

The ripple effect of mathematics lesson study: One school story

A paper presented at the annual meeting of the Canadian Society for the Study of Education

May 2009

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This research was funded by the Ontario Ministry of Education and the Elementary Teachers' Federation of Ontario (ETFO). Views expressed in the paper are not necessarily those of the Ministry or of ETFO.

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Introduction

Three teachers at an elementary school in central-Eastern Ontario volunteered to participate in lesson study focused on mathematics as part of a district initiative. Their collaboration in lesson study was a powerful experience that led to changes in their practice and eventually affected the school culture and the way that professional development was approached in the school. Our goal in this paper is to tell the story of the effects of lesson study activity on the small group of teachers and how it impacted the larger school community.

The lesson study team was part of a larger initiative involving 3 additional teams from the secondary panel (12 teachers in 4 teams) who used Japanese Lesson Study as a framework to investigate teacher-selected focus areas in math instruction and approaches to pedagogy using the interactive whiteboard. The study was conducted in partnership with researchers from Trent University and the University of Toronto, who used a mixed methods approach (Creswell & Plano-Clark, 2007) to investigate the impacts of lesson study in mathematics in the Ontario context.

This paper presents the case study of one team of teachers who found the lesson study experience to be so powerful that they expanded their project, pursuing new sources of funding in order to continue their work and adding another member to their team. The small lesson study project began to ever increasingly affect the larger education community. We call this “the ripple effect”.

Ripples are strongest where the stone hits the water and ebb out from this centre of activity. We see the stone at the center of activity as Lesson Study itself. From here, we observed how the ripples increased in diameter to include wider educational communities. This metaphor allows us to recognize where the largest and most immediate effects occur – with the teachers on the team. By the same token, it also allows us to acknowledge that the effects on the school are gentle, but growing. From this image, we have theorized about the complex and fluid nature of teaching and of schools, and the overlapping ways in which lesson study affects both.

Background

The Authors

In order to provide a reasonable context for this paper and our work, we will briefly describe our individual roles in the project:

Heather Hedges is a teacher on the lesson study team. She teaches a Grade 7/8 class (one of two in the school, the other teacher also being a member of the team). She is recognized in the school for her math background and began her career as a secondary math and English teacher, but moved to the elementary panel to work in the intermediate division, where she has taught for 8 years.

The team's participation in the larger research project led to a close partnership with university researchers Cathy Bruce and Tara Flynn. Cathy is an Associate Professor who teaches math to preservice teachers at the Trent University School of Education and Professional Learning and she was the principle investigator in the study. She observed lesson study activities and participated actively in the introduction and debriefing of the public lessons at the school. She supported the team by providing additional professional development in patterning and algebra and guidance in the organization and analysis of the student data collected by teachers.

Tara Flynn, a teacher who works as Cathy's research assistant, had particularly close involvement with the lesson study team. In the first year of their collaboration, research funding allowed for her to work in Heather's room as a teacher apprentice/research assistant; in this role, she was able to provide some classroom support as well as collect video documentation of math classes and related use of the interactive whiteboard.

The Lesson Study Team

In the first year of the study, the team of three teachers focused on understanding lesson study and developing their understanding of effective uses of the interactive whiteboard in the math classroom. In that year, the team consisted of two Grade 7/8 teachers (representing the entire intermediate division) and one Grade 4 teacher. In the second year of the project, research funding allowed the team to expand the project to include a primary teacher from their staff (so that each division was now represented) and to develop some exploratory lessons in their focus area. These exploratory lessons allowed the teachers to really develop their understanding of

student learning in content areas across the divisions; for example, the team developed a problem which they tried, with only minor variances, in Grades 1, 4, 7 and 8. The teachers had been careful to choose a focus area – communication – that was broad enough to allow them to do this kind of cross-divisional planning and experimentation. Specifically, their focus was on the use of tools and technology, including manipulatives as well as the interactive whiteboard, to facilitate communication in mathematics.

