Determining what we know and how well we know it: The promises and perils of knowledge management

Co-Principal Investigators

MSP Knowledge Management and Dissemination Project

Iris Weiss
Horizon Research, Inc.

Barbara Miller
Education Development Center

Knowledge Management and Dissemination
NSF MSP

Note: Soon after the LNC, these slides will be available on the KMD website

http://www.mspkmd.net

Knowledge Management and Dissemination
NSF MSP

Table Task

- On your table is a description of two plans for deepening teacher content knowledge in order to improve their mathematics and science instruction.
  - Individually, take a few minutes to read these plans -- the context applies to both of them.
  - At your table, take a few minutes to discuss which plan you would recommend and why.

Knowledge Management and Dissemination
NSF MSP

Which of the following best characterizes the discussion at your table?

Our recommendations were based:

1. Primarily on research findings
2. Primarily on people's prior experiences
3. About equally on research and experience

Knowledge Management and Dissemination
NSF MSP

Evidence-based decision-making

- Increasingly, there have been calls for basing practice on empirical evidence.
- However, for multiple reasons, practice tends to be based on a wide variety of sources.

Knowledge Management and Dissemination
NSF MSP

Sources of Evidence

- Research findings about particular strategies
- Your own experiences
- Experiences of people you respect
- Beliefs about what is important
- The particular context

Knowledge Management and Dissemination
NSF MSP

Plan One vs. Plan Two?

- The empirical research does not provide very much guidance about which plan would be more effective in this context.

Evidence-based decision-making

- We will never have sufficient knowledge to guide all of the decisions MSP projects and others need to make, in part because each context is different, and in part because there are so many trade-offs to be considered.

Knowledge Management and Dissemination
NSF MSP

Evidence-based decision-making

- But the fact that we don't know everything doesn't mean that we don't know anything.

- Educational research and development efforts are expected to draw on the accumulated knowledge of the field, however incomplete.

Knowledge Management and Dissemination
NSF MSP

Evidence-based decision-making

- NSF MSP funded KMD to help future MSPs and other R&D efforts ground their strategies, including evaluation/ research designs, in what is already known.

**

Knowledge Management and Dissemination
NSF MSP

Knowledge Management and Dissemination Goal

To synthesize knowledge generated through the Math and Science Partnerships and integrate it into the broader knowledge base for education reform

Knowledge Management and Dissemination
NSF MSP

Areas for Exploration: Focus on K-12 Education

- Teacher Content Knowledge (TCK)
- Teachers as Intellectual Leaders (TL)
- Teacher Induction (TI)

Knowledge Management and Dissemination
NSF MSP

Knowledge Management Framework

- KMD is acquiring two types of knowledge:
  - empirical research findings, including MSP research
  - practice-based insights, including from MSP community

Knowledge Management and Dissemination
NSF MSP

Empirical Research

- Identified and screened studies, from research literature databases, to ensure that each includes an empirical investigation of the topic of interest

- Summarized research questions and framework, research methods, findings, conclusions, and implications

Empirical Research

- Developed and applied standards of evidence to fairly assess contributions and limitations of research studies using different methodologies, building on earlier work by the NRC and others

Knowledge Management and Dissemination
NSF MSP

Empirical Research

- Provided a rating and narrative for each of six domains:
    1. Adequate documentation of activities
    2. Internal validity
    3. Analytic precision
    4. Generalizability/external validity
    5. Overall fit
    6. Warrants for claims

Knowledge Management and Dissemination
NSF MSP

Practice-based Insights

- Developed and applied process of collecting and vetting practitioner knowledge from various sources:
  - MSP leader interviews
  - On-line discussion boards (MSPnet) and focus group reflections
  - On-line collection of insights, evidence, and examples (modified Delphi Panel) from panels of experienced practitioners, researchers and evaluators

Knowledge Management and Dissemination
NSF MSP

- Detailed information on our methodology and results can be found on the MSP KMD web site: www.mspkmd.net

