Early Stages of a Knowledge Synthesis on Teacher Professional Learning Communities (PLCs) Focused on Mathematics and Science Teaching

Edward (Ted) Britton, WestEd

This paper describes early work from a new project to synthesize existing knowledge about STEM teacher PLCs. Research analysts led by Kathleen Fulton at the National Commission on Teaching and America's Future (NCTAF) and by the author at WestEd are collecting and evaluating knowledge about experiences of both prospective teachers and classroom teachers of mathematics and/or science across grades K-12. The NSF-funded synthesis draws on types of research addressed by a conventional literature review but also examines three other types of knowledge. At of the time of the May 2009 conference, the search and preliminary inspection of knowledge is most advanced for research articles. Therefore, after describing the overall project, this paper focuses only on research publications.

Overview of Synthesis Project

There are two overarching questions guiding this secondary analysis, sponsored by the recent Synthesis funding category of the DRK12 Program at the National Science Foundation: What do we know about STEM teacher PLCs? How well do we know it? More specific foci include: configurations of STEM teachers in PLCs; the purposes of PLCs; approaches to conducting PLCs, including through online venues; and internal or external facilitation and substantive expertise made available to PLCs. Analysts are seeking knowledge about the relationship of these and other PLC attributes to effects on the following: teachers' content knowledge and pedagogical content knowledge, implemented instructional practices, their students' achievement, and teachers' job satisfaction and retention.

Five types of knowledge are being analyzed and synthesized. The first two types are standard to a conventional literature review:

(1) **elaborated empirical research studies** published since 1995, mostly articles in peer-reviewed journals for primary research, or dissertations (e.g., Miller, 2008; Nelson & Slavit, 2007); and
(2) **other research**, i.e., non-empirical research (e.g., theory building), research-based articles, or empirical research reports having less specified methods than articles in peer-reviewed journals, including recent conference presentations (e.g., Britton, 2008; Capobianco & Felman, 2006; Gellert, 2009).

Because experiments with teacher PLCs are proliferating faster than formal research into the phenomenon, the project goes beyond a conventional literature review by also examining three additional types of knowledge that are influencing the field:

(3) **published expert knowledge and advice** located in periodicals or on websites (e.g., Melville & Wallace, 2007; Riel & Fulton, 2001; professional development tradebooks; advice about PLCs on Web pages of the American Chemical Society's Education Division);
(4) **published descriptions of models** of STEM teacher in PLCs (sometimes with 'lessons learned' but without formal research, e.g., Kolenda, 2007; Shinohara & Deahler, 2008); and
(5) current practice-based expertise acquired through an organized, formal online discussion by a **panel of practitioner experts** in conducting PLCs with STEM teachers.

The overall synthesis considers the evidence base for and gaps in each type of knowledge when analyzing both congruent and conflicting relationships between them. Researchers consider in detail the strengths and limitations of each knowledge source when explaining, weighting and situating studies in project reports. Project methods adapt those developed by the Knowledge Management and Dissemination project (KMD), funded at Horizon Research by the NSF MSP program (www.mspkmd.net). As part of that project, WestEd previously piloted these methods in synthesizing research knowledge type 1 on understanding beginning mathematics and science teachers, and their mentoring and induction (Britton & McCarthy, in preparation).

Intensive Search for Relevant Research

The remainder of this article focuses on research knowledge types 1 and 2. Currently, a set of over 55 studies of knowledge types 1 and 2 published since 1995 in English have these criteria:

- The studied 'community' phenomena must involve 3 or more classroom or preservice teachers, but the PLC can also have other kinds of participants (e.g., administrators, college faculty); excludes articles with sole focus on 2-person interactions such as team teaching and mentoring relationships.

- The studied 'PLC' phenomenon should have these attributes: include concerted focus of teachers interacting for varied purposes related to improving their teaching; usually more than a short-term, one-shot experience (e.g., a week or two), although this criterion is less absolute for PLCs involving pre-service teachers; not treated in the article as one strategy among a primary focus on a broader project, such as school reform, such as developing a whole school community; can use face-to-face activities, online modes, or both.

