks, which have applicability across every school in the State.

Plans for Evaluation of the El Paso Math/Science Partnership

As you can see, the El Paso MSP is an ambitious initiative with multiple and interrelated components. Thus to evaluate it, we must monitor the implementation and results of many strands of activity within a clear, overarching framework. Our evaluation has two key aims: accountability through the rigorous measurement of results; and ongoing improvement in our programs.

We believe in holding ourselves accountable for measuring change in the lives of young people. We have begun with the identification of key objectives and benchmarks for which indicators have been developed to measure the major outcomes of the Partnership. Examples include trends regarding the percent of area students passing the mathematics and science portions of the Texas Assessment of Knowledge and Skills, and the percent of students completing a college-preparatory high school program. We use student data to identify the overall results of our efforts and to highlight areas in which more work is needed. Looking at student achievement and attainment over time is an indispensable part of our work, and we appreciate federal support for the collection and rigorous analysis of student data.

In order to enhance our program we utilize evaluation planning, data collection and reporting that include the systematic monitoring of interrelated program improvements intended to contribute to success on each outcome indicator. We examine the extent to which we are achieving our numerical benchmarks and track backwards to examine interim steps and program interventions that influenced their outcomes.

Because we are committed to improving the programs that our partnership has launched in El Paso, we need to gather and systematically analyze evidence about those programs in our own context. We welcome this nation's growing commitment to supporting experimental research in education, while recognizing that full-blown experimental trials cannot provide all the answers that our MSP partnership needs. We have programs in place right now that have achieved varying degrees of success which we need to understand in detail. While we await better answers from the education research community, we are working with an external evaluator to conduct comparisons and analyses, on the ground, in our own classrooms.

The program elements of the El Paso MSP are intended to make a difference in the supply of well-qualified math and science teachers, in school and district leadership, in classroom practices, and ultimately in student achievement. Our evaluation plan takes into account that all partners have roles to play, and multiple new and established programs to support. Thus, our evaluation plan will focus attention on the following: the implementation of key program elements across participating districts, schools, and post-secondary departments; the short-term results of implementation; and how the presence or absence of particular program elements contributes to longer-term results.

For example, we will analyze enrollment and completion statistics in a college-preparatory core curriculum, by district, feeder pattern, and student group. Where students are not completing this curriculum at the desired rate, we will identify the courses they are not completing and the program interventions in those subjects that they have or have not experienced. We will also analyze relevant data on school leadership, counseling, and classroom practices affecting those students. These com-

parative analyses of different conditions and supports across schools will point the way to improvement in our efforts.

Similarly, we will look at the rates at which prospective teachers are entering and completing each of the pathways to certification introduced or enhanced through support from the El Paso MSP. Profiles of typical enrollees in each pathway will be compared. Through surveys of participants (and non-participants, such as engineering students who do not choose to enter teaching), we will identify reasons for entry and persistence in these certification routes.

Staff Developers' work will be analyzed from several related perspectives. Teachers and Lead Learners will provide data on the kinds of support they receive from Staff Developers. Through classroom observation, we will follow-up to measure the results of this support infrastructure. The work of Staff Developers will also be examined as one component in a more comprehensive system of teacher induction and support that may help in teacher retention as well as the improvement of classroom practice. We will identify facilitating mechanisms and barriers to effective staff development that may exist in district and State policies, principals' actions, teachers' schedules, and the learning opportunities available to the Staff Developers themselves.

The evaluation questions about alignment will also be addressed through measures of the enacted curriculum. In addition, we will look at progress in curriculum alignment all the way from elementary through post-secondary education.

The research component of the El Paso MSP will be a subject of our evaluation in its own right, as a significant intervention intended to engage classroom teachers, post-secondary faculty, and others in systematic reflection on practice and results. We will study the operations of such key elements as the collaborative working relationships between post-secondary faculty and pre-K–12 teachers, which have traditionally proved difficult to establish. We will also incorporate the results of teacher research into our inquiry.

In summary, by tracking back from key benchmark indicators to the specific mechanisms intended to affect them, by understanding instances of success and failure and by taking into account the mutually reinforcing nature of related program efforts, we expect to generate reports that are realistic, useful, and analytically sound. Evaluation is helping us hold ourselves accountable for results, and it is helping us strengthen our programs as we go forward.

Lessons Learned

Let me share with you some of the lessons we have already learned over the 13 months of implementing MSP. First, we have learned that this work must be undertaken K–16. Reforming K–12 will only work for the long-term if our teacher preparation programs in colleges and universities have themselves improved, if they too are focused on the best national content standards, if they are also aggressively working toward fully engaging students in the learning process. And, given that teacher preparation encompasses the entire University, not just Colleges of Education, those that educate prospective teachers in the core subject areas—the Colleges of Science and Liberal Arts—must also work toward improving teacher quality.

A second lesson learned is that partnerships must address the issue of K–16 curriculum alignment, that is, seamlessly linking what is taught at each point in the education continuum—from elementary, middle and high school—with what is expected and taught at community college and at university. The MSP Mathematics and Science Alignment brings together K–12 teachers from all MSP school districts, MSP staff developers, as well as mathematics faculty from the El Paso Community College, and faculty from UTEP's Colleges of Education, Engineering and Science. A major goal of the initiative is to develop course outlines along with curriculum frameworks, that will be implemented by teachers across the twelve districts. Those outlines and frameworks provide clear and specific information about math and science content at each grade level that all students must understand and be able to do and the level of rigor demand at which they must be able to do them in order to prepare for college level mathematics and science. The outline is mapped to textbooks and materials used by the districts and is not limited to any one adopted mathematics program. We have completed work on Algebra I and II, as well as K–8 and are beginning work on Geometry, K–8 science and the high school science courses.

A third lesson learned is that we must ensure a full and robust set of support and assistance mechanisms necessary for building school capacity. Our professional development work is focused on building knowledge and leadership about school improvement and institutional change among principals and other site administrators, district leaders, college and university faculty and deans. We have, however,

prioritized teachers and making sure that all who teach math and science are fully qualified. MSP is helping to do that through increasing the number of teachers certified and earning masters in math and science. In addition, we also provide professional development to ensure a deep understanding of concepts, among in-service teachers to the point where they can build student capacity to do high level math and science. We not only focus on content but also on pedagogical content. That is, implementation of instructional practices appropriate to specific math and science concepts. This deepening of knowledge and practice requires a reorganization of where and how we deliver professional development. The majority of that development is now provided in classrooms by MSP staff developers, thus bridging the teacher learning and practice gap. Through all of this professional development work, we continue to raise issues of teacher and administrator beliefs and attitudes about who can learn—and who cannot—and support educators to begin to come to terms with their beliefs and the impact of those beliefs on their students' achievement.

Conclusion

Woven throughout this brief picture of our MSP work I trust that you've been able to see the elements that are critical to us:

- Equity
- Partnerships—in particularly K–16 partnerships
- Deep commitments and understanding about what all children deserve.

This is work very much in progress. We've had our share of things that have worked very well—and those that haven't. Through it all we remain committed to continuing to learn what it takes to bring about real and lasting improvements for every single student in our community.

Thank you Mr. Chairman for this opportunity to testify, and for your interest in the El Paso Math/Science Partnership. I would be happy to respond to any questions.

BIOGRAPHY FOR M. SUSANA NAVARRO

Susana Navarro graduated from the University of Texas at El Paso with a major in political science in 1968. After working at the U.S. Commission on Civil Rights in Washington on a landmark study of Mexican American education, she began her graduate studies at Stanford University, where she received her Ph.D. in educational psychology in 1980.

After earning her doctorate, she worked with the Mexican American Legal Defense and Education Fund (MALDEF) for five years as National Director of Research and Policy Analysis. From 1985 until early 1991, she worked with the Achievement Council, a statewide non-profit organization in California, which she helped create, as Associate then Executive Director.

In 1991, she returned to El Paso, where with regional education, business and civic leaders, she founded the El Paso Collaborative for Academic Excellence, an organization which she has headed since its inception. The Collaborative, a city-wide effort to improve academic achievement among all young El Pasoans, is now in its twelfth year of operation and has become a national model for urban school reform. Dr. Navarro's work has been featured in numerous national publications, including *Education Week, The Chronicle of Higher Education* and *Phi Delta Kappan.* She serves as Principal Investigator for the El Paso Mathematics and Science Partnership, a $30 million grant, which was awarded to the Collaborative in 2002. In addition to MSP and other grants from the National Science Foundation, the Collaborative has received support for its systemic reform work from the Pew Charitable Trusts, the U.S. Department of Education, the Lucent Foundation, Exxon and the Coca Cola Foundation, among others.

The El Paso
Collaborative
For Academic
Excellence

October 28, 2003

The Honorable Nick Smith
Chairman, Research Subcommittee
2320 Rayburn Office Building
Washington, DC 20515

Dear Congressman Smith:

Thank you for the invitation to testify before the U.S. House of Representatives Science Committee, Subcommittee on Research on October 30 for the hearing entitled *Implementation of the Math and Science Partnership Program: Views from the Field.* In accordance with the Rules Governing Testimony, this letter serves as formal notice of the Federal funding I currently receive in support of my research.

- $29,319,178, EHR-0227124, National Science Foundation/El Paso Math and Science Partnership, 2002
- $1,645,430 ESR-9908105, National Science Foundation/El Paso Systemic Program, 2003

Sincerely,

M. Susana Navarro, Ph.D.
Executive Director

The University of Texas at El Paso Education Bldg., Rm 413 500 West University Ave. El Paso, Texas 79968-0683
(915) 747-5778 FAX (915) 747-5144

Chairman SMITH. Thank you. Dr. Ferrini-Mundy.

STATEMENT OF DR. JOAN FERRINI-MUNDY, PRINCIPAL INVESTIGATOR FOR THE COMPREHENSIVE MSP GRANT AT MICHIGAN STATE UNIVERSITY

Dr. FERRINI-MUNDY. Good afternoon, Chairman Smith and Members of the Subcommittee. It is a pleasure to appear here before the Subcommittee and provide testimony on the Math Science Partnership Program, and in our particular case, the project PROM/SE, which is currently at its very early stages of implementation at Michigan State University, in collaboration with our five partner consortia.

I am the co-leader of PROM/SE with my colleague at Michigan State, Dr. William Schmidt, who had a lead role in TIMSS, the Third International Mathematics and Science Study. This effort has just been launched in the past month. We are grateful to the National Science Foundation for this opportunity to have a major impact on mathematics and science learning, and frankly, we are daunted by the enormity of the task.

PROM/SE is a comprehensive research and development effort to improve mathematics and science teaching and learning in grades K–12. It is based on assessment of students and teachers, improvement of standards and frameworks, and the preparation and professional development of teachers.

I emphasize that our partnership is a research and development effort. We are committed to understanding through this work how the multiple models for improving teaching and learning that we will build within PROM/SE actually will impact student learning in a range of ethnic, cultural, racial and economic settings that are so diverse that they mirror the diversity of the Nation.

PROM/SE is a partnership among six entities. Five of these are K–12 consortia of school districts in Michigan and Ohio, together with Michigan State University. The project is large in scope. We intend to impact nearly 400,000 students through work with hundreds of teachers across nearly 70 school districts.

The goals are straightforward. First, we intend to use empirical evidence as a basis for our efforts to improve mathematics and science learning. We will assess students in grades three through twelve using TIMSS-like instruments and other instruments that are being designed currently, and we will survey teachers and administrators about their instruction, about their contexts and about their curricula.

Secondly, we will work with our partners to develop and to agree upon challenging content standards that will work to align instruction and assessment in those local districts with these standards. Mathematicians, scientists, school leaders, all together will work to accomplish this design of standards and action teams that bring together people from higher education and from the K–12 partners.

Third, we are interested in designing professional development that helps all teachers have the capacity to teach to these high standards, and that emphasizes subject matter knowledge in ways that support teachers in their daily work in classrooms. The professional development involves a model of building level associations, called PROM/SE associates, as well as the technologically-based re-

source system that will be designed, again, by our mathematicians, scientists and educators.

Fourth, at Michigan State University, we are engaged in rethinking the ways in which future teachers are prepared to teach, to high standards in mathematics and science, and the MSP part of that work will be particularly focused in science.

Fifth, and ultimately, we are aiming to improve students' learning and achievement across our districts, across our partner sites and across the diversity that our project encompasses.

In the TIMSS study, analysis of the curriculum standards in the high-achieving countries showed that those standards were mathematically and scientifically coherent. These tables indicate down along the rows, essentially, a progression of subject matter, from more straightforward, fundamental concepts to more advanced concepts, and the columns suggest in which grades these topics are typically treated across the high-achieving countries, and you see, basically, this pattern of a focus on depth, on central ideas, on beginning and ending ideas across a relatively small grade span, and then moving on to more sophisticated ideas.