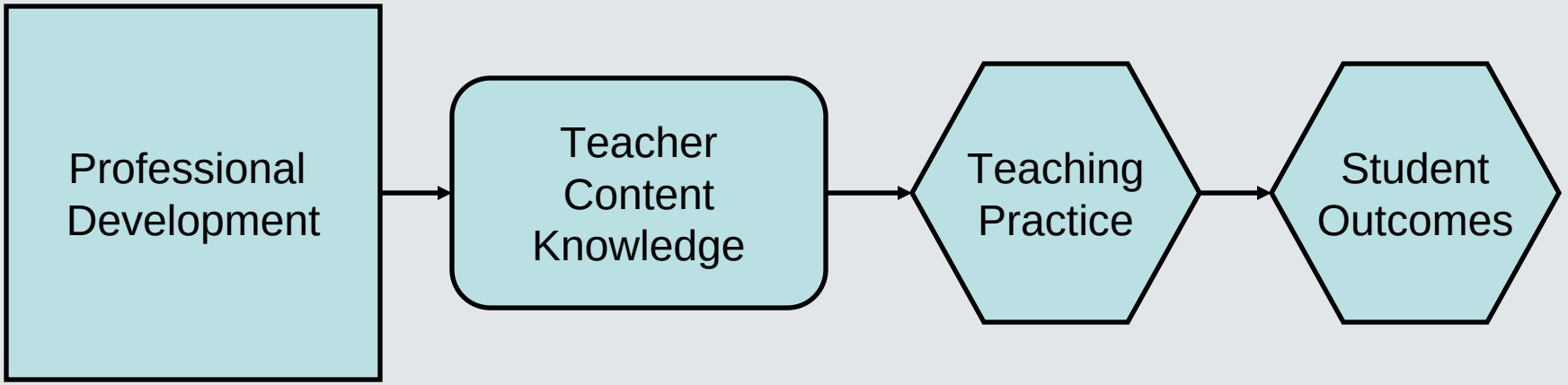
**

Knowledge Management and Dissemination
NSF MSP

- What have we learned about deepening teacher content knowledge?

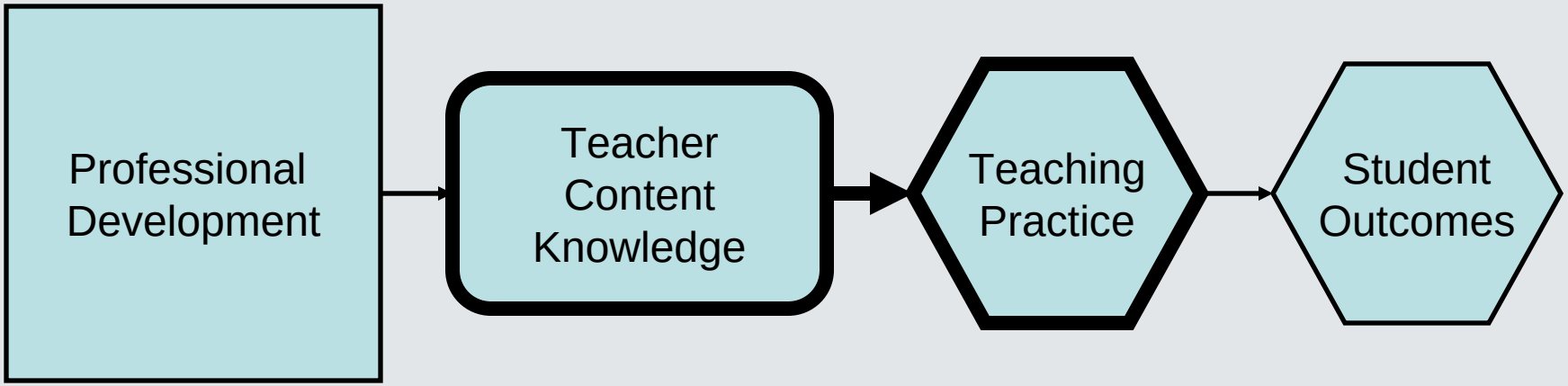
Knowledge Management and Dissemination
NSF MSP

Logic Model for Deepening Teacher Content Knowledge (DTCK)



Knowledge Management and Dissemination
NSF MSP

Logic Model for Deepening Teacher Content Knowledge (DTCK)