School Context

Highland is a K-8 school located in an urban area of a town of about 75,000 people in central-Eastern Ontario. Its school population of 264 students face significant socio-economic challenges. The school has a higher percentage of students living in lower-income households compared to the provincial average (22% percent, compared to 16.5% provincially, according to the Ontario Ministry of Education's school profile). Only 19% of Highland's students have parents who have some university education, significantly lower than the provincial average of 36.9%.

Highland's math and reading scores in the Grade 3 provincial assessments (EQAO) are on par with the provincial averages, with 59% of students achieving the provincial standard in writing (compared to 61% provincially), and 70% in writing (compared to 66% provincially). Reading and writing scores suggest a strong upward trend for student achievement, with 31- and 56-point increases respectively over the past 3 years. Math scores in Grade 3 tell a similar story, with 63% of students achieving the provincial standard (a 29-point jump over 3 years).

Student achievement scores in Grade 6 are consistent in reading and writing, hovering near the provincial average at 65%. The Grade 6 math scores tell a different story, however, with 32% of students achieving the standard compared to 61% provincially – a 24-point drop over the past 3 years (School Information Finder, 2009).

In spite of its challenges, the atmosphere at Highland is a pleasant, welcoming place. A high level of energy and commitment is evident among the staff. The principal is active and highly visible in the school. There is cheerful banter in the hallways and in the staff room. Aside from lesson study, collaborative professional development has been taking place in the school in the form of divisional, mandated Professional Learning Communities (PLCs), for which teachers meet in their divisions to establish short-term targets for student achievement, mostly in literacy.

Theoretical Framing

Japanese Lesson Study

The lesson study model undertaken in this project is inspired by Japanese Lesson Study, an intensive professional development model that Stigler and Hiebert (1999)

describe as a way for teachers to look at their own practice “with new eyes”. In general terms, lesson study involves the collaboration of teachers over the course of several months to a year to plan a research lesson based on goals for student learning that they have identified together (typically, in an area of difficulty for students). This research, or public, lesson is then taught by one of the team members to his or her class with other members, as well as invitees from the school and broader educational community, observing. Following the public lesson, the group of observers debriefs on what they saw in the lesson, focusing on student learning and unanticipated responses. This debriefing period drives the continuation of the cycle as the next set of goals is established. These final phases of the cycle – implementation / reflection / debrief – should feel less like a final performance and more like a catalyst for further study and improvement of practice (Lewis *et al.*, 2006).

Lesson study has been described as a systematic inquiry into teaching and learning. As a professional development model, lesson study has garnered the attention of researchers and educators due to the fact that it “is embedded in the classroom and focused on students, it is collaborative and ongoing, and it is based on teachers’ own concerns and questions” (Darling-Hammond & McLaughlin, 1995). In this way, lesson study is a teacher-led or teacher-initiated activity that has the potential to improve teaching based on research in and evidence from the classroom (Lewis *et al.*, 2006). Like more traditional action research, lesson study turns teachers into researchers in their own classrooms. As Stepanek (2001) points out, the inquiry-based nature of lesson study honours “the fascinating and complex nature of teaching.”

In Japan, lesson study is sanctioned and supported by the Ministry of Education (Fernandez, 2002). According to Takahashi & Yoshida (2004), lesson study has resulted in improved and more child-centred instruction in Japan over the past 20 years. The use of lesson study as an effective professional development tool has spread rapidly in the United States since 1999 (Lewis *et al.*, 2006). Less is known about the proliferation of lesson study in Canada, but in Ontario, the Ministry of Education’s Report of the Expert Panel (2004) cited lesson study as one professional development activity that teachers may consider as they are developing a learning team.

Takahashi & Yoshida (2004) suggest that lesson study is a powerful source of growth for teachers in Japan because it allows teachers to make sense of pedagogical ideas, to change their perspectives about teaching and learning, to see their practice from the child’s perspective, and to enjoy support and collaboration among colleagues. They discuss three characteristics of lesson study that they believe make it so appealing to teachers in North America. First, lesson study allows teachers to focus on teaching and learning in the authentic and grounded environment of the classroom. Second, in lesson study, students and student learning remain at the heart of professional development. Third, lesson study is teacher led, encouraging active involvement in instructional change and curriculum development by teachers.

