A Blended Model for Professional Development in Mathematics: Impacts on Teacher Practice and Student Engagement

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A blended learning program for professional development was created to help middle school teachers meet the demands of a challenging new curriculum in mathematics. The program combined face-to-face sessions and online learning components. We studied its implementation over a one year period and found that the model was effective in creating opportunities and conditions for teachers to improve their mathematics teaching practice. Classroom observations suggest that students of participating teachers became more engaged in their learning; however their responses to an attitude survey did not reflect this. Results also suggest that low SES students, ESL students, and boys benefited slightly more than others from their teacher's involvement in the program.

Purpose of Study

The Teacher eLearning (TeL) Project employs a blended learning model for professional development in mathematics that contains both face-to-face and online components. It was developed to address the need for flexible, long term, content specific inservice to help middle school teachers meet the demands of a challenging new curriculum in mathematics.

We investigated the impact of the project on teacher confidence and capability to create an engaging classroom environment for their students for the teaching of mathematics, and on students as demonstrated by their classroom engagement and perceptions about mathematics. We also investigated whether the project had differential effects on particular groups of students (e.g., special education, ESL, low SES), and examined other implementation issues that arose during the study.

Theoretical Framework

School innovation stands or falls depending on what teachers choose to do in the classroom (Elmore, Peterson, & McCarthey, 1996; Fullan, 2001). For an innovation to be successful teachers need to learn new skills—and equally as important they may need to unlearn beliefs about students or instruction that have dominated their professional careers (Darling-Hammond & McLaughlin, 1996). In the last decade or so, a consensus has emerged that traditional stratagems of professional development, based on one-shot workshops and lectures from outside authorities, offers very limited growth opportunities for teachers. Research has shown that professional development is most effective when it is long-term, collaborative, school-based, focused on students' learning, and linked to curricula (Hiebert, Gallimore, & Stigler, 2002).

More specifically, in the field of mathematics education, numerous studies point to the need for long term professional development opportunities, and improved knowledge of school-related mathematics content and mathematics pedagogy (Ball & Bass, 2000; Ball, Lubienski, & Mewborn, 2001; Boaler, 2002; Lampert, 2001). Research has shown that the mathematics teacher carries out a diverse group of tasks, including choosing and managing representations of mathematical ideas, selecting and formulating questions, analyzing and responding to student interpretations, deciding among alternative courses of action, and leading discussions. To perform these tasks effectively, the teacher must be able to draw on a deep understanding of fundamental mathematical ideas interwoven with knowledge of teaching and learning (Ball & Bass, 2000; Ma, 1999).

There is general agreement that we must help middle school teachers understand 1) that mathematics is interesting, 2) that they can make sense of mathematical ideas, and 3) that sharing and discussing strategies is a vital part of the process. There are ongoing efforts to design appropriate inservice programs to meet these goals. One professional development model that is attracting a great deal of interest is "lesson study." Research into lesson study has found that the process of investigating a concept, then planning, teaching, sharing and revising a lesson plan helps teachers develop content knowledge and pedagogical skill (Fernandez, 2002; Presmeg & Berrett, 2003; Stepanek, 2001; Stigler & Hiebert, 1999). Another finding is that teachers involved in lesson study develop closer ties to colleagues, which act as a positive influence on their teaching (Graven, 2003; McGraw, Arbaugh, Lynch, & Brown, 2003). Lesson study as it is usually practiced involves considerable time and commitment on the part of the teachers; however, many of its key elements, e.g., investigating what research says about how students learn a concept, and collaborating on the development of a lesson, can be incorporated into other professional development models.

The design of the blended learning model employed by the TeL project was based on the foregoing general principles of professional development and included elements of the lesson study approach. By combining face-to-face experiences with online learning over time, TeL project developers argued that the amount of face-to-face time (and resultant costs for substitute teachers) could be reduced and that the online component would provide the mechanism for sharing, reflection, and development of a community of practice (Wenger, McDermott, & Snyder, 2002). Other advantages of blended learning cited by Driscoll (2002) are: easing the transition of learning from traditional classroom instruction to e-learning; allowing instructors the opportunity to develop e-learning skills in small increments; making training materials available to learners before or after face-to-face workshops; and preserving the investment in traditional materials that have worked well in the past.

