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Goals for the 2012 Learning Network Conference

1. To learn more about effective STEM teaching: What are ways of defining and theorizing it? What are ways of measuring it? What are supports that work to improve STEM teaching?

2. To network: What can we learn from each other? How can we benefit from each other's expertise and what we are learning?

3. To continue learning: What new ideas can you take away from this conference and put to use in your MSP work when you return home? What ways will you continue to work with others you meet at the LNC?

About This Summary

This overview of the 2012 Math and Science Partnership Learning Network Conference offers brief summaries of the plenary presentations and panel discussions that took place during the conference. The intent is to provide a sense of the overall conference themes and highlights.

Online:


Readers interested in pursuing any of the plenary session presentations summarized here are encouraged to access MSPnet to find full video recordings of the presentations as well as PowerPoint presentations and detailed speaker biographies. All papers submitted for working group sessions during the conference are also available on MSPnet. In addition, readers may access a multimedia version of the conference poster session at the link above.
OPENING REMARKS

Welcome

Katherine J. Denniston
Acting Division Director, Division of Undergraduate Education
National Science Foundation

Katherine Denniston welcomes participants to the 2012 Learning Network Conference (LNC), underscoring the importance of the Math and Science Partnership (MSP) program and observing ways in which the MSP has changed over the years in response to the needs of the community and has grown stronger as a result.

A key word in the program’s title is “partnership,” Denniston notes, recalling that she recognized and acted on the need to move from an insular approach to science education when she became Director for the Center for Science and Math at Towson University. Reaching out and forming strong alliances between the College of Education and the Fisher College of Science and Math facilitated subsequent strong alliances with the community and local school districts.

“We are here for the next few days to learn from you,” Denniston remarks. “You are the feet on the ground, the ones who are doing the work, and it is your experiences from which we can learn.” That process includes sharing failures as well as successes so that others may benefit from what we have learned, she advises.

Math and Science Partnership (MSP) Program

James E. Hamos
MSP Program Lead
National Science Foundation

James Hamos launches the 2012 Learning Network Conference with an overview of the Math and Science Partnership program’s purpose, scope, and timeline. The goals of the program as stated in the new solicitation may be familiar and focus on students, teachers and evidence. However, a noteworthy addition is inclusion of the acronym “STEM,” which emphasizes the fact that the MSP has been funding research and development in K-16 teaching and learning.

NSF’s Math and Science Partnership

A research & development effort at NSF for building capacity and integrating the work of higher education with that of K-12 to improve student achievement through a sharp focus on three inter-related issues:

• Ensure that all students have access to, are prepared for and are encouraged to participate and succeed in challenging and advanced STEM courses

• Enhance the quality, quantity and diversity of the K-12 STEM teacher workforce

• Develop evidence-based outcomes that contribute to our understanding of how students effectively learn the knowledge, skills and ways of thinking inherent in mathematics, computer science, engineering, and/or the natural sciences
Since its inception in 2002, the MSP has included 178 projects and an investment of $871 million, and those figures do not include the new solicitation. In terms of geographic range, forty-one states as well as Puerto Rico have been part of the MSP community. “We believe that you are very important assets in engineering extensively over the past few years and thinking about its role in K-12 education. There has also been a major project that focuses on computer science, Hamos notes, and the MSP is encouraging more in that area. Use of “STEM” in the solicitation begins to move from math and science as disparate silos to something potentially much greater.
each one of these locations,” Hamos notes. MSP projects may contribute by working with the US Department of Education programs, working on Common Core State Standards in mathematics, and thinking about Next Generation Science Standards and Race to the Top. “We need you to be important advocates, sharing what you know and putting your ideas out to that entire community.”

Hamos proceeds to welcome participants representing completely new MSP projects as well as some new projects that have grown out of previous MSP projects.

Turning to topic of the Learning Network Conference, Hamos observes that the purpose of the LNCs over the years has been to address current issues of the moment, beginning in 2003 with a focus on evidence.

This year’s theme is focused on teachers and teaching, includes three major strands, and has been designed to offer multiple opportunities to address these questions in a variety of ways.

### 2012 Learning Network Conference

**Framing Effective Teaching in STEM**

- How do we define effective STEM teaching in preK-12 and post-secondary education?
- How do we prepare and support teachers and faculty to teach effectively?
- How do we know we are making progress toward more effective STEM teaching?
STEM TEACHING IN THE AGE OF THE COMMON CORE: PROMISES AND PARADOXES

Suzanne M. Wilson
Distinguished Professor and Chair, Department of Teacher Education, Michigan State University

Suzanne Wilson begins her presentation by offering a longer, alternate title that reflects her current thinking. “If we are to do our work well, we need to do it fully conscious of the very noisy, sometimes cacophonous environment that we work in,” she elaborates, “and partnerships are an important platform for doing the kind of messy, multidimensional work that needs to be done in the face of those competing concerns and interests.”

Wilson then introduces some of the ideas contained in the 2011 report on STEM Education by a National Research Council committee, beginning with a definition of high quality STEM teaching.

High Quality STEM Teaching

Effective instruction capitalizes on students’ early interest and experiences, identifies and builds on what they know, and provides them with experiences to engage them in the practices of science and sustain their interest.

Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics
Committee on Highly Successful Schools or Programs in K-12 STEM Education; National Research Council, National Academies Press, 2011
http://www.nap.edu/catalog.php?record_id=13158

She points out the importance of the language used and proceeds to “unpack” the statement.

Unpacking that Vision

• Effective instruction actively engages students in science, mathematics, and engineering practices throughout their schooling.

• Effective teachers use what they know about students’ understanding to help students apply these practices. In this way, students successively deepen their understanding both of core ideas in the STEM fields and of concepts that are shared across areas of science, mathematics, and engineering.

• Students also engage with fundamental questions about the material and natural worlds and gain experience in the ways in which scientists have investigated and found answers to those questions. In grades K-12, students carry out scientific investigations and engineering design projects related to core ideas in the disciplines, so that by the end of their secondary schooling they have become deeply familiar with core ideas in STEM and have had a chance to develop their own identity as STEM learners through the practices of science, mathematics, and engineering.

Here, there is language about core practices, about applying, about deepening, about investigation, core ideas, and identity. The logic regarding learning and teaching outlined in the report begins with student interests. Teachers
need to identify and build on what students know. Teachers then need to provide them with experiences to engage them in the practices of STEM.

This engagement will sustain students’ interest, which will lead to students successively deepening their understanding both of core ideas and concepts, and this will help them develop their own identity.

The touchstones include the need for core ideas and the need to identify certain practices (unpacking what some call “inquiry,” what others call “habits of mind”). Practice also emphasizes the importance of acting, not simply knowing, Wilson points out. It involves the use of knowledge and the application of knowledge. Another touchstone is that there is successive deepening, which might have something to do with development, with progressions, with a spiral—it is unclear at this point. There is language about scientific investigation, design projects, and meaningful and relevant problems, and there is language about developing a STEM identity.

While offering this definition of STEM teaching and learning, the authors of the report also point out that this kernel, the thing that happens between teachers and students in the classroom, cannot be understood in an isolated sense, but in a context. “This context includes somebody anchoring this experience in some core set of ideas and practices that are named and held steady,” Wilson explains. For example, one of the most difficult things about preparing new teachers to teach is that we do not know what they are going to be teaching. There is a need for an anchoring of what people are going to be learning in school in a smaller set of core concepts and identifiable practices.

We need to understand that the quality of one’s teaching does not just involve the individual teacher as the unit of analysis, but also what happens in a school, Wilson states.
There is persuasive research, she notes, that suggests that even when looking at teachers with relatively high capacity, unless they are working in schools with strong communities of teachers who are working together on the core problems of curriculum in the school, and unless they are working with a principal, a leader, an administrator who is encouraging them to keep their eyes on student achievement and that curriculum, the school doesn’t do well. “Teaching quality is not just about teachers, it is also about the context in which teachers work,” Wilson observes.

We also need to understand all of this in terms of the capacities of teachers and administrators and the need for ongoing professional development and learning opportunities for everyone in order to be able to do this work.

When the NRC committee presents this idea of effective STEM teaching and learning, they do not do so in a vacuum, or in the absence of thinking about the importance of resources and structures that enable support and keep the teacher-student relationship going, Wilson emphasizes. She punctuates this portion of her presentation by offering participants a discussion assignment (see sidebar).

Wilson then turns to the context in which this push for more attention to and concern for the future of STEM is occurring, the larger context in which we are all operating. She points to the need to situate definitions of effective teaching and learning and the work of MSP projects in that larger context.