Knowledge Management and Dissemination
NSF MSP

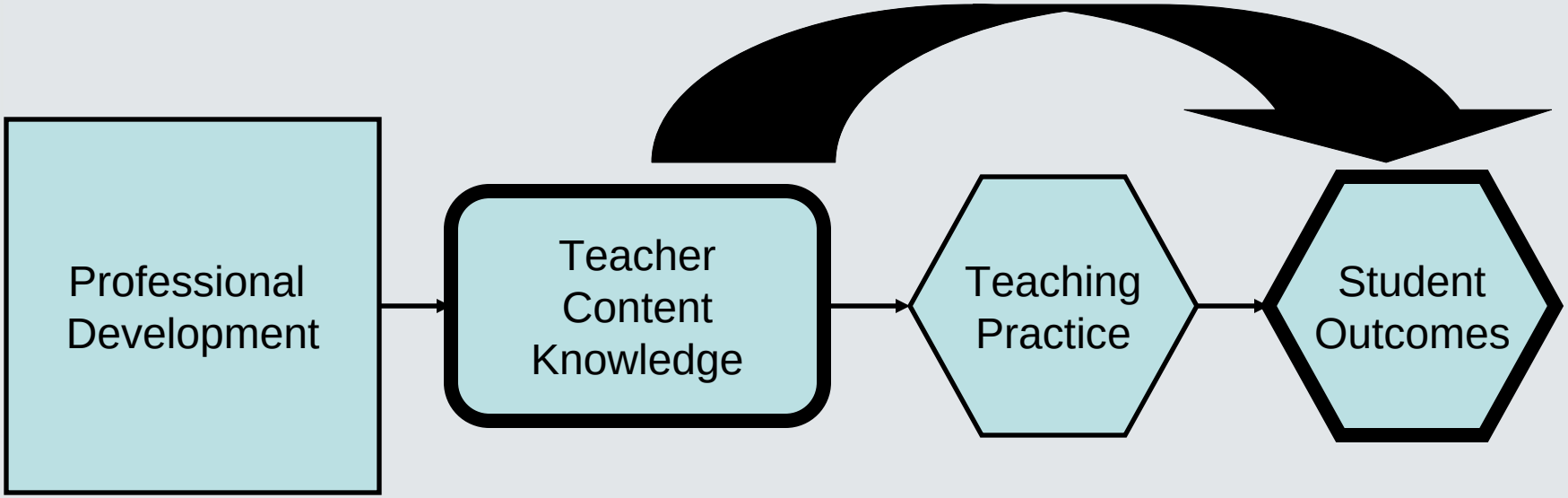
Teacher content knowledge matters…

- For teaching practice
  - Selecting content to emphasize
  - Selecting instructional strategies and sequences
  - Selecting assessment tasks
  - Implementing curriculum materials
  - Engaging in teacher professional communities

21 studies in mathematics, 7 studies in science

Knowledge Management and Dissemination
NSF MSP

Logic Model for Deepening Teacher Content Knowledge (DTCK)



Knowledge Management and Dissemination
NSF MSP

Relationship between TCK and Student Outcomes

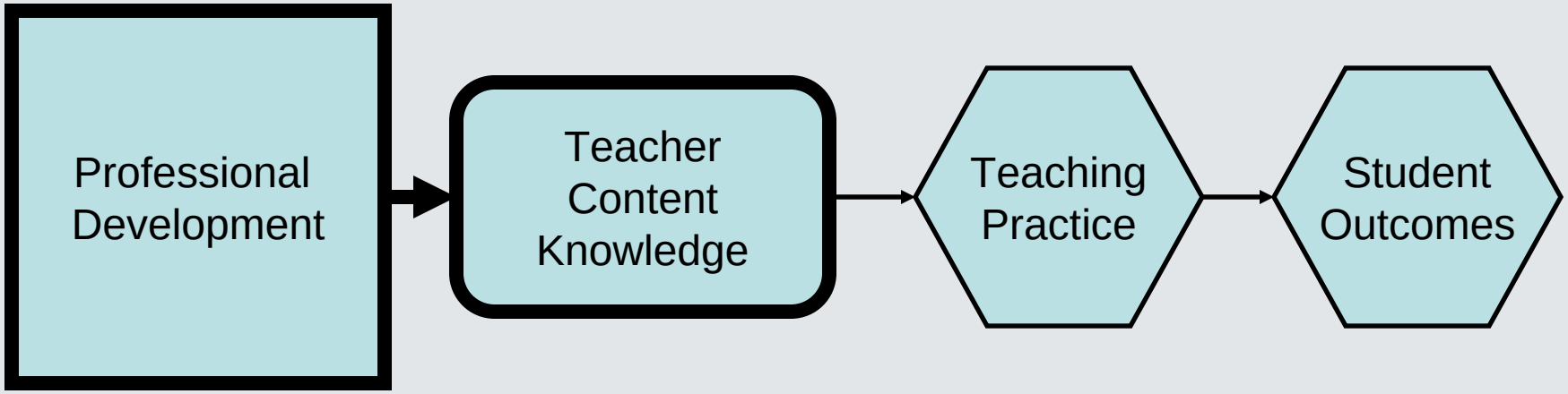
- 2 studies in mathematics
- 2 studies in science

Knowledge Management and Dissemination
NSF MSP

Teacher content knowledge matters for student outcomes

For example, Magnusson and colleagues (1992) found that when teachers held an incorrect idea about heat energy and temperature, their students were more likely to develop the same incorrect idea than if the teacher correctly understood the concept.

Logic Model for Deepening Teacher Content Knowledge (DTCK)



Knowledge Management and Dissemination
NSF MSP

Research on PD to deepen teacher content knowledge

- 13 studies in mathematics
- 26 studies in science

Knowledge Management and Dissemination
NSF MSP

What do we know about strategies for deepening teacher content knowledge?

- Designing programs
- Implementing programs

Knowledge Management and Dissemination
NSF MSP

Designing Programs: Understanding Teacher Needs

- Advice: Expect the nature and extent of teacher content-related needs to be different for different topics.

