MATHEMATICS TEACHER PROFESSIONAL DEVELOPMENT AS THE DEVELOPMENT OF COMMUNITIES OF PRACTICE

Rebecca McGraw
University of Arizona

Fran Arbaugh
University of Missouri – Columbia

Kathleen Lynch,
Catherine A. Brown
Indiana University – Bloomington

In this research report we share results of a study of an adaptation of Lesson Study, a form of professional development typically used in Japanese elementary schools, with secondary mathematics teachers in the United States. We draw on Wenger's (1998) concept of "communities of practice" and Grossman, Wineberg, and Woolworth's (2001) discussion of "pseudocommunity" to present our analysis of two types of activities: a cycle of lesson development, implementation, and revision as it occurred in one lesson study group (LSG), and book discussions that occurred in large group meetings all LSGs. Our analysis suggests that activities such as these can support community of practice development and that "community development" is useful as a concept for structuring and studying mathematics teacher professional development.

Many teachers and providers of professional development have become interested in Lesson Study, a form of professional development typically used in Japanese elementary schools (Stigler & Hiebert, 1998). In Japan, *research lesson* or *study lesson* refers to lessons that teachers jointly plan, observe and discuss. The same two words in reverse order, *lesson research* or *lesson study*, refer to an instructional improvement process of which the research lesson is the heart (Lewis, 2000). When a Japanese school engages in *Lesson Study*, teachers form *Lesson Study Groups* (LSGs). (See Lewis, 2000 for an extended discussion of LSGs and the process of Lesson Study.)

In this research report, we share some results of the use of an adaptation of Lesson Study with secondary mathematics teachers in the United States. The research was conducted as part of a professional development project titled Collaboration for Enhancing Mathematics Instruction (CEMI), funded by Lucent Technologies Foundation. CEMI lesson studies are conducted in LSGs consisting of middle and high school mathematics teachers, university mathematicians, university mathematics educators, and pre-service secondary mathematics teachers. The CEMI participants began meeting as a large group and in their smaller LSGs during the fall of 2000. We report here on the activities of one LSG during the spring of 2001 and the large group during the spring of 2002. It is the goal of the CEMI project to adapt the Japan lesson study model for several purposes including providing professional development for project participants and bringing together people with diverse perspectives but with the common goal of providing secondary students with quality mathematics education. The research component of the

project seeks to understand these activities and their impact on the participants and the participants' classroom teaching.

We present here results from analyses of two types of CEMI activities. The first activity consisted of a cycle of planning, implementation, and reflection engaged in by one LSG. The second activity consisted of a series of book discussions engaged in by the CEMI project participants as a whole. Wenger's (1998) indicators of communities of practice and Grossman et al.'s (2001) discussion of *pseudocommunity* guided our analyses.

This report is one piece in an ongoing research project. Previous analysis presented at PME-NA (Brown, McGraw, Koc, Lynch, & Arbaugh, 2002) focused on aspects of assistance (Tharp & Gallimore, 1988) present in lesson study activities. In this report, we look more broadly at the activities of the CEMI project in an effort to understand how communities of practice may develop in this context. Examining the data in multiple ways through different lenses allows us to understand better this particular professional development experience and the ways in which this experience supports teachers' professional growth. Considering two CEMI professional development activities in the first and second year of the project from a community of practice perspective, we address the following questions.

> To what extent have communities of practice developed within a LSG?
>
> To what extent can a LSG be characterized as a community of practice?
>
> What are the specific indicators of community of practice formation or lack thereof in the context of the LSG work?
>
> To what extent can the CEMI participants as a group be characterized as a community of practice?

In addition, in the conclusion of this report, we discuss how the work presented here influences the future direction of our research and professional development efforts.

Learning and Communities of Practice

Underlying the analyses presented here is a focus on learning as a social process that occurs through participation in practice.

> Learning in this sense is not a separate activity. It is not something we do when we do nothing else or stop doing when we do something else.... Learning is an integral part of our everyday lives. It is part of our participation in our communities and organizations. The problem is not that we do not know this, but rather that we do not have very systematic ways of talking about this familiar experience. (Wenger, 1998, p.8)

Adopting this perspective on learning, we focus on participation in the practice of teaching as we try to understand and support mathematics teacher learning.