There is a conversation going on in this country regarding the need for more attention to STEM teaching and learning, the need to do everything we can to improve STEM teaching and learning, and the need to marshal the resources and capacity to ensure that all students understand STEM and have some sort of identity, whether as a literate consumer or as an active participant in a STEM discipline.
At the same time, different states are in different stages of development in an effort across the country to think about whether it is time to have Common Core State Standards. This effort to identify a smaller number of topics that would be studied thoroughly and well and would be assessed in meaningful ways is not the same thing as the call for STEM education, Wilson points out, and involves a different discussion. In the United States we have parallel discussions of important topics in education that often go on in different circles with different actors. Partnerships are important because they provide places where these different actors may cross paths.

The conversation about accountability has been going on for some time with consequences that have not been particularly productive, including the marginalization of science in the elementary school curriculum. That conversation ranges from topics like school report cards to an increasing number of conversations about value-added measures of teachers and models for teaching, and to conversations about value-added modeling for teacher education programs. The logic that is part of this accountability movement is based on the idea that you can figure out some way to come up with a number that says whether or not a value was added by this unit, whether it is a person or a program. We should all be aware of this, and mathematics and science departments may be the next in line for measuring the value-added of math and science education, Wilson cautions.

There is a connection to a parallel conversation about teacher quality, teacher evaluations and teacher preparation or professional development. While these are all related conversations, they are not necessarily aligned with one another. Wilson opines that MSP projects are probably already quite smart about how complicated it is to pull these together in some sort of meaningful way.

The promise is a conversation in which we have multiple concerns about accountability, curriculum, STEM teaching and learning, and about teachers. There are many connections that one can imagine could help, Wilson observes. For instance, if we had Common Core curricula, or if we knew that all elementary teachers in a teacher education program were going to be teaching a certain set of ideas and knew what materials they all had access to, we could then ground their preparation in those materials and core ideas. Right now, we don’t actually know what those teachers are going to be teaching, which makes it very difficult to do high quality teacher preparation.

If we had a handle on high-level practices, on the kinds of instruction that lead to higher student engagement and student learning, we could also organize teacher professional development and teacher preparation around those practices, an effort that a number of people across the country are working on now (Deborah Ball, Francesca Forzani, and Magdalene Lampert at the University of Michigan; Elham Kazemi, Morva McDonald, and Mark Windschitl...
Framing Effective Teaching in STEM

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at the University of Washington; and Megan Franke at UCLA). They are attempting to identify a core set of practices of teaching and train new teachers in mastering those practices. Unfortunately, right now a lot of teacher preparation is focused on things like writing lesson plans and writing pedagogical autobiographies. “These are not practices,” Wilson points out. “These do not prepare someone to go in and do the work of a teacher.”

This is a parallel argument to the practice argument in the NRC committee report, saying it is not sufficient that someone is exposed to a set of ideas about science. To develop conceptual understanding, to become literate or to become someone who does STEM work, they need to practice, to apply, to engage in the doing of something meaningful and relevant. The same is true of teacher development and preparation. People need to practice, Wilson asserts.

Turning to school culture, Wilson observes that there are many ways in which all of the reform efforts can be enhanced by thinking about what it would take in a school to bring those efforts together. “My argument would be that a school culture is going to be destroyed if we don’t think about bringing those things together in a meaningful way,” Wilson states. If you try to combine varying standards and practices regarding teacher evaluation, curriculum, and state mandated tests, it is a recipe for disaster, increasing the pressure on the schools to respond to very high stakes calls to change their behavior in the name of STEM teaching and learning. “Unless we create schools in which people can make sense of those policies, can put them together in meaningful ways, and feel like they have some say in how the policy is implemented, we are going to have a bunch of people who are trying very hard to close the door, or are going to respond by being reactive instead of proactive,” Wilson cautions.

University cultures are subject to the same pressures and need to engage in collective work on these issues. Universities need to think about how to prepare teachers to teach to standards for which they themselves don’t understand the context. That problem already exists and is going to get more extreme, Wilson reports. STEM disciplinary departments have to think about how to help all of the practicing teachers help their students come to the university with what they will need in order to take courses that the university is going to have to rewrite because students will come to the university better prepared for the study of STEM disciplines. Universities will need to engage in a lot of work in terms of STEM and higher education and Common Core standards, which will require an enormous amount of communication.

Wilson observes that upon reading the Race to the Top first year reports, the one message across all of them is, “Communication, stupid.” Reading between the lines, it becomes apparent that every state ran into major issues because the actors involved all need to be informed and on the same page. “Partnerships
are well positioned to help us understand what it takes to pull these multiple agendas together in some sort of coherent and collective way,” she states.

There is a huge amount of work to be done, Wilson observes, work that many MSP projects are already engaged in.

By “specification,” Wilson explains, it is one thing to say that a teacher will build on students’ previous experiences. It is another thing to say what that looks like when the teacher is teaching sixth graders about plate tectonics. What does that look like? That specification work is necessary for the STEM vision, for the Common Core Standards, and for teacher evaluations, which need to include observable behaviors that are aligned with what we are looking for. And that specification will require very hard, detail-oriented work.

Wilson then asks participants to engage in a second discussion assignment regarding contexts, connections, and contributions (see sidebar).

Wilson concludes her presentation by identifying four paradoxes or challenges. The first paradox in doing this kind of work is this attempt at alignment and coherence versus chaos and cacophony. “Unless you are very, very proactive, the educational system in the United States is built for cacophony to rule,” Wilson observes. We add another office or another person to do the work, but that work is deeply related to and cannot succeed unless that person is working with other people. Wilson cites professional development as a prime example of this, often entering the schools via riders on various grants, when there are new textbooks or assessments, when it bubbles up in a school, or when a motivated teacher goes off on his or her own. What is lacking is a coherent, careful way of thinking about what needs to happen in a school or district to build capacity over time, using diverse resources in order to do that well.

A second challenge is that even if we attempt to narrow the focus, there is a wide range of things we need to be smarter about. Wilson offers the example of a current project she is conducting with the American Museum of Natural History, working on the question of how to do professional development that allows teachers to conduct secondary research in science rather than the type of field work or experiments they may typically do with their students. The aim is to expand their ideas about what science is and help them understand how to do secondary research using large data bases in sensible ways, which they can work on with their students. The AMNH project is very subject-specific, involving zebra mussels in the Hudson River.
The challenge is that the country needs a national answer that goes across those subject-specific questions, and we do not yet have a way of coordinating that effort. There is no central coordinating body or information source identifying where the holes are in professional development on science and identifying what your group should be working on. On the one hand, Wilson says, we need deep work drilling down about specific topics, but we have to be much more thoughtful about making sure that we cover the breadth of issues we need to understand and face if we are going to be prepared to teach teachers how to teach.

A third paradox is that of building capacity when actors are seen as part of the problem and part of the solution. Many K-12 teachers do not have sufficient subject-matter knowledge in order to do their work well. We name that as a problem, but we also need their help in solving that problem. We need them to participate in PD, to encourage their colleagues to participate, to offer feedback when the PD isn’t working. This problem has also been identified with teacher educators, those who teach the STEM courses that teachers take on the university level, or those who teach the methods courses. There is a lot of talk regarding the idea that the teaching that goes on in higher education, either because of the quality of instruction or what is taught, is not preparing people to be effective STEM teachers. We need to have those conversations in ways that the actors involved are not demonized or told, “If we just fix you, we’ll have the answer.”

need ways to think about this when we know that the people involved, including ourselves, are both the targets and the collaborators, Wilson urges.

The final paradox involves trust. While we all need to be self-critical in order to do the work and gather data to inform our work, being attacked is not a productive route. Because this is about teachers and kids, because it is interpersonal work, because it is personal and makes one feel enormously vulnerable, and because there is so much wrong that we need to work on, one tension we all face, particularly when working across stakeholder groups, is how to work on trust in an age of accountability and “racing.” For example, in order to become a Race to the Top state, states race to do what is necessary to get the legislation in place, including teacher evaluation systems. That won’t be good for education unless we figure out ways to do that work in ways that build trust across the different stakeholder groups that is necessary in order to have good instruments in place, and a system of information that can help us change those instruments.

“These paradoxes and tensions are things we need to face as we think about how we are going to respond to this cacophonous set of reforms and pushes to improve STEM education, to improve our curriculum, to improve teacher preparation and professional development, and to have evaluation systems in place for people and for programs,” Wilson concludes.
TRANSFORMING LEARNING FOR STEM: AN NSF PERSPECTIVE

Cora Marrett
Deputy Director, National Science Foundation

Cora Marrett notes that the theme of this Learning Network Conference is particularly appropriate for the National Science Foundation at this juncture. In trying to foster discovery, the foundation does so through the nurturing of creativity, of inventiveness. That creativity and inventiveness lies at the heart of the NSF. It also, Marrett points out, lies at the heart of the teaching enterprise.