Knowledge Management and Dissemination
NSF MSP

MSP Example

An MSP's summer institute for secondary teachers focused on two strands of mathematics content: algebra and geometry.

The MSP found that teachers view algebra very procedurally, so they decided to focus on getting teachers to see the concepts behind the procedures.

Knowledge Management and Dissemination
NSF MSP

In contrast, said the PI, "The big issue with geometry is that when kids come in to high school geometry courses, teachers think that they are ready to do deductive work. In almost every case, kids come in with a very, very poor structural understanding of the geometric figures that they are having to face."

As a result, the MSP’s focus in geometry was on teacher pedagogical content knowledge, in particular teachers' understanding of students' developmental stages in geometry learning.

Designing Programs: Content-based Investigations

- Advice: Developing deep mathematics/ science conceptual understanding takes time; teachers need multiple opportunities to explore new ideas.

Research on Content-based Investigations

- Content-based investigations are a fairly common PD strategy.
- The KMD literature search found:
  - 7 studies in mathematics
  - 20 studies in science

Knowledge Management and Dissemination
NSF MSP

Example from the Literature

Puttick & Roseberry's (1998) case study of an elementary teacher involved in multiple content-based investigations over 2 years found, in relation to specific investigations, that the teacher:

- *"…began to work with basic ideas underlying equilibrium (e.g., the role of weight as a downward force, the notion of a system in balance)," and*

- *"…acquired a grounded understanding of acceleration and of Galileo's theory of accelerating bodies in particular."*

MSP Example

- An MSP engages secondary mathematics teachers in extended investigations of advanced, challenging problems. The PD focuses on:
  - what it means to do the work of mathematics,
  - key ideas in the high school curriculum that relate to these challenging problems.

This MSP is conducting case study research to connect teachers' experiences in the PD with their developing knowledge of what it means to do mathematics, and how that knowledge plays out in their practice.

Knowledge Management and Dissemination
NSF MSP

Implementing Programs

- Advice: Be true to the discipline — Professional development should model mathematics/science "habits of mind."

Knowledge Management and Dissemination
NSF MSP

Example from the Literature

Hill and Ball (2004) analyzed natural variations in implementation among 15 teacher summer institutes focused on number and operations. Institutes implemented with a focus on mathematical analysis, reasoning, and communication had larger impacts on teachers' mathematics content knowledge. **

Knowledge Management and Dissemination
NSF MSP

- What have we learned about using teacher leaders?

Knowledge Management and Dissemination
NSF MSP

Teacher leader practice impacts teachers' classroom practice

- Providing instructional support to teachers
  - Inside the classroom (e.g., modeling lessons)
  - Outside the classroom (e.g., leading professional development)
  - 8 studies

Knowledge Management and Dissemination
NSF MSP

Teacher leader practice is related to student outcomes

- Positive impact on student outcomes in classrooms taught by teacher leaders
- Positive impact on student outcomes from school-level effects, including teacher leader practice
  - 7 studies

Knowledge Management and Dissemination
NSF MSP

What do we know about teacher leaders?

- Improving teachers' classroom practice
- Working with principals
- Developing teacher leaders' knowledge and skills

Knowledge Management and Dissemination
NSF MSP

Improving Teachers' Classroom Practice: Teacher Leader-Led Professional Development

- Advice: Whenever possible, choose teacher leaders who have strong content knowledge as well as classroom experience.

Knowledge Management and Dissemination
NSF MSP

Example from MSP Research

- Manno and Firestone (2006) found that teacher leaders identified as content experts (minimum of an undergraduate major in the teacher leader's content area and teaching certification in that area) were more likely to:
  - provide support in curriculum implementation, including leading professional development and
  - establish greater trust between themselves and the teachers with whom they worked

Knowledge Management and Dissemination
NSF MSP

MSP Example

- Teacher leaders in one project co-designed and presented grade-level professional development sessions on individual *Investigations* units prior to teachers being asked to teach the units.

Knowledge Management and Dissemination
NSF MSP

- Because these teacher leaders had piloted the program in their own classrooms, they were confident about how the program worked with students. Because of their experience, they were able to share their genuine enthusiasm for the units and the program and also able to answer specific questions that teachers had.

Improving Teachers' Classroom Practice: Teacher Leader Modeling

- Advice: Demonstration lessons and other modeling experiences should be structured to engage teachers in reflecting on their classroom practice.

Knowledge Management and Dissemination
NSF MSP

MSP Example

- An MSP's teacher leaders provided model lessons for teachers with these features:
  - The teacher leader and teacher agreed beforehand on the explicit learning goals of the lesson
  - The teacher's observation of the modeled lesson was framed by a specific question, e.g., how students were engaged in sense-making of key ideas

Knowledge Management and Dissemination
NSF MSP

Working with Principals

- Advice: Recognize that it's a two-way street. Teacher leaders need the active support of principals, and principals benefit from the knowledge of teacher leaders.