In PROM/SE, we will work on standards and frameworks that emphasize significant ideas in mathematics and science and that convey high expectations for all students, and that are well-articulated across the grades. TIMSS also provides the kind of analytic tools that we will use as a starting point for our decision-making and for gathering evidence.

Let me say more about what I mean by that. This table, or this diagram, shows down in the lower right-hand corner the results of student performance on an item about seesaws and fulcrums. The graph on the left, and that student achievement spans grades three through twelve, and you see an upward trend, in the graph to the left, you see that achievement trend again, and above it, in the line graph, you see how much time is devoted to the teaching of this topic across the grades three through eight. You can imagine that as we put together sets of items and take these sorts of measurements, and take a look at what is going on in our partner districts, we will be able to tell lots of stories, in particular about what is happening within areas of the content, and these analyses will provide us with the basis for our work in PROM/SE.

The professional development efforts in the projects will use this evidence. Structurally, the model rests, in part, on our work with PROM/SE associates. These will be teachers who represent schools across the partnership and will serve as resources, coaches and math science experts for their colleagues. We will build technological resources that these teachers can access at all levels.

Very briefly, because we are just beginning, the five-year project begins with assessment and identification of the associates, continues with data analysis standards revision and professional development. PROM/SE provides a number of opportunities as well as challenges. Let me discuss them. First, despite the scale of the project, our approach, with this emphasis on data and evidence, we hope will allow us to customize the PROM/SE activities to local needs. Districts will be able to select the areas of mathematics and science content that they feel need special attention and work together with the PROM/SE team to focus on those areas.

It is our hope that the professional development we provide will be layered in ways that enables teachers with differing needs to access it in individual ways. For example, more seasoned teachers who are looking to refresh their subject matter knowledge will need to be able to access this material in one way. Newer teachers who are looking for interesting lesson ideas and ways to support their day to day practice may need to access it in a different way, and we are hopeful that we will be able to produce materials and compile materials that allow all of these sorts of options.

We are already learning that an initiative such as PROM/SE involves building new ways of communicating among mathematicians, scientists, educators, classroom teachers and school administrators. This is about building new communities with strong communication channeled through them.

We will be producing standards that we hope can serve as national models, and finally, I reiterate that we are strongly committed to research, to learning about how change and improvement can be effected and sharing what we learn nationally through this project.

Thank you.

[The prepared statement of Dr. Ferrini-Mundy follows:]

PREPARED STATEMENT OF JOAN FERRINI-MUNDY

Good afternoon Chairman Smith, Ranking Member Johnson and Members of the Subcommittee: It is a pleasure to appear before the Subcommittee and provide testimony on the Math and Science Partnership Project—PROM/SE—presently at the early stage of implementation at Michigan State University. Michigan State University and its five K–12 partners—St. Clair County, Ingham County, and Calhoun County Intermediate School Districts in Michigan, and the High AIMS and SMART consortia in Ohio—have joined in Project PROM/SE (Promoting Rigorous Outcomes in Mathematics and Science Education), and on September 26, 2003 were notified that their $35,000,000 Math Science Partnership project would be funded by the National Science Foundation. At Michigan State University, Dr. William Schmidt and I are the co-leaders of this effort.

Partnership goals

PROM/SE has four goals:

- Gather empirical evidence as a basis for revising content standards, aligning instructional materials with those standards, and monitoring student learning.
- Improve mathematics and science opportunities for all students, especially those from under-represented and disadvantaged groups by developing more coherent, focused and challenging content standards; aligning standards with instructional materials; and eliminating tracking in grades K–8.
- Improve mathematics and science teaching so it is aligned with standards, through subject specific professional development.
- Reform the preparation of future teachers so that teachers at all levels are ready to teach challenging mathematics and science to diverse student populations.

Our theory of how to improve achievement for all children is simple: we need to understand what students know, what standards expect, and what teachers teach, and work to improve all three. At the outset, students in grades 3–12 across the partner sites will be assessed in mathematics and science, using items from the Third International Mathematics and Science Study (TIMSS), as well as other instruments. Teachers will be surveyed about background, knowledge, preparation, and topics that they teach, and districts will be surveyed about their standards, instructional materials, and professional development. On the basis of data, we will review and revise standards, analyze alignment of standards with curriculum and teaching practice, and provide professional development for teacher leaders, teacher participants, and guidance counselors. Related reform in the MSU teacher education

program will be undertaken during this same five-year period together through Teachers for a New Era, a project funded by the Carnegie Corporation.

Lessons learned to date

Although our MSP funding has only recently been announced, this group of partners has been working together to design and envision our effort for more than two years. In particular, the partners share a commitment to the use of data and evidence as key tools in the revision and strengthening of standards and the design and implementation of professional development of teachers so that teachers will be well equipped to teach to high standards. The ultimate goal is improved learning and achievement in mathematics and science for all students.

We are learning that it is crucial to build on the infrastructures that exist in each of these distinct K–12 partners, including the professional development efforts already underway through local resources in all of these areas, and the grade-by-grade standards that are being developed in States to address No Child Left Behind. For instance, MSU has collaborated extensively with our partner in the St. Clair ISD through a project called Promoting Results in Science and Math (PRISM). Initiated in 2000, PRISM is a multi-year collaboration between the ISD and MSU to evaluate and improve the quality of the curriculum and teaching for all students. The first phase involved a thorough analysis of the curriculum. TIMSS assessments were administered in May 2001 to about 17,000 students in grades 3–12. Using these data, St. Clair ISD began in the fall of 2002 the design and implementation of a reformed curriculum and of a customized professional development approach based on the data. St. Clair's experience serves as a showcase for the partnership's evidence-based approach.

Our extensive baseline data-gathering will ensure that we can tailor our program to the unique needs and circumstances of our 69 participating school districts. Each will have access to the results of students' performance and analysis of standards and teacher practice, so that it will be possible to build on a base of knowledge that serves as the foundation for continued improvement.

We also are learning that the enormous challenges of communication and relationship building are central in a project of this magnitude. Engaging school personnel in decision-making and implementation of project ideas from the outset, helping stake-holders within the school communities come to understand and develop commitment to the premises of PROM/SE, and enabling the project working groups to build new cultures and norms that span mathematics, science, education, and the world of the K–12 schools, are crucial to the success of PROM/SE.

Ensuring that participants remain active in the program

In addition to the hundreds of teachers and school leaders who will have direct roles in the program, and the thousands of teachers who will benefit from the professional development resources that will be designed, more than 50 Michigan State University scientists, mathematicians, and education faculty have agreed to participate in various roles in the project. They will be able to be part of the assessment design and analysis, the design and implementation of the professional development, and the revision and analysis of standards. Two of the MSU co-PIs, Dr. Peter Bates (Chair of the Department of Mathematics) and Dr. George Leroi (Dean of the College of Natural Science) are well positioned to promote and reward the engagement of MSU faculty.

The design of the project relies on sustained participation of personnel in the K–12 sites, including Site Coordinators and PROM/SE Associates, who will work closely with MSU faculty in all aspects of the project. We anticipate that PROM/SE will generate new collaborations and relationships among groups that have not traditionally engaged together in work of this type. Such collaborations are likely to lead to new project and spin-off efforts during the five years of PROM/SE, and, we hope, in the post-PROM/SE years as well.

Tailoring PROM/SE to the unique needs of the participating school districts

With its emphasis on evidence-based improvement, PROM/SE is designed to be responsive to the particular and unique needs of the participating partners. We anticipate finding certain areas of mathematics and science that are strong in some sites, and that need improvement in others, and will build a comprehensive professional development system that allows these sites to access the key areas in which they wish to focus. In addition, because we will be examining local standards in use in the districts, together with data about teachers' instruction, we will have a baseline for articulating the different emphases and instructional priorities across the partner sites. We will build accordingly on these differences in all project efforts.

Because our five K–12 partners span a range of socioeconomic and contextual situations, we also stand to learn a great deal about the ways in which this variation interacts with efforts to improve standards and instructional practice. This requires acknowledging and understanding the differences among the participating districts.

Professional development for pre-service and in-service teachers

Richard Elmore describes the challenges that today's accountability climate creates for teachers in schools: teachers, administrators, and guidance counselors are being asked to "do something new—engage in systematic, continuous improvement in the quality of the educational experience of students and to subject themselves to the discipline of measuring their success by the metric of students' academic performance" (Elmore, 2002, p. 3). He goes on to assert that few people in K–12 schools are prepared, either through their education or previous experience, to do this. Indeed, our approach in PROM/SE is to help teachers build and use tools, based on evidence, that will help them in this new climate, and to model how this might be achieved nationally. The PROM/SE professional development (PD) model will have as a unique resource the detailed evidence base that allows us to build on information about student achievement, teachers' understanding of the subject matter, the nature of district standards and their alignment with instructional materials. Teachers need to know where students have difficulty, what kinds of difficulties they have, and how to help them overcome them, while moving toward significant content goals in mathematics and science.

Elmore makes the interesting point that "if most of what teachers learn about practice they learn from their own practice, it is imperative to make the conditions and context of that practice supportive of high and cumulative levels of achievement for all students" (Elmore, 2002, p. 19). This has implications for where, when, and how professional development occurs; it needs to be physically close to where the teaching occurs; it needs to happen while teachers are teaching; and the curriculum of professional development needs to be based on the content and challenges that arise for teachers in classrooms. Our model involves a combination of summer experiences and academic year offerings, as well as virtual professional development. By involving principals and counselors, as well as district leaders, we are addressing context and conditions. Our strategy combines a teacher-leader (coaching) model with a technology-based PD curriculum.

Because the students we are trying to impact are located in all of the more than 700 school buildings that our partnership encompasses and because we wish to leave no child behind, we are committed in our PD to "leaving no building behind." This means identifying a resource person for mathematics and for science (the same person for elementary schools) in each school together with the principal and in the case of secondary schools, a counselor as well. The role of PROM/SE Associates will be to understand the data, the way that the data can be used to drive improvement, and the notion of tying instruction and instructional materials to challenging and coherent standards. And, it will be teams of PROM/SE Associates, working with MSU personnel and other district leaders, who actually do the revision of the district and partner standards—an important element for their own professional development.

The professional development for the Associates will occur during summer institutes, weekend workshops in the academic year, and virtually through on-line offerings. The first summer institutes will focus on the revision of standards on the basis of information about student achievement, teacher characteristics, and district context. Associates will also have opportunities to learn about leadership, coaching, and working with their peers to improve mathematics and science teaching. Associates will be prepared to work locally in their districts on the standards revision process, on using student data, and on helping teachers work with a wide array of instructional practices and materials to align them with local standards. The Associates will begin their work with the larger group of Teacher Participants in partner-site based weekend workshops and in summer institutes. Associates will be involved in providing site-based, ongoing PD for teachers in their districts in the ensuing academic years.

Through the PROM/SE Associates and the MSU-based PROM/SE staff, we ultimately plan to provide PD directly for about 25 percent of the teachers of mathematics and science in our partner sites; these 4500 teachers will have opportunities to come to summer institutes and academic year workshops sponsored through the project, and to work directly with the District Associates in their buildings. The remaining 12,500 teachers of mathematics and science in the partner sites also will benefit from the activity of PROM/SE; the data and evidence to be gathered in each partner site will be widely available, and the revised content standards will be a resource for all teachers.

Research indicates that professional development should be focused on a well-articulated mission, aimed at improving student learning, content driven, derived from analysis of student learning of specific content in a specific setting, based on instructional materials that the teachers are using, and connected with the specific issues of instruction and student learning in the context of actual classrooms (see, for example, Ball, 1997; Cohen & Hill, 2000; Elmore, 2002, p.7; Loucks-Horsley et al., 1998). The PROM/SE PD model will incorporate all of these views, and will have as a unique resource the detailed evidence base that allows us to build on information about students' learning and teachers' understanding of the subject matter. We regard the ongoing professional development of teachers in the partner sites as the most crucial intervention of our PROM/SE activity. Our professional development has three main goals. We will enable teachers to:

- use evidence about student learning to influence their teaching practice
- use coherent and rigorous content standards as a guide to providing all children with opportunities to learn challenging mathematics and science
- employ instructional practices and materials in ways that align with those standards

At this time we envision these professional development activities to be organized topically and to span the K–12 spectrum. Mathematics and science topics will ultimately be determined by what we learn from the data-gathering phase, but we can predict some areas at this time: functions; rational numbers and proportional reasoning; and data and statistics, for example, in mathematics, and properties and changes of matter, structure and functions of living systems, and structure of earth systems in science. In our planning discussions, the K–12 partner sites have expressed a number of needs for their teachers, which include: "how to help teachers develop and implement more rigorous and coherent curriculum" (St. Clair County), "how to build capacity for coaching and building-level support" (Ingham), "getting a handle on data collection and how to use data" (High AIMS), and "doing gap analysis, and delivering the content effectively" (Calhoun). The partners express a sense that teachers' subject matter knowledge for different areas of the curriculum is uneven, and are concerned that teachers who seem to "have the content" are still unable to "deliver the curriculum."

