Chapter 9
Our Journey of Understanding Through Lesson Study

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Introduction

Proficiency in both the content and the practices explored in our methods classrooms are essential for teacher educators, but our prior experiences sometimes prove insufficient to prepare us to introduce new teaching practices to our students. Japanese Lesson Study offers such a case in point. Research suggests that it offers great promise (Lewis, 2000; Marble, 2006, 2007; Stigler & Hiebert, 1999), and we wanted to share this powerful professional development approach with our methods students. But we had little actual experience with the practical aspects of how it would work in our classrooms since none of us had engaged in lesson study as participants ourselves. To deepen our understandings of this process and our students' learning (Clandinin, 1985; Connelly & Clandinin, 1985; Connelly, Clandinin, & He, 1997), we undertook a study of our own classroom practices (Cerbin & Kopp, 2006).

So that we could more fully help our students understand lesson study, the authors decided to conduct a Japanese Lesson Study of our own collective efforts to teach our students. Specifically, we aimed to systematically explore our own strategies for incorporating the teaching of assessment into our elementary science methods classes.

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As a result of our participation in the lesson study activities, our discussions have turned to a more thoughtful examination of our shared understandings of the pedagogy of science teaching. This, in turn, developed into the present study – a self-study of our growth as science teacher educators as a result of having engaged in the initial Lesson Study. As our insights led to new questions and new perspectives, we have come to understand the important role of theory in our practices.

Theoretical Framework

Collectively the four authors share many theoretical perspectives on learning to teach science. Three specific areas of agreement stand out. First, we each base our teaching on sociocultural constructivism, emphasizing the collaborative nature of learning and the important roles played by more knowledgeable others (Luria, 1976; Vygotsky, 1978, 1986). We build on the work of Schon (1983) and Shulman (1986) who support the use of reflection to deepen understanding about both content and practice. In addition, we firmly believe in the value of creating learning communities in our classrooms (Bielaczyc & Collins, 1999; Stoll & Louis, 2007). Taken together, these three elements define the major parameters of our collective understanding that guides how we teach our students to become teachers. In the past, these elements have been combined loosely to function as tacit and assumed principles shaping our practice rather than offering a well-articulated robust theoretical framework.

In fact, specific theories and empirical studies describing and explaining "educators' expertise on teaching about teaching subject matter" (Berry & Van Driel, 2012, p. 120) are scarce. However, the three elements we tacitly shared strongly echo the work of Dana, Campbell, and Lunetta (1997), who claimed that teacher education had focused for too long on teaching techniques and methods grounded in an objectivist epistemology and had failed to engage learners in a more meaningful pedagogy. Dana and his colleagues challenged science teacher education reformers to move toward a new paradigm guiding elementary science teacher preparation based on three central constructs: constructivism, reflection, and professional community (p. 422–423). The tacit framework that the authors independently adopted in our individual practices powerfully suggests that such a paradigm has become widespread among science teacher educators.

Although the links between sociocultural constructivism, reflection and professional community are loosely defined, we would argue that these various dimensions outline an untested theory about teacher preparation that shapes our practice. In our early efforts to explore these ideas, however, it was the *practice* of teacher education that we were focused on improving. And, though our practices rested on dimensions that had not been fully examined as a coalesced theory, we did not consider our efforts to be a conscious exploration of the underlying theories on which they were based. But, because the contours of our study follow the lesson study work of Lewis (Lewis, 2000; Lewis & Tsuchida, 1998), we found ourselves engaged

in just such an examination of theory. For example, rather than trying to reproduce what research suggested was 'good practice' for developing an understanding of teaching science, we tested this notion engaging in multiple trials of a lesson. We used data from each trial to refine our thinking as well as redesign our instruction. After the fact, we realized that the process and the product changed many facets in our individual science methods courses.

Participants

The researcher-participants in this study are the four authors. We each have taught K-12 prior to entering the university, have taught at research institutions, and are now employed at universities that focus on teaching and teacher preparation. At the time of the lesson study we were the only science teacher educators at our campuses, making the collaborative approach to investigating our teaching more attractive.

Collectively we entered the lesson study believing that there is much to be learned from students and that studying the complexity of lessons could help us become better teachers. With its emphasis on observing student engagement with lessons, lesson study provided an excellent venue to do this.