Knowledge Management and Dissemination
NSF MSP

Research on Working with Principals

- Collaboration between teacher leaders and principals gives principals access to the specialized knowledge of teacher leaders (content and pedagogy) to inform leadership decisions.
  - 4 studies

Knowledge Management and Dissemination
NSF MSP

MSP Example

- MSP leaders and others note that principal support for teacher leader efforts is critical, including providing time, materials, and public encouragement

- “Some progress can be made with a passive principal or a hands-off principal, but sooner or later, if the principal is not supporting the work, a plateau will be reached and it is unlikely that a system (school) will be impacted over the long haul.”

Knowledge Management and Dissemination
NSF MSP

Developing Teacher Leaders' Knowledge and Skills

- Advice: Teacher leaders need more than preparation in content and pedagogy; they need to have opportunities to develop the role-specific knowledge and skills they will use in their work in schools and districts.

Knowledge Management and Dissemination
NSF MSP

- “Too often, assumptions are made that good teachers will be good teacher leaders. While it is important to have the personal qualities necessary to lead, teacher leadership also requires a new set of skills and knowledge that prepare teacher leaders for new roles and responsibilities.”

MSP Example

- An MSP used a variety of strategies to prepare teacher leaders to provide in-class support to teachers.
  - Teacher leaders attended 2-3 professional development sessions before they began their work in the classroom, dedicated to providing them with the basic knowledge they would need to carry out their leadership roles.

Knowledge Management and Dissemination
NSF MSP

– After teacher leaders began their work with teachers, preparation staff conducted on-site visits to observe teacher leaders' work in the field. Based on their observations, staff worked one-on-one with individual teacher leaders to improve their skills in areas of need.

Research on Developing TL Knowledge and Skills

- Teacher leaders generally carried out the work for which they had been prepared. 6 studies

- Wallace et al. (1999) and Miller et al. (1999) found that teacher leaders tended to reproduce in their practice the model of preparation they had received. The proportion of time in the preparation programs devoted to subject area content, pedagogy, and leadership corresponded with the time that teacher leaders spent in these areas in their work with teachers.

Comparing Empirical Research and Practice-based Insights

- Empirical findings tend to be larger grain size; practice-based insights tend to be more contextualized and nuanced.

Knowledge Management and Dissemination
NSF MSP

Comparing Empirical Research and Practice-based Insights

- We were surprised at how little guidance the available research provides and how much guidance expert practice provides, although without the backing that empirical research would provide.

**

Knowledge Management and Dissemination
NSF MSP

Why don’t we know more from the Empirical Research?

- For TCK, systematic keyword searches identified nearly 2000 relevant items published since 1990

Knowledge Management and Dissemination
NSF MSP

- However, approximately 90% of the studies were screened out because:
  - They were advocacy or opinion pieces, not research, and/or
  - They were studies of pre-service teachers only, and/or
  - They did not include a measure (quantitative or qualitative) of teacher content knowledge.

- The 174 TCK studies that passed “eligibility” screening were reviewed using MSP-KMD’s standards of evidence to identify their contributions to the knowledge base.

Knowledge Management and Dissemination
NSF MSP

- Similarly, only 58 of the nearly 800 studies identified in the TL literature review passed through the screen and had standards of evidence applied.

Knowledge Management and Dissemination
NSF MSP

Why don’t we know more from the empirical research?

- In applying standards of evidence, we often found vague or incomplete documentation of programs or interventions.

- Consequently, we know something worked, but we don’t know a lot about what “it” was.

Knowledge Management and Dissemination
NSF MSP

Why don’t we know more?

- Studies tended to be more like program evaluations rather than research on particular strategies.
- Consequently, we know the overall experience worked, but we don’t know how much particular interventions contributed to the gains.

Knowledge Management and Dissemination
NSF MSP

Why don’t we know more?

- We often found serious limitations with study research designs, including:
  - Selection bias in samples and contexts
  - Lack of comparison groups or criteria
  - Idiosyncratic instrumentation, without evidence of validity/reliability/credibility

Knowledge Management and Dissemination
NSF MSP

Why don’t we know more?

- There are too few studies of any one phenomenon to be able to have confidence in the robustness of the findings in any case.

- High quality research is expensive, which may explain why so many in-depth studies in the literature involved fewer than 5 teachers.

Knowledge Management and Dissemination
NSF MSP

Why don’t we know more?

- There is a tension between design for change and design for learning.
- From a system change perspective, if you plan on having two cohorts, it makes sense to start with the schools that are “ready.”
- But doing so makes research on program effectiveness problematic; it will not be possible to disentangle the effects of differences in readiness from the impact of the interventions.