After teachers have participated in summer institutes and project workshops, the project will also provide academic year connection to PROM/SE virtually, through a variety of on-line professional development resources for teachers, designed in a virtual PROM/SE Professional Development System. The idea is to establish—beginning with the initial assessment—a culture of collaborative learning, goal-setting and lesson planning, implementation, assessment and evaluation similar to that observed in Japan (Jacobs et al., 1997; Stigler & Hiebert, 1999). We envision using technology both as a repository for resources designed especially for this project, as well as material selected and embedded into our project context. For example, videoconferencing may make possible the sharing of progress, ranging from full district reports on particular innovations, to crafted lessons by a particular group of teachers in a given school. We will examine various platforms, as possible tools to help teachers "make their teaching visible" by creating their own video library of their practice and by developing their capacity to interact with these videos. PROM/SE Associates will be prepared to help teachers in their districts videotape lessons in the focal topic areas for site-based or on-line professional development discussions and will encourage the sharing of these videos within schools as well as across schools within and beyond their district. We will promote the use of monitored chat rooms as well. We will also expand and adapt a set of on-line courses already successfully implemented at MSU to facilitate professional development as part of the Virtual PD; these courses eventually will become part of a set of master's offerings for in-service teachers interested in refreshing their mathematics and science content knowledge.

Assessing improvements in teacher content knowledge and pedagogy

Beginning with the baseline assessment activities, we will be designing and using new tools for examining teaching knowledge and practice. Over the course of the project we plan to design special studies in selected areas to look more deeply at the relationship of teacher content knowledge and pedagogical content knowledge as it relates to student achievement and to classroom practice. This collection of coordinated research studies will allow us to gain a deeper understanding of these complex relationships. These studies will be designed in consultation with our National Advisors and with the project evaluator.

Coordination with State agencies

MSU faculty in the PROM/SE team have been deeply involved in efforts to revise the Michigan Department of Education Mathematics Standards, and thus have current connections with key State officials involved in assessment and standards. In addition, personnel from the Michigan and Ohio Departments of Education will be invited to serve as members of the project advisory boards and action teams. We will pay particular attention to the maintenance and growth of these relationships over time so that State personnel come to know the capacity that will be generated through PROM/SE, in terms of school and university faculty who can become engaged in State efforts in mathematics and science education.

Sufficient resources to develop and test our models

We have found that, with the announcement of PROM/SE, a number of districts are inquiring about joining the project—and the PROM/SE Executive Management Team is developing policies and guidelines for the addition of new partners, with the notion that new partners will need to bring their own resources to this effort.

PROM/SE is an ambitious project of enormous scope and complexity. The project team holds as a high priority the idea that we will conduct research around the activities of PROM/SE, so that this effort can provide us with models and understandings of how improvements of this type can be implemented in a range of contexts. We believe the resources are indeed sufficient for the implementation that is planned in PROM/SE, but to conduct the kind of research and evaluation that can truly help us learn from this project and others like it will require additional resources.

Conclusion

The Math Science Partnership Program provides an exciting opportunity for significant improvement of mathematics and science teaching and learning across educational levels beginning in the earliest grades and through the undergraduate years. The improvement toward which all of us in the MSP Programs strive should not be the sole measure of the success of this substantial investment. In addition, we need, as educators and citizens, to learn from the MSP program about the ways in which models, embedded experiments and innovations, and particular implementations of different theories of action all interact with these improvement efforts. Resources and capacity for building strong research agendas around the MSP programs would seem to be essential to ensure a lasting and sustained benefit from this important set of initiatives.

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Promoting Rigorous Outcomes in Mathematics and Science

PROM/SE
An NSF Math Science Partnership

Testimony prepared for the Research Subcommittee of the Science Committee of the U.S. House of Representatives, October 30, 2003

Joan Ferrini-Mundy, Michigan State University

PROM/SE is supported by NSF Cooperative Agreement No. EHR-0314866.

PROM/SE is a comprehensive research and development effort to improve mathematics and science teaching and learning in grades K-12, based on assessment of students and teachers, improvement of standards and frameworks, and preparation and professional development of teachers.

PROM/SE Partners

Ingham, MI Intermediate School District

St. Clair County, MI Intermediate School District

Calhoun County, MI Intermediate School District

SMART Consortium -- Cleveland, Ohio Area

High AIMS Consortium - Cincinnati, Ohio Area

Michigan State University

PROM/SE Scope

PROM/SE Scope

~70 school districts

~1400 PROM/SE associates

~5000 inservice teachers

~800 preservice teachers

~400,000 K-12 students

PROM/SE Goals

- Build reform efforts on a base of empirical evidence
- Develop challenging content standards and align instruction with those standards
- Provide professional development based on disciplinary content and standards
- Reform the preparation of future teachers
- Improve student learning

PROM/SE Strategies

- Assessment of students
- Surveys of teachers and administrators
- Collaborative work on standards
- Building on professional development infrastructure of our K-12 consortia
- Engagement of Michigan State University faculty in mathematics and science.

High Achieving Countries' Curriculum Standards

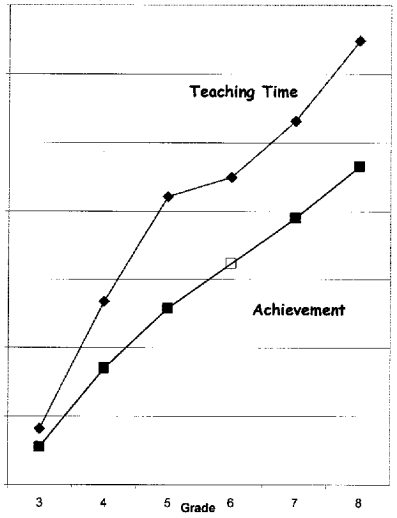
Mathematics Topics

Topic	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Whole Number Meaning	●	●	●	●	●			
Whole Number Operations	●	●	●	●	●			
Measurement Units	●	●	●	●	●	●	●	
Common Fractions			●	●	●	●		
Equations & Formulas			●	●	●	●	●	●
Data Representation & Analysis			●	●	●	●		●
2-D Geometry: Basics			●	●	●	●	●	●
Polygons & Circles				●	●	●	●	●
Perimeter, Area & Volume				●	●	●	●	●
Rounding & Significant Figures				●	●			
Estimating Computations				●	●	●		
Properties of Whole Number Operations				●	●			
Estimating Quantity & Size				●	●			
Decimal Fractions				●	●	●		
Relationship of Common & Decimal Fractions				●	●	●		
Properties of Common & Decimal Fractions					●	●		
Percentages					●	●		
Proportionality Concepts					●	●	●	●
Proportionality Problems					●	●	●	●
2-D Coordinate Geometry					●	●	●	●
Geometry: Transformations						●	●	●
Negative Numbers, Integers & Their Properties						●	●	
Number Theory							●	●
Exponents, Roots & Radicals							●	●
Exponents & Orders of Magnitude							●	●
Measurement Estimation & Errors							●	
Constructions w/ Straightedge & Compass							●	●
3-D Geometry							●	●
Congruence & Similarity								●
Rational Numbers & Their Properties								●
Patterns, Relations & Functions								●
Algebra & Trigonometry								●

Science Topics

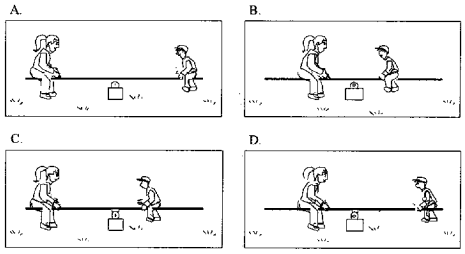
Topic	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Organs, tissues			●	●	●	●	●	●
Physical properties of matter			●	●	●	●	●	●
Plants, fungi			●	●	●	●	●	●
Animal types			●	●	●	●	●	●
Classification of matter			●	●	●	●	●	●
Rocks, soil			●	●	●	●	●	●
Light			●				●	●
Electricity				●		●	●	●
Life cycles				●	●	●	●	●
Physical changes of matter				●	●	●	●	●
Heat & temperature				●	●	●	●	●
Bodies of water				●	●	●	●	●
Interdependence of life					●	●	●	●
Habitats & niches					●	●	●	●
Biomes & ecosystems					●	●	●	●
Reproduction					●			●
Time, space, motion					●	●	●	●
Types of forces					●	●	●	●
Weather & climate					●	●	●	●
Planets in the solar system					●	●	●	●
Magnetism						●	●	●
Earth's Composition						●	●	●
Organism energy handling						●	●	●
Land, water, sea resource conservation						●	●	●
Earth in the solar system						●	●	●
Atoms, ions, molecules							●	●
Chemical properties of matter							●	●
Chemical changes of matter							●	●
Physical cycles							●	●
Land forms							●	●
Material & energy resource conservation							●	●
Explanations of physical changes							●	●
Pollution							●	●
Atmosphere							●	●
Sound & vibration							●	●
Cells							●	●
Human nutrition							●	●
Building & breaking								●
Energy types, sources, conversions								●
Dynamics of motion								●
Organism sensing & responding								●
Evolution, succession, diversity								●

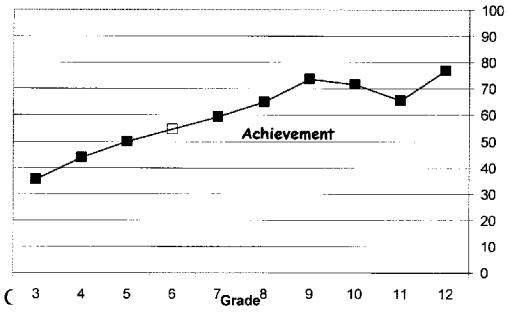
Performance Growth on a Single Item



N8. A girl wanted to play on a seesaw with her little brother.

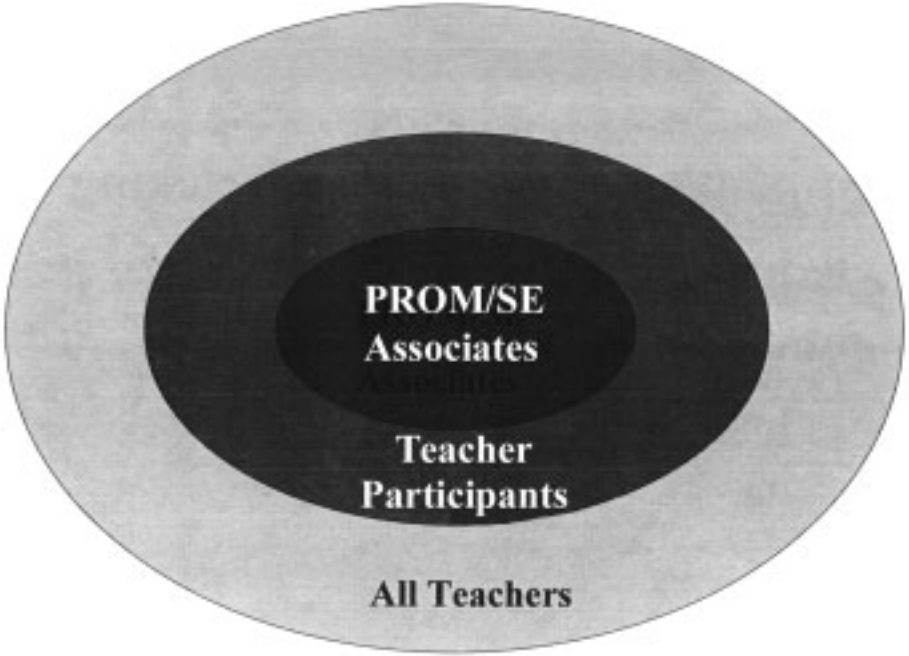
Which picture shows the best way for the girl, who weighed 50 kg (kilograms), to balance her brother, who weighed 25 kg?