In addition to studying the change in our teaching of assessment that was the focus of our lesson study, we have now engaged in a study of self. This has moved our thinking to a more theoretical footing and has required additional reading, reflecting, and discussion.

Methodology

Self-study of teacher education practices (Pinnegar, Hamilton, & Fitzgerald, 2010) promotes the construction of knowledge about teaching from the collection and analysis of observational data. As knowledge is constructed, advocates posit, it becomes evident in teaching (Pinnegar & Hamilton, 2009). Thus, self-study involves critical analysis of ways of understanding and articulating knowledge of practice (Loughran, 2007). Because lesson study involves recursive observation and reflection on both teaching and learning (Kamen et al., 2011), it provides a solid framework for self-study. For those unfamiliar with this professional development strategy, a brief description is provided below.

> The premise behind lesson study is simple: If you want to improve teaching, the most effective place to do so is in the context of a classroom lesson. If you start with lessons, the problem of how to apply research findings in the classroom disappears. The improvements are devised within the classroom in the first place. (Stigler & Hiebert, 1999, p. 111)

Japanese Lesson Study was first described and has been widely promoted in the United States by Lewis (1995). She reported on this fairly common professional development activity in Japan and described five characteristics of lesson study necessary for its success: The lessons are planned collaboratively over a period of time; the taught lessons are observed by other teachers; the lessons intend to bring to life a particular goal or vision of learning; the lessons are recorded; and the lessons are discussed and shared with others. In Lesson Study the center of attention is shifted away from a particular teacher and his/her instructional actions and toward the resulting actions, words and ideas of the students in the class. Slowly gaining acceptance in the United States, many sites and resources about Lesson Study can be found on line. (See Note 1).

Context of Our 2005 Japanese Lesson Study on Methods Instruction

We entered our Lesson Study having read about the mechanics of the process (Lewis, 2000) and had even required our students to apply lesson studies in some of our individual methods classrooms (Marble, 2007), but as a group we had no deep theoretical comprehension of the inner workings of this approach. Unaware of Dana and his colleagues' arguments, our exploration of teaching teachers integrated each of the three elements he proposed: sociocultural constructivism, reflection, and professional community. Our PSTs first engaged in groups with a hands-on experience, reflected on their experiences together and then convened as a whole class to share ideas and understandings. We also included a fourth element stressed by Dana et al: the integration of science content and pedagogy. Teaching PSTs with limited experience in scientific inquiry and content is typical in pre-service elementary teacher education courses. We wanted to know how a hands-on exploration of a scientific concept (density) and the simultaneous exploration of pedagogical methods (assessment) could work to deepen our students' understanding of both.

We began with several meetings over the course of a semester brainstorming pedagogical strategies we found challenging in our teaching and we quickly agreed that teaching about assessment was an area with which we all struggled. As science teacher educators, we strongly believed that pedagogical topics for our methods courses should be contextualized with a specific science concept and we considered several concepts to deploy during our study of classroom practice. We wanted the topic to be complex enough to generate a range of understandings while allowing for an active hands-on inquiry experience. Ultimately, we selected an activity involving sinking and floating to deepen our PSTs scientific understanding. The lesson engaged the PSTs in exploring a variety of assessment strategies in order to capture their own developing understanding of the concepts of density and buoyancy as well as the pedagogy of assessing students for understanding.

In Japanese Lesson Study, teachers examine their practice by focusing on what the students say and do during the instructional activity. We designed our investigation to follow the protocols and structures of Lesson Study as closely as possible. The Assessment Lesson was taught three times, once on each of our home campuses to our own students. As many of the authors as possible observed the teaching of each lesson and, immediately following, we met as a team to debrief, sharing data and ideas about how the lesson had gone and what students had learned. Our initial research using lesson study allowed us to collect data on student engagement as a result of our instructional planning.

A final iteration of the lesson was taught as a public research lesson at an Association of Science Teacher Education (ASTE) conference session with a fourth group of PSTs from a local university and an audience of professional science educators attending the conference (Kamen, Weinburgh, Marble, & Naizer, 2006). Session attendees participated as observers in the final research lesson and debriefing. The conference session challenged us to explicitly and publicly share what we had learned and provided an opportunity for peer critique.

Several years later, we met again as a team to revisit our experiences and to explore its impacts on our long-term understandings and practices. During this later exploration, we have utilized a collective method that involves the "interactive exploration of an issue by a team of researchers" (Lunenberg & Samaras, 2011, p. 844).