From an MSP abstract:

- "Further, these results suggest benefits of designing MSP project implementation in ways that facilitate most valid assessments of impact. For example, random assignment of eligible teachers to participate in [project] would provide greater confidence that observed effects are not associated with teacher self-selection or with administrator support for the most qualified applicants."

Knowledge Management and Dissemination
NSF MSP

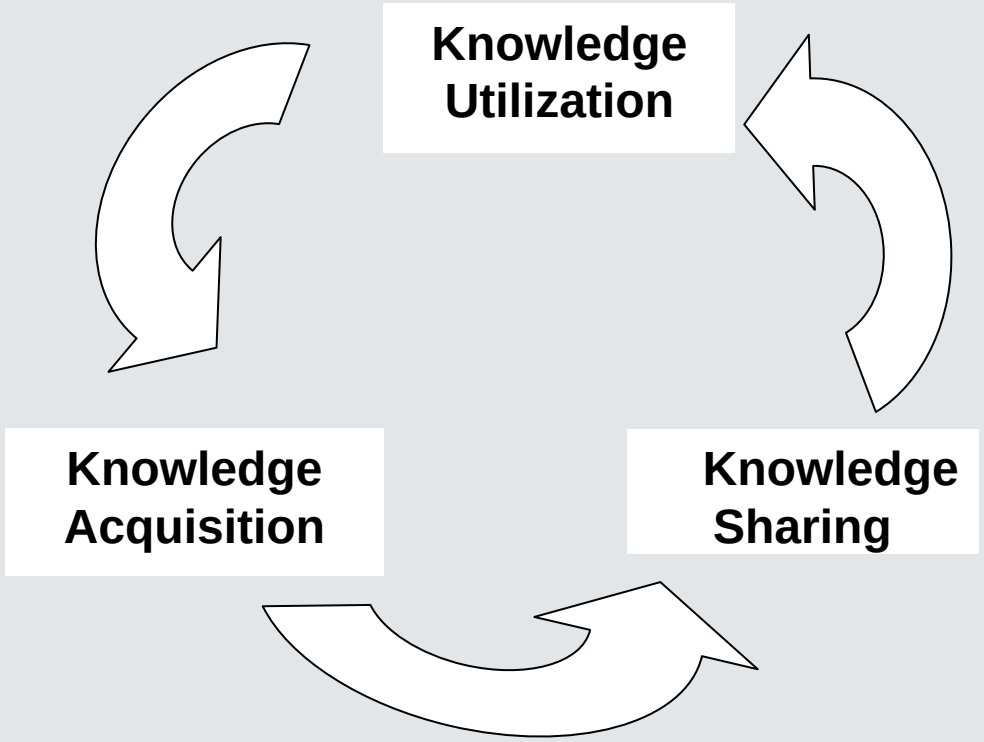
Why don’t we know more?

- Even when individual studies are well-designed and well-implemented, it is difficult to look across them and figure out the extent to which the findings might generalize.

How can we learn more?

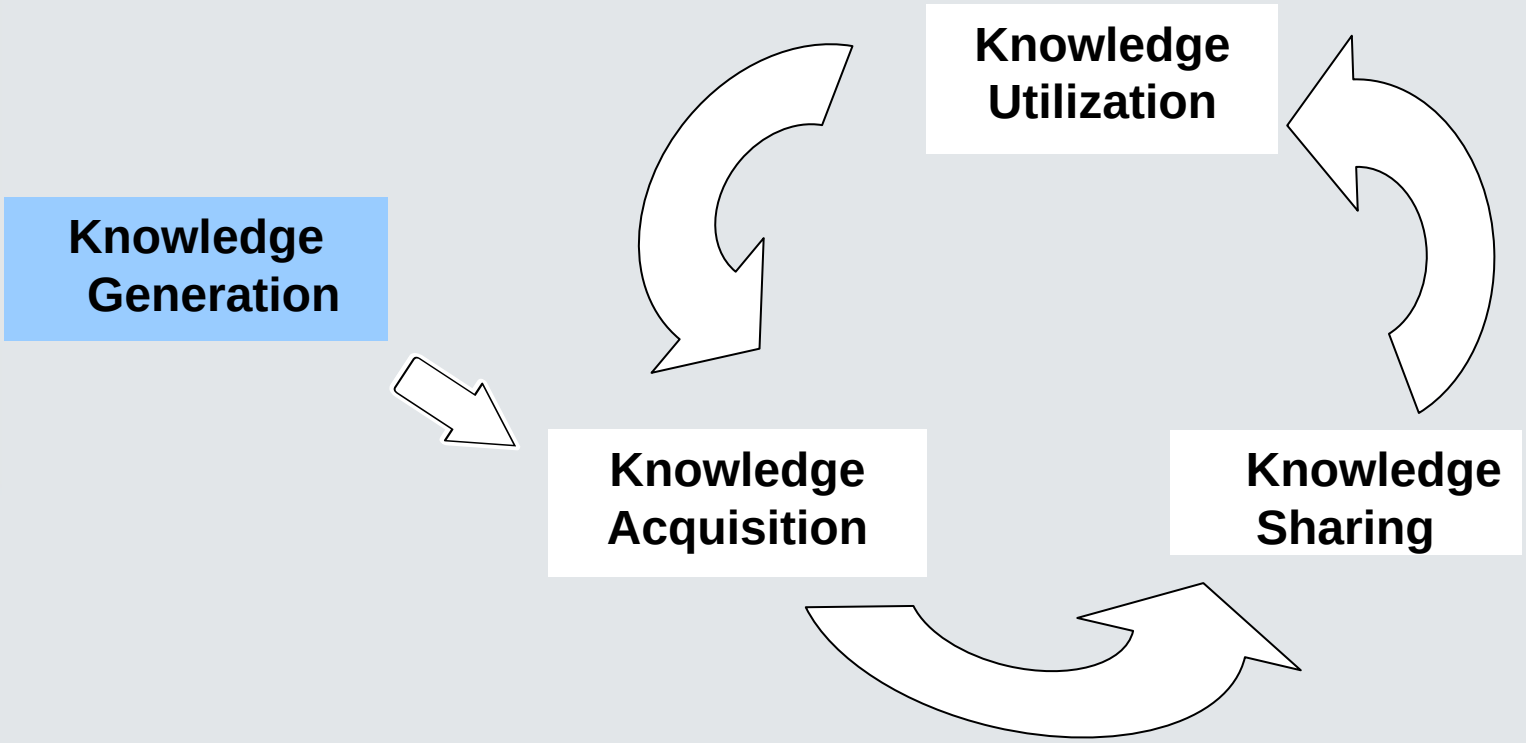
Knowledge Management and Dissemination
NSF MSP