PROM/SE Professional Development

- Subject matter knowledge for teaching
- Knowledge of students and how they learn mathematics and science
- Knowledge of teaching practice in mathematics and science


PROM/SE
Associates
Teacher
Participants
All Teachers

PROM/SE Plan

Year 1: student and teacher assessment, analysis of current standards, identify PROM/SE Associates (one per building)

Year 2: data analysis, revise mathematics standards, PD for Associates and teachers

Year 3: revise science standards, PD for Associates and teachers in math and science

- **Year 4:** repeat assessments, link to NCLB, PD for science teachers, new courses and programs in science TP at MSU
- **Year 5**: continued assessment, virtual PD, assessment of MSU teachers and pupils

Opportunities in PROM/SE

- Customization to local needs based on evidence
- Design of a layered professional development system to meet needs of diverse teachers at all levels
- Building new cultures with mathematicians, scientists, and educators
- Creating shared commitment to high expectations for mathematics and science learning
- Research about key questions in targeted areas
- Potential for creating and studying national models that will be of national value

BIOGRAPHY FOR JOAN FERRINI-MUNDY

Dr. Joan Ferrini-Mundy is Associate Dean for Science and Mathematics Education in the College of Natural Science at Michigan State University, where she is also a Professor of Mathematics and Teacher Education. Dr. Ferrini-Mundy has worked in mathematics teacher education since 1982 when she co-founded the SummerMath for Teachers Program at Mount Holyoke College. Since that time she has been the principal investigator of several State, federal, and foundation grants in research and teacher education, both at the University of New Hampshire, where she was on the Mathematics Faculty for 16 years and directed the Master of Science for Teachers Program, and at MSU. Ferrini-Mundy served as a Visiting Scientist in NSF's Teacher Enhancement Program (1989–91), and as Director of the Mathematical Sciences Education Board at the National Research Council (1995–1999). She received the Louise Hay Award for Contributions to Mathematics Education from the Association for Women in Mathematics in 1999, and won awards for teaching and for public service at UNH, as well as the Balomenos Award from the New Hampshire Council of Teachers of Mathematics. Ferrini-Mundy has been active in the National Council of Teachers of Mathematics (e.g., Chair of the Writing Group for *Principles and Standards for School Mathematics,* member of the Board of Directors, Chair of the Standards Impact Research Group), the American Mathematical Society, and the Mathematical Association of America.

Currently, Ferrini-Mundy serves as co-PI of the MSU Teachers for A New Era Initiative, a reform of the MSU Teacher Education Program, funded by the Carnegie Corporation of New York and partner foundations. Ferrini-Mundy also directs an NSF-funded research project, "A Study of the Algebra Knowledge for Teaching" and is a Co-director of the NSF-funded "Study of the Development of Leaders in Mathematics and Science Education." With Dr. William Schmidt, she serves as co-leader of the recently awarded NSF Math and Science Partnership project "Promoting Rigorous Outcomes in Science and Mathematics Education" (PROM/SE). She served on the Mathematical Sciences Education Board RAND Mathematics Study Panel (2000–2002), the NAEP Mathematics Assessment Framework Committee (2002), the ACHIEVE Mathematics Advisory Panel (1999–2002), the TIMSS 2003 Expert Panel (2002–2003), and the NSF EHR Mathematics Education Portfolio Review Expert Panel (2003–present). Ferrini-Mundy's publications include edited books, textbooks, chapters, and papers. She is a frequent presenter at national and international meetings, and participates as an advisor to several mathematics and science education projects and initiatives across the Nation. Her research interests span calculus teaching and learning, the development of teachers' mathematical knowledge for teaching, and K–12 mathematics education reform.

MICHIGAN STATE
UNIVERSITY

October 28, 2003

The Honorable Nick Smith
Chairman, Research Subcommittee
2320 Rayburn Office Building
Washington, DC 20515

Dear Congressman Smith:

Thank you for the invitation to testify before the U.S. House of Representatives Science Committee, Subcommittee on Research on October 30 for the hearing entitled *Implementation of the Math and Science Partnership Program: Views from the Field.* In accordance with the Rules Governing Testimony, this letter serves as formal notice of the Federal funding I currently receive, or have received in the past two years in support of my research.

- $35,000,000, EHR-0314866, National Science Foundation, "Promoting Rigorous Outcomes in Mathematics/Science Education, 10/1/2003-9/30/2008
- $340,324, REC-0106709, National Science Foundation, "Knowledge of Algebra for Teaching", 9/1/2001–8/31/2004
- $455,560, ESI-0101110, "The Context for Developing Leadership for Mathematics and Science Education", (Co-PI) 2/1/2001-7/31/2003
- $500,000, REC-0093292, National Science Foundation, "CAREER: Examining the Mutual Construction of Learning and Teaching in University Mathematics Classrooms", 8/1/2000-7/31/2005 (Substitute PI for Karen King)
- $124,911, REC-0231943, National Science Foundation, "Studying the Role and Influence of Standards in K-12 Mathematics Education: A SIRG Research Catalyst Conference" (Co-PI), 1/15/03-21/31/04 (Award to NCTM)
- $139,658, ESI-0092547, National Science Foundation, "Using Videos for Professional Development -- A Conference Grant" (Co-PI) 2/1/01-7/31/02 (Award to BSCS)

In addition, I regularly serve as a consultant on various other NSF-funded projects in science and mathematics education.

Please contact me if additional information is needed.

Sincerely,

Joan Ferrini-Mundy

Joan Ferrini-Mundy
Associate Dean for Science and Mathematics Education, College of Natural Science
Professor of Mathematics, Professor of Teacher Education

COLLEGE OF
NATURAL SCIENCE
Associate Dean for Science and Mathematics Education
Joan Ferrini-Mundy
Michigan State University
211 North Kedzie Lab
East Lansing, MI
48824-1031
517/432-1490
FAX: 517/432-5653
e-mail: jferrini@msu.edu

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DISCUSSION

Chairman SMITH. Thank you. I am going to start with you, Dr. Ferrini-Mundy. What do you mean by improving math and science learning? What does that mean?

Dr. FERRINI-MUNDY. At a surface level, it means seeing achievement scores go up, and we are——

Chairman SMITH. Whose—so——

Dr. FERRINI-MUNDY [continuing]. Absolutely committed to that. The students, K–12 students.

Chairman SMITH. Quality or quantity, how do you balance quality and quantity?

Dr. FERRINI-MUNDY. I think we have to aim for both. We want all students to show gains. We also want them to be learning significant mathematics, important math and science skills, as well as concepts, and so a big piece of our emphasis will be on meeting and understanding. We want these students to be able to use their mathematics and science, to apply it, to move to the next level with understanding. And so a lot of this involves designing assessments and working with assessments that let us take a look at those kinds of features.

Chairman SMITH. Any other comments in this area? Dr. Yasar?

Dr. YASAR. I know we are looking at the achievement scores, but that—it may not tell the whole story, so in student attitude and interest and their progress over a number of years could tell us that students have learned from these projects.

Chairman SMITH. I am glad to see representatives from our educational area of NSF here, and from the Department of Education. I mean just from my Michigan farms, a barnyard standpoint, it seems to me like you need a capable teacher and a capable student, and then you need motivation and balance and that sort of comes down to the classroom. Mr. Mikols, Mr. Chi, how do you motivate an unmotivated student, or isn't that the right question?

Mr. CHI. Well, I would like to take a stab at trying to answer that question. I think if we start with what that student is interested in, I am sure that we could find the science and find the math that is inherent in anything that they are interested in. I think part of the reason why they feel unmotivated is because they lack control, that they are not pursuing interests that they have, and I think that being able to seek out the concepts that are inherent in anything that they are interested in is a way to draw them into the science classroom and the math classroom and the technology classroom. I think the MSP project provides that opportunity to have a network available to any teacher to try to cross disciplines and try to bring students in a variety of different subjects.

Chairman SMITH. Mr. Mikols, any thought then, and then Dr. Navarro.

Mr. MIKOLS. Yeah, just to go with what Mr. Chi said, a lot of time, student interest is so crucial, and if we can allow students to pursue something that is of interest to them, and then try to tie the mathematics and the science to that, then the students are more likely to be motivated, because it is something of their choosing. It is something of their design. And allowing them to design

the kinds of questions that then need to be asked to pursue the problem that they are trying to solve, and then working in the content with that. And sometimes, it is just a matter of also offering students a sampling of some of the different things that technology is capable of doing, and exposing kids to things that they, perhaps, haven't seen or thought of before, as well. And if you can kind of mix those two ideas together, allowing some choice for the student, but also opening things up for them, then perhaps that will help with the motivation of students.

Chairman SMITH. You had a comment, Dr. Navarro.

Dr. NAVARRO. What we have done is tried to get scientists and engineers into the classroom to begin to show practical applications of math and science learning. That begins to kind of pique the interest of students, and we also try and provide them information about what they can do, not only in terms of practical applications of math and science, but how it has implications for employment opportunities for the future, and what the employment opportunities will result in financially and in a variety of ways. That gets the interest of lots of students.

Chairman SMITH. You mentioned how important it was, K–16. How about the technology that is moving into the assembly line for a lot of these students that—I don't know what percentage of your students go on to college, but how important do you think just the math and science ability is going into the new technology of computerized pressing and stamping operations and molding operations?

Dr. NAVARRO. Well, that is one of the things that we have realized, that it is tremendously important not just for students that are going on to college, but for all students that are hoping to try and find a job that will provide them a living wage, and we are trying to make clear to students what the linkages are between what they learn in math and science, and again, what they will do in even a regular kind of job. It doesn't necessarily have to be a college level job. That we have found to be a tremendously important piece of information that students and especially parents don't understand now, so parents are less asking us why do my kids have to take Algebra I and Algebra II. I think they are increasingly understanding it because of the presentations we have made to parents, not just educators, but business people as well.

Chairman SMITH. Yes, Dr. Ferrini-Mundy.

Dr. FERRINI-MUNDY. I think on this point, particularly in mathematics, emphasis on some of the sorts of skills and processes of the discipline can be really compelling in trying to make the case that this prepares all people for all sorts of workplaces, so problem-solving, reasoning, justification, inquiring, being able to formulate conjectures, the sorts of things that don't necessarily show up on lists of topics of content, but that are crucial to the teaching of math and science.

Chairman SMITH. I think I had better move on. My time has gone up, but we will do enough rounds to get all of your answers and part of my questions. I mean, part of the goal of this hearing is should we—is there anything we need to do in changing NSF, the way we are peer reviewing, the way we are modeling the goals of this science math partnership effort? So we are looking for im-

provements of direction, how much knowledge is out there that we probably might try to capture some of the knowledge that is out there. Mr.—Dr. Honda.

Mr. HONDA. Thank you, Mr. Chairman. He has given me a title that I haven't earned yet.

Chairman SMITH. You have earned it.

Mr. HONDA. Well, I appreciate the presence of the witnesses and your experiences, also, and they are all sort of compartmentalized in terms of your area of expertise and practice. But what I have heard was that they need to be integrated and they need to be applied accordingly. To the classroom teacher, Mr. Chi, and to Mr. Mikols or Mikols, I appreciated your field-based experience and your insights. And my question would be, given that experience and given those insights, you have talked about, I guess, to paraphrase, sort of integrating the subject matters and not compartmentalize them is a critical thing, because we tend to school our youngsters to compartmentalize everything from the get-go, and by the time they are in high school or middle school, you know, every subject is separate and they shouldn't be integrated. And I think that that is a large mistake in something that, as a policy, that may be a suggestion that you may want to think about for board members. So I guess my question would be, based upon your experience, which you have gathered now and some insights, what policy changes would you recommend to the board, not to superintendents, they are the implementers, but to the board, so that you can enhance the kinds of things you see.

Integrating teacher energies and encouraging integrated approaches to curriculum development and instructions, where science and math are integrated with English and history, because we want to have our youngsters feel that they have some roots in some of the history. For instance, the Mayans had astronomy and math as well developed as the Arabs and the Moors had, and they both developed the concept of zero. You know, youngsters from ethnic backgrounds are not taught that, that they have a history, and so that can be integrated. It is going to take a lot of work in terms of team building among the instructors, but are those ideas that could be turned into policies for school boards?

And then, as the national policy, should we be looking at that rather than only curriculum development? Teacher preparation, it seems to me, critical from what I am hearing, and rather than only looking on—focusing on kids, I assume all kids can learn, so my question is what policy implications do you look at in terms of teacher preparation at a national level? What you have experienced personally, I think, becomes very powerful. My question to the researchers and the teachers are—what you have learned now, is that replicated in—if you do the research on literature, and if that is so, why are we not making that next step? What is that next step in terms of a national policy, so that we can move away from focusing on student achievement, and talk about national expectations? And it may come down to us putting resources where our mouth is, and stop blaming the victims.

So, those are my questions. You may not have time to respond to them all orally, but if you have a written response that you

wouldn't mind sharing, I would love to read it, and I appreciate all of your experiences.

Dr. YASAR. Can I comment? There may be things to be done, not only at the school district level, but also at higher education. As you know, the target in our project is——

Chairman SMITH. Turn your microphone on.