Notably absent from the lives of teachers in the U.S. and elsewhere is the opportunity to develop and/or participate in professional communities as an integral part of the practice of teaching. This does not mean that teachers do not learn, but rather they are limited in their ability to learn *from each other* because they do not regularly engage in practice *with each other*. From a learning through participation perspective, we can cast our work as teacher educators (and, we suspect, recent work of many teacher educators) in part as

an effort to help teachers develop professional communities based in practice, or, to use Wenger's (1998) term, *communities of practice*.

Communities of practice are communities developed out of and defined by members' collective engagement in a joint enterprise (Wenger 1998). It is through this engagement that meanings are negotiated and a shared repertoire of routines, words, tools, and ways of doing things are developed. Because communities of practice are typically informal structures, indicators that they have formed can be found in the ways members interact, rather than in formal statements or the attainment of specified goals. Some indicators that a community of practice has formed include: (1) shared ways of engaging in doing things, (2) the rapid flow of information among members, (3) the absence of introductory preambles, (4) the quick setup of a problem to be discussed, (5) knowing what others can contribute, (6) ability to assess the appropriateness of actions or products, (7) specific tools, representations, and other artifacts, (8) local lore, shared stories, and inside jokes, and (9) jargon and shortcuts to communication (Wenger, 1998). Using these indicators, we can consider the extent to which our professional development efforts result in the formation of communities of practice.

For this analysis, we also draw upon the notion of *pseudocommunity* (Grossman et al., 2001).

> As community starts to form, individuals have a natural tendency to *play community* – to act as if they are already a community that shares values and common beliefs.... The imperative of pseudocommunity is to "behave *as if* we all agree." (p. 955)

In pseudocommunities, individuals do not question or challenge each other. Speaking in generalities without negotiating meanings allows individuals to maintain a superficial level of agreement during conversations. Behaviors associated with pseudocommunity are expected when a group of individuals is first brought together; however, if true community is to form, then individuals must begin to press for clarification, raise alternative viewpoints, or in some way attempt to negotiate shared, collective, community-level meanings and modes of action.

We believe communities of practice could be fertile ground for teacher learning, and, therefore, are interested in the extent to which they develop in various settings. We do not wish to give the impression, however, that the content of learning within such communities is unimportant. As previously stated, this paper is one piece in an ongoing research project concerned with not only the creation of sites for mathematics teacher learning, but also the substance and nature of the learning that occurs within those sites.

CONTEXT AND METHODOLOGY

CEMI supported three LSGs in the spring of 2001. Each LSG was charged with following a lesson study cycle similar to that used by Japanese elementary teachers: develop a lesson collaboratively, teach the lesson, revise the lesson, teach the lesson again, and revise the lesson again. We report on one of the three LSGs in this paper. (We call this focus lesson study group LSG1.) The members of LSG1 were two in-service secondary mathematics teachers, Mr. Davis and Ms. Cochran; two pre-service secondary mathematics teachers; one university mathematician; one mathematics education

professor; and two mathematics education doctoral students. The LSG met six times and the planned lesson was taught by each of the two teachers.

LSG group work continued during the fall semester of 2001. Members were added and groups reconfigured according to individual interests and teachers' teaching assignments. During this semester, the mathematics educators (professors and doctoral students) raised a concern about the need for balance within the project between curriculum development and reflection on issues related to teaching and learning mathematics. Consideration of research is an integral component of lesson study in Japan, but not typically considered a part of the practice of teaching in the U.S. The project leader suggested that it might be useful to temporarily suspend LSG activities in order to read and discuss books related to important issues in mathematics education and other project participants voiced support for the idea. Instead of meeting in their individual LSGs, CEMI participants met five times during the spring of 2002 as a whole group to discuss three books (agreed upon by the participants): *Beyond Formulas in Mathematics Teaching and Learning* (Chazan, 2000), *The Learning Gap* (Stevenson & Stigler, 1992), and *The Teaching Gap* (Stigler & Hiebert, 1999).

The data used for this report are two-fold and were collected in the spring semester of 2001 and the spring semester of 2002. We report on the activities of one LSG during the spring of 2001 and of the large group during the spring of 2002. Data collected from LSG1 pertaining to this report were audio-taped accounts of six meetings. In addition, we utilized audio-taped accounts of five large group book discussion meetings from the spring of 2002.

Audiotapes were transcribed and transcripts were verified for accuracy. Data were coded using the indicators of community of practice (Wenger, 1998) described previously. The first three authors used data from two LSG1 meetings to negotiate meanings of codes and establish inter-rater reliability. Subsequent coding of the remainder of the data was divided among the first three authors. We then extended our analysis and searched for indicators of pseudocommunity (Grossman et al., 2001) or lack thereof in LSG1 activities and large group book discussions.