Data Sources

Each time the lesson was taught, observers (science methods professors) concentrated on what the learners (PSTs) were saying and doing. Data (field notes, videotape record and artifacts) were collected from each lesson and analyzed by the team of participant-researchers. Immediately following each lesson, we met to debrief and reflect on the students' learning and to discuss ways we might modify the lesson. We also reflected on what we were learning about teaching elementary education majors about teaching science.

Prior to revisiting our experience for the second phase of the study, the authors viewed the video recordings of the original planning sessions, actual lessons, post-lesson debriefings, and the conference sessions. Additional data in the form of memories, analytic memos, and syllabi revisions were collected. In a brainstorming session, each author discussed what elements of the original study remained most salient and what each author thought was the major change in his/her teaching and understanding of how to best help pre-service teachers learn to teach science. Sharing through Google docs and multiple conference calls, each author captured ideas, questions, and concerns. As a result, we engaged in an ongoing and open dialogue in which we respectfully recognized the differences in each other's viewpoints and sought clarification and understanding.

Data Analysis

We used a grounded theory approach, employing a modified constant comparison (Glaser & Strauss, 1967) approach, as we examined the data individually and then collectively over several iterations. Each iteration of the research lesson conducted in 2006 provided the research team with raw data to analyze. Following the protocols of Japanese lesson study, each lesson had been taught, notes taken, and the team debriefed in order to continue to push understanding that would help us solve the stated problem of how to teach assessment to PSTs.

Data from the lesson study project were revisited in 2014 in order to move the analysis to a more reflective, conceptual understanding of teacher educator change. Each member of the team watched the original recordings of the lessons and reviewed written artifacts before making initial open codes. To tighten and provide checks and balances, the team held conference calls in which we served as critical friends to one another (Costa & Kallick, 1993; Miles & Huberman, 1994). The critical friend acts as both a highly trusted 'friend' and as a provocateur that challenges, questions and critiques. The critical friend provides context for the learner to push critical and supportive feedback on his/her work. From the sharing of individual codes, we developed our first set of theoretical codes and analytic themes (Charmaz, 2006). The next phase of analysis involved dialogue methodology (Lunenberg & Samaras, 2011) through which the team created the final list of themes. The last phase occurred during the writing as we continued to revise our thinking (Yagelski, 2009).

Key Findings

As a collective, we learned important ideas about ourselves and about teaching elementary pre-service teachers. Several key findings emerged very early in the process; others have emerged over time. Four of these are presented below.

The Complex Interaction Between Content and Pedagogy

We anticipated that both of the constructs under study would pose challenges for our students; in fact, that is why these were selected. The term "density" is used frequently in everyday speech in ways that promote confusion when the scientific conception is examined. A complex topic, density is often misunderstood and teachers working with the concept often fail to move beyond the hands-on experience to promote concept development. Our sociocultural constructivist approach first led us to have our PSTs use small group discussion to reexamine their prior understandings of density in order to develop more sophisticated ideas. We expected this

activity would create discomfort, particularly in the public context of a classroom community. Moreover, we welcomed this discomfort, thinking it critical to the process of learning new ways of thinking.

Our lesson design called for the PSTs to expose their prior knowledge in discussion, test it through a group hands-on activity, reformulate their understandings of density, and then complete assessments to allow them to demonstrate their new understandings. During the assessment activity they would explore a variety of ways to demonstrate their new knowledge, including Multiple Choice tests, an essay prompt with model response, creating a model boat, or performing a skit. We thought of the lesson as helping each PST think about how to assess learning in science. The pre-activity of sinking and floating would provide context and an anchored experience about which to discuss assessments.

From the very first lesson we conducted, we observed our PSTs struggling to combine learning about new content with new pedagogy. We entered the study thinking that teaching simple content while simultaneously introducing new pedagogy would enable us to have the lesson serve two ends: the science content would provide a contextual vehicle for learning about assessment, allowing for a synergy that would deepen the PSTs understandings of both.

But quickly we saw and heard our students struggling much more than we had expected to attend to both problems simultaneously. While it came as no surprise that many of the students held incomplete or incorrect content knowledge of floating/sinking and density, we were frustrated at how powerfully these prior notions preempted their thinking about the quality and practice of assessment. Student comments such as "we didn't cover that" and "I'm not good at multiple choice" indicated our students were attending primarily to their own content knowledge rather than their developing pedagogical knowledge related to assessments. A majority of student comments referred back to the sink/float context despite our explicit intended focus was to have them explore the value of various assessment methods. One group of students was very excited that their clay boat floated, but even though they successfully completed the task, the students could not explain why their boat floated, and thus could not demonstrate any new knowledge of buoyancy and density.