Marrett cites a quote by Albert Einstein regarding matters of teaching and creativity: “It is the supreme art of the teacher to awaken joy in creative expression and knowledge.” There is, she observes, perhaps no more compelling a portrait of a teacher in STEM than that of someone committed to instilling joy about creative endeavors, and generating at the same time deep knowledge and understanding. “These are matters that we share between the National Science Foundation and the world of teaching,” Marrett notes.

She then poses a specific request to MSP projects, asking for their active involvement in sharing widely what has been learned about how teaching and learning in STEM are being revitalized and enriched. “Our success in moving forward depends heavily on our ability to engage you beyond the work that you are undertaking now in this kind of national enterprise,” Marrett states, “an enterprise that demands our ability to explain, to work with a number of groups beyond our own borders.”

A refrain that Marrett hears from decision makers and those outside the community that Education and Human Resources funds is, “We do not know what the yields have been from NSF’s investments to improve STEM teaching and learning. What are the outcomes?”

NSF touts the fact that the research it funds contributes to a knowledge base, and it takes pride in the contribution to the knowledge base about teaching and learning. However, questions are posed regarding what has been uncovered, what has been found to transform the potential outcomes for STEM education. What has evolved that helps with the translation of theory and evidence into effective practice?

This is a particularly opportune time to raise this question, Marrett notes. Soon, NSF will be appearing before Congressional committees that will make decisions about NSF funding for fiscal year 2013. Marrett anticipates the following questions: What have you learned? How is this being translated? How can teaching and learning be enhanced through the kinds of investments that NSF has made?
The MSP is a critical program for helping NSF respond to these queries, enabling NSF to talk about significant kinds of outcomes. “We need your help in talking about the kinds of findings that the investments have yielded and what we anticipate from the investments still being made and those being made for the future,” Marrett explains.

The sharing of findings with wider audiences is not something that can be undertaken by NSF alone, she notes. It is partnerships represented at this LNC that can cite the lessons that have been learned, lessons have already been enacted at local and district levels. The question becomes, how can we talk about this at a national level?

Those engaged in the MSP are pivotal in indicating what must be assessed. What warrants translation? What are the gaps still to be filled? “We are in no way saying that all of the findings are there. There is knowledge still to be created,” Marrett acknowledges, “but it is a lot easier to get support for continued development of knowledge if you are able to say something about what has already come out of the work that has been done.”

The NSF is a national science foundation and needs the engagement of those who have operated at other levels in other sectors, she points out. Those involved in MSP can help to answer the question of how to bring it all together to identify the benefits that should accrue to all, not just a single community or single population.

Marrett commends the 2010 National Impact Report from MSP, which reflects impressive, statistically significant results. This is no small matter in the policy world, where lack of evidence and the assurance, “Trust us,” doesn’t impress, she notes. Evidence that indicates the kind of teaching that is making a difference for outcomes is an extremely important kind of finding. Summaries from the MSP Knowledge Management and Dissemination (KMD) Project identify instruments that we know teachers can use to improve instruction, instruments whose effectiveness has been tested and proven through rigorous analyses. “So not only are rigorous analyses possible,” Marrett observes, “but we know that teachers can use these instruments for improving instruction.”

The report also includes identification of effective approaches uncovered by the Boston Science Partnership for recruiting students into challenging STEM courses. Work by the University of Michigan and others have led to identification and development of tools and instruments that can strengthen professional development, tools with documented reliability and validity.

“These kinds of things that give us a sense of what matters under what conditions are extremely important. Your findings that have already been produced, findings that will be produced, these make a difference for trying to understand what the yields have been from the investments,” Marrett states.

The powerful findings included in the report will be augmented through the presentations
made at this LNC. “This conference is a superb place for continuing to talk about what we have learned,” Marrett observes. “I am asking you to think about what we have learned and how we communicate that learning to people who don’t have the advantage of sitting in this room, or to people from your institutions who don’t have the grasp of the investments and their yields that you have.”

The messages are powerful, but Marrett poses the question: How will these messages be communicated beyond the borders of this conference? How will we assure that others gain the benefits? Communication beyond this conference is imperative, Marrett asserts, and proceeds to review some of the consequences in the policy arena.

The NSF budget approval provides the MSP program with $55 million dollars for future Targeted Partnerships, which can be seen as a Congressional vote of confidence. In many ways, that is a testament to the hard work that the MSP projects have undertaken, pursuing a community-based approach to successful STEM education. However, Marrett notes, often that vote is based more on promise than on what has been delivered. Do members of Congress who vote on this idea have a full understanding of what has come out of these investments? They may think it’s a great idea, Marrett says, but how long can continuation be based on the notion that it is a great idea?

We can develop a much better sense about the findings, both of what works and, equally important, what does not work. This conference offers an extraordinary opportunity to examine what has come out of these partnership activities. Just as important, Marrett emphasizes, is figuring out ways of communicating those outcomes, both for the work of MSPs in their communities and for NSF at the national level.

NSF is interested in assuming an active role in disseminating findings, but cannot shoulder all of the responsibility for sharing results, Marrett cautions. That must be done in concert with those working on MSP projects. “We regard you as a powerful community, a community aiming to advance creativity in teachers, in students, and perhaps in systems of educational decision making. If you are that powerful, and you are, we want to call on your for your engagement, for your involvement, in any number of ways,” Marrett concludes. “Remember that the fortunes of STEM education might rest quite strongly not only on what individual projects determine, but how these come together. The success of the entire enterprise might well depend on your helping us understand the most effective strategies for communicating and conveying what has to take place. I look forward to your insights on how, together, we can marshal outcomes in the interest of transforming education in science, technology, engineering and mathematics for the benefit of the larger society.”

The LNC: An Opportunity to Share Findings and Communication Strategies

Cora Marrett introduces another way in which she would like to call on assistance from the assembled MSP projects. There is currently a drive in the federal government centered on accountability and the effective stewarding of resources. In terms of stewarding resources, the question has been posed: What justifies the bringing together of project directors and principal investigators? Until policies are in place, it is Marrett’s role to decide whether a given conference or workshop will be held. One justification should be the excellent opportunities for what you can do together that could not be done separately, Marrett observes. A conference like this offers the opportunity for exchanges of findings and of strategies to assure that results are understood and conveyed.
Edward (Ted) Britton  
Associate Director, Senior Researcher and Evaluator  
STEM Program, WestEd

Ted Britton focuses his comments on strand two of this Learning Network Conference, support of effective teaching. Britton worked early on in the MSP program on teacher induction, and more recently with the Knowledge Management and Dissemination (KMD) Project. This presentation centers primarily on work at the middle and high school levels and reflects Britton’s bias towards science, though the work was based equally on science and math, much of it predating the wider focus on STEM.

Britton begins by addressing the issue of teacher induction and why it is relevant despite widespread teacher layoffs. What are the purposes of teacher induction?

In the policy realm, teacher induction is about supply issues and is not just recruiting teachers, but retention. Britton submits the hope that, based on research findings, it is also about early career learning or what the New Teacher Center likes to call “accelerated teaching,” enabling new teachers to be the best they can be as fast as possible. “It is about launching new professionals on their trajectory of career-long learning about being a teacher,” Britton states.

A final argument for teacher induction is that it is the human and professional thing to do. Britton encourages those participants who have been teachers to think about what might have been valuable as part of their own induction process. While the territory of teacher induction is large, Britton focuses his attention here on content knowledge.

Teacher Induction: Purposes

- teacher retention
- early career learning (accelerated teaching)

…and it’s the human, professional thing to do.
Another Incident of Inspiring Induction...

After shadowing another first-year teacher for a day and observing that the teacher’s students didn’t appear to be the most challenging, Britton talked to the teacher’s department chair. The chair explained the first-year teacher had purposely been given the best students because there was no way the most challenging kids in the school should be in a first-year teacher’s class. The chair then noted that the most challenging students required her own expertise based on twenty years of experience.

Both of the examples above were from New Zealand, highlighting the point that lessons learned about teacher induction are international, based on looking at research in other countries. Britton relates that his original post-graduate work was in the TIMMS study with Bill Schmidt, who sparked his interest on what could be learned from other countries. This isn’t about US bashing, Britton notes. In fact, a number of countries have the same sink-or-swim approach with new teachers that the US does. However, some countries do have dramatically different teacher induction that offer inspiration and warrant consideration.

While positive examples like the two above may also be found in the US, a phenomenon in the US would make that more improbable. The first issue is where new teachers are placed. In urban districts they are concentrated in “new teacher schools,” comprised entirely of new teachers. It is far easier to be magnanimous and generous regarding induction when you have one new teacher; far more problematic when it is all new teachers. This also highlights the importance of accelerated learning. With a school full of new teachers, anything you can do by way of teacher induction to move them along as quickly as possible in terms of knowing content and how to teach needs to be done for the sake of the kids in that school.