RESULTS

Indicators of community of practice, such as the lack of introductory preambles, the rapid flow of information among members, and the use of tools, and artifacts, were noticeably absent from the early meetings of LSG1, but were more prevalent in later meetings. LSG1 members decided to focus their lesson plans on developing second-year algebra students' understandings of sequences and series. Between planning meetings, group members located materials related to the topic and then spent considerable time during the initial planning meetings sharing and discussing these materials. The following excerpt is representative of the context of these discussions.

> I think if we do something like the auditorium problem, and you're given the information…. Your friend buys you a concert ticket in seat 995 in a concert hall. Sixty-five seats in row one, 67 seats in row two, 69 seats in row three. So the number of seats in a row, and they understand that there are going to be two added to each row.... And then you have the questions. How many seats in the last row? How many seats total in the concert hall? (unidentified LSG1 member, 3/21/01)

Explanations like this occurred frequently during initial LSG1 meetings. Members spent time describing their individual interests and concerns with respect to teaching sequences and series, various methods for organizing classroom activities, and the ways in which they felt they could contribute to the group. For example, Ms. Cochran informed the group that she had easy access to a computer lab should they need one. Although this may be considered as evidence that a community of practice has not formed, we view it as a necessary precursor to community development, leading to a point in the future when group members will have shared knowledge of certain problems, and an understanding of what others know and can do related to lesson development and implementation.

Evidence exists across LSG1 meetings of members challenging one another. One such exchange involved whether to allow students to use graph paper to divide shapes into fractional parts (students would then find the sum of the parts as a way to estimate the sum of an infinite series):

> Is there a certain kind of graph paper that we could use that would lend itself to this kind of drawing – that would help them be more exact? ...
>
> Maybe, but I'm not sure that graph paper is the right thing because … I don't think that being able to draw well is what [we want them] to think about...
>
> I wonder in terms of drawing whether it might be even easier to have people cut out the triangles... (exchange between members at the 3/21/01 LSG1 meeting)

This excerpt is the beginning of a protracted debate over how to have students carry out this activity in a way that would maximize their understanding of fractional parts and their sum. Exchanges such as this one are evidence that these LSG1 members were not strictly bound by the norms of agreement indicative of pseudocommunity. They were willing to make statements that might put themselves in conflict with other group members for the sake of the joint enterprise. Such exchanges occurred not only in the planning phase but also after implementation, during the reflection/revision stage.

As the meetings progressed, we found the LSG1 members beginning to use shortcuts to communicate, for example the use of the term "the concert hall" during the 3/28/01 LSG1 meeting to refer to the problem described previously. We also noted use of jargon such as "connections" and "communication" used to refer to the discussion of specific standards in *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics, 2000). This jargon came from previous discussions of these standards by CEMI participants as a whole that were appropriated by LSG1. We also found, however, a few instances of the unquestioned use of jargon by group members, such as references to "standards." The lack of negotiation of meanings of such terms is troublesome, because, without negotiation, a community-level understanding of the term cannot be reached.

We found some evidence in LSG1 activities of inside jokes and the rapid flow of information among group members. We also found a few instances of talk that we consider the precursor to shared ways of doing things and the ability to assess the appropriateness of actions and products. For example, one of the LSG members suggests a method for dividing up the labor of lesson development in a productive manner. This

method of division of labor then would have the potential to become a shared way of doing things in the future.

Overall, as we consider the activities of this LSG, we find not a community of practice, but a group of individuals engaged in a joint enterprise and beginning to develop a shared repertoire of words, tools, and ways of doing things. Identifying some precursors to the indicators of community of practice described by Wenger (1998), we characterize this LSG as having the potential for community development.

Evidence of community of practice among all CEMI participants was extremely difficult to find, at least in the data we analyzed for this report, i.e. the book discussions that constituted the large group activities of the spring of 2002. Because participants made use of the posting and replying feature of the project web site prior to book discussion meetings, we found some instances of individuals knowing what others thought and referring to others' ideas. But this is somewhat different than knowing what someone else knows and can do related to the joint enterprise of planning and implementing a mathematics lesson. In the case of the book discussions, the joint enterprise was simply to read and discuss the books. Although we might call this a kind of practice, it does not seem to be the kind of practice that suggests community development, at least not in our case. This does not mean the book discussions were not a useful part of the CEMI professional development project or that they did not impact the work of the LSGs, but we were unable to see either the indicators of community or the potential for the indicators in the book discussions.