Dr. YASAR. Sorry. To have a formal education in CMST, in other words, MST. If MST certification were recognized at the station education departments, where teacher candidates get their certification in MST, rather than just in mathematics or in science and technology, they could be very useful in the school districts. I have—some of my students who graduated from other programs, who were exposed to education in math, science and technology, in the school districts, they are teaching not only mathematics, but also science and technology. And for school districts, this is going to take care of a huge need, because most computer science graduates go to industry, and school districts have problems finding teachers who can teach technology. They go to math teachers and say can you teach this, they say no. I didn't receive a formal education. So, through the training, or formal education, or State education departments creating MST certification, we could have teachers who are able to teach in more than one area, and team teaching, of course, is also another solution in the districts, and I believe that is what is going on in other projects at this point.

Mr. HONDA. You know, Mr. Chairman. Just a real quick comment. I think I also heard from Mr. Chi that there is a need for teachers as a profession to always tell ourselves that we are only good teachers when we constantly remain students, and that somewhere along the line, we stop being students, and we get stuck in our instructional capabilities, and we forget that students need to learn constantly and so should teachers, and so that—I appreciated that insight. I hope that always stays with you, and becomes a strand in the policy and philosophy. I think perhaps we have lost—also, perhaps in your written response, you might want to discuss the concept of equity in education, because I suspect that equity does not exist even in one school district. And then I guess the other one is where is instruction? Where can it be conducted? Does it have to be in the four walls? Stepping back from our institutionalized thinking of instruction, are there ways that we can maximize technology, the presence of technology in other places and look at different ways? You have the toughest job in the world, and you are not being compensated properly, but I appreciate your stick-to-it-iveness in education and I just want to thank you.

Chairman SMITH. We will do a second round and a third round and a—we will try not to wear you out too much. We appreciate what you have done to get here. Dr. Ferrini-Mundy, how are you going to go about discovering what works and making that kind of report? At Michigan State, is that a five-year project, or a four-year?

Dr. FERRINI-MUNDY. Five.

Chairman SMITH. How—and then, what would be—is there going to be in a fashion that we can put it out across the country, is it—how usable is it going to be?

Dr. FERRINI-MUNDY. We hope it will be usable. I mean, as I have mentioned, we are just starting, and we are just trying to create a shape for this project. We will begin with this building of a sort of baseline set of data. So, we will look at where students are, what teachers——

Chairman SMITH. Is your mike on?

Dr. FERRINI-MUNDY. It says it is on. We look at where students are, what teachers are doing—is that—what kinds of standards are in place. We will try to summarize that information and then track that as this project unfolds. We also expect, because this is so large, that different parts of the project, different districts, different schools, even different buildings, will use variations of professional development. Some might do a sort of coaching model, where teachers work with their colleagues inside classrooms to support their instruction. Others might move more into a technology-oriented, Web-based sort of e-learning.

Chairman SMITH. Did your proposal include dissemination?

Dr. FERRINI-MUNDY. Yes. Yes, our sense will be that we will conduct a range of studies within the big project and create a plan for actually producing that into a form that is disseminatable and shared with the White House.

Chairman SMITH. Do we have, and I don't know, maybe I should ask the question to you—of all the knowledge out there, of all of our efforts to improve the way we teach and learn, has somebody got that on a database someplace that you can—that researchers can go pick out different studies that have taken place over the last 100 years, and do we have that?

Dr. FERRINI-MUNDY. There are examples of that. There are also syntheses, wonderful research syntheses. The National Research Council produced a report called "Adding It Up: A Mathematical Proficiency for All Students." That compiles research about mathematics teaching and learning for grades K–8, and there are examples like that and folks access those sorts of things.

Chairman SMITH. Do we have any initial—Mr. Chi, Mr. Mikols—do we have any initial data, or do you have suggestions on—I don't know what to call them, demonstrations, hands-on projects that tend to stimulate interests? Does that work in your classrooms? Do you use it?

Mr. MIKOLS. Yeah, we use hands-on projects, and——

Chairman SMITH. Well, with your technology and computers and——

Mr. MIKOLS. Right. And as Mr. Honda was asking, is there a mechanism in place where we could require students to incorporate the different disciplines. In my district, they mandate that students have a certain number of hours of community service, so why we can't mandate that there is some sort of project that is hands-on and technology-based that is interdisciplinary as part of a requirement for a student to graduate. I don't know why that couldn't be possible, and it could be something that is of a student's choosing. I have done several different projects in conjunction with science teachers, and those have been effective, measured mainly by reactions from the students. They are—the projects that I have done have been with advanced placement students, I have taught advanced placement calculus, and I did them in conjunction with an

advanced placement biology teacher, and the response that we get is that this was an extremely worthwhile project that they learned a lot, and it incorporated technology and it is something that they would be able to use, and it is something that they talk a lot about.

We have also done hands-on projects with some of our younger students as well, and they are appreciative of the fact that they do have some say in what it is that they are learning, and it is tied to content that is linked to standards, so——

Chairman SMITH. The question as far as any guidance or suggestions to the National Science Foundation. What were your—what might be—what were your major barriers to implementation? Should there be any changes in terms of future partnerships? Any thoughts you have on was there sufficient outreach by NSF, in anything other than saying you're approved? Yeah, Mr. Yasar.

Dr. YASAR. NSF brought together MSP projects last year in January, and there is going to be another one in this coming January for all these projects to interact and discuss how to build a culture of evidence, so there is a lot of emphasis on that. We are all aware that money has been put into education for many years, but we need to do things differently. As we try different things, we need to build in a culture of evidence, of evidence-based, and there is a great emphasis on that. NSF also expected all the MSP projects to develop strategic plans. I am so thankful that they require that, because we took our grant proposal probably 10 degrees deeper in developing an evaluation plan that addressed student progress, teacher—impact on teacher, and we hope that at the end of the five year period, we will have a lot of data to contribute to this evidence base.

Chairman SMITH. Okay. Dr. Navarro, I sort of got the impression from some of your comments that the money coming in allowed you to continue the good things you are doing. Is there an endpoint? Are we discovering something that eventually other schools without being given additional Federal money grants, can continue the kind of effort?

Dr. NAVARRO. I mean, I think that there are many things that are coming out of the MSPs and the previous NSF-funded efforts that will provide direction to districts and schools that don't get these funds. The reality, though, is that if you have a large school system, as we do with the close to 160,000 students in it, and you are trying to get them from where they are now, how they are teaching math and science, the level of knowledge that their teachers have, and you want to get them to a dramatically new place, it seems to me that additional resources will be needed. That is what MSP is allowing us to do, and engaging the full resources of higher education institutions——

Chairman SMITH. But you will continue——

Dr. NAVARRO [continuing]. To help us do that.

Chairman SMITH [continuing]. The quality program that you have instigated after the Federal funding stops?

Dr. NAVARRO. Absolutely. We have gotten commitments from higher education institutions and the districts to continue this, and they are finding ways of building it in—slowly but surely—into their budgets and into their own strategic plans.

Chairman SMITH. One of the complaints many teachers have is that the faculty and institutions of colleges, university, higher education, have the content knowledge, but are often somewhat weak on what it takes to be a teacher and teach that knowledge. Any comments that any of you might have in terms of this Math Science Partnership in helping—and should we move in the direction of helping cure some of those problems, or is it a problem?

Dr. NAVARRO. I think that if you—if I could just—I think if you get people to the table, K–16, without a notion that the higher ed people are going to be kind of telling the K–12 people what to do, or that they are the only ones with the content knowledge, I think that that helps enormously. People come together at the same place, at the same table, in our MSP, and that helps everyone understand that we all have something to learn from one another, and that there are plenty of content experts at K–12 as well, and that there is a lot to be learned about teaching and learning at the higher education level from K–12 people.

Chairman SMITH. Any other thoughts on this issue, Dr. Ferrini-Mundy?

Dr. FERRINI-MUNDY. No. I would echo what Dr. Navarro has said, and add that when people are at the table on sort of equal footing, it is also quite interesting when the K–12 folks, the classroom teachers in particular, start to raise the real issues that they face in their teaching, and the subject matter questions that K–12 math and science teachers face are hard, and they are different from the subject matter questions that professional mathematicians and scientists face, and that professional mathematicians and scientists can't always figure out the best way to help a child understand what a fraction is, or the best way to help a child understand what place value is about, and so when you get them together and really looking at the problems of teaching, I think you do find an equal footing.

Chairman SMITH. So, will anything in your particular project proposal, going through Michigan State, look at the ability to light my fire, and excite kindergarten and first grade and second grade students in science, math, in relation to their science and math training, as opposed to their teaching abilities and love of students?

Dr. FERRINI-MUNDY. Right, I mean, our hope is to try to bring those together, to put them in a place where those two conversations are going on at the same time, with people who have strong content knowledge and strong knowledge of teaching.

Chairman SMITH. I have a question for you, Mr. Chi, and you, Mr. Mikols. We often find that those schools with the lowest levels of academic achievement have teachers with the lowest levels of skills and knowledge, and in many cases, these teachers want to do the very best for their students, but are unable, due to a lack of information or education. Upon graduation, were you prepared to teach your State's standards in math and science, and generally, moving it away from a personal question, what do you see as the possible lack of students coming from the education—the university system and going into teaching of science and math in K–12? Starting with you, Mr. Chi, and then you, Mr. Mikols.

Mr. CHI. Well, just to address, sort of at the same time, your question before, I think the MSP program has really encouraged a

collaboration between higher education and teachers in the middle school and teachers in the high school system, and because of that, there has become an increased awareness on the part of the teachers in higher education, in the colleges and universities, that—of the different kinds of issues and problems that are faced by teachers in the high school and middle school. Because of that, they are becoming more sensitive, and as a result, they are better able to approach their students as well, and so I think there is a little bit of a rubbing off. There is content being disseminated from the colleges to the high school and middle school level, and there is a sensitivity to pedagogy and the intricacies of teaching to the college and university professors as well.

As far as how prepared I was, in terms of my college and university experience related to my ability to teach my content area, which is science, I feel that I was extremely well-trained, and I came out of college with a plethora of skills to better present the topics and to increase student interests in my classroom. So I feel pretty fortunate in that area.

Chairman SMITH. And that was—be a combination of the curricula that you—that—whatever the—that you took while you were in school, or some of your own initiatives, or a combination, I suspect?

Mr. CHI. Well, where I attended college, which was SUNY–Geneseo, I was there as a secondary education major, and, being a content specialty of biology, it was almost as though I was double majoring, where I had a very rigorous content in terms of my biology background and my science background, and at the same time, there was a very intense training, in terms of the pedagogy, so I feel I was very well balanced when I came out.

Chairman SMITH. And Mr. Mikols, then we will move on to Mr. Gingrey.

Mr. MIKOLS. The comment that was made that low achievement, many times, is linked to schools with high teacher turnover and having a large population of teachers that are uncertified or not adequately trained. That is true. And one of the schools in my district, that I am working in, because it is a cited school from the State as a low-performing school. They have a population of 1,200 students and they had one returning teacher in their math department for this school year, so the idea that we are training teachers and then losing them the next year, and then having brand-new teachers come in and having to retrain them again, and then when that pool of qualified teachers runs out, we are having to go to hiring uncertified teachers to fill those positions, and it is a huge problem.

There is a college in our area, Roberts Wesleyan College, that has a program in conjunction with the city school district that is allowing students to take a teaching job. I am sorry, I shouldn't say students, because it is—you are thinking of high school students, but they are allowing people to take a teaching job while they are students at Roberts Wesleyan achieving their teacher certification. So we are dealing with many, many teachers that don't have a lot of training, and they are being put right in the classroom. So, the recruitment issue that I think the MSP program can enhance, to me that is huge. We have to attract teachers early and often that

are highly qualified that are thinking of teaching as a primary career, not something to fall back on once other things have not been successful.

Professional development is another thing: you just can't overemphasize the value of quality professional development that is ongoing, that is accountable, that takes teachers and moves them out of their comfort zone to get them to change and become learners of stuff that is going to be helpful to students.

I will close with one other statement. I graduated from Geneseo as well in 1992, with a degree in mathematics, and part of our curriculum was graphing calculators back then, so I feel well prepared, in the sense that even 10, 11 years ago, the need for technology was known then, and I felt like I was ahead of the game with that.

To get certified, I had the degree in mathematics, and then we also had to minor in education, so then we also had pedagogy courses that helped us to take that content and deliver it in ways that would be effective in the classroom.

Chairman SMITH. Mr. Gingrey.

Mr. GINGREY. Thank you, Mr. Chairman, and I do apologize for having to step out. I may have missed, obviously missed some of the questions, so if I am—if it has already been asked, just forgive me. I obviously didn't hear the answer. When I was in school, all math courses were taught, I think, Mr. Honda may have touched on this a little bit earlier, as stand alone courses. I mean, I can remember, you know, taking algebra and geometry and trigonometry and finally, when I got to college and was introduced to calculus, everything was just kind of stand alone, and it wasn't—I never really enjoyed math as much as I think I should have. I never really thought that there was any connection between math and physics and chemistry, but as I went through college, and approached my Bachelor of Science degree in chemistry, I finally realized that all of this stuff, at some point, sort of comes together. It all is the same basic thing, but I never understood that until I was almost a college graduate and about to disappoint my pure science teachers and go to medical school.