Typically, blended e-learning is viewed as mid way along a continuum that at one extreme has traditional face-to-face instruction, and at the other extreme totally web-based instruction. Richards (2002) makes the point that blended learning should not be seen as an “add-on” to instruction, but as an integrated component of a course designed to produce a more effective learning environment. Indeed, there is evidence of positive learning outcomes associated with blended learning as compared to entirely face-to-face instruction and fully online learning. Franks (2002) reported that students in blended learning courses outperform those in face-to-face and Internet only courses. The University of Central Florida’s extensive experience with blended learning at the undergraduate level suggests that on average, blended courses have higher success rates and lower withdrawal rates than their comparable face-to-face courses (RITE, nd). Moreover, the majority of faculty indicate that more and higher quality interaction occurs in their blended courses than in their comparable face-to-face sections. Little research has been done at this point on the blended approach for teacher professional development; however Curtis and Swenson (2003) found that blended learning was an effective way of meeting the needs and learning styles of busy professionals. Therefore, our aim in this study was to extend our understanding of the merits of blended learning in the field of teacher professional development.

Methodology

Participants

A total of 48 grade 6, 7, and 8 teachers from three school districts in a large Canadian urban area who were enrolled in the TeL Project participated in the study. They volunteered to participate in the project because of their desire to improve mathematics instruction. Approximately half of the teachers were from high SES schools and half from low SES schools.

The TeL Program

The program was delivered in three, eight-week online modules (labeled A, B, and C) between September and April in the 2003-04 school year. Teachers were provided with a half day release from teaching per week to participate in the online sessions and to prepare their lessons. In addition to the online components, there were four, day-long face-to-face sessions, which were held at the beginning of Module A, end of Module A/beginning of Module B, end of Module B/beginning of Module C, and end of Module C.

The program curriculum covered the following pedagogical and mathematical themes:

- *Pedagogy* - Lesson design, Transforming traditional tasks, Assessment, Using technology, Engaging students, Creating and using games.
- *Mathematics* - Number sense, Geometry, Algebra, Probability.

A full description of all components of the TeL program is beyond the scope of this paper; however, some of the detail is included here to provide context for the results.

Online components. The course management system eCollege was used for the delivery of the online components. Through eCollege the participants accessed downloadable articles, video teaching examples, interactive applets, worksheets, and forms, joined live moderated chat sessions, discussed their implementation of program activities in their classes, posted reflective journals about their experiences trying out TeL project activities, received messages from facilitators, and uploaded their work.

Articles for online discussion were selected to broaden teachers' knowledge, and to connect theory and practice. Some were from mathematics journals, e.g., "Developing Algebraic Thinking" from the Fall, 2002 issue of NCTM's *Online Journal of School Mathematics*. Others, written by consultants to the program, synthesized the main ideas on a topic, e.g., "What are concept maps and how can they be useful?" In each case a set of questions helped focus teachers' reading. For example, in unit 3 of module A, the reading assignment was:

> In Chapter 4 of his book, Van de Walle states that: Most, if not all, important mathematics concepts and procedures can best be taught through problem solving. That is, tasks or problems can and should be posed that engage students in thinking about and developing the important mathematics they need to learn (Van de Walle, 2001, p.40). Please read pages 40-44 and respond to the items below:
>
> 1. Are there challenges to teaching geometry, in particular, from a problem-focused approach?
> 2. How does GSP [Geometer's Sketchpad software] contribute to this approach?"

Teachers were divided into five groups for their online work, which consisted of chats, threaded discussions, and electronic journals. An experienced mathematics resource person facilitated each group. While chat sessions were difficult to coordinate and sometimes sparsely "attended," analysis of sessions illustrated the value of this component. In one example, a group, with the aid of a whiteboard, investigated how a teacher could help students prove that angles are equal; later in the chat they moved to consider "what is an even number?" The chat transcript revealed the tentative nature of the participants' mathematical knowledge and illustrated the skill of the moderator, who used a chance comment to help the teachers deepen their understanding of 'definition'.