As we progressed through the three iterations of the lesson, we revised the lesson to explicitly focus student attention on the role of assessment. Still students often reverted to questions or comments about the science content rather than engaging in any discussion about the various assessments. In the end they were unable to divorce themselves from efforts to extend their limited content knowledge, trumping any deeper reflection on the activity and its possibilities for understanding assessment.

Lesson Study as a Powerful Professional Development Tool

Secondly, we confirmed our intuitive belief that Japanese Lesson Study provides a rich framework for professional growth for teachers at all levels. As a group we now have a working familiarity with the process and an applied experience to draw on in helping our students understand and engage with this professional development approach. But even more importantly, lesson study helped us address major issues in our own practices of how to teach PSTs. One can be seen in how we now attempt to combine content and pedagogy in our lessons, described above. A second involves how we now focus on students. All of us now recognize and practice more "student centered" approaches in our own teaching, where students, their understandings and efforts are at the very core of our discussion and analysis. For example, one of the authors describes how, as he now prepares to observe student teachers, he asks them before hand what it is that they want him to attend to most closely. Another author was profoundly influenced by a change we made during one of the lesson planning meetings, a move from having students examine their own efforts to having them examine other students' work. She now exclusively uses the work of other students (often the work of K-6 students) to help her PSTs assess learning. And, for all of us, listening to students during our lesson study data collection observations has provided convincing evidence that it is not what the teacher does but what students understand that serves as a measure of effective practice.

Several of us have found ways to use lesson study in our methods courses while others are using lesson study elements. But all of us now incorporate two new approaches in our own instruction that grew out of the lesson study activities. First we each promote the practice of having the PST concentrate on student interactions in their planning, instruction and reflections. We find this challenging because PSTs want to think about their actions without thinking about the consequences for the learner, but that making the practice explicit helps them shift the focus from the teacher to the student. A second outcome of our lesson study concerns the role of lessons in the developmental process of learning. We each now emphasize that the process of planning, teaching and assessment is not one where the PST creates the 'perfect, finalized' lesson but rather as an organic process that must change in response to the contexts of the classroom.

The Value of Professional Community

A third outcome of our collaborative work involves how we now understand the value of professional community. Although we had read the scholarship on community of practice, this experience brought home the value of collaboration with others who are knowledgeable about our work. While all of the authors have been actively involved in the science education community, we all teach at small universities and may be the only (or one of two) science educators on campus. The lack of

local colleagues with extensive knowledge of science methods and associated issues left each of us feeling somewhat isolated in spite of having good working relationships with peers. While we feel that a lot of common ground can be found with our colleagues in mathematics, social studies, language arts, or general teacher education, specialized knowledge required for science methods deepens from collaboration with other science educators. The lesson study process forced us to spend extended time focused on the teaching of assessment as well as the science content – pre-planning teach, debrief, second teach, debrief, third teach, debrief, public lesson and debrief. These repeated and intensive conversations promoted powerful reflections on our teaching and students' learning, rather than cursory self-reflection often done on the way back to our offices after class.

In addition, we have come to realize that our professional community extends beyond our collaborations in the classroom. The fourth lesson conducted at the professional conference involved colleagues in a unique experience. Rather than passively presenting our collaborative work to attendees, we actually invited them to join us to observe, discuss and reflect on the work in a lesson taught using PSTs in an elementary science methods class from a local college. This approach to a conference session substantially altered the relationship between the presenters and the audience, creating a collaborative public research community in which all of our ideas were shared and debated.

The Recognition of Practice as a Test of Theory

Finally, a key outcome of our work is that we now realize, though the lesson study activities were focused on improving our practice, we were also testing the theoretical framework on which that practice rested. Perhaps this should not have come as such a surprise, since we had built our practice on a loose association of beliefs about teaching without articulating for our selves or others how we embodied these notions and how they played out in our practice.