While New Zealand doesn’t have the problem of concentrating all new teachers in one place, they do understand that early teacher induction is about career learning. There is a national government policy, which is funded to provide resources to each local district. For twenty-five years, every new teacher in New Zealand at the middle and high school levels has received a full-time salary and twenty percent release time, explicitly to be spent in a new teacher induction program. While teacher supply may have gone up and down over those twenty-five years, Britton observes, clearly that policy was not about a response to supply and demand, it was a response to the desire to launch the best possible teaching as quickly as possible.

In some regions in France, first-year teachers are expected to do a “memoir,” an action-research project, in which they examine their practice, shown here in three examples of:

**Figure 1: New Zealand Beginning Teachers**

- First-year teacher “memoir” (‘action research’): actual sample topics, mathematics
- Obstacles linked to the learning of cosine.
- Can one educate geometric perception in three dimensions?
- Leading students grades 6-7 to distinguish an object from its representation in Cavalierian perspective: reasons for hope.
Elaboration of “Comprehensive”
Limited vs. Comprehensive Teacher Induction

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<td>Also promotes career learning, enhances teaching quality</td>
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<td>Policies</td>
<td>Provides optional participation and modest time, usually unpaid</td>
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<tr>
<td>Initial teaching conditions</td>
<td>Limited attention to initial teaching conditions</td>
<td>Attention to assigned courses, pupils, non-teaching duties</td>
</tr>
<tr>
<td>Level of Effort</td>
<td>Invests limited total effort, or all effort in few providers, activities</td>
<td>Requires substantial overall effort</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Program</th>
<th>Limited Induction</th>
<th>Comprehensive Induction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resources</td>
<td>Does not provide resources sufficient to meet program goals</td>
<td>Provides adequate resources to meet program goals</td>
</tr>
<tr>
<td>Levels of the education system involved</td>
<td>Involves some levels of the system, perhaps in isolation</td>
<td>Involves all relevant levels of system in articulated roles</td>
</tr>
<tr>
<td>Length of program</td>
<td>One year or less</td>
<td>More than one year</td>
</tr>
<tr>
<td>Source of support</td>
<td>Primarily or solely uses one mentor</td>
<td>Uses multiple, complimentary induction providers</td>
</tr>
<tr>
<td>Conditions for novices and providers</td>
<td>Usually attends to learning conditions for novices</td>
<td>Also provides good conditions and training for providers</td>
</tr>
<tr>
<td>Activities</td>
<td>Uses a few types of induction activities</td>
<td>Uses a set or articulated, varied activities</td>
</tr>
</tbody>
</table>

Britton references the book documenting these findings, noting that the touchstone words here are “comprehensive,” “systems,” and “early career learning.” Regarding the systems approach, “Figure 1” (sidebar page 17) depicts a map of who interacts with a beginning science teacher in New Zealand. The support coordinator is the assistant principal, who convenes all of the new teachers in the school every week across subjects to take them through an explicit curriculum focused on being a new teacher. The department head is another linchpin, meeting with new teachers every week to talk about content and pedagogy. Those department heads have a half-day a week release time for duties which include the active mentoring, support, and development of new teachers in the department. There are also “buddy teachers” as well as science department technicians. During this study, it was common to find these technicians in New Zealand, the UK, and Australia in every school—lab techs in the science departments who maintain and provide all of the equipment for hands-on science experiments and help new teachers understand how that equipment works.

The chart in the sidebar at left offers contrasting views of limited induction, the most prevalent form of teacher induction in the United States, versus comprehensive induction seen in models elsewhere. Britton points out that under “length of program,” comprehensive induction states “more than one year.” In the US, induction commonly lasts for one year or less. In programs in other countries looked at during this study it was two or more years for a formal teacher induction program or system. In interviews with US teachers during the spring of their first year, the teachers related that while the training and ideas being introduced in induction were fascinating, they were barely hanging on getting the basics down. They would have loved to receive more training during a second year, when they could better absorb what was being offered.

Britton relates another anecdote from a large “gold standard” study conducted by the Department of Education, looking at induction in 20 American cities at the elementary level conducted by the New Teacher Center or the ETS Pathwise program. Britton’s team traveled to the 20 sites with the task of assuring that the treatment was happening. Five hundred
teachers were involved in the induction programs and 500 were not, and both groups were followed to see if they stayed in teaching or if their standardized test scores showed a difference in language arts and math. In years one and two there was no difference. In year three there was a statistically significant difference in favor of the teacher induction program. There is the idea of latent affect of teacher induction, Britton suggests, leading to gains beyond the moment you are conducting the program.

The research focus shifted from looking at programs to looking at the teachers themselves and their needs. The focus during this presentation is on their content knowledge needs.

<table>
<thead>
<tr>
<th>4 Kinds of Subject-Specific Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Science-specific (math-specific) needs of beginning teachers</td>
</tr>
<tr>
<td>• content knowledge</td>
</tr>
<tr>
<td>• pedagogical content knowledge</td>
</tr>
<tr>
<td>• curricular</td>
</tr>
<tr>
<td>• practical</td>
</tr>
</tbody>
</table>

In talking to people about the content knowledge needs of new teachers, the most common answer involves the teacher knowing their subject (e.g., a chemistry teacher knows their chemistry). Britton argues that content knowledge extends beyond disciplinary knowledge. There is a distinct difference between college science versus school science. For example, most teachers haven’t studied earth science since they themselves were in middle school. They go through secondary and post-secondary education without encountering it, and are most probably not studying it in the course of teacher preparation. Then they are assigned to teach earth science in middle school and are no more prepared in terms of content knowledge than the students. While this may be an exaggeration, it is an acute problem, Britton states.

There are also gung-ho new teachers who are excited about the content and want to teach it all, never mind the scope and sequence. That could go on for months if no one is paying attention, Britton observes.

Then there is workplace science. People from industry and alternative routes are entering science teaching because presumably they know their content. A person in the workplace doing the same chemical procedure in a pharmaceutical lab for years may have deep knowledge, but it is narrow. Suddenly they are teaching a panoply of science education topics.

Finally, there is connecting to the real world and students’ lives, something we all need to do better at, Britton observes.

In the realm of disciplinary content knowledge, Britton relates, they looked across several studies at about 100 new math and science teachers, following and observing them two or three times per year. A wide range of needs were identified, outlined at right. It is not news that new teachers (or veteran teachers) are having content knowledge problems, Britton says, but...
what are the implications for one-size-fits-all teacher induction that doesn’t address science specifics for new science and math teachers? It is probably inadequate, he concludes.

What can be done about this? Britton notes that there are explicit programs in the country, many with NSF funding, that specifically attempt to work with new math and science teachers, though relatively few compared to all of the new teachers that are out there. Second, it used to be gospel that you should differentiate your instruction because different learners have different needs, but we don’t do that in professional development nor in teacher induction, he observes. There needs to be diagnostic and customization work about different new teachers’ needs and what you are going to do about it, leading to a thoughtful menu of responses to different situations.

Then there is balance and timing. One line of thought is that new teachers are barely surviving and need support in managing the classroom, and have no time to talk specifically about being a science or math teacher in their induction program. This is another case for diagnosis, Britton argues. Some new teachers get it and have the drill down by November and could well cope in their first year with subject-specific matters.

This work took ten years across a range of projects and involved a number of people listed here.

Britton switches gears to address the topic of professional learning communities (PLCs). As an introductory exercise, he asks participants to brainstorm for a moment, and list and count the number of different terms they use for PLCs. The point, Britton explains, is that if you are discussing PLCs with someone, it is probably wise to do a little checking first to clarify what you are talking about.

Confusing Range of Phenomena, Names
- What are they called?
  - We found 30 TERMS (and their variants)
Because PLC can have so many meanings, the project needed an operational definition to determine what pieces of research to include.

### What Did We Include?
- Our project definition - minimum for inclusion in synthesis
  - 3 or more STEM teachers per group learning collaboratively about STEM teaching meeting at least several times usually for at least a couple of months

Three guiding questions were borrowed from the Knowledge Management and Dissemination Project.

#### 3 Guiding Questions (from KMD Project)
- What Do We Know?
- How Well Do We Know It?
- What Else Do We Need to Know?

The five knowledge sources for this project are outlined below. On the research articles that had methods, as in most primary journal articles, a 32-point inspection was conducted. This didn’t turn out that well, Britton acknowledges, because the research was methodologically weak and had some recurring problems that could have been easily fixed. The prevalent issues causing low ratings on the research in these articles include: potential researcher bias, with research conducted by those involved in the PLC; sampling problems, with no information regarding why these teachers were in the PLC and others not; lack of detail regarding level of effort of the PLC including meeting frequency and duration. Britton observes that in his experience working with KMD and using KMD methodology in other research projects these flaws, which would take a sentence or two to correct, appear repeatedly.