Teacher Growth and Collaboration

In his model of staff development, Barth (1990) has found it helpful to consider teachers as belonging to one of three groups. Group 1 includes teachers who are unwilling or unable to examine their teaching practice or have other adults examine what or how they teach. Group 2 includes teachers who are able and willing to reflect on what they do and to effect periodic changes based on these reflections, but are uncomfortable opening themselves to the scrutiny of other adults. Group 3 in Barth's model includes teachers who are able and willing to scrutinize their practice and are willing to make themselves accessible to other adults. His model for staff development involves attempting to shift teachers from Group 1 to Group 2 to Group 3. This brings the concept of differentiated instruction – which the educational community has strongly embraced as a necessary instructional approach for children – to bear on the discussion of adult education and teacher growth. As Barth wrote, “if teachers differ in their ability to examine practice and have others examine it, then perhaps our attempts to help them grow professionally should be correspondingly different” (54).

Barth points out that the system in which educators work operate from a “deficiency model of adult growth”; education for teachers often takes the form of one-day workshops aimed at “fixing” practice, and in which teachers are passive participants, as evidenced by the verb “to inservice teachers” (Barth 50). Barth focuses on relationships within schools as a means of tapping into the resources already on staff. In this way, lesson study can be an asset-oriented approach to teacher development, allowing staff members to build relationships and share strengths. One way to do this is through classroom observations, which is an important component of lesson study. Barth points to the importance of classroom observations. For him, it is an absolutely essential condition for teacher growth:

The crux of teachers' professional growth, I feel, is the development of a capacity to observe and analyze the consequences for students of different teaching behaviors and materials, and to learn to make continuous modifications of teaching on the basis of cues students convey. Teachers also need to be able to relate their classroom behavior to what other teachers are doing in their classrooms. (49)

Of course, teachers observe students every day, and effective teachers base programming decisions on what they observe and notice about their students' learning. But purposeful observations that involve a shared experience that can be deconstructed and analyzed together takes this to another level, and breaks teachers out of their isolated teaching worlds to share expertise with one another. In order to know what other teachers are doing in their classrooms, it follows that they must have opportunities to see the teaching and learning occurring in those classrooms. To really “see” the process of student learning and critically examine pedagogy, teachers need one another. As Bird & Little explain, “at least two persons are needed: one to

teach and another to observe and record the teaching, so that both can analyze the practices employed, compare them with alternatives, assess the actual or potential consequences of using one practice rather than another, and draw conclusions” (501).

The thought of being observed can be intimidating for teachers who are used to working in professional isolation from their colleagues behind the classroom door. The culture of schools has done little to form positive impressions around classroom observations. As Bird & Little (1986) point out, observations are often used to evaluate teacher performance and to catch out incompetence. Being observed at work, then, can be perceived as a “bureaucratic ritual or attack” (495). Teachers “tend to turn inward, relying on their own experience in the classroom” (Hargreaves, 1984, in Bird & Little). Bird & Little further point out that the reward for experienced teachers is to be left to “struggle toward proficiency virtually alone” (495). That isolation, “which sometimes is regarded as a teacher’s right, also cuts them off from support and recognition” (Rosenholz & Kyle, 1984, in Bird and Little). This isolation “deprives teachers of the stimulation of working with peers and the close support they need to improve throughout their careers” (Bird & Little, 494).

This lack of opportunities to collaborate makes teaching a “uniquely isolated profession” (Hindin *et al.*, 2007). And yet, Puchner and Taylor (2006) point to research that shows collaboration among teachers to be one of the most important features of a school culture for fostering professional development, teacher satisfaction, teacher effectiveness and student achievement. Other research points to a shift that is happening in schools, bringing teachers together to hone their practice and reflect on their teaching (Hindin *et al.*, 2007).