But I guess my question for any of you, maybe in particular the high school teachers, Mr. Chi and Mr. Mikols, if there were some way at the outset, and let us call the outset the eighth or ninth grade, to explain to students, maybe an introductory course to mathematics, so that they understand that, at some point in their career, all of this is going to come back together, and it is going to have some real meaning to them and some real utility, and it is not just passing another course, and each and every one is stand alone and there is no rhyme or reason to it, and that is the experience I had. Now, that is a long time ago, I have to admit, I hate to admit, but there has just got to be some way to excite youngsters to math and science, and I want to hear what your thoughts are in regard to that, because maybe it is happening. I don't—I was a school board member before I became a State Senator, before I became a Member of Congress, but I didn't see it as a school board member, and you know, I went into a lot of schools. It is still like, ugh, you know, I have got to sign up for chemistry or physics or whatever, and this nerd concept and all of that stuff, you know,

you get. Members of Congress, I think, don't want to sign up for the Science Committee. There is still a little bit of that mentality, excuse me, Mr. Chairman.

We have got some great scientists on the Committee, some Ph.D.s, and I am honored to be a Member of this committee, and to serve on Chairman Smith's Subcommittee, but you know what I am saying. It is that mentality that we just need to get beyond, because this is a world in which, you know, science is exciting and, I mean, you know, somebody mentioned earlier possibly having someone come into the classroom, whether it is a surgeon or maybe the F–18 fighter pilot that I had the honor to fly with recently in full flight gear, and to talk about aviation, physics and that sort of thing and negative gravity. It is just, you know, so if you all would comment on that particular suggestion of an introductory course to mathematics where people at the very beginning would understand that there is something to this, and not just everything stand alone.

Mr. CHI. Well, I think where we need to sort of begin is to change the perception about what the typical scientist is. I think you sort of touched upon that a little bit, and many students have a misconception that a person who is involved in the mathematics and the sciences is stiff and nerd-like or what have you, but to broaden their perspective and to show them that a fighter pilot, an aviator, a criminologist, is doing science and using mathematics and incorporating technology into their field, I think that will broaden their perspective on what it means to be involved in the sciences. That is a first—that is an important first step, and to get students interested, I think—I would hate to put it this way, but somewhat, we need to disguise some of these activities and mention the science and the mathematics later on, introduce them as fun, interesting topics to investigate, and then later on, sort of reveal to them that there is some science and there is some mathematics and there is some technology involved in these activities, these fun catch activities are scattered through our curriculum in Brighton, and oftentimes, the "sleeper student" who is just cruising through and just trying to pass the course may suddenly be sparked with some interest when we are getting ready to drop a 10 pound pumpkin out of a window, when we start to discuss the idea of gravity, and it is those activities that, as you pointed out earlier, grab and get student attention, and those are some of the activities that need to be incorporated into some of these curriculums, or curricula.

Mr. GINGREY. Dr. Yasar.

Dr. YASAR. You just gave me an opening, and on your display, I have a system that I just—it took me probably, if you were watching, 10 or 20 seconds to build, and we have offered this to students. I don't know if there are any physics Ph.D.s here, but I can put a system up here in a minute and in 10 seconds, I said, and it will take a physics professor 10 pages of handwriting and probably an hour to develop equations of motion and predict the system. Here, we have a tool that allows not only me, but only—but also middle school students to simulate a physical system. And any student, or any person who sees this, asks the question, wow, what can I do with this? Well, they can do all kinds of things.

So, a layered approach using technology, layered approach means I show you something, get your interest. I don't tell you what it is taking to do this. I hide the mathematics and the laws behind this. You don't need to know the physical—physics laws, and you don't need to know how to solve a mathematical equation. I show you this, you build an interest, and then you come with more questions. Then I introduce to you the mathematics.

I believe the threatening aspect of mathematics is that it involves multiple steps. That is why students are afraid of taking up on mathematics, and I think this is the largest problem in mathematics and science education.

Mr. GINGREY. Dr. Ferrini-Mundy.

Dr. FERRINI-MUNDY. Thank you. I think this is a great example, if you can keep it there. So bump this discussion up now to the teacher preparation world, where the segmentation and the sort of compartmentalization that you mentioned that you experienced in high school continues. People who are in mathematics departments divide themselves up, the topologists are different from the analysts are different from the algebraists, and the courses that are taken in mathematics or in physics or in chemistry are still quite separate from one another. And yet you think about what knowledge a teacher would need to bring to bear with this task, with this model in place, how they would necessarily need to use their mathematics and their physics in concert, how they would need to understand how those ideas worked together to apply to this situation. It is not likely, I would venture, that the physics and mathematics that they have studied in college necessarily prepares them for handling a piece of curriculum that has the richness of this thing that we are looking at right now.

So, your question leads into very interesting and difficult challenges in teacher education. How do we offer capstone courses or integrative kinds of experiences for the prospective teacher, so they could do the sort of thing that I think you are pointing toward, which seems very promising and interesting.

Dr. NAVARRO. Right, and I would just add that just as you are saying, Joan, about the issue of teacher preparation as being the place where you really want to try and bring all of those elements together, one of the issues that I think we would have to address is the issue of curricula, and how do we provide the kinds of curricula that help synthesize all of this for students, so that not necessarily when—would we wait until they get into high school, but in their early school experiences, we are helping them see how they need to bring all of these elements together. And we have to make that easy for teachers to do, because even given the best teacher preparation, they still will be guided by the curricula that they have, and that is where we need to make the linkages and synthesize this knowledge for them.

Mr. GINGREY. Mr. Chairman, I know I have used up all of my time, and I apologize for that, and if there is another round, maybe we can continue on this, or do we—can we hear from——

Chairman SMITH. I will take my next five minutes now and then give it to you. Some schools have decided, some school boards have decided that at the minimum, every student has to take algebra and pass it, as a qualification for graduating from high school. And

it was interesting, the reaction of a couple students that said well, they didn't like the math. It was really too much work, but as long as it is a requirement, they are going to do it. Says it takes a little extra homework, and so I am not sure where the motivation—I mean, it is obvious where the motivation comes from in this one. I wanted to ask the question, also, about parents, and anything in our studies, or should we encourage some of the studies to involve parents in this whole effort of exciting math and science education? Who would like to—and how do you do it? How should we research it? Or should we have a special effort in some of the requests for proposals that include that? Anybody wish to respond?

Dr. NAVARRO. Well, I will just talk a little bit about the first issue that you raised, and also link it to parents, and that is we really believe that we have to expect more of students before they will recognize how important it is to deliver on things, so that one of the things that we did was work closely with our partner districts to support them in requiring that all students take three to four years of college preparatory mathematics and science in order for students to graduate. We strengthened that when we realized that some schools, and schools with the largest number of poor and minority students were most likely to be waiving lots of their students from those requirements.

Now, we limit the requirements to just 10 percent, but parents were a very big part of this, because some of the parents were just very upset, why does my child have to take algebra II? Why does my child have to take chemistry? It is very hard, it requires too much homework, and I think that is where these presentations on the part of key business and community leaders are really crucial. Parents, once they understand that this will enhance the ability of their children to do well in the world of work, to earn far greater lifetime incomes, are easy to be persuaded. Now, you also have to provide supports for students so that they can take these courses and do well, and that there is tutoring available and that sort of thing. Parents will require that, but we have been very successful in providing education, particularly to key leaders within each of the communities, each of the school communities, so we are focusing on three or four parent leaders and provide them the education and training, the information that is needed, and then they reach larger sets of parents back at the school.

Chairman SMITH. Mr. Gingrey, I am going to let you get this.

Mr. GINGREY. Mr. Chairman, thank you. Mr. Mikols, I think you were going to respond to my question and didn't get a chance.

Mr. MIKOLS. Yeah, the point that you were bringing out is where do the kids start to see the link between math and science, and where is the interest level. We know by shows like CSI that that interest is there, it is just how do we get it into the classroom, and Dr. Yasar was talking about layering things and Dr. Navarro was saying well, this is not something that should just be something that is from grades twelve through sixteen, but where do we begin it? And one of the tools that we have used in the CMST program is a tool called STELLA, and it is a program that you can use to make mathematical models of rates of change, and we have made a program that models half-life, and half-life, I think, is a fairly easy topic for even younger students, fifth, sixth, maybe seventh

grade, to grasp of what is happening, but the program is layered in the sense that it does take quite a bit of thinking to make the program, so that is something that you could offer to students of—at the higher levels, but to use the program, that is something that sixth, seventh and eighth grade students could do and get it, a good idea of how mathematics is used to discuss what half-life is, and there are different graphs, and the analysis of graphs is something that kids and adults need to know how to do.

So this is just an example of one of the tools that we have had in CMST that does take math and science and link it together in such a way that you could present that to students of varying degrees of sophistication in math and science.

Chairman SMITH. Dr. Ferrini-Mundy wanted to respond. Dr. Ferrini-Mundy.

Dr. FERRINI-MUNDY. I wanted to just pick up from this and come back to your question about parents. The sorts of instructional approaches that you are hearing about here, this notion of integration of math and science, this notion of hands-on and inquiry-oriented model, base sorts of teaching. That kind of instruction looks unfamiliar to lots of parents, particularly when you say well, this really is mathematics, or this really is physics. It doesn't look like the mathematics or the physics that parents may have studied themselves, and so the education piece is really crucial in looking at different models for how to help parents see the value of this kind of course work and at the same time, understand that these approaches have promise, and that children will learn something useful even from something that might look quite unfamiliar to a parent. I think those are really hard questions and continued efforts along those lines are needed.

Chairman SMITH. My short version has been that—telling parents that Social Security is going broke and maybe their retirement security depends on how well their kids do in math and science.

Dr. FERRINI-MUNDY. That is good.

Dr. YASAR. I don't want to put my school district on the spot, but there is some difference in terms of parental involvement in these two school districts. At Brighton, teachers are running away from parents. At City School, parents are running away, we can't find them. So, you could attribute some of the low success, you know, achievement, to lack of parental involvement at the City, and I believe there is an MSP project already that targets parental involvement, so we need to see more of that.

Chairman SMITH. The phone call I got is, there is somebody that came through security that shouldn't have gotten through security, so I told my guards to—Mr. Gingrey, we will start your five minutes, Mr. Gingrey.

Mr. GINGREY. Thank you, Mr. Chairman. I think your suggestion about a Social Security scare tactic is not a bad one, because you know of what you speak. I have heard you do many special orders on what is going to happen to Social Security if we don't reform it. But while we are waiting on that, I did want to ask about the idea of paying math and science teachers more, particularly at the high school level. I know a lot of times that it is a third rail to mention that to any of the education establishment. In no way to suggest that the arts and language and history and other things are not

extremely important, but it is tough to teach math and physics and chemistry, and it takes—in my opinion—a really dedicated and very intelligent teacher to do that, and if we had a Mr. Chi or a Mr. Mikols in every high school in the country, we wouldn't have a problem. I am very, very impressed with your testimony and—of everybody that is here who has testified, but you know, I have always thought that—and I know in some school districts maybe it is an optional thing that they can do at the local level, but you just can't expect bright teachers that we need to teach math and science, to stay in a low-paying profession, although I know there is other gratification, other reasons why you do it.

What do you think about that? What do you think about the idea of—in every school, paying more to math, science and physics teachers, and I am talking about the pure science and, you know, you—we might quabble over what is science, but I am talking about math, physics and chemistry. Can you comment on that?

Chairman SMITH. I think the two teachers might——

Mr. MIKOLS. Yes. Yeah, I would be the first one to say sure, you know, that is a great idea. But it is a question of market. You know, you have a certain supply, you have an overwhelming demand, and I think what we can try to do, by offering more money to people to go into math and science teaching, is to increase the supply of math teachers, because right now, in my district, we don't have enough, and financial benefit is one thing that may get people to consider a career in the Rochester City School District. And you know, with our passing rates at the eighth grade exam, what they are, we are looking at lots of different options, and one of the things that has been mentioned is paying stipends to teachers to go from some of the higher-performing schools, and some of the teachers with proven success and experience to go to some of these schools that are on the cited list as low-performing, to try to get them to go and lend their expertise and their experience so that these other teachers that I told you about, that are making up the huge overwhelming majority of their staff, that are extremely inexperienced, have someone who is skilled and has a lot of experience to go to, so—and maybe money is the way to do that.

Dr. NAVARRO. We have provided additional resources at several points in the continuum. First, there are through NSF-funded scholarships and fellowships, more students studying math and science and going into education at the secondary level in math and science that are receiving help with tuition and fees, so those scholarships and fellowships is a draw for students, particularly in our low income area. Secondly, a number of the districts have found it necessary, because of the severe shortages, particularly of secondary teachers, to offer those additional stipends for teachers that are fully certified in math, science to go into the high schools, and so that has been an important aid in getting some additional teachers that are fully certified into these high schools.