A range of impacts on teachers’ content knowledge were identified as a result of this knowledge synthesis process. There were also impacts on teachers’ instruction.

There were few studies on the link to student achievement, Britton reports, and those were primarily in mathematics. Many of these studies

#### 5 Sources of “Knowledge”
- Research with methods details (e.g., journals), 30 articles
- Research without methods details (e.g., AERA papers), 21 articles
- Published expert policy, advice (STEM organizations, books, Ed week), 74 articles, websites
- An expert panel discussion, 8 people @ 3 rounds write/talk
- Models (published ‘lessons learned’), 22 articles (Background articles, 36)

### Impacts on Teachers’ Content Knowledge
- Learned content
- Deeper discussions about content
- More confident about teaching content
- More focus on students’ understanding of content

### Impacts on Teachers’ Instruction
- Stronger attention to student reasoning
- More research-based practices (e.g., inquiry, problem solving)

### Impacts on Student Learning and Achievement
- Positive research results in mathematics achievement.
- Not enough research studies to confirm science achievement.
- Local evidence and expert knowledge of enhancements in both math and science learning and achievement.
Critical Elements for PLC Design, Implementation

- Shared values and goals
- Leadership support
- Time
- Use of student data and work
- Collective responsibility
- Good Facilitation
- Trust

What Do We Know?
The current studies are...
- 78% qualitative only
- 85% inservice
- only 18% about online (part or whole)
- even across grade levels
- twice as many mathematics as science
- 2/3 in last five years; half in last three years

What Do We Still Need to Know?
Need more research...
- focused on science teachers in PLCs
- focused on PLC aspects possible in preservice
- focused on changes in teaching rather than changed beliefs, or intentions to change
- focused on immediate and long-term student learning outcomes
- focused on or including role of an online component
- quantitative in nature
- comparing models of PLCs rather than a single model
- random investigations of PLCs happening in the field

Looking at changes in student knowledge of specific content rather than changes in test scores or student achievement.

Regarding critical elements for PLC design and implementation, Britton addresses the issue of trust. It can be scary for teachers to talk about content, he observes, or to acknowledge that there is a content knowledge problem. One way to take the edge off is to focus on student work that teachers bring in and begin the conversation by talking about what the students know and need to know.

The research to this date is mostly qualitative and about inservice, Britton reports, with only 18% about online PLC activities. Two-thirds of the research reviewed was conducted in the last five years; half in the last three. This leads to what we still need to know.

Britton notes that the KMD Project took up where this study left off, conducting further knowledge synthesis, reviewing even more research studies, and taking it another level one grain size more detailed. KMD is releasing an 80-study synthesis on teacher induction, available at their website.

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- random investigations of PLCs happening in the field
too busy, they’re just surviving.” That could be true of some individuals but not others, Britton notes.

Connecting Part I, II

- New teachers and PLCs (and PD at large)?
- international and U.S. examples
- wise inclusion

In China at the middle school level, every mathematics teacher is part of two PLCs, one that does lesson planning across the same course and grade. Then they have research PLCs on teaching math that are school wide, with several groups, each cutting across several grades in the school and across mathematics courses. That is for all teachers, Britton relates, and explicitly includes the new teachers.

In fact, he notes, from the standpoint of being professional and human, several interviewees who were facilitators for those PLCs said that of course, not only do new teachers need to be part of this like every other teacher in the school, but sometimes the agenda for the PLC is changed to focus specifically on the issues that the new teachers are facing. Interestingly, Britton observes, this is not part of the formal description for the teacher induction program for a given city like Shanghai.

“But if you are doing systems thinking about the entire surround that the new teachers experience, and about every part of that system you can leverage and articulate in some way to better their situation and move them along as fast as you can, then you will think of all of these things that aren’t part of the official program, including how you are handling the learning communities and dealing with the job of the new teachers within those communities,” Britton concludes.
Introductory Remarks

Kathleen Bergin

Bergin applauds participants for their work and leadership and opens with a quote from John Quincy Adams: “If your actions can inspire others to dream more, to learn more, to do more, to become more, you are a leader.” She welcomes members of the US Department of Education (USDOE) MSP in attendance at this LNC, noting that from the beginning the NSF MSP has had a collaborative relationship with the USDOE MSP.

Bergin encourages participants to look at the new solicitation, which includes two interesting elements in Research, Evaluation and Technical Assistance (RETA) that have grown out of conversations with colleagues at the USDOE. First, NSF is seeking proposals regarding state STEM plans and research entailed in determining all of the assets in STEM that a state could bring to bear to improve STEM education in that state, as well as researching the process so that other states could learn from this process of looking at data and assets and plans for the future.

There is also a call for a STEM Education Resource Collaboratory in the solicitation to address the question of what has been learned from the MSP as well as other NSF investments in STEM education. Further, it addresses the question of how to share this knowledge and its implications for their own work with teachers and others working in schools. What is needed is unique, innovative mechanisms to get this information out to researchers and practitioners so that it can be translated into practice.

Panel Presentation

Integrating STEM in the Broader Reform Effort

James H. Shelton III

Shelton stresses the fact that the efforts to keep STEM at the forefront and drive integra-
tion across the agencies is still a priority, and is starting to take form in the collaborative work being done by NSF and USDOE so that it can continue across administrations. He underlines the importance of thinking about this work not in terms of isolated programs, but in alignment with overall strategies and the broader frames being brought to this work.

One important frame for this administration and for USDOE is the notion of thinking about things from cradle through college and career. In STEM, there is work on the early learning phase through Ready to Learn and other programs. Work in K-12 is continuing through MSP, through work on teacher effectiveness, and extends to after-school programming. Then there is the work with Carl Weiman, who has joined the Office of Science and Technology, on undergraduate instruction of STEM subjects. Finally, Shelton notes, we know that there is significant drop-off in the percentage of graduate studies done by US students in STEM fields. Money and resources are being spent by the Federal Government around that issue, accompanied by acknowledgement of the need to bring that work into alignment with the overall effort. In both NSF and USDOE, Shelton reports, you will see increasing efforts to bring alignment across all of these programs.

That STEM work must be couched in the context of a broader reform effort. “When it is held out as separate and distinct,” he observes, “it is difficult for it to become part of the fabric that we know will be maintained regardless of political affiliation, regardless of what happens with administrations at the federal, state or local levels.” It must be embedded in a way that penetrates all the way down to classroom practice and can be sustained despite whether or not STEM happens to be a priority of those in office, he concludes.

Race to the Top
Ann Whalen

Whalen offers an overview of Race to the Top, a $4 billion program to force states to invest in comprehensive reform. “The idea was that working in silos isn’t going to get us where we needed to go,” she relates, “so great teachers and leaders, college and career-ready standards and assessments, turning around the lowest performing schools, and having great data systems that provide quality information to educators in the classroom to improve their instruction should be part of a larger, comprehensive plan.” Rather than one single lever, it involves pulling all of these together within states to accelerate student achievement.

Rather than the traditional approach of having states compete for funding by submitting a plan, Race to the Top requires states to demonstrate that they have conditions for reform in place, including structures, laws, regulations, and policies that, with additional support, will enable them to accelerate reform within their state. Forty-six states put together applications focused on comprehensive reform, pulling together stakeholders from districts and higher
Quality STEM Education
Ann Whalen

Many states are working with higher education partners, STEM advisory councils, and the business community to build new syllabi and courses to identify what a quality STEM course of study looks like, and are then working to identify how to support that implementation on the ground so that it becomes part of a comprehensive reform, building capacity at the state and local level.

In addition, all twelve states receiving grants, ranging from $75-700 million, have invested in the educator workforce in the STEM field, increasing both traditional and alternative routes to entry and assuring those educators will be supported through ongoing professional development, incentives, and networks.

STEM education, particularly for underrepresented students, is built into the application as a competitive priority. Applications indicate that states are including STEM not as an add-on, but as part of their comprehensive plan. The state-specific year-one progress reports just released show that in Race to the Top states, they are making significant efforts to integrate STEM work into standards regarding preparation of college and career educators in readiness for Common Core, as well as into teacher evaluations. They are not looking at this as a silo or an add-on to their work, Whalen observes, rather they are integrating STEM into their everyday decisions, projects, and capacity-building at the local level.

Another $200 million in grants have been released for Phase III Race to the Top winners, seven states that were finalists but not grant recipients in Phases I and II. They received a portion of what their total grant would be to help accelerate additional reforms in those states, and were required to invest a meaningful share of those grants into STEM projects in the course of demonstrating how they were going to achieve comprehensive reform. The focus of states in Phase III is similar to that seen in Phases I and II, investing in what it takes to transition to college and career-ready standards in math as well as assuring that science standards are up to par and investing in the workforce to attract and support the best and brightest talent in STEM fields.