Teachers' journaling fell off as the program continued. This may have been related to facilitators' lack of expertise in creating an engaging online learning environment, since it is widely recognized that facilitation is key in leading to deeper and more reflective learning on the part of teachers (Loucks-Horsley, Hewson, Love, & Stiles, 1998). An exception to the general downturn in participation was section 5. During the first module this section had very frequent postings that exhibited a substantial amount of contact with the facilitator. Although not as lengthy as postings in other sections, the postings of section 5 members were discerning and thoughtful. The second module saw a dramatic decrease in participation. Postings were much shorter and there were very few of them. (Note: Module B overlapped a major school reporting cycle, and conflicted with preparations for the December break.) In module C this section rallied. The number of postings increased, and entries were longer and more detailed. Notably, the facilitator for section 5 was very experienced in preservice and inservice education. She was also keenly aware of the needs of the participants in her group.

Face to face sessions. Here is a description of an activity called *Line Up* that took place in a face-to-face session.

> Split 80 participants into two groups of 40: let them compete. Have two identical batches of 40 numbers. Select from the list of 48 possibilities below (include the negatives). [The list included 48 whole numbers, fractions, decimals and 'cryptic numbers' e.g., the number of equal sides in a scalene triangle, the length of the diameter of a circle with unit radius, the next element in the series 1,2,4,8,16.] Jumble up the numbers in each group. Hand them out randomly. On the mark, each group works to line up in a half circle, all in order.

Line Up illustrated several key program ideas: 1) that the best problems lead students to talk about mathematics, 2) that there is no need for everyone to do the same problem, 3) that people often have different strategies for solving a problem, and 4) that doing arithmetic doesn't have to be boring. The activity also required the participants to get out of their seats and negotiate with one another as they solved the problem. Kinaesthetic activities such as this were used throughout the program; they helped teachers expand their strategies for engaging students.

In *Transforming Traditional Tasks,* another face-to-face activity, participants were asked to select one of the typical grade 6 textbook questions shown in Figure 1 and turn it into a richer task.

1. Subtract the following:		
a) 5304 - 3101	b) 9823 -2397	c) 3547 - 2987
2. If an astronaut trained for 3 years, how many months was she training for? How many weeks was she training for?		
3. Calculate		
a) 0.748 x 4	b) 0.693 x 8	c) 08.11 x 3
4. List all of the factors for these numbers		
a) 3	b) 12	c) 48
5. Convert these fractions to decimals		
a) 25/100 b) 8/10 c) 99/100		

Figure 1: Sample Grade 6 Textbook Questions

Teachers often have difficulty finding a good problem for a particular topic; *Transforming Traditional Tasks* was important because it helped teachers see their textbook as a potential source of rich problems.

Teachers were also introduced to a number of excellent mathematical activities at face-to-face sessions. Two that teachers particularly enjoyed were Roofs and Traffic Jam. Roofs, an activity in module A, required students to determine which sets of measurements (i.e., numbers) produced a 'roof' under various conditions. The activity involved measurement and geometry, and introduced participants and their students to the Geometer's Sketchpad. Through eCollege teachers were also able to access a video of participants who had used the Roofs activity, and to download the lesson plan and student worksheets.

Traffic Jam, a well-known game, was used in module B. It requires a player to interchange the positions of two lines of people by "jumping" or "moving forward one space." In the TeL adaptation, the facilitator asked three participants to line up facing another three participants, and had them play the game—another application of the kinaesthetic to mathematics. Groups of participants then played the game. After looking for patterns, making conjectures and discussing strategies, the teachers went back and used the activity in their own classrooms.

Data Collection and Analysis

At the beginning and end of the program teachers were given a survey about their attitudes, beliefs, and practices on teaching mathematics, which was adapted from Kennedy, Ball, and McDermott (1993). We visited a sample of 14 classrooms in the fall and again in the spring to observe teachers conduct a mathematics class. At one of the face-to-face sessions toward the end of the program, we met with teachers for a half day to solicit their feedback on the program itself, how it affected their practice, the extent of their collaboration with colleagues, and the impact of the new methodologies on their students. Principals, facilitators, and program leaders were interviewed at the beginning and end of the program. Lastly, 427 students enrolled in classes of teachers participating in the program completed a survey about their attitudes and perceptions related to learning mathematics and mathematics as a subject. The survey, which was given at the beginning and end of the program was based on the mathematics survey questions from the Science Work Experience Programs for Teachers (SWEPT) project (see http://www.sweptstudy.org/), and supplemented with some items from the student survey portion of the Repeat of the Third International Mathematics and Science Study (TIMSS Study Center, 1998).