One of the arguments that people have made in our community is that if individuals graduating with a degree in science can move into industry and get jobs at $50,000 plus, what is it that, beyond their concern for their fellow human beings, is going to draw them to schools where we know the demands are great, and sometimes,

the challenges are enormous, so if there is a small financial incentive for doing that, we think that it can be used effectively.

Mr. GINGREY. Well, we have a course at the Federal level. We have done a number of things and as we move toward the final reauthorization of the Higher Education Act, there is more—there is going to be, hopefully, more loan forgiveness for math and science teachers and at the local levels, I think a lot of school systems will pay an incentive, a bonus, if you will, for a math or a science teacher to go into a high need area, and that is great. But I mean, I think, and I think you have answered my question, that you just literally, at the very outset, the generic starting salary should—there should be—because again, and you mentioned, I think, Mr. Mikols, about supply and demand. I think that is the bottom line, that we just don't have enough of you guys and gals that, you know, are math and science teachers, and we need to incentivize you, to not only start in that direction, but to stay there.

Chairman SMITH. We are going to wind this up pretty soon. A couple questions I have got is I have been encouraging my schools of education that turn out any teacher to start requiring a basic course in math and science, so whether they are teaching English or phys ed or whatever, they have at least a little understanding in math and science that maybe helps in some of the questions that might be asked, some of the stimulus, some of the—prevent some of the teachers from saying well, boy, don't ask me, I never did as good at it and it didn't hurt me.

Any comments? Shall I keep doing that?

Dr. NAVARRO. Yes. Absolutely. We require an increasing number of courses for all teachers, and I think it is now up to something in the range of 28 credit hours in mathematics and science for all teachers, irrespective of what they are going to be teaching. The big issue for us is who is teaching those courses at the post-secondary level, and that is one of our challenges in MSP is to make sure that the university faculty members that are teaching those courses can excite these teachers rather than frighten them, make sure that those prospective teachers get more excited rather than—about math and science, rather than come to feel that their initial perceptions that this was not something I wanted to learn were right.

Chairman SMITH. Are any of your MSPs partnering in any way with the private sector?

Dr. NAVARRO. We are working with our Chambers of Commerce to do these presentations at the middle school level about—in particular, about ensuring that students know why they should go to college, and also why they should study math and science. That is something that has worked very well. The business people love to make those presentations. They come into contact with real teachers and students, and we help them understand what the issues are, so we provide a script for them, they can tailor it to a certain extent.

Chairman SMITH. I mean we put——

Dr. NAVARRO. They like doing it.

Chairman SMITH. We specifically put it in the legislation that it has got to be a university and it has got to be a K–12, but with the option of partnershipping with the private sector and as we

were discussing before we put the gavel down, there are a lot of companies out there that are trying to enhance at least their—the math and the science interest in their schools, and so a lot of companies do a lot of work, and I would hope, somehow, to NSF or wherever, we need to—we are going to start looking at some of the work that they are doing. Dr. Yasar.

Dr. YASAR. In Rochester, Xerox gets a lot of its employees from the city school district or others, so they have an interest in supporting education through scholarships and internships. I think that is a great example for MSPs. Can I add a comment? It may not be directly related to business. We talked about teachers, and I know there is a lot of burden on them. We could make things a little bit easier for students, and please note that I went to school in a different country, where students were given 15 minutes breaks between classes. They had time to relax, plus they stayed in one classroom, rather than racing between different classrooms. I think we put a lot of burden on students, and not giving them enough time for break, it just builds the tension in them. Second, time management, class management, becomes a burden on them. So, these may be other factors you may consider in—for schools to restructure their classes and so on.

Chairman SMITH. Mr. Gingrey, do you have any more questions?

Mr. GINGREY. I would like each one of you, maybe, if you would like, to conclude with about a minute on anything that you would like to pass on to the Committee. What happens is the other Members of the Committee will review the testimony and anything that you would like to add, starting with you, Dr. Ferrini-Mundy.

Dr. FERRINI-MUNDY. Yes, I would just again thank you for the opportunity to speak here today, to say that I think, although we are new at it, that this MSP program looks very promising. I think that there will be some things that NSF seems already to be doing that may become quite crucial. Connecting these projects, I mean it is obvious just from the conversation here that we can learn from each other and if the Agency is able to really enable us to do that, that will be crucial, and also, to build up this commitment, I think, to evidence, to sharing research findings, to learning from these projects. I think it could be a wonderful contribution to the improvement of mathematics and science learning.

Chairman SMITH. Dr. Yasar.

Dr. YASAR. I want to thank you for inviting me, and I want to thank NSF and the Federal Government for the opportunity. I have never been so excited about a project, so whatever education, 25 years of education I had, it all comes to a culmination here, and the integrated math and science education, I never found a champion program under DOE or NSF for years, and MSP gave us that opportunity, and brought school districts and higher education and industry together, so I would like you to support this program, as long as and as much as you could. Thank you.

Chairman SMITH. Good. Thank you. Mr. Chi.

Mr. CHI. Well, I would like to address something that was brought up earlier. I forget which one. One of you mentioned equity in one of your comments, and I think the MSP program has, through its funds, has provided access to some of the technologies, to peoples that might not necessarily be able to get their hands on

that technology, be it for financial reasons, economic reasons, and by narrowing the gap between the haves and have-nots, I believe that we are coming closer to a place and time where people have access to and skills in technology that will open up opportunities for them that they might not otherwise have, if it wasn't for programs like this.

Mr. MIKOLS. Again, I would like to thank you for the opportunity to appear here.

Chairman SMITH. Mr. Mikols.

Mr. MIKOLS. And just with the job I have to do with my district, we realize that change is necessary. Change can be fearful, but we also realize that change is possible and that change represents growth, and through programs like the CMST, where we are able to use technology to allow students to take on a larger role in the responsibility of their learning, we see that it is crucial.

Chairman SMITH. Dr. Navarro.

Dr. NAVARRO. I think this is—I have been doing this work for about 20 years. I think MSP is the hardest work I have ever done, that our community has ever done, and I just hope that as we run into the inevitable difficulties and complications of this, that there will be an understanding that the difficulty and the problems are part of the process, and that we can learn from those and share our understanding and that NSF and Congress will understand when we run into these problems and will see it as an opportunity to really learn much more about what it takes to really excite and light the fire in young people about math and science.

Chairman SMITH. Again, thank you all, not only for being here, but for the work that you do to improve math and science education. That is, I think, so important to our future. And one last request I would have of you. If you would consider answering any questions that staff thinks that maybe we didn't answer, that we asked, that we should have asked, and defining Mr. Honda's question that he wanted you to respond to, if you would—we would send those to you and if you might respond, we would appreciate it.

With that, the Subcommittee is adjourned.

[Whereupon, at 2:24 p.m., the Subcommittee was adjourned.]

Appendix 1:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Osman Yasar, Principal Investigator, Targeted MSP Grant, SUNY–Brockport

Questions submitted by Representative Michael M. Honda

Q1. What approaches and policies could move the K–12 educational framework toward a model that takes a fully integrated approach to subject matter [where fully integrated would mean moving beyond the idea of teaching just math and science together, but also including such other disciplines as history, literature, etc.]?

A1. The most effective way to implement a fully integrated approach would be through a mechanism or a tool that demonstrates the interplay of subject matters. Today, many disciplines in humanities and sciences use simulation and modeling technology to advance knowledge and discovery. There must be a curriculum in schools that draws upon modeling-based computational and information technologies. There is need for quality professional development to train teachers how to use a curriculum that is student centered, multidisciplinary, and uses technology effectively. Furthermore, there is need for a multidisciplinary education and preparation teachers. No real change could occur at K–12 without changes in our colleges.

Q2. Do you have suggestions on how this model could be sold to students at the local level, as well as how this could be achieved on a national level?

A2. Assessments and standards on the State and eventually the federal level should address a multidisciplinary approach. Use of technology to promote such an approach could be easily sold to students. As traditional, lecture-based classroom roles are changing, educators and students work collaboratively in more open-ended teaching and learning experiences. The motivational aspect of technology is a principal reason that educators try so hard to master and apply technology tools. Perhaps the best way to sell this model is to pilot such a multidisciplinary (integrated) curriculum. Government funding should be made available to schools and communities. School administrators could push to mandate projects at all grade levels that require a multidisciplinary approach. School boards must have tangible evidence that this approach works if they are going to buy into it. Satisfied students and teachers demonstrating achievement of State and national standards will be very convincing. A concerted effort by federal funding agencies and professional societies could help bring national attention and endorsement.

Q3. Do you have any policy recommendations for ways to change teacher training and professional development so that teachers will be prepared to teach in such an integrated education system?

A3. State Education Departments need to issue *multi-area* teaching certifications. An example is a certification in math, science, and technology (MST). There are many advantages of such a combined MST-certification to its holders, including improved employability and adjustability to changing job environment and school needs. Universities need to offer degree programs with necessary credits to satisfy certification requirements in more than one area. Teacher preparation and training programs need to incorporate a multidisciplinary and technology-based education. An example is our MSP project at the SUNY College at Brockport.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Ed Chi, Science Teacher, Brighton School District, New York

Questions submitted by Representative Michael M. Honda

Q1. What approaches and policies could move the K–12 educational framework toward a model that takes a fully integrated approach to subject matter [where fully integrated would mean moving beyond the idea of teaching just math and science together, but also including such other disciplines as history, literature, etc.]?

A1. In my opinion, the project portfolio based model would be able to take a more integrated approach to the subject matter. Not only can science, mathematics, literature and social studies be included but also art and technology. In this model, students approaching the end of their high school studies are required to create a portfolio with an overarching theme of their own choosing. Their choice must be submitted well in advance of their presenting their portfolio to a team of their teachers. The portfolio would include an exploration of the historical, literary, scientific, even the artistic and technological aspects of their topic. For example, a student may choose Civil War America as their overarching theme. The student can include a paper on the Red Badge of Courage, an analysis of the cotton plant's life cycle and explanation of its transformation from seed to fabric to fulfill the Literature, Science and Technology requirements. The student can create a paper analyzing the consequences leading up to the Civil War. At a set time students will present their portfolio to a team of their teachers where the student will be interviewed about their experience and the process of creating their portfolio.

Q2. Do you have any suggestions on how this model could be sold to school boards at the local level, as well as how this could be achieved on a national level?

A2. To my knowledge, many schools have tried this model in the recent past. However, it has since fallen out of fashion. However, I feel colleges and universities who train teachers can continue to include this model in their educational foundations courses.

Q3. Do you have any policy recommendations for ways to change teacher training and professional development so that teachers will be prepared to teach in such an integrated education system?

A3. State University of New York College at Geneseo had an educational foundations course that required students from a variety of disciplines to work on a portfolio-based assessment project. During this project, teams of students chose themes and put together a sample of such a portfolio. We also created assessment rubrics and critiqued other student teams' projects.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Jeffrey M. Mikols, Math Teacher, Rochester City School District, New York

Questions submitted by Representative Michael M. Honda

Q1. What approaches and policies could move the K–12 educational framework toward a model that takes a fully integrated approach to subject matter [where fully integrated would mean moving beyond the idea of teaching just math and science together, bat also including such other disciplines as history, literature, etc.]?

A1. There must be curriculum used in schools that support such a model. Many teachers use creativity in planning lessons that will engage students and address a multidisciplinary approach There exists curricula, however, created by experts in education that have been carefully researched, planned, arid field tested that is ready for teachers to use. Using such curricula does not absolve teachers from planning lessons, it just gives them a place to start their planning process. There are curricula, some funded by NSF, that take a multidisciplinary approach that is not solely math and science linked. It would not be wise to roll out this type of curriculum without training. This emphasizes the need for quality professional development to train teachers how to use a curriculum that is student centered, multidisciplinary, and uses technology effectively. It is also important that a school district adopts a curriculum such as this for K–12. I currently work in a school district where there is a traditional mathematics curriculum used K–5, a multidisciplinary, student centered, conceptual based mathematics curriculum used in grades 6–8, then a traditional mathematics curriculum used in grades 9–12. It is confusing to students to go from a traditional approach to a student centered approach, then back to a traditional approach.

Q2. Do you have suggestions on how this model could be sold to students at the local level, as well as how this could be achieved on a national level?