Knowledge Management Framework



Knowledge Management and Dissemination
NSF MSP

Adapted Knowledge Management Framework



Knowledge Management and Dissemination
NSF MSP

Framing a Research Agenda

- Research→Research
  - In research, answering one question leads to many others.
  - However, there are few incentives for replicating studies in different contexts, or otherwise following up on others' work.

Framing a Research Agenda

- Practice→Research
  - Focusing research on problems of practice helps to bridge the research to practice divide.
  - Practice-based insights can be considered hypotheses for research – to be systematically studied with different populations in a variety of contexts.

Knowledge Management and Dissemination
NSF MSP

How can we learn more?

- Many MSPs have evidence that their interventions are effective, and those findings should be shared.

- In addition to the quantitative analyses, case study descriptions of interventions, target audience, and context, and discussions of lessons learned about sustainability, would be extremely helpful to the broader field.

Knowledge Management and Dissemination
NSF MSP

How can we learn more?

- Individual MSPs would add even more to the knowledge base if they systematically studied their treatments under different conditions – with more and less experienced PD providers, teachers with stronger and weaker content backgrounds, etc.

How can we learn more?

- Similarly, MSP projects would add more to the knowledge base and increase the likelihood of going to scale if they studied different configurations of their interventions:
  - How much drop-off in impact is there with a reduced level of treatment?
  - Would providing fewer hours of PD to a larger proportion of teachers in a school have a greater impact on teaching and learning?

Knowledge Management and Dissemination
NSF MSP

How can we learn more?

- The fact that MSPs have similar goals and similar interventions provides an opportunity for more transformative research, accelerating the generation of knowledge about what works, for whom, and under what conditions.

Knowledge Management and Dissemination
NSF MSP

How can we learn more?

- Setting up cross-site studies has the potential to add considerably to the knowledge base, providing information about the effectiveness of particular interventions in different contexts.