STEM as a Priority
James H. Shelton III

Shelton notes that in the Investing in Innovation Fund (i3), STEM was not a specific priority in the first year. Last year it was an explicit priority, and over 50% of the i3 grants incorporated STEM in some fashion. The i3 is a tiered evidence program, he explains, something we will be seeing more of through USDOE and other agencies. USDOE will be working closely with NSF to achieve more alignment in evidence standards so that these programs become highly leveraged and feed each other.

The premise is simple, Shelton observes: a little bit of money for a little evidence, a lot of money for a lot of evidence. The notion is to fund things that will go to scale with a significant amount of evidence, while still stimulating that pipeline of new and innovative ideas that deserve to be evaluated to see if they should be funded and expanded to reach more students and teachers in more classrooms.

Shelton calls for participation of the NSF MSPs in contributing to the community of thought on a number of issues. The first request is for MSPs to identify examples of success in initiatives they have started scaling and sustaining themselves. How can those lessons learned be captured and translated back to the community and fed into programs like i3 so that other new
programs don’t have to repeat the hard lessons MSP projects have learned over time?

Second, a number of other programs are going to be emphasizing STEM. There is the opportunity, whether through teacher professional development programs, incentive programs, or after-school programs, to think about where to include STEM. Something called a “Secretary’s priority” has been created, and that priority can easily be added to any program in the Department. This means there will be many more opportunities for those working in STEM fields to see where their work aligns with the broader reform efforts within the Department, and the likelihood of STEM priorities being included in grants regarding teacher preparation institutions, alternative pathways, and so on, is very high. NSF MSPs should be thinking about how what they are doing can be taken to the next level, be expanded, and be sustained.

Third, USDOE is attempting to create a much more coherent frame around all of this work and embed it in the pillars of reform around standards, data systems, assessing student performance, and transforming our worst performing schools so that they are not just improved but re-envisioned. All of this can benefit from the kind of thinking NSF MSPs have been doing in their work and create opportunities to feed into USDOE work. The only way that is going to happen, Shelton advises, is if we are intentional about it. The current low level of participation by NSF MSPs in Race to the Top (see sidebar) is disappointing. How can we make that kind of active integration and participation a reality so that the expertise NSF MSPs are building becomes something that is relied upon as these new programs are put together?

Resources will most likely be fewer in the future, Shelton cautions, and there is a need to get better at leveraging every single dollar. We can no longer have single-purpose dollars, and using the voice of this community to drive better integration and more thoughtful use of resources is very important.

The President’s focus on STEM education is now anchored by the report from the Jobs Council that focuses on the STEM education and the need for a STEM workforce, Shelton notes. He advises participants to read the article, “How the US Lost Out on iPhone Work,” *New York Times*, January 21, 2012. “We all know that jobs, jobs, jobs is going to be the mantra as far into the future as we can see for a while,” he observes. That lens on the workforce is something we need to start talking about at these meetings.

There is also a fairly significant national movement that has begun to galvanize around the President’s Council of Advisors on Science and Technology (PCAST) report focused on STEM and the importance of STEM education. Points in that report include the need to increase the number and quality of STEM teachers, the need to increase the number of STEM graduates, and the need for advanced research capabilities focused on STEM education.
All of these recommendations have begun to generate supporters from the business community and from policy decision makers who need people to talk to who know what these things mean in practice. “My point,” says Shelton, “is that there are a lot of things that should be putting wind behind your sails. You need to raise your sails and grab hold of the steering wheel so they can take us in the direction we want to go. My closing message every year is that you ought to be driving these conversations.”

Questions and Answers

Aligning STEM Efforts Across Agencies

- The recent Federal STEM Education Inventory from OSTP offers an inventory of STEM across all federal agencies. How are NSF and the USDOE thinking about aligning what they do around STEM education?  • Kacy Redd, Association for Public and Land-grant Universities

- The good news is that money and resources are being spent on STEM. The bad news is that efforts are fragmented. There is a federal agency collaborative that has been pulled together to figure out how to get better alignment around that work that will deliver a strategic plan to Congress by the end of this year. Two things need to happen quickly. First, in a time of diminishing resources, fragmentation without explanation puts you at a significant disadvantage and work is needed by the end of the year to provide those explanations.

Second, significant pieces of work that should be aligned may be around 80% aligned, but that is because those involved were thinking along similar lines, not because of intention. The challenge is to work towards the kind of alignment that will allow us to get much more leverage out of these efforts and make better use of the resources.

Third, and more challenging politically, is that a lot of the fragmentation is driven by small programs being set up without context or consideration for how they fit into the broader scheme. That will also be part of the conversation, including making a distinction between those things driven by Congressional interest and those things that are more important to the strategic efforts of agencies involved in this work.  • James Shelton III

Parental Involvement

- How can STEM reform be thought about without parental participation when all of the studies show that parental participation is a major part? In any of this training, is there training on how to be culturally sensitive, how to deal with the urban child? Our program is conscious of that, but I have not heard here anything about dealing with parents and making them an inclusive part of this. Most of our children who are struggling come out of poverty situations, and along with poverty
comes illiteracy. You are doing all of this great training for teachers and for children, but you can’t keep the child on the weekends, you can’t keep the child overnight, they have to go home.  

- Bryon McIntyre, Buffalo Public School District Parent Coordinating Council

- It is easy in these contexts to not talk about parental engagement because the focus is on systems and system engagement. One of the things that we suffer from is lack of a good evidence track record around parental engagement and support. Similar to its priority around STEM, the USDOE has created a priority around parental engagement and has recommended an increase in funding for parental engagement. The bad news is that we still don’t have a lot of high-quality recommendations regarding what people should be doing with that additional funding, or a lot of case studies to point to as models of how to be effective at engaging parents and helping them be better supports for their children. That is the next phase of the work.  

- Kathleen Bergin

**Update on Developing Assessments**

- Regarding the groups funded to develop assessments, do you have an update about the current status of that work and implications for those doing STEM programs and, more importantly, for policy over the next five years or so?  

- Elisabeth McGrath, Stevens Institute of Technology

- This question refers to USDOE funding of two consortia comprised of twenty to twenty-five states each, working on the next generation of assessments for K-12 in English arts and math. They are on trajectory to provide not just summative assessment, but assessment systems that include formative, diagnostic, interim and summative as a suite of supports by the 2014-15 school year. Year one was a building year in terms of governance. They put out model frameworks over this past summer to gain public input on the transition from the Common Core to the new assessment system, and are now in the process of putting

i3 Applicants in Areas of Assessment

- One of the themes in the i3 program is to create supply to meet the demand being created by Race to the Top and others. One area more applicants were expected was in innovative and authentic assessment, particularly in areas like science. That hasn’t happened, and they would like to hear about ones that they should be highlighting and paying attention to.  

- James Shelton III

Bryon McIntyre poses a question
Opportunities

- Grant programs will be announcing competitions and it will be worth your while to check those. The program may not have “math” or “science” in its name, but STEM priorities are being embedded in existing programs like the Teacher Incentive Fund and the after-school programs. You’re urged to check the Federal Register and the DOE website because programs for 2012 will be announced over the next several months. • Patricia O’Connell Johnson

- Also look within your states because a lot of states have started putting out competitive grants as well. They need help with capacity building and are requiring partnerships because they are learning from examples like i3. • Ann Whalen

Identifying Problems Working with States

- If you attempted to work in your state with Race to the Top, what challenges did you encounter?
  • Kathleen Bergin

  We had a great deal of difficulty getting the Pennsylvania Department of Education to return phone calls, or finding names of those involved, which seemed to be carefully hidden. There is apparently no requirement that IHEs with MSPs be engaged in the process. The Race to the Top application began under a previous administration and was carried forward, but there was a lot of transition in and out of jobs as well as within our partnering districts. • Pennsylvania

- When we raised the question of doing evidence-based changes within the curriculum the response was, “We don’t have time for that. We need to get good curriculum in there and don’t have time for what the researchers would give us.” It seemed to be a process of rushing ahead, getting things in place and maybe later asking if things were reasonable. • Illinois

- Pennsylvania and Illinois are two states that are in Phase III of Race to the Top and are in early stages of the process, still trying to figure out who their lead is, what projects they are going to do, and where their budget lands. MSPs are encouraged to persist in approaching and trying to work with these and other states. In February and March there will be scopes of work on the USDOE website that will help inform these conversations.