A2. State assessments often determine what teachers value as important to train their students on. Assessments on the State and eventually the federal level should address a multidisciplinary approach. There must be research presented to local school boards that demonstrates that this approach will work with the demographics in their community. Another important component is to show that this curriculum is aligned with local, State, and national assessments. It is not sufficient to teach to any test, but ignoring assessment components is not a valid option, either. Perhaps the best way to sell this model is to pilot such a curriculum and demonstrate student work and allow teachers and students to present to school boards what it is they are learning and how they enjoy this model of learning. School administrators should push to mandate projects at all grade levels that require a multidisciplinary approach. School boards must have tangible evidence that this approach works if they are going to buy into it. Satisfied students and teachers demonstrating achievement of State and national standards will be very convincing.

Q3. Do you have any policy recommendations for ways to change teacher training and professional development so that teachers will be prepared to teach in such an integrated education system?

A3. Professional development is the key to implementing effective change in an education system. There are many crucial components to effective professional development. Professional development must be embedded in the regular school day with actual classrooms and students. Teachers can use their training with their target audience while being supervised and coached by expert teachers. Theoretical training about what should happen in the classroom is not enough. Teachers must have the opportunity to experience what should happen first hand. Expert teachers could coach, co-teach, model, and help with planning the teacher being trained. This support must be ongoing. Professional development must be nurtured over a period of time. A one time training during an all day session with no follow-up will not lead to the type of change necessary for this model to work. Establishing model classrooms where multidisciplinary, student centered curricula are being used would be an effective way to allow trainee teachers to see first hand the effectiveness this type of environment provides. These model classrooms provide opportunities for the ongoing professional development that is necessary. Teachers being trained could visit at any time and see exactly what they are being told they should establish in their own classroom.

ANSWERS TO POST-HEARING QUESTIONS

Responses by M. Susana Navarro, Principal Investigator, Comprehensive MSP Grant, University of Texas, El Paso

Questions submitted by Representative Michael M. Honda

Q1. What approaches and policies could move the K–12 educational framework toward a model that takes a fully integrated approach to subject matter [where fully integrated would mean moving beyond the idea of teaching just math and science together, but also including such other disciplines as history, literature, etc.]?

A1. It is my view that a fully integrated approach to subject matter would not necessarily require that all disciplines be taught together, but that students draw from different disciplines in learning all subjects. It is also critical that students have a strong grasp in core areas—particularly reading fluency, comprehension and writing—in order to be successful in all content areas.

My colleagues and I at the El Paso Collaborative for Academic Excellence, recognize the importance of literacy in ensuring that students are successful in all subjects. Because of this, we are implementing the Literacy in Action initiative as a key strategy for assisting students facing increasing language laden content in all subjects, but particularly in mathematics and science. Our work in Literacy prepares students to think at deeper levels and drew on the skills necessary for reading in the various content areas—including math and science—using informational/expository texts.

To address the need for reading in the content areas, full time Literacy Leaders work collaboratively with teachers in piloting and revising a writing curriculum produced to support capacity building needs. By utilizing the writing curriculum there has been an increase in comprehension and application in the classroom. A priority continues to be the use of text analysis, particularly in non-narrative forms of writing, as a way of helping students to increase their ability to read and comprehend content in standards-based curricula in mathematics, science and other content areas. As a result of our work in Literacy, we can report: higher than expected student scores on the Texas Assessment of Knowledge and Skills (TAKS), which also exceeded the state average; improved student writing selections as shown through an increase in length and complexity both in general course work and state writing assessments; an increased number of hours of professional development in classrooms and through non-traditional forms such as book groups and small grade-level study groups; higher levels of professional discourse due to professional reading and discussions; restructuring of school budgets to prioritize increased funds for the purchase of informational/expository texts; and increased participation by secondary teachers participating in professional development activities, including the Guest Author series.

Relevant policies for promoting strong skills in literacy to support learning across all content areas, could include requirements that teachers across all subject areas receive sufficient professional development pertaining to key components of literacy.

Q2. Do you have suggestions on how this model could be sold to school boards at the local level, as well as how this could be achieved on a national level?

A2. In promoting the integration of content areas—particularly a more comprehensive approach to literacy—it is important to recognize first that discipline-based standards and testing determine what is taught in the classroom, and that efforts to better integrate core subject areas need to be reflected in the standards, textbooks and other curriculum materials, and ultimately tests for which students and schools are being held accountable.

An emphasis on ensuring that teachers are effectively trained to integrate key competencies—particularly focused on literacy—into all subjects is where the greatest difference can be made. This requires that sufficient time and resources be allotted for professional development.

Q3. Do you have any policy recommendations for ways to change teacher training and professional development so that teachers will be prepared to teach in such an integrated education system?

A3. Teacher preparation typically reflects the value of singular content specialization and training has been emphasizing content specialization rather than inter-disciplinary approaches. At times, there are important reasons for this—particularly at the secondary level where students sometimes are taught by teachers without a de-

gree in their field. It must also be recognized, however, that within higher education—faculty tend to focus on their own disciplines. Despite these challenges, however, the importance and value of applying high-level skills, in literacy for example, to all content area cannot be diminished.

In addition to encouraging higher education faculty to emphasize the importance of literacy in training teachers, Congress may want to consider funding demonstration projects—within higher education institutions and school districts—to promote inter-disciplinary coordination among university faculty, across colleges and departments. Once these models are evaluated, it would then be useful to share best practices and lessons learned.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Joan Ferrini-Mundy, Principal Investigator, Comprehensive MSP Grant, Michigan State University

Questions submitted by Representative Michael M. Honda

Q1. What approaches and policies could move the K–12 educational framework toward a model that takes a fully integrated approach to subject matter [where fully integrated would mean moving beyond the idea of teaching just math and science together, but also including such other disciplines as history, literature, etc.]?

A1. The concept of a "fully integrated approach to subject matter" in K–12 education is both tantalizing and daunting. Intellectually, the idea that curriculum might be organized in an elegant way so that main ideas and themes are taught through a rich mix of contexts across the academic disciplines is highly appealing. There have been efforts to move in this direction, including various middle school "thematic" approaches to instruction, including team teaching that couples teachers of social studies with teachers of science, large projects for students that take up some major problem such as global warming, and use it as a setting from which to address key ideas in the academic areas of science, mathematics, the language arts, etc. A common pairwise "integration" is often proposed between mathematics and science, and there have been some curricula over the years. (E.g., In the 1970s, the Unified Science and Mathematics for Elementary Schools project (USMES) was funded at the Education Development Center by the National Science Foundation based on recommendations by Cambridge Conference on the Correlation of Science and Mathematics in Schools. This was an elementary integrated mathematics and science curriculum. More recently, COMAP has produced *Mathematics: Modeling Our World,* a grades 9–12 standards-based curriculum. Each unit of the program is based on a theme, such as medical lab testing and the broad range of mathematics that is used in that field.) These materials are attractive, interesting, and highly engaging for students and teachers. However, they are not widely used.

The challenges with integration are quite substantial. First of all, K–12 curricular organization in the U.S. historically has been by subject matter. When integration is broached, new agreements about curricular goals need to be reached, and inevitably, even when only two areas are being integrated (such as mathematics and science), the traditional curricular goals of one area take a back seat to those of the other, for practical reasons. So, for instance, a curriculum organized around interesting themes that have a science orientation is likely to take up mathematical tools and applications that are needed to advance the ideas of the science, but might not take up other areas of mathematics that have been considered essential in the U.S. curriculum for years.

So, given that I am somewhat hesitant to claim that a fully integrated model is reasonable, I certainly would agree that more integration in the K–12 system would be desirable. What policies and approaches would help support the system in this direction? Here are a few ideas:

- Provide funding for the continued development, implementation, evaluation, and dissemination of K–12 instructional materials that are interesting models of integration
- Support research that helps us learn about the impact of integrated instructional materials on student learning and achievement in traditionally valued areas of the school curriculum
- Design assessment tools to measure "integrated" understanding. In addition, if high stakes assessments, such as those that will be used by states in NCLB, explicitly addressed students' understanding of key integrative themes and ideas, then possibly instructional practice might shift.

In closing, however, I cannot underscore how ambitious it would be to move in a concerted way toward more systemic integration in K–12 education. There are enormous conceptual obstacles (disagreement about what is meant by integration, what areas of the curriculum should be integrated, in what ways, what would be left out, etc.), capacity issues (teachers are not prepared in ways that help them to do this kind of integration; universities are organized along disciplinary lines and so reform in undergraduate education would be needed as well), and resource issues (very few suitable instructional materials exist, assessments need to be designed, etc.).

Q2. Do you have suggestions on how this model could be sold to school boards at the local level, as well as how this could be achieved on a national level?

A2. Again, this question assumes that a strong model could be designed that would be defensible within the education community. Taking that assumption (which I feel is unrealistic), then to "sell" this to school boards, as well as nationally, it seems, would require having solid educational research, conducted over several years, to demonstrate the impact of the model, and variations of it, on student learning under a wide range of conditions (e.g., in urban settings, with teachers who are well prepared, in communities with strong involvement of local business, etc.). Because an integrated approach would require rethinking of educational standards in states and nationally, a massive effort in assessment and research, keyed to the new "integrated" goals, would be needed. Such a program of conceptualization, development, research, and refinement is probably at least a 15-year undertaking.

Q3. Do you have any policy recommendations for ways to change teacher training and professional development so that teachers will be prepared to teach in such an integrated education system?

A3.

- In teacher education, introduce integrated courses (e.g., mathematics and science, or mathematics and language arts) in the subject matter preparation of teachers
- Provide funding for the continued development, implementation, evaluation, and dissemination of instructional materials for use with pre-service and in-service teachers that are interesting models of integration

In terms of policy, we would need shifts in teacher certification policies at the State level, and in the definitions of "highly qualified teachers" that are part of NCLB.

Appendix 2:

Additional Material for the Record

Museum of Science
It's ALIVE!

Date: November 12, 2003

To: House Science Subcommittee Hearing on Math Science Partnerships

From: Museum of Science, Boston

Re: Promise of science museums in fostering science and technology literacy

Literacy in mathematics, science and technology is critical for our country to maintain its global position and standard of living. As consumers, citizens and workers, we must be able to make informed decisions about the scientific discoveries and new technologies shaping our lives. With our reliance on engineers and technical workers from abroad and pressures on foreign students to leave our country on completing their studies, there is a real concern about the possible consequences for our economy and national security. Science and technology literacy will give our youth a head start—whether in science, engineering, technology, education or business.

Unfortunately, less than 15% of United States high school graduates have enough math and science to pursue scientific/technical college degrees; and less than 2% of US high school graduates go on to earn engineering degrees (reported in the November 2002 American Society for Engineering Education publication *Prism).*

Museum of Science President Ioannis Miaoulis spearheaded the introduction of engineering into the Massachusetts K-12 science and technology curriculum in 2001 as Dean of Tufts' School of Engineering. He believes engineering activities foster the problem-solving and design skills necessary to succeed. Engineering, which is richly interactive, can inspire young people to pursue mathematics and science by enlivening them and making them relevant.

Science centers are in an excellent position to spark students' interest in science and technology. Offering engaging, informal hands-on learning in a dynamic environment, museums have resources that many schools do not and can provide activities complementing the school curriculum through field trips, pre-visit and post-visit classroom activities, teacher training, and outreach programs.

Many science centers, such as the Museum of Science, already collaborate with schools to bring the excitement of informal education to the classroom, while supporting and linking programs to local, state and national standards. Museum visits are often an integral part of the science curriculum.

In addition, given the priorities of universities to produce research and college graduates, many museums are better positioned to take the lead on federal grants for K-12 education. Science centers can bring the resources of several universities together to serve the needs of school districts because museums do not compete with them.

In a hub of research and innovation, the Museum of Science is now helping catalyze a statewide and national expansion of science and technology literacy by *working with schools* to modify their curricula and train educators to implement the standards and by *fostering*

lifelong learning through the presentation and informed discussion of scientific and technological advances. As Boston's most-attended cultural institution, the Museum draws 1.6 million visitors a year. Of those, 250,000 are school children and teachers. Another 40,000 are served through outreach programs. Its exhibit plan, *Science Is an Activity*, has been awarded several National Science Foundation grants and shaped exhibit development at other science centers.

There is an extraordinary opportunity for museums, companies, and universities to work together to foster math, science and technology literacy. Whether through financial support, in-kind equipment donations, loaned scientific and technological expertise, internships, training or volunteering, company employees could take pride in knowing they have made a real difference in their communities.

The Museum of Science has already begun the work of promoting science and technology literacy, thanks to several partnerships. For example, a Science Education Partnership Award from the National Institutes of Health's National Center for Research Resources enables partners—including Harvard School of Public Health, Whitehead Institute for Biomedical Research, and Massachusetts General Hospital—to bring an impressive roster of scientists and engineers to the Museum in the Frontiers of Health Science Series. In another example, with the MIT Media Laboratory and Intel Corporation, the Museum's Computer Clubhouse program, an award-winning out-of-school learning environment, serves thousands of inner-city youth worldwide who use technology creatively with adult mentors.

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