Our data collection and analysis intentionally focused on student learning during the lessons, but our debriefing sessions increasingly were spent clarifying our own content knowledge and tacit practices of teaching science teachers. Reexamining our taped debriefings, we found that we continually switched back and forth between reflections on the science content learning and how important or unimportant it was in order for students to be able to evaluate assessments on the topic. Our deliberations began to be dominated by what we had assumed true at the outset: that learners can learn new content alongside new pedagogical methods for teaching and assessing that content.

We were testing our underlying theories of teacher education through practice. The science methods classroom had become our 'laboratory' and each of the teaching sessions resulted in our changing a variable and observing the outcome of the variation. Our initial assumption that both new science content and pedagogy can be learned simultaneously was seriously challenged by the students' behaviors,

resulting in our constant distraction from concentrating on their ability to learn about assessment. The interference was so strong we had to remind each other repeatedly that the goal of the lesson was related to understanding how to help PST's learn about assessment. If combining content and pedagogy proved so difficult for us, how difficult must it be for the PST learners in our classrooms?

Discussion

We did not enter our lesson study collaboration thinking of it as an experiment and of our classrooms as laboratories; rather we thought about our joint effort as a way to improve our practice. However, revisiting the data and reflecting on our work together reveals that our theoretical understandings were clearly put to the test during our lesson study. We created multiple recursive scenarios in which to observe how our instructional approaches impacted student learning and we systematically manipulated components of the lesson as we encountered problems or recognized opportunities that influenced the outcome. We changed such things as number of objects that the PSTs had to sink/float and how the assessment portion of the lesson was conducted. It was not just our practices that were under scrutiny, but our theoretical understandings as well. How does reflecting back on our experience with a theoretical lens using the methods of self-study make it richer?

Working from Theory

Fernandez (2002) noted that Japanese teachers working with lesson study had the benefit of significant direction to and experience with approaching the practice as "… a form of research that centers on conducting classroom experiments" (p. 400). She describes lesson study in Japan as informed by a systematic perspective that allows teachers to learn from each other. While working with teachers in the United States to learn about lesson study, she found they frequently struggled because they had not developed and could not deploy the research skills they needed to approach their examination of classroom practice in this way, and often were limited to considering their efforts as lesson building activities.

We recognize that our PSTs are similarly limited when it comes to thinking about their learning. They regularly approach classroom activities in our methods classes as a series of discrete opportunities to acquire skills rather than to support the development of a research-based perspective on teaching. In order to help them understand and employ lesson study in their practice, we enthusiastically agree that PSTs should experience and understand how their own research and that of others will enhance their classrooms. This raises the question of what is realistic for PSTs to have as theory and how can we move them forward? What are we really trying to accomplish in methods courses if students do not have a theoretical understanding

of both the content and the pedagogy? Unfortunately, our lesson study experience suggests that we have a ways to go before we find answers to these questions.

Windschitl (2004) goes even further. His examination of the inquiry approaches of graduate science teacher candidates revealed that the great majority of them worked with "folk theories" of scientific inquiry that limited them to thinking of each experiment in isolation from any scientific theory. Even students with advanced degrees or work experience in laboratory science pursued versions of inquiry that notably lacked connections to theory or scientific models. He concludes by calling for deeper, richer inquiry experiences during pre-service methods classes, and requiring that those inquiry experiences be grounded in the students' theoretical knowledge.

We know our undergraduate methods students work with a more limited base of experience and knowledge than PSTs with graduate degrees in science. No doubt they need considerable time and engagement to begin to examine the theoretical understandings underlying either the content or the pedagogical issues we challenged them to confront. So how do we approach this problem of helping our students work with their theoretical understandings from the beginning of their teaching experience? How do we support our students' understandings that their actions in the classroom are grounded in theory whether conscious or not?

Problematizing the Curriculum for Students

We found the line between discomfort that mobilizes learning and discomfort that preempts learning is a very fine one. We witnessed our students' dual discomforts as they wrestled with the concept of density and then had to be public with their own lack of understanding. Our solution was to give them the assessment answers from students in other classes. This lowered the affective filter (Krashen, 1985) and allowed them to concentrate on what kind of knowledge each assessment could best capture. This, in turn, enabled them to address the questions of assessment but at a cost: their constructions of the density concept were only minimally explored in the final lessons. If new ideas in content and new pedagogy create interference, must one always be deferred? Is it always the case that we must make such a choice? What would a third space look like?