In terms of pseudocommunity, we found a pattern in which participants did not question the positions of others, but were willing to voice alternative viewpoints.

> I think Chazen drew some unnecessarily harsh lines … when he was talking about are variables unknown or are they this or are they that …
>
> I liked thinking about it because it made me think about math and teaching math in a different way …
>
> I thought Chazen was too strident in saying the way the traditional people look at it is as the unknown. Maybe that's what he remembers … [but] it wasn't for me the defining moment between traditional and whatever the current way is …
>
> I don't think the kids pick up whether it is unknown or whether it is relationship (comments made by four CEMI participants related to Chazen (2000), 2/21/02)

Although multiple reactions to the book are expressed and each speaker's comments relate to those of the previous speaker, we do not see participants challenging each other's statements. This excerpt was typical of the book discussions, in that participants did not often push to reach consensus on issues presented in the books.

DISCUSSION

We are interested in making professional collaboration an integral part of the practice of teaching secondary mathematics. In pursuit of this goal, we seek to understand how such collaborations may be developed and sustained. Analyses of two types of CEMI project activities using Wenger's (1998) indicators of community of practice suggest that the joint enterprise of lesson study may lead members of newly formed LSGs to engage with

each other in ways that could be characterized as "community forming." We postulate that the creation or appropriation of artifacts, the development of shared knowledge, and the increase over time of the use of shortcuts to communicate that we found in LSG1 are indicative of movement toward community of practice. We also found instances in which LSG1 members were willing to debate how best to design and implement the lesson, indicating a break in the superficial agreement characteristic of pseudocommunity (Grossman et al., 1998). We did find other evidence of pseudocommunity, however, such as the acceptance without negotiation of general but important terms such as "standards."

Reflecting on the course of CEMI activities through the lenses of community of practice and pseudocommunity, we can see our (and other project mathematics educators') desire to engage the large group in reading about and discussing issues related to the teaching and learning of mathematics as an attempt to focus attention on participants' underlying beliefs about teaching and learning, and to stimulate negotiation of meanings for some of the language that went uninterrogated in the LSGs. Analysis of the book discussions shows that although a variety of understandings and interpretations were brought out, negotiation of meanings in order to achieve consensus did not occur. We can speculate that this was due to the lack of a joint enterprise that required consensus. It may also be due to this lack of joint enterprise that we did not find indicators, or the precursors of indicators, of community of practice in the book discussion data.

The research presented here influences the future direction of our work in multiple ways. With respect to CEMI project activities, it suggests we should seek to maintain LSGs over longer periods of time – multiple semesters – so that the groups have opportunities to move beyond the "community forming" stage of development. Also, it would be beneficial to integrate large group and LSG activities so that the various understandings raised in the large group could be negotiated through the joint enterprise of the LSGs. With respect to research, we plan to analyze data on the other LSGs in order to gain greater insight into the community of practice aspects of LSG work. We need also to understand better the extent to which the development of communities of practice in LSGs and other joint activities can be valuable to teachers both individually and collectively.

References

Brown, C. A., McGraw, R., Koc Y., Lynch, K., & Arbaugh, F. (2002). Lesson study in secondary mathematics. In D. S. Mewborn, P. Szatjn, D. Y. White, H. G. Wiegel, R. L. Bryant, & K. Nooney (Eds.), *Proceedings of the of the twenty-fourth annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, 3,* 1427-1438. Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Chazan, D. (2000). *Beyond formulas in mathematics teaching and learning: Dynamics of the high school algebra classroom.* New York: Teachers College Press.

Grossman, P., Wineburg, S., & Woolworth, S. (2001). Toward a theory of teacher community. *Teachers College Record, 103*(6), 942-1012.

Lewis, C. (April 2000). *Lesson study: The core of Japanese professional development.* Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA. (Available at http://www.lessonresearch.net/AERA_2000.html).

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Authors.

Stevenson, H. W., & Stigler, J. W. (1992). *The learning gap: Why our schools are failing and what we can learn from Japanese and Chinese education*. New York: Simon & Schuster.

Stigler, J., & Hiebert, J. (1998). Teaching is a cultural activity. *American Educator,* Winter, 4-11.

Stigler, J. W., & Hiebert, J. (1999). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom*. New York: The Free Press.

Tharp, R., & Gallimore, R. (1988). *Rousing Minds to Life: Teaching, Learning, and Schooling in Social Context*. New York: Cambridge University.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge: Cambridge University Press.