But building a culture of collaboration is not easy, nor does collaboration alone “automatically produce happier, more professional teachers or result in improved teaching” (Wallace, 1999, 67). Wallace (1999) discusses “true collaborative cultures”, which are not driven by specific projects but are “deep, personal and enduring and are absolutely central to teachers’ daily work” (67). Little (1990) calls this “joint work” (in Puchner and Tayler, 2006). As Puchner and Taylor (2006) explain, joint work means a shared responsibility for teaching. And because it requires shifting from the private isolation of the classroom into the public sphere, it requires teachers to admit that they do not know everything, and that they might need to rely on someone else (Puchner and Taylor, 2006). Lesson study may be a way of establishing a culture of collaboration in which teachers feel safe doing so.

Method

Following the case study tradition (Stake, 1995), we collected descriptive data of participant activity over a two-year period. This one school team was a natural case study because we were able to observe the team very closely due to Tara’s position at the school. Although the other three teams in the larger project reflected similar

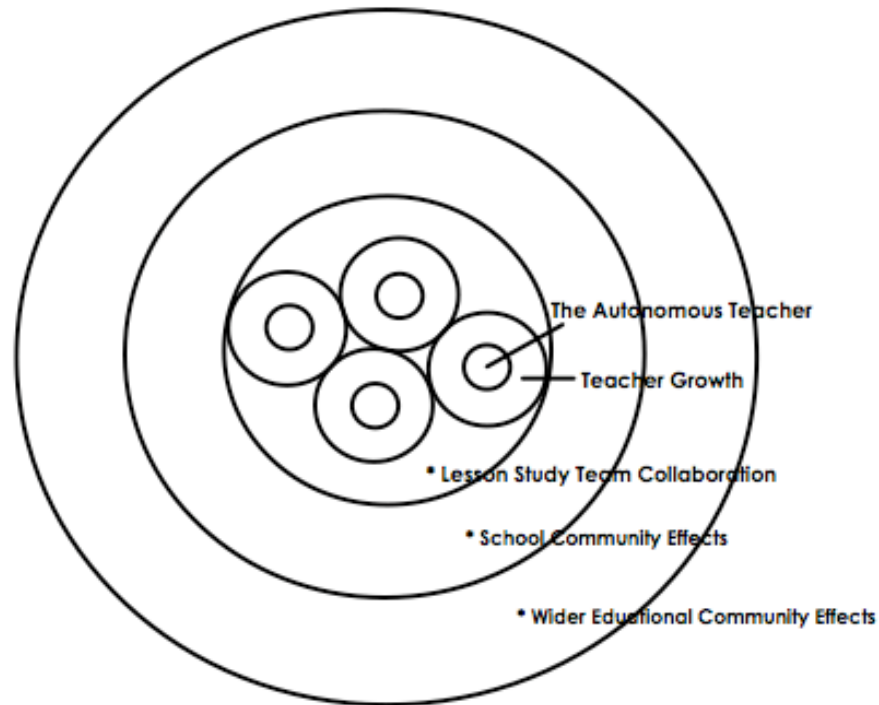
findings, this case acts as an explanatory example, i.e., provides the best evidence we have of the impacts of lesson study.

Data sources included over 30 student and teacher video episodes, approximately 12 lesson study observations and related field notes, transcribed focus group interviews and individual interviews of participating teachers and the principal in the first and second years of the project.

Analysis of the data consisted of open coding by two of the authors independently (drawing out key words and ideas in the texts) (Creswell, 2007). Written responses and transcripts from the second year of data collection were electronically formatted to create a space for open coding along the right side of the page. Subsequently, codes were compared to triangulate the analysis and to support the development of the findings based on agreement between the two coders. Active axial coding (describing processes) was used to merge themes together to find larger categories of processes found in the data sets (Charmaz, 2003). Categories were then cross-referenced with journal entries and previous transcripts from year one of the study to confirm that the categories and codes were robust. Member checks were conducted throughout the data collection and writing stages.

In order to ground our theoretical understandings of the results, we generated diagrams that were continually revised through our writing and discussions. The diagrams helped us to capture the complex experiences of the lesson study teacher team. As analysis and discussions occurred, we began generating a diagram of our overall understanding of “what happened”. Figure 2 represents our most current understanding of the lesson study phenomenon as an organic process of how collaboration might occur in a given school. This findings section is organized from the centre ripples outward according to the diagram.