Furthermore, though we were successful in helping our students engage with the assessment goals of our lesson, we are not confident we met another instructional goal: helping our students think about and reflect on how this comfort/discomfort works with their own students? Our findings now make us want to ask the question, "How do we problematize the lessons so that our students engage with the multiple rich dimensions of pre-service practice?" We want them to think/reflect/struggle about how to work with students and to see that there is no 'formula' for a 'great science lesson' or a 'perfect assessment'.

Even as we felt the frustration of the time limits that the university class schedule put on the lesson for us, we want to foreground the decisions that teachers must

make around time available and the depth of understanding that can be reached in that time. We know that it takes time to understand complex ideas and yet we tend to move through our own instruction at a very fast pace. This self-study of a lesson helped us to value and honor the slowing down process necessary if deep learning is going to occur.

The Public Nature of Practice

Sharing our classroom practices with colleagues who are critically watching our students' and their understandings created a certain amount of tension for each of us. Yet we found the collaborative discussions that surrounded our lessons provided a richness that might never occur to each of us working alone. And, over time, the shared experience among the four of us allowed a continuing dialogue about the results and our understandings long after the actual events.

One element of the systematic approach to Japanese lesson study is the public dissemination of results through multiple avenues, including the 'research learning presentation meeting' (Fernandez, 2002, p. 396). In the absence of such school based events in the United States, we undertook to accomplish this through the lesson presentation at ASTE. This going 'public' represented one of the most intimidating aspects of our lesson study. The risks were indeed high. We engaged in a lesson with students who were totally unknown to us and then exposed our lesson to critique from our peers. Again, we found the actual experience to be rich and valuable, enabling an even deeper dialogue that stretched our thinking and understanding. The move from our trusted group of four professors to the larger group provided the space for new ideas and further insight into our teaching. It also served as a venue for helping others learn about teaching science methods to PSTs.

Back to Theory

We are somewhat surprised that our lesson study work stimulated challenges to our theoretical understandings. And, even so, we might not have recognized these challenges if we had not later convened for a second round of self-study focused on our own growth as teacher educators. In our later discussions, important questions have been asked but not answered that will continue to influence our thinking as we move forward. For example, given the time it takes to learn and engage with the many complex ideas we believe that our PSTs need to know, might we look to a new model for teacher education that allows continuing engagement over multiple years rather than a single semester methods course? If so, then what role should the development of their theories of scientific understanding and classroom practice play in such an extended engagement? And is there a truly unique and distinct theory that

might guide elementary science teacher education, or should our students be working to develop a larger, interdisciplinary understanding of teaching?

Conclusions

What began as a collective desire to learn more about a professional development approach became much more, both an exploration of each of our approaches to teaching as well as a deeper consideration of the theory underlying those approaches. Through our collaborative self-study, we each gained powerful personal and communal insights, in the process becoming more thoughtful, mindful teacher educators. Sharing our experiences with other science educators has done much more than satisfy our needs for professional community: it has revealed areas in which we can each grow and flourish with support from knowledgeable colleagues. Collectively our foci have shifted: from what we teach to what our students learn; to facing our trepidation of teaching as a public practice; and to recognizing the important role of theory in shaping both our understandings and those of our students. And our insights into how Japanese Lesson Study works and how to make it work for us have left us confident about using this professional development tool. It has truly been a journey, beginning with our collective need to know something new and leading us to challenge much of what we thought we knew already.

Note

1. There are a number of sites now dedicated to research and practice of Lesson Study. The Lesson Study Group at Mills College is perhaps the oldest of these and can be accessed at http://www.lessonresearch.net/. Also on line are sites for the Center for the Collaborative Classroom (https://www.collaborativeclassroom.org/lesson-study); the Lesson Study Project at the University of Wisconsin – La Crosse (http://www.uwlax.edu/sotl/lsp/); and the Chicago Lesson Study Group (http://www.lessonstudygroup.net/index.php).

References

Berry, A., & Van Driel, J. H. (2012). Teaching about teaching science: Aims, strategies, and backgrounds of science teacher educators. *Journal of Teacher Education, 64*(2), 117–128.

Bielaczyc, K., & Collins, A. (1999). Learning communities in classrooms: A reconceptualization of educational practice. In C. M. Reigeluth (Ed.), *Instructional design theories and models* (Vol. 1, pp. 269–292). Mahwah, NJ: Lawrence Erlbaum Associates.