- The studied phenomena either (1) entirely involves mathematics and/or science teachers, or (2) extensively discusses specifics of STEM teachers' involvement,

including substantial presentation of study results specific to the participating STEM teachers.

The project's search for literature employed standard search engines to locate studies, but for several reasons had to use unusually intensive methods both for searching or screening the potential studies obtained. Practitioners and researchers use a very wide range of terms to label the phenomenon of teachers working together to improve their practice. Analysts entered the terms of Figure 1 and variations of them into the Psych Info and EBSCO Education Complete search engines. While variants of 'professional learning community' and 'lesson study' yielded the greatest number of candidate articles, most of the other 'PLC' terms also yielded some candidate studies. The search parameters also used Boolean logic to require every obtained entry to include terms related to STEM teachers.

Figure 1. Search terms used for 'professional learning communities' and STEM teachers.

Terms for PLC	Terms for STEM Teachers (incomplete)
professional learning community	science teacher
learning communities	chemistry teacher
critical friends	earth science teacher
critical friends group	mathematics teacher
networks	physics teacher
collaboration	
teacher collaboration	
lesson study	
lesson study group	
study group	
teacher network	
teaching network	
sharing best practice	
shared practice	
collaboration time	
professional development	
colleague	
professional colleagues	
grade level collaboration	
subject level collaboration	
collective inquiry	
collaborative teams	
collaborative learning	
collaborative inquiry	
group lesson planning	
joint lesson planning	
professional teaching teams	
district learning teams	

facilitated learning community
supported learning community

Searches with these terms yielded approximately 20,000 hits, which created challenges that necessitated an intensive screening process. Through using the EBSCO feature 'sort by relevance' (relevance to the search terms), analysts were able to limit formal inspection to the first 750 entries. However, there was great inconsistency among these in writers' use of the widely-varying terms for PLC-like activity in Figure 1, with any individual term having multiple meanings employed across the article set and often conceptually overlapping with the referent phenomenon associated with other terms. Therefore, these terms alone found in article titles and abstracts frequently were very inadequate for determining whether the objects of study were PLC activities of interest to the project.

In addition to providing the greatest number of candidate articles, variants of the terms 'professional learning community' and 'lesson study' also yielded after screening a higher percentage of articles of interest of the project. While variants of terms containing 'collaboration' did unearth articles incorporated in the project synthesis, they also yielded the most false positives, i.e, types of collaboration that did not involve a professional learning community.

Any article wherein study subjects exclusively were mathematics or science teachers was of immediate interest, or, at the elementary level, ones examining only mathematics and/or science teaching. However, article titles and abstracts were frequently inadequate to determine whether a sufficient proportion of study subjects were mathematics or science teachers, and/or whether articles results and discussion gave sufficient attention to subject-specific issues to warrant project attention.

Whenever an abstract was inadequate for making a judgment regarding either the 'PLC' or math/science criterion, full articles had to be inspected. An indicator of the necessity of this intensive search and screen process is that more than half of the articles obtained to date were in periodicals outside of those focused on mathematics and/or science education; therefore, solely relying on an issue by issue inspection of STEM education research journals would not have yielded the full body of STEM-specific PLC research on this topic, which is a alternative primary search strategy described in some published literature reviews in STEM education.

In addition to the above search engine investigation, project staff secondarily are soliciting potential articles from project advisors, checking articles' references and authors for additional leads, and scanning other articles that have cited the obtained articles. While it is imperative that this NSF-funded project be thorough in its treatment of STEM-specific work, the project will have to grapple with contextualizing synthesis results in the overall background of seminal research about PLCs at large (not specific to STEM education).

What Do We Know? Landscape of Studies' Characteristics

A baseline answer to this question is clearly identifying what has been studied and how it has been studied. Even from this baseline analysis, the project also will be able to identify research gaps. Shortly after the conference (June), an updated version this paper will characterize the relative amounts of work among the set of identified studies with respect to the characteristics below, listed in no particular order. A more advanced answer to this question will be discussion of the studies' findings, which should be written by fall 2009.