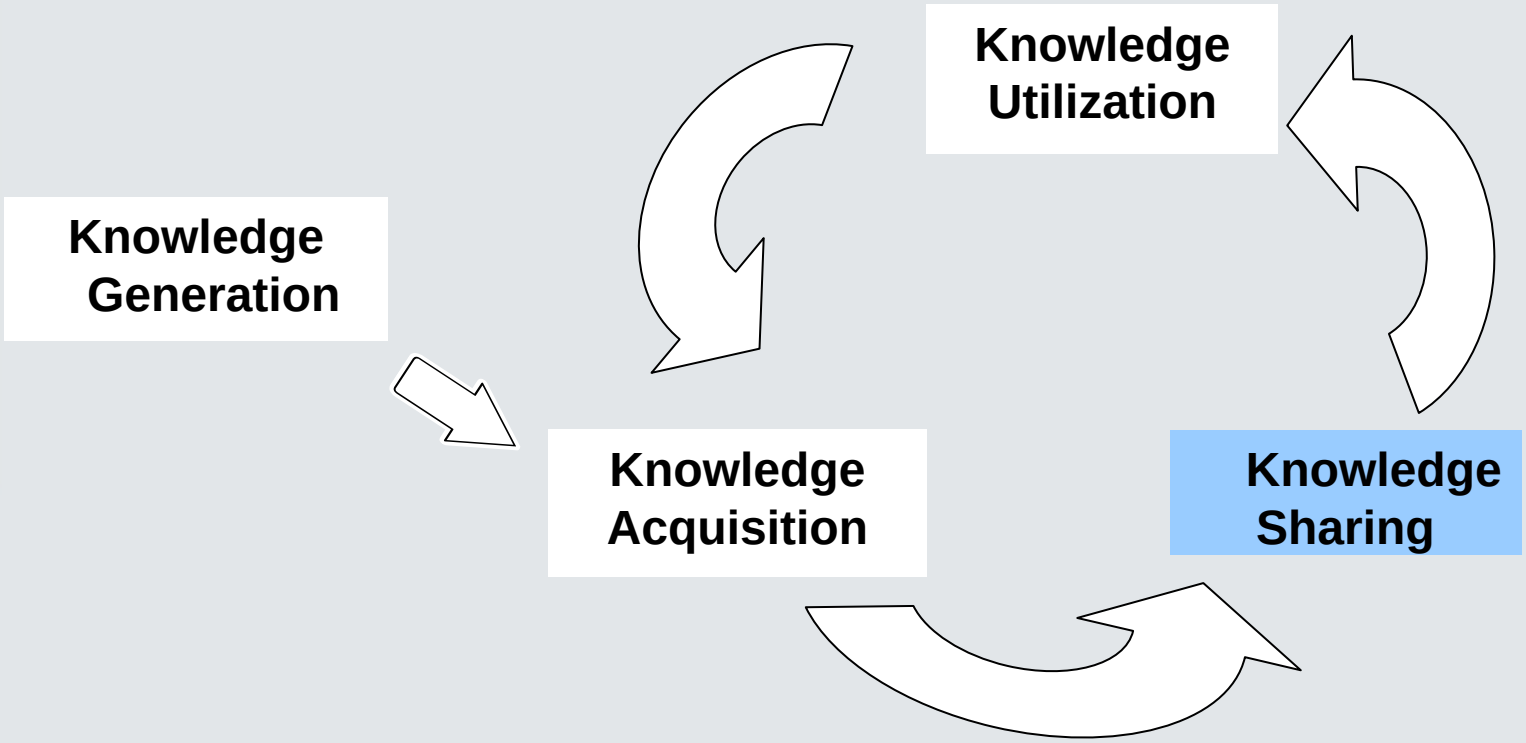
How can we learn more?

- Among the advantages of cross-site research:
  - STEM disciplinary faculty who are new to social science research will likely appreciate the guidance that the research design and protocols provide.
  - Projects that are too small to get project-representative results can still contribute to the knowledge base.

**

Knowledge Management and Dissemination
NSF MSP

Adapted Knowledge Management Framework



Knowledge Management and Dissemination
NSF MSP

Knowledge Sharing

- Knowledge Reviews
- Presentations at professional meetings
- Articles submitted to journals
- MSP cases focused on sustainability
- TCK Instrument Database

Knowledge Management and Dissemination
NSF MSP

Knowledge Reviews

- Approximately 20 posted to-date
- Reporting empirical research and practice-based insights
- Opportunities for MSPs to provide additional input
- http://www.mspkmd.net

Knowledge Management and Dissemination
NSF MSP

TCK Instrument Database

- A total of 168 instruments surfaced in the TCK research review.
- RETAs have developed measures of TCK
-
- Partnerships have developed measures of TCK
- Only instruments that provide a way that others can come up with “scores” are included in the database

Knowledge Management and Dissemination
NSF MSP

TCK Instrument Database

- Instruments can be searched by:
  - Subject
  - Type of knowledge (disciplinary, pedagogical content, ways of knowing)
  - Nature of assessment items (selected response, constructed response, other)
  - Grade levels of teachers studied

Knowledge Management and Dissemination
NSF MSP

- Database includes:
  - Descriptions of instruments (but not the instruments themselves)
  - Scoring information
  - Validity and reliability information, when available
- 62 instruments included to-date
- http://www.mspkmd.net

Knowledge Management and Dissemination
NSF MSP

Next Steps

- Developing Knowledge Reviews on STEM Disciplinary Faculty Involvement
- Updating existing Knowledge Reviews, including adding recent MSP research
- Developing a TCK/TL materials monograph

Knowledge Management and Dissemination
NSF MSP

Coming Soon…

- A request, with encouragement from your Program Officer:
  - Recent research by MSPs on TCK/TL
  - Materials developed/used by MSPs for TCK/TL work
  - Instruments developed/used by MSPs for TCK work

Knowledge Management and Dissemination
NSF MSP