Cerbin, B., & Kopp, B. (2006). Lesson study as a model for building pedagogical knowledge and improving teaching. *International Journal of Teaching in Higher Education, 18*(3), 250–257.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. Los Angeles: Sage Publication.

Clandinin, D. J. (1985). Personal practical knowledge: A study of teachers' classroom images. *Curriculum Inquiry, 15*, 361–385.

Connelly, F. M., & Clandinin, D. J. (1985). Personal practical knowledge and the modes of knowing: Relevance for teaching and learning. In E. Eisner (Ed.), *Learning and teaching ways of knowing* (pp. 174–198). Chicago: University of Chicago Press.

Connelly, F. M., Clandinin, D. J., & He, M. F. (1997). Teachers' personal practical knowledge on the professional knowledge landscape. *Teaching and Teacher Education, 13*, 665–674.

Costa, A. L., & Kallick, B. (1993). Through the lens of a critical friend. *Educational Leadership, 51*(2), 49–51.

Dana, T. M., Campbell, L. M., & Lunetta, V. N. (1997). Theoretical basis for reform of science teacher education. *The Elementary School Journal, 97*(4), 419–432.

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

Glaser, B. B., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Piscataway, NJ: Transaction Publishers.

Kamen, M., Junk, D. L., Marble, S., Cooper, S., Eddy, C., & Wilkerson, T. (2011). Walking the talk: Lessons learned by university mathematics methods instructors implementing lesson study in their own teaching. In H. Lynn, A. Alice, & M. Aki (Eds.), *Lesson study practice and research in mathematics education: Learning together* (pp. 165–175). New York: Springer.

Kamen, M., Weinburgh, M. H., Marble, S. & Naizer, G. (2006, January). *Implementing lesson study among elementary science methods instructors*. Presented at the annual meeting of the association science teacher education. Portland, OR.

Krashen, S. (1985). *The input hypothesis: Issues and implications*. New York, NY: Longman.

Lewis, C. (1995). *Educating hearts and minds: Reflections on Japanese preschool and elementary education*. New York: Cambridge University Press.

Lewis, C. (2000). *Lesson study: The core of Japanese professional development. Invited address to the special interest group research in mathematics education*. New Orleans, LA: American Educational Research Association.

Lewis, C. & Tsuchida, I. (1998, Winter). A lesson is like a swiftly flowing river: Research lessons and the improvement of Japanese education. *American Educator*, 14–17 & 50–52.

Loughran, J. (2007). Research teacher education practices: Responding to the challenges, demands, and expectations of self-study. *Journal of Teacher Education, 58*(1), 12–20.

Lunenberg, M., & Samaras, A. (2011). Developing a pedagogy for teaching self-study research: Lessons learned across the Atlantic. *Teaching and Teacher Education, 27*, 841–850.

Luria, A. R. (1976). *Cognitive development: Its cultural and social foundations*. Cambridge, MA: Harvard University Press.

Marble, S. (2006). Learning to teach through lesson study. *Action in Teacher Education, 28*(3), 86–96.

Marble, S. (2007). Inquiry into teaching: Lesson study in elementary science methods. *Journal of Science Teacher Education, 18*(6), 935–953.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Pinnegar, S., & Hamilton, M. L. (2009). *Self-study of practice as a genre of qualitative research: Theory, methodology, and practice*. Dordrecht, The Netherlands: Springer.

Pinnegar, S., Hamilton, M. L., & Fitzgerald, L. (2010). Self study inquiry practices. In S. Schonmann (Ed.), *Key concepts in theatre/drama education* (pp. 345–350). New York: Springer.

Schon, D. (1983). *The reflective practitioner: How professionals think in action*. London: Temple Smith.

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14.

Stigler, J., & Hiebert, J. (1999). *The teaching gap*. New York: The Free Press.
Stoll, L., & Louis, K. S. (2007). *Professional learning communities: Divergence, depth and dilemmas*. New York: McGraw-Hill.
Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
Vygotsky, L. (1986). *Thought and language*. Cambridge, MA: MIT Press.
Windschitl, M. (2004). Folk theories of 'Inquiry:" How preservice teachers reproduce the discourse and practices of an atheoretical science method. *Journal of Research in Science Teaching, 41*(5), 481–512.
Yagelski, R. P. (2009). A thousand writers writing: Seeking change through the radical practice of writing as a way of being. *English Education, 42*(1), 6–28.