- mathematics, science, or both
- elementary, middle and high school levels
- pre-service, inservice or both
- phenomenon utilizing online approaches or components
- different models for PLC process and activities
- foci on different substantive aspects of teaching
- qualitative, quantitative or mixed methods

A birds-eye inspection of the article set prior to the conference leads the author to predict the following patterns: (1) articles mostly are qualitative investigations; (2) focused on a single inservice teacher PLC model; (3) not involving online components; (4) studied by personnel currently or previously associated with the conduct or development of the phenomenon, or having prior connections (of varying degrees) with the participants involved. Undisclosed or unaddressed potential researcher bias was a leading methodological weakness in the previously analyzed body of work on beginning STEM teachers (Britton & McCarthy, in preparation). Few articles compare different PLC modes. Most studies examine teacher experiences and reactions to the PLC experience, and fewer investigate changes in teaching; only in a few instances does the study design or conditions permit examination of changes in student outcomes. The substantive foci of the PLCs and models for carrying them out are wide-ranging.

How Well do We Know It? Methodological Strength of Research

For research articles with elaborated methods (type 1), analysts will in summer 2009 evaluate the methodological integrity of each study and the evidentiary utility of its claims. Over the last decade, there have been increasingly frequent and more urgent calls for enhancing the rigor of educational research and its reporting (cite, cite). Drawing on the research methods typically found in doctoral level texts and with the input and review of an advisory panel of research methodologists, researchers, and reform leaders, the earlier Horizon Research and EDC project developed a set of 31 standards of evidence (SoE) for empirical research. The SoE and the process for applying them result in a careful review of the claims of individual studies and provides ratings based on specific indicators, operationalized for different qualitative and quantitative research methodologies, and narrative justifications for these ratings in six areas: adequate documentation, internal validity, analytic precision, generalizability/external validity

determination, overall fit, and warrants for claims. Inspection of each article requires five to eight hours by a Ph.D.-level analyst who has been trained and evaluated for inter-rater reliability on the method. (See complete SoE descriptions and process specifications in the MSP KMD *Standards of Evidence Codebook* (http://www.mspkmd.net/pdfs/soe.pdf.). In the prior review of 57 studies of beginning mathematics and/or science teachers by WestEd analysts, only six studies did not have significant methodological limitations that dampened their evidentiary utility (Britton & McCarthy, in preparation).

References

Britton, E., & McCarthy, E. (in preparation). *Addressing challenges faced by early career mathematics and science teachers*.

Britton, E. (2008) *Roles of communities in mathematics and science teacher induction: Issues and international examples*. Washington, DC: National Commission on Teaching and America's Future, www.nctaf.org.

Capobianco, B. M., & Feldman, A. (2006). Promoting quality for teacher action research: lessons learned from science teachers' action research. *Educational Action Research, 14*(4), 497-512.

Gellert, L. M. (2009). *New Elementary School Teachers and Mathematics: An Investigation Through Participation in a Community of Practice*. Paper presented at the 2009 Meeting of the American Educational Research Association.

Kolenda, R. L. (2007). Japanese Lesson Study, Staff Development, and Science Education Reform – The Neshaminy Story. *Science Educator, 16*(1), 29-33.

Melville, W., & Wallace, J. (2007). Workplace as Community: Perspectives on Science Teachers' Professional Learning. *Journal of Science Teacher Education, 18*(4), 543-558.

Miller, T. K. (2008). Prospective elementary teachers' experiences in learning mathematics via online discussions: A phenomenographical study. *Dissertation Abstracts International Section A: Humanities and Social Sciences, 69*, 1710.

Nelson, T. H., & Slavit, D. (2007). Collaborative inquiry among science and mathematics teachers in the USA: professional learning experiences through cross-grade, cross-discipline dialogue. *Journal of In-Service Education, 33*(1), 23-39.

Riel, M., & Fulton, K. (2001). The Role of Technology In Supporting Learning Communities. *Phi Delta Kappan, 82*(7), 518-523.

Shinohara, M., & Daehler, K. R. (2008). Understanding Science: The role of community in content learning. In A. Lieberman & L. Miller (Eds.), *Teachers in professional communities: improving teaching and learning*. New York: Teachers College Press.