All interviews were tape recorded and transcribed. The transcripts as well as field notes and content from teacher journals were coded and analyzed using the constant comparative method (Glaser & Strauss, 1967) with the assistance of the qualitative analysis package Atlas.ti. The SPSS statistical package was used for analysis of survey items.

Findings and Discussion

Teacher Outcomes

Several consistent patterns emerged about the impact of the TeL program on teachers by the program's end. Foremost was the teachers' development of confidence in teaching mathematics. In and of itself, this was a significant accomplishment of the program, as Graven (2003) identifies confidence development as a key component of in-service teacher learning. This confidence made teachers more willing to experiment with new ideas, activities, and approaches in their classrooms. Even those who were already quite confident for the most part about their mathematics teaching abilities at the beginning of the program appeared to have benefited by trying new ways of having students solve problems and by thinking more broadly about the teaching of mathematics. The teachers' increased confidence seems to have led to more collaboration and sharing by some, both with other teachers across grades within their own schools and with teachers in other schools. Consequently, some teachers began to be seen as leaders in mathematics teaching in their schools as a result of the program.

We also found that participating teachers appeared to be more committed to reflecting on their pedagogy. Teachers began talking with colleagues about the pedagogy of mathematics, whereas in the past they were more likely to talk only about content. Related to this was their greater use of language in the mathematics classroom, for example, by having students describe the problem solving process they use rather than just giving the correct answer. While this is an encouraging development, it can become quite routine if teachers only have students dryly describe what they did instead of discussing the merits of their approaches. The idea of the three-part lesson (which consists of a teacher introduction to the topic, a substantial student exploratory period, followed by a teacher led summation) introduced during the TeL program seemed to take hold too, even though not all teachers were implementing it fully. Additionally, teachers started favouring more open-ended assignments and activity-based learning using manipulatives, became more skilled in questioning, and began relating mathematics more to everyday life.

A third finding is that teachers' ideas about how students learn appeared to have undergone a transformation as a result of the program. They came to believe that students can learn in a more open-ended way than they had previously thought and that leaving students with puzzling problems is acceptable. There also was evidence of teachers having students work more with each other in groups. Another related finding is that more teachers were having students engage in debates about what the correct solution is to a problem, rather than answering the question for them.

Lastly, teachers developed new technology skills due to the program. Most prominent was the use of Geometer's Sketchpad in the classroom, which they liked using because of the very positive student response to this tool. They became comfortable with the use of the Internet for professional development as well: for example, searching for teaching resources on the web, taking part in online discussions, and participating in synchronous chat sessions.

Student Outcomes

The overarching goal of the TeL program was to better prepare teachers to help increase student outcomes. This is a worthy goal because research has shown that student achievement gains are more influenced by the student's assigned teacher than other factors such as class size and composition (Darling-Hammond & Youngs, 2002). Furthermore, a study of the National Assessment of Educational Progress (NAEP) done by Wenglinksky (2000) found that eighth grade students did better in mathematics when they had teachers who: engage in more hands-on learning and emphasize higher order thinking; have professional training in working with diverse student groups; and have training in how to develop higher order thinking skills. Consistent with this research the TeL program emphasized hands-on learning and, to a lesser extent, higher order thinking and teaching diverse students. Therefore, one should reasonably expect some influence from the TeL on students. Our finding about the program's influence were quite mixed, however.

By the end of the program, significantly more students reported that they spent less time studying mathematics (as well as other subjects), they appeared to value it less, felt it is of less importance to their lives, and more boring than at the beginning of the study. Overall, this paints a fairly discouraging picture of students' thinking about mathematics. Unfortunately, our research design did not have a comparison group of students whose teachers were not in the program. So we have no way of telling whether this is a typical decline in student attitudes, or if the program helped stem the tide of the typical attitudinal pattern for middle school students. Alternatively, it could be that students think of mathematics as "sums" and other rote work, and when they responded to the survey did not think of the games and activities introduced into their classes as "math."

On the more positive side, students said that teachers were using more relevant examples by the end of the program than at the beginning, and that they believed that success in mathematics can be attributed less to natural ability, good luck, and memory (and presumably more to hard work and understanding). They also reported using the textbook less, using more exercise sheets, and writing on the board more often. These may be viewed as positive developments because: (1) the textbooks were old and did not address the new curriculum or methods in use; (2) the move to exercise sheets shows that teachers were looking elsewhere for materials such as those from the TeL program and the Internet; and (3) writing on the board more suggests more student involvement in the lessons.