Figure 2: The ripple effects of lesson study at Highland Heights



The metaphor of ripples in water works particularly well for us because of its organic nature and the natural way in which lesson study has spread out from the team's centre of activity. It allows us to conceptualize the effects of lesson study at the school in a way that reflects the complexity of the school environment; ripples are an observable outcome of a stone dropped in the water, but the mechanisms by which molecules arrange themselves to cause this effect are difficult to describe, and like water, are quickly conflated.

The diagram illustrates how the teachers were essentially autonomous in their teaching activity as a starting point. Once the lesson study process was introduced, their teaching selves began to expand as they began to interact with one another. The members of the lesson study team learned to collaborate with one another and developed a strong sense of belonging and power in the lesson study team. The team then shared their learning with the whole school community in different ways, in part with the support of their school administrator, who sought ways to involve the larger staff in lesson study related activities, and in part through discussions with colleagues in grade divisions. Further, the ripples expanded to the wider educational

community as the teacher team presented their learning across the school district and the province of Ontario at various conferences and educational meetings.

Findings

Our findings showed lesson study to have meaningful effects at Highland. The ripples of lesson study included teacher growth that occurred through the collaboration of the team and visible changes to the culture of collaboration and professional practice at the school.

Teacher Growth through Collaboration in Lesson Study

Math has always been an area of difficulty for me...not only in teaching but in my own school career. I have such negative feelings about my understanding of math as a teacher in large part because I never really even got it as a student. Last year, participating in the Lesson Study project was the first time in my whole life that I actually felt reeealllly good about a math lesson I had taught. That public lesson was the result of 3 heads (and more!) coming together to create an amazing lesson that met an incredible goal. We walked away thinking about how well things went, but more importantly, how we could improve or progress the next time. (Journal entry, Oct. 6, 2008)

It is no exaggeration to say that lesson study has been a transformative experience. The transformative power of lesson study comes from the time and professional trust the teachers were offered in order to work collaboratively in pursuing their own goals. This opportunity to collaborate was the driver for teacher growth. Teacher collaboration in lesson study at Highland took the following forms:

1. Planning meetings, in which the team defined their problems and goals, asked questions and explored possible answers to these questions, all with the aim of formalizing the public lesson;
2. Observing and debriefing the public lesson;
3. Observing and debriefing exploratory lessons;
4. Informal activities that took place in between these events (such as informal conversations and emails among teachers).

In our analysis, we found that these collaborative activities (particularly observing one another teach) built trust among team members, leading to a comfort with risk-taking and classroom experimentation. It also helped teachers to develop new understandings about student learning and about mathematics. Finally, lesson study enabled teachers to build on their professional relationships with one another.

Observation as a catalyst for teacher learning

Observation warrants special mention as the most powerful aspect of the lesson study collaboration to facilitate teacher learning. Teachers were provided with release time to go into each other's classrooms and watch each other teach as part of the lesson study cycle and this emerged from the data as a powerful theme. Classroom observations were the vehicle for transformation of practice and culture in the school.

Classroom observation is a central feature of lesson study; in the public lesson, which is a core component of lesson study, other members of the team observe while one of the teachers leads the lesson that the team planned together. Observers often use team generated observation guides that are tightly focused on student responses and student learning. The debriefing session provides a structure for the teachers and other observer participants to describe what they saw and learned. In the first year of the study, teachers cited classroom observation as pivotal in their lesson study experiences. In their second year of lesson study, the team planned and observed exploratory lessons in each other's classrooms in addition to public lesson observations, further extending their opportunities to observe in one another's classes.

Teachers valued the opportunity to observe other teachers in action, and they valued the opportunity to *be* observed. For most of the teachers on the team, lesson study represented the first opportunity to be in another classroom, or to have others in their classroom watching them teach, since their days as pre-service teachers.