  Regarding curriculum, there is a sense of urgency at state and local levels in the attempt to figure out the transition to Common Core Standards. People need to be reminded there is no silver bullet or quick fix and that it is important to learn from what we are doing. In i3, Race to the Top, and other programs the USDOE is trying to send a message regarding continuous improvement, scaling what works, and learning from implementation. If you are not hearing that echoed in the field, let USDOE know and advocate for it in your own states. • Ann Whalen
Is There a STEM Professional Shortage?

• An article, “What Scientist Shortage?” in the *Columbia Journalism Review* by Beryl Benderly (http://www.cjr.org/reports/what_scientist_shortage.php?page=all), calls into question the issue of whether there’s a shortage of STEM folks or a glut. Colleagues at Penn reacted when I forwarded them this article with a barrage of responses about the post docs and grad students they’re unable to place in STEM positions because they don’t exist. Are we really looking at this picture honestly, or are we not looking at something we maybe should be looking at?  • Jane Horwitz, Penn Science Teacher Institute

Based on the Jobs Council, on conversations with the Business Roundtable and the Chamber of Commerce, and on responses to the immigration debate around highly skilled workers, CEOs don’t know they can get as many workers as they want. If there is a statistical case to be made that there are as many science majors, in particular engineers, as necessary, I would love to see it and know why the companies trying to hire them don’t know where to find them.

Another factor here could be a mismatch between the types of STEM majors being produced and the types of STEM majors needed to fill these jobs. Engineering is a particular gap area, as well as people who have cross majors between the sciences and engineering. Finally, we tend to think about the STEM fields in very particular ways and particular categories when in fact, in some cases (e.g., for advanced manufacturing work and other categories) we have no pipelines other than cross-training people from other disciplines. I would like to review the article to be able to respond more fully.  • James Shelton III

• And if the people in that article would be willing to go to middle and elementary school to teach, that would be wonderful.  • Ann Whalen

A Topic for Next Year’s LNC

• This question of how we move ideas from this community into the broader national framework is so big that it would be a very logical topic for next year’s Learning Network Community.  • James Hamos
LEARNING AND NETWORKING

Over the course of the two-day conference participants engaged in learning activities, dialogue and reflection with their own project teams and with members of other MSP projects to learn from what others are doing, drill more deeply into framing effective teaching in STEM, and identify how information gained at the LNC applies to individual MSPs.

Coffee House Activity

Working in groups of five, with members representing different MSP projects and roles, participants were armed with marker pens and rotated the facilitation role as they considered five questions. The questions were posted in the center of each table, and discussion notes regarding each question were recorded on the tablecloth. The tablecloth notes reappeared and were used as the focus for discussion during a subsequent session in which project teams gathered and reflected on what they have learned.

The Questions

1. How do you describe effective STEM teaching?
2. What are some ways to generate evidence to be able to recognize whether and how STEM teaching is effective?
3. How can such evidence be shared in ways that the community can act upon it to make STEM teaching more effective?
4. What roles do you see STEM faculty, evaluators, K-12 administrators, K-12 teacher leaders/professional development specialists playing in making STEM teaching more effective?
5. What are the necessary supports to enable effective STEM teaching?
Exploring Dilemmas of Effective STEM Teaching

This “speed dating” activity enabled participants to gain multiple perspectives on the dilemmas faced by MSPs and identify projects they wanted to explore further during the Poster Session. Participants paired off in a series of ten-minute rounds, introducing themselves and the work of their MSP projects and then addressing the following questions:

- What are some of the dilemmas related to effective STEM teaching?
- What are common dilemmas that both projects in the discussion dyad are facing?
- What strategies can be used to address those dilemmas?

Poster Session

Participants learned more about the strategies other MSPs are using to identify and work towards effective STEM teaching during the Poster Session. A multimedia presentation of the posters from this LNC may be found in a Virtual Poster Hall online at http://hub.mspnet.org/index.cfm/msp_conf_2012.
To see a video of this presentation, including an introduction by James Hamos as well as the original PowerPoint slides, go to: http://hub.mspnet.org/index.cfm/msp_conf_2012

Framing Effective Teaching in STEM

Ferrini-Mundy begins by applauding those assembled for working effectively to make a difference in STEM education in K-12, undergraduate, and informal education arenas. She notes that the MSP program, which spans so many parts of the system, is mature enough to see findings and lessons learned.

This is an exciting time in the Directorate for Education and Human Resources (EHR) and at NSF because of continued interest in and attention to education across government. Those at EHR want to be in the lead for the focus on STEM education at the K-12 level and will need to draw heavily on the work of MSP projects and partner with sister agencies, particularly the US Department of Education.

The focus of this presentation is on future directions and future needs and on the help needed from MSP projects. At this juncture, Ferrini-Mundy reports, there is a press to be able to point to the return on investment in STEM education, which may change the way MSP projects look at what they do. The theme throughout these remarks is how to do that effectively, which includes measuring impact. Ferrini-Mundy notes that while we are fairly good at measuring outputs—number of people reached, number of sessions held, numbers of partnerships formed—we need to keep pressing to look at good examples of the impact on the learners, on the future science workforce, on the future public that will need to work with STEM. Looking at the future, thinking of the MSP program and the kinds of well-established partnerships and activities represented, those assembled are challenged to think about how to capitalize on this work and summarize its impact in useful ways beyond the education community.

The focus on teachers and teaching and the critical role teachers play is something EHR and the NSF hold central.

“Teachers are the single most important factor in the K-12 education system, and they are crucial to the strategy of preparing and inspiring students in STEM.”


The PCAST report from which the above quote is drawn will soon be followed by a report on undergraduate education. These reports are important, Ferrini-Mundy notes, drawing together ideas from across agencies and the field and can
be seen as shaping funding recommendations and requests.

Dr. Suresh, the Director of NSF, has initiated a notion called OneNSF, “a wonderful focus for us in the agency in terms of working across boundaries, working together, breaking down barriers.” One of the points around the OneNSF idea is that education work, traditionally seen as within EHR, needs to span the agency, and the science that goes on in NSF needs to be more central and fully visible in the education work that is funded.

NSF’s plan identifies three strategic goals: transforming the frontiers, innovating for society, and performing as a model organization. Ferrini-Mundy encourages participants to focus on MSP work and the first two goals, which may help to underscore what is needed. In the previous strategic plan for NSF there was a goal for education, a “learning goal,” which was separate from the “discovery goal,” which is where the future of science was situated.

In this new plan, “transform the frontiers” is explicit about the need to transform the frontiers of science, of education and learning, of schools and informal learning settings, with the focus on moving into the future, building new ideas, testing them, summarizing the results, and sharing those results. Education is just as fully engaged in “transform the frontiers” as the rest of NSF, which will be reflected in the research components of future solicitations, Ferrini-Mundy advises. What are you learning, how are you testing hypotheses, how are you gathering data and evidence to inform your work, and how are you sharing that?

Regarding the second goal, “innovate for society,” Dr. Suresh is particularly interested in seeing NSF-funded discoveries make their way into policy, into practice, into the market. Ferrini-Mundy has worked hard to ensure that education is central to this effort, which could include cyberlearning innovations, instructional practice innovations, models for teacher learning, tools for measuring teacher knowledge, or great ideas being implemented by projects like
The NSF has a strong interest in bringing those to widespread use, either through the commercial sector or policy changes.

MSP projects are encouraged to address this goal by thinking beyond the scope of their own work to forming the right partnerships and moving ideas to wider use. Scale-up, translation, and widespread implementation of ideas is obviously complicated and requires adaptation in situating the ideas in new local settings, Ferrini-Mundy acknowledges, but it is the education community that ought to be out in front, modeling for the agency how to do this work of innovating for society.

Much thought has been given to how EHR’s investments might sit in at least three different kinds of categories. Research and development investments are at the center of what EHR does. There are also a range of leadership programs, which ideally use results from R&D to guide the leadership, scholarship, and fellowship programs. Finally, there is “experiments,” where EHR is looking towards the future and partnerships within the rest of the agency.

The next slide addresses Dr. Suresh’s OneNSF idea. Ferrini-Mundy reports that in the last year, an exciting set of working relationships have been established among all of the NSF directorates, and EHR is collaborating in new ways at new levels with all of the other directorates and offices in the building. This has been based on belief in Dr. Suresh’s idea that what goes on in EHR, together with what has been going on and funded across the agency, is crucial to making a difference.

The three “E”s—energizing, engaging and empowering—have been used as slogans and a way to think about this. “Engage” can be thought of as K-12 oriented, but goes beyond that to attracting people to the excitement of STEM areas. Going beyond numbers reached, the focus is on how particular engagement strategies actually make a difference in helping students think about career opportunities, in improving science literacy, and so on. “We need to drill down into the concept of engagement to see how it works,” Ferrini-Mundy explains, adding that the reason it is part of the OneNSF idea is that much of the science we would like people to engage with is being funded across the agency. Ferrini-Mundy poses a challenge for MSP projects: Think about cutting edge science—from NSF-funded projects involving telescopes and research vessels to research at the poles—and its place in the work you might be doing in K-12.