Teachers and principals together reported that students enjoyed the mathematics activities teachers introduced from the program, and that students found them very engaging. They both saw signs of improvements in students' self esteem, attitudes, motivation, and better on-task behaviour as a result of project activities. Our classroom observations were less sanguine. We saw in about half of the classes improvements in engagement, interaction, and higher level discussions; however, there were problems in some of those cases of teachers failing to understand the intent of the activities or to provide sufficient guidance to solidify student understanding.

In sum, on the basis of evidence from teachers, principals, and from our own observations, students became more engaged in mathematics as a result of the program, but we do not have data on how widespread this engagement actually was. This greater engagement did not appear to translate into improved attitudes toward mathematics, unless one accepts the position that students' survey responses were about the traditional rote mathematics and not about the new activity-based program that teachers introduced.

Differential Student Effects

As noted above, the amount of time by students reported studying for mathematics decreased beginning to end of the program. When these data were analysed according to SES, we found that low SES students did not drop nearly as much as high SES students. Even more surprising was a substantial reversal in student opinion about the importance of doing well in mathematics between high and low SES students from beginning to end. The attitudes of low SES students actually improved over that period. A tentative conclusion one might reach is that the TeL program classroom activities and teaching strategies may have benefited low SES students more than their high SES counterparts.

Teachers seemed to agree that special education students, students with exceptionalities, at-risk students, and English as a Second Language (ESL) students seemed to have greater confidence and made more of an effort in math class when program activities were presented. Their opinion about the value of the activities for ESL was supported by the principals as well. The only other differential effect observed was by teachers was that boys seemed more engaged with the hands-on mathematics activities than girls.

Other Findings

The program was not without its difficulties, although in comparison to its successes they were relatively minor. Perhaps the most disappointing aspect was the weakness of the online community. Teachers were not as engaged in posting messages to the discussion forum and contributing to their online reflective journal as one would have hoped. This may have been related to facilitators' lack of expertise in creating an engaging online learning environment, since it is widely recognized that facilitators are key in leading to deeper and more reflective learning on the part of teachers (Loucks-Horsley et al., 2003). Problems relating to release time were also encountered by some teachers. These problems included the guilt engendered by the substantial amount of time the teachers spent away from their students, difficulties in locating and preparing for substitute teachers, and the stress of having to deal with annoyed parents who questioned why teachers were absent so frequently.

Conclusions and Significance

The blended learning model used in this project proved to be effective in creating opportunities and conditions for teachers to improve their mathematics teaching practice. More work needs to be done to refine the model's design to improve the fit with teachers' schedules and curricula. To make the model more sustainable financially, the amount of release time for teachers would have to be reduced. One possibility being discussed by program organizers is to have a face-to-face summer institute followed by online sessions throughout the fall and winter with one or two intervening face-to-face sessions.

We believe that the findings of this study are significant as they advance a possible solution for school districts trying to address a major challenge—how to improve mathematics instruction through teacher professional development. Our results suggest that the blended learning model offers an alternative to districts that combines the advantages of face-to-face professional development sessions with those of online learning. Moreover, the underlying design of the approach is consistent with the literature on the characteristics of effective professional development. Lastly, the study contributes to our understanding of how this new approach to teacher professional development can be implemented and improved upon.

References

Ball, D. L., & Bass, H. (2000). Interweaving content and pedagogy in teaching and learning to teach: Knowing and using mathematics. In J. Boaler (Ed.), *Multiple perspectives on the teaching and learning of mathematics.* Westport, CT: Ablex.

Ball, D. L., Lubienski, S., & Mewborn, D. (2001). Research on teaching mathematics: The unsolved problem of teachers' mathematical knowledge. In V. Richardson (Ed.), *Handbook of research on teaching (4th ed.).*

Boaler, J. (2002). Learning from teaching: Exploring the relationship between reform curriculum and equity. *Journal for Research in Mathematics Education, 33*(4), 239-258.

Curtis, L., & Swenson, P. (2003). Hybrid courses plus: Blending F2F, online and handheld computer for effective learning. *Society for Information Technology and Teacher Education International Conference Proceedings*, 520-523.