The Grade 4 teacher, who taught a public lesson in the first year of lesson study, experienced nervousness leading up to the performance. Immediately afterwards, she reflected:

It was a really great experience. I wish we could see each other more often that way. It's intimidating in a way, but if you understand people are there just to help you out, or in a way that's building you to make you a better teacher, then you don't feel intimidated. (Transcript from the debriefing of the public lesson, May 14, 2008)

With increased reflection time, this teacher grew even more enthusiastic about the experience: "Thank God I did that! There are people who will teach forever and never have an opportunity to be part of that. That's pretty neat. Thank goodness I was part of that. And thank goodness I did it!" (Focus group interview transcript, June 5, 2008) Nearly a year after the experience of being observed teaching the public lesson, this teacher continued to reflect on the value of the experience, with regret that many colleagues either didn't have the opportunity or, if presented with the opportunity, would be resistant to being observed. She admitted that the idea was scary at first, but that as her trust in her colleagues grew, as she realized that the observers weren't there to criticize her teaching but to have a constructive professional dialogue about student learning, she overcame this fear: "it's okay to have people watching you, because they are not honing in on all the bad things, but

they're picking up all the great things. The discussion isn't about *you*." (Focus group interview transcript, Mar. 24, 2009)

An interesting layer added by lesson study is the use of video. Because the public lessons are videotaped, the teachers also have the opportunity to observe *themselves* teaching afterward. Bird and Little (1986) observe that, "because teaching is hard to do and to watch at the same time, teachers can spend entire careers without actually seeing their best work" (495). Videotaped lessons can help to overcome this problem. For example, the researchers videotaped the public lesson taught by the Grade 4 teacher, and then watched it with her with an audio recording running in the background to capture her comments and observations. After viewing the video and recording the teacher's comments, we briefly interviewed the teacher about the experience of watching herself.

Researcher: Have you ever seen yourself teaching before?

Teacher: No, never. Can you imagine having done your job for ten years and never see yourself do it? How can you even reflect on how well you are doing it if you've never seen yourself do it? (Transcript of interview, Oct. 7, 2008)

This teacher valued this experience, reporting that she had been nervous about watching the tape, thinking she would be embarrassed, but instead "caught" herself doing a lot of positive things with students, which was affirming. Watching the video allowed her to reflect on her teaching in new ways. Recognizing the potential of video to enhance her learning, another teacher wrote, "I'm looking forward to the video-taping of my lesson, as I think it will promote more self-reflection—or at least make self-reflection easier." (Journal entry, Oct. 23, 2008) These examples speak to the power and potential of purposeful observation through lesson study.

Risk-taking and trust-building

The observations were critical for the building of trust, which allowed open constructive dialogue among colleagues. This trust – and the growing sense of comfort that accompanied it – gave teachers the freedom not only to take risks and experiment in their classrooms, but to do so in front of their colleagues. This trust also gave them the space to self-reflect openly on their teaching practice. De Sonneville (2007) calls this "acknowledgement." She describes it thus:

Acknowledgement of a colleague is giving them the space to articulate their position without judgement and validating their perception of their own experience. When one colleague gives another the space to acknowledge himself or herself, this acknowledgement can be the impetus for the teacher to explore their own behaviour self-critically and to make the transformative change which is integral to the learning process.

This is borne out by a quote from one of the teachers, who talked about how the collaboration led to an increase in reflective practice:

There is a shift happening. And I feel that I've grown more this year than I have in 17, of taking risks myself and trying things in new ways. I'll have to be honest that when I went to teachers' college, and we used to have those journals that we had to do. In April, when my journal was due, I sat down at the computer and said: "September 5: today was my first day in the classroom and I was very nervous." Because I've never really bought into the reflection piece and so that's a big shift for me – to genuinely buy in because I see the value of it and I want to do it and I see myself growing. (Transcript of teacher presentation, Feb. 12, 2008)