“Enabling” moves students past being excited to beginning to understand and make good use of STEM content necessary as citizens going for-
ward. “Energizing” involves setting them on a path to undergraduate and graduate levels. The attempt is to integrate the philosophy within each of these areas in EHR.

This is an exciting moment, Ferrini-Mundy reiterates. “We have the attention of Congress, we have the attention of the rest of NSF. I think everyone is waiting to see what kinds of exciting things the education communities can come up with to act upon these great opportunities.”

One point that needs to be made, she notes, is that it is impossible to do education work well without fully understanding the context in which that work is happening with students, with teachers, with principals, and being able to build toward that toward the advancing of frontiers. Ferrini-Mundy calls on the MSP community for its help in understanding how to summarize those needs. In talking with colleagues across the agency, EHR needs to be able to bring to the table what has been learned about the context in which education takes place. Otherwise, there may be assumptions that it is simpler than it is, or the idea that just streaming telescope data to a first grade class would be good. “We have to find ways to capture not only the impacts and outcomes of your work,” Ferrini-Mundy explains, “but the contextual learning that you are assembling along the way, the implementation research that is occurring, to help us understand the conditions under which certain kinds of changes can be made and why.”

While posing grand challenges for a field has been a practice in other arenas, it has not been a tradition in education. These are driving questions around which we might all rally. The challenges listed at right apply across NSF and become unifying questions. These sorts of questions are being discussed with colleagues across the building. “We then put these ideas out for your response and consideration and begin, with you, to form the shape and direction of our investments going forward.” Ferrini-Mundy concludes by stating, “Thank you for the tremendous work that you do in your projects. Consider carefully how you can get your message out in clear ways and we can all stay connected to improve STEM learning for all kids.”

The Science of Learning

“Most learning occurs in a social context or ecosystem.”

“This learning ecosystem includes teachers, principals and school administrators, guidance counselors, families, peers, neighborhoods, and a variety of other person or factors that can assist or thwart academic development.”

Framing Effective Teaching in STEM

To see a video of this presentation as well as the original PowerPoint slides go to: http://hub.mspnet.org/index.cfm/msp_conf_2012

James E. Hamos
MSP Program Lead
National Science Foundation

Hamos observes that powerful threads and messages have run through this year’s Learning Network Conference activities, panels and speakers, both in the way attendees have worked to think in new ways about teaching and teachers and in what those representing government agencies are thinking about.

The new MSP solicitation contains some of the recurring themes heard during the conference. This is the tenth year NSF has been funding these partnerships. Based on a process of “blue sky” thinking over the last year, Hamos and colleagues began to consider ways to maneuver the program forward while holding to some deep-held beliefs. One thing that emerged from this process was four focal areas for the Targeted Partnerships. The first relates to a point eloquently made during the Q&A session with the USDOE panel. As much as we focus on formal education, the students we work with have lives that extend far beyond that. Engaging the community to both ask and address parts of this question is what the first focal area is about. There is no set answer or specific vision for what this means; it is about truly understanding that we have to do more than dealing with formal schooling and content knowledge by itself, and that kids spend more hours in other parts of their lives than they do in school and homework.

The second focal area on current issues related to STEM content is probably the biggest area that we have all been working on, Hamos observes. What is content? How do we build it deeply? Common Core State Standards as well as a range of other testing and assessment issues are also in the vanguard of current concerns.

The third focal area is something that has not been allowed within MSP in the past and concentrates more on the learner, while most MSP work has been about teachers (though teachers are also learners). The notion of identifying and cultivating exceptional talent draws from a report by the National Science Board on innovators. Equity and access are part of the language in this focal area, and cultivating the next generation of innovators is what this focal area is about.
In the past, MSP has never focused solely on the preparation of new teachers. The final focal area represents an acknowledgement that we do need innovation and new design and are now willing to think about how you create new teachers and about innovative ways to support them in those early years.

Another part of the solicitation is pertinent to this audience and draws from a practice in the early years of MSP from 2003 to 2005. NSF understands that the evaluation work is very hard. How do you gain insights regarding your work that are objective and significant and how do you create a community of people asking those kinds of questions? Early on, MSP funded two projects to offer technical assistance to the evaluation community within MSP. That is being included again in this new solicitation, and is one of the new Research, Evaluation and Technical Assistance (RETA) programs.

Then there are a set of questions that reflect the themes you have heard throughout this conference from Suzanne Wilson, from Ted Britton, from the USDOE panel, from Cora Marrett, and from Joan Ferrini-Mundy. First, there is the question of what is going to survive beyond NSF funding? What are the strategies for sustainability in your work? What lessons can we draw on? Are there important ideas about how your projects think about that earlier on? Studying this is extremely important to NSF.

The second piece of that question relates to the understanding that MSP work is not conducted in a vacuum. What are the shifts in local and state policy and what is the impact on educational research work?

Then there is the question of how to move our knowledge to the broader community. This will include research that enables states to identify and coordinate the infrastructure and resources to continue their work on STEM education. This begins to move beyond MSP but also relates to your relationship to your states. “You are an important source of knowledge for your state,” Hamos observes.

Finally, there is the notion of the STEM Education Resource Collaboratory. This is an attempt to imagine how to synthesize knowledge and effectively get it into the hands of practitioners now. How can the work that we do grow and

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**Research: Sustainability and Impact of Policies; State Plans for STEM Education**

- Research on: (a) sustainability of partnerships from the past and current NSF MSP portfolio, ideas emanating from these partnerships, or institutional changes that have persisted; or (b) local, state and/or national policies that have resulted from and/or impact NSF MSP projects.

- Research that enable states to identify and coordinate the infrastructure/resources, both organizations and people, that can be mobilized within a state, multiple states or a region and the use of extant data to support the identification of specific and targeted needs to advance K-12 STEM education.

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**STEM Education Resource Collaboratory**

The STEM Education Resource Collaboratory will focus on:

a) gathering and synthesizing knowledge from STEM educational research that can be meaningful for K-12 practitioners, drawing upon varied sources of research, including that supported by NSF’s Directorate for Education and Human Resources, particularly the past and current MSP portfolio;

b) designing innovative mechanisms of actively disseminating research-based findings to STEM educational researchers and practitioners;

c) providing approaches for practitioners and researchers to consider translational research in order to implement the ever-evolving research on effective K-12 STEM educational projects, programs, and practices; and

d) engaging educational practitioners and STEM education researchers and social/behavioral/economic sciences researchers in identifying areas of mutual interest for further educational research.

The Collaboratory will pay particular attention to dissemination and translation of educational research among practitioners involved in STEM education programs of the U.S. Department of Education and in support of STEM education within states and/or across local communities.
be utilized faster than any mechanism we have to date? This has the potential for an $8 million grant over five years, Hamos notes. While it won’t solve all of the issues, it is the seed of an idea to try to draw on the knowledge generated by the MSP and others, extending beyond EHR. It talks about ideas that should be drawn together, including ones drawn from literature and knowledge out in the field. Hopefully, being able to respond to questions about the return on investment in the MSP or in EHR will be part of the equation, but this is an open-ended exercise to identify meaningful knowledge for practitioners. Those practitioners aren’t defined—they may be teachers, principals, district administrators.

It also looks beyond existing mechanisms for dissemination that have not yet solved all of the issues. This does not fund or define the notion of translational research. The hope is that those in the MSPnet Academy will be thinking over the next year about translational research in education or design-based implementation research and talk to MSP members about what this could look like, how it might be funded, and so on.

The Collaboratory is a place to raise major themes, a place where things are drawn from research and practice, and a place to identify where further work needs to be done. One of the biggest things NSF would like the Collaboratory to be able to do is “set the wind to your sails,” to use James Shelton’s expression; to get the word out to your states, to the work that is being done by USDOE and beyond.

Hamos punctuates his presentation with a homework assignment (see sidebar), giving participants ten minutes to discuss and record their ideas for collection at the end of this session.

After the exercise, he notes the value of this type of input from MSP projects. “I know that many of you are thinking about things we should do at NSF,” Hamos observes, and while he cannot promise that all suggestions will be acted upon, he does encourage participants to bring those suggestions to him. He also encourages participants to take advantage of the MSPnet Academy and to pose topics of interest to the community. This LNC conversation will continue and expand beyond this session through the Virtual Poster Hall on MSPnet. Finally, participants are asked to contribute highlights, key parts of project work worth of others knowing about now, particularly things with data behind them, as well as photos. These contributions from MSP projects are used extensively in communicating about MSP to policy makers and stakeholders.