Darling-Hammond, L., & McLaughlin, M. W. (1996). Policies that support professional development in an era of reform. In M. W. McLaughlin & I. Oberman (Eds.), *Teacher learning: New policies, new practices* (pp. 202-218). New York: Teachers College Press.

Darling-Hammond, L., & Youngs, P. (2002). Defining "Highly Qualified Teachers": What does "Scientifically-Based Research" actually tell us? *Educational Researcher*, 13-25.

Driscoll, M. (2002, March). Blended learning: Let's get beyond the hype. *e-Learning*, p. 54.

Elmore, R. F., Peterson, P. L., & McCarthey, S. J. (1996). *Restructuring in the classroom: Teaching, learning, and school organization*. San Francisco: Jossey-Bass.

Fernandez, C. (2002). Learning from Japanese approaches to professional development: The case of lesson study. *Journal of Teacher Education, 53*(5), 393-405.

Franks, P. (2002). *Blended learning: What is it? How does it impact student retention and performance?* World Conference on E-Learning in Corporate, Government, Health, & Higher Education, 1477-1480.

Fullan, M. G. (2001). *The new meaning of educational change* (3rd ed.). New York: Teachers College Press.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago: Aldine.

Graven, M. (2003). Teacher learning as changing meaning, practice, community, identity and confidence: The story of Ivan. *For the Learning of Mathematics, 23*(2), 28 - 36.

Hiebert, J., Gallimore, R., & Stigler, J. W. (2002). A knowledge base for the teaching profession: What would it look like and how can we get one? *Educational Researcher, 31*(5), 3-15.

Kennedy, M. M., Ball, D. L., & McDiarmid, G. W. (1993). *A study package for examining and tracking changes in teachers' knowledge* (Tech. Series 93-1). East Lansing, MI: Michigan State University, National Center for Research on Teacher Education.

Lampert, M. (2001). *Teaching problems and the problems of teaching*. New Haven: Yale University Press.

Loucks-Horsley, S., Hewson, P. W., Love, N., & Stiles, N. E. (1998). *Designing professional development for teachers of science and mathematics*. Thousand Oaks, CA: Corwin Press.

Ma, L. (1999). *Knowing and teaching mathematics: Teachers' understanding of fundamental mathematics in China and the United States.* Hillsdale, NJ: Lawrence Erlbaum Associates.

McGraw, R., Arbaugh, F., Lynch, K., & Brown, C. A. (2003). Mathematics teacher professional development as the development of communities of practice. In N. A. Pateman, B. J. Dougherty & J. T. Zilliox (Eds.), *Proceedings of the 27th Conference of the International Group for the Psychology of Mathematics Education held jointly with the 25th Conference of PME-NA* (Vol. 3, pp. 269-276). Honolulu, HI.

Presmeg, N., & Berrett, J. (2003). Lesson study characterized as a multi-tiered teaching experiment. In N. A. Pateman, B. J. Dougherty & J. T. Zilliox (Eds.), *Proceedings of the 27th Conference of the International Group for the Psychology of Mathematics Education held jointly with the 25th Conference of PME-NA* (Vol. 4, pp. 47-54). Honolulu, HI.

Research Initiative for Teaching Effectiveness (nd). Retrieved April 25, 2005 from http://pegasus.cc.ucf.edu/~rite/

Richards, C. (2003). Distance education, on-campus learning, and e-learning convergences: An Australian exploration. *International Journal on E-Learning, 1*(3), 30-39.

Stepanek, J. (2001). A new view of professional development. In J. Stepanek (Ed.), *Lesson Study: Teachers Learning Together* (Vol. 2, pp. 2-5): Northwest Teacher: Theme issue.

Stigler, J. W., & Hiebert, J. (1999). *The Teaching Gap*. New York: The Free Press.

TIMSS Study Center (1998). *Science teacher questionnaire: Main survey*. Chestnut Hill, MA: Boston College.

Van de Walle, J. A. (2001). *Elementary and middle school mathematics, teaching developmentally* (4th ed.). New York: Addison Wesley Longman.

Wenger, E., McDermott, R. A., & Snyder, W. (2002). *Cultivating communities of practice: A guide to managing knowledge*. Boston, MA: Harvard Business School Press.

Wenglinsky, H. (2000). *How teaching matters: Bringing the classroom back into discussions of teacher quality*. Princeton, NJ: Educational Testing Service.