In interviews, teachers expressed a greater comfort in trying new things and taking risks as a result of their lesson study activity. "[M]ath has probably been one of the areas that I needed to grow the most in, in terms of my personal willingness to take risks ... [lesson study has] impacted me directly in math in terms of being more comfortable to experiment, not fall back on the same old" (Focus group interview, March 24, 2009). This teacher also expressed a greater comfort in asking questions of the others about areas of math of which she is unsure, a sentiment that was echoed by the other teachers (Focus group interview, March 24, 2009). This developing sense of trust among the teachers on the team was especially built through the shared experience of classroom observations. We found that when teaching colleagues came in to observe in the classroom, when this observation was focused on students and was followed by constructive professional dialogue, trust grew. Looking back on her experience of teaching and then debriefing a public lesson, one teacher said, "discussion was about the task that we had made up together, so I didn't feel that it was a discussion about *me*." (Focus group interview, Mar. 24, 2009) There is a relaxing of the pressure "to know everything," a feeling that "three heads are better than one." (Focus group interview, Mar. 24, 2009) The teachers also reported that once they felt a lessening of the pressure to have all the answers, they were able to hand more power over to their students; they were better able to listen to students or put a question back to the class. This, combined with students seeing the teachers working together to solve problems in class, contributed to the sense of 'learning community' in the classroom. In this sense, the teachers were modelling accountability for learning to their students. As the principal described in an interview, "We want kids to take ownership of their learning. Well then, teachers need to take ownership of their learning too." (Mar. 24, 2009)

New understandings about student learning

Teachers also reported that the experience of observing and debriefing revealed new understandings about student learning, which could then be translated into pedagogy. For example, a public lesson in which many students unexpectedly chose an inappropriate manipulative for exploring fractions led the teachers to wonder how they could have worded the task differently (Focus group interview, Mar. 24, 2009). Over time, teachers also demonstrated greater comfort in using alternative forms of assessment (listening to student communication, performance tasks that aren't

“pencil-and-paper”, rich and open-ended problems) that led them to a deeper understanding of how students learn.

Teacher understanding of mathematics concepts: “digging deeper”

Lesson study had a meaningful impact on the teachers’ conceptual understanding in mathematics. “I’m the least comfortable and the least confident in my own math understanding and ability, and to try to teach a concept that I only know because I learned the formula... it [lesson study] kind of gets you to dig deeper” (Focus group interview, March 24, 2009). Researchers have observed this process of “digging deeper” at many of the planning sessions, as when the team spent time building physical models of algebraic expressions (Field notes and video files, Nov. 14, 2007) or debating the meaning of multiple representations (Field notes, Jan. 15, 2009).

Building teacher relationships

Because two of the teachers on the team are in the intermediate division, the impact appears to be strongest in that division. These teachers represent the entire intermediate division at the school and are an interesting case for this reason. They work across the hall from one another. Several years ago, observing a power imbalance between the Grade 7s and 8s and wanting to improve the student community in that division, the teachers along with the principal made the decision to create two split Grade 7/8 classes.

Since that time, the intermediate teachers had been doing some coordination of programming, but it was lesson study that allowed the relationship to blossom into full-blown collaborative planning. In focus group discussion, the two teachers noted how their professional relationship had changed as a result of lesson study:

Heather: I think lesson study really helped. I don’t think it would be the same if we didn’t have that, because it’s easy to have a grade partner who you don’t talk to... Even when Karen and I were still good friends before lesson study, we didn’t talk about teaching. We really didn’t. We talked about the kids, we complained. But we never really talked about lessons.

Karen: Yeah, you’re right. The fact that we whip stuff back and forth across the hall now and do each other’s lessons...(Focus group interview transcript, Mar. 24, 2009)

Here the teachers are noticing how their lesson study collaboration has resulted in ongoing co-planning beyond their regular lesson-study activity. The collaboration has spilled over into their day-to-day teaching. One of the teachers was struck by the observations of another colleague, the resource teacher, who is not a member of the lesson study team. He had been coming in to provide teaching support in both classrooms in the year prior to lesson study and during the first year of the project. His observations highlighted this overall change emerging from their work in lesson study:

Karen: He [the resource teacher] said when he first started doing it, he'd go back and forth across the hall and what intrigued him most was the fact that we might be in the same area of the curriculum, but how different the lessons were. What was going on in the two rooms was so different – different perspectives on everything. And a couple of weeks ago he came into to do an announcement, and he comes across the hall and he says, it was the same lesson, in the same spot, in the same discussion – and he was blown away.

Heather: And not to say that we don't still have our individuality but at least we collaborate more so that when we create something, we create it together. (Focus group interview transcript, Mar. 24, 2009)

Thinking back to their relationship prior to lesson study, Heather noted that they were able to vent frustrations, but not in a productive way: “You would express your frustration with no inkling of improvement really, because we didn't really have that kind of relationship.” The other teacher noted that they continue to share their frustrations with one another, but now there is “also productive conversation.” Their conversation indicates that lesson study has affected lasting change in the professional relationship.

School-Community Effects

The impact of lesson study on the wider school community was visible in four areas: the crossing of boundaries traditionally formed by the classroom and by grade divisions; an increased focus on math in the school; enhanced use of technology throughout the school, and the building of more positive professional relationships.

Crossing boundaries through lesson study

With the inclusion of the primary teacher in the second year of the project, all divisions were then represented in the lesson study team. The teachers set out to take advantage of this cross-grade opportunity by creating exploratory lessons that would allow them to work with one problem presented in developmentally appropriate ways for each grade. They then discussed what students did with the problem across the grades, an exercise that helped all the teachers better understand student learning (where students are coming from and where they are going) as well as content (the degree of understanding of the same concepts in primary, junior and intermediate grades). It also challenged the teachers to explore problems that were open and rich enough to be accessible across a broad range of ages and stages. In one recent cycle of lesson study, they expanded their work in this area by asking 4 teachers on the staff who were not on the lesson study team to try the exploratory lesson and share their observations of students with them.

Prior to lesson study, teachers were mandated to meet in their grade groupings (K-3, 4-6, 7-8 divisions) to form PLCs and set S.M.A.R.T. goals (a district mandate, standing for goals that are specific, measurable, attainable, realistic and time-bound) in literacy, but there were no mechanisms in place for sharing across divisions. An

important outcome of lesson study at Highland was the cross-divisional collaboration of the teachers. This cross-divisional sharing added a new dimension to the culture of professional development at the school.

Increased focus on math in the school

The school participated in district-mandated PLCs in which divisions met to set short-term goals for student achievement. Previously, these goals were entirely literacy oriented because of a focus on literacy in the district. When the school board expanded the focus to numeracy, the team was already in its second year of lesson study in mathematics. Because the teachers were already engaged in an ongoing professional dialogue about math, they were well-prepared to set their goals in this subject area. In fact, they were able to influence the agenda of the PLCs in math to parallel the work they were already engaged in with lesson study (they set their focus around the process goal of communication in math, which was also the focus of their lesson study work in year two). According to the principal, the work of the team in lesson study has also affected the overall tone of the PLCs held in the school. The principal believes the rest of the staff saw this teacher-led initiative and the ownership that the teachers had over the process, and that this sent a “key message” to the rest of the staff, which had an important ripple effect. Lesson study is “giving the message that teachers have ownership, and that’s how you’re going to be a better teacher and that’s how kids are going to improve. The whole focus is so that *kids* do better. That’s the purpose.” (Interview with principal, Mar. 24, 2009) Clearly, teacher agency has increased over the two years of the project.

Some of the principle activities of lesson study are leading to new collaborative activities with teachers in the school beyond the lesson study group. For example, the team’s Grade 4 teacher talked to colleagues in the junior division about “how great it is” going into each other’s classrooms, seeing each other teach, and designing rich tasks (all part of her lesson study experience with the team). Out of that discussion, an idea emerged among the junior division to do what she referred to as a “math rotation,” in which the division planned a two-day task sequence where students rotated among the classrooms doing different activities, and then returned to their own class to consolidate what they had learned over the two days. The teachers then debriefed on the experience as a group. Heather described the enthusiasm of one of the junior grade teachers involved, and remarked: “So there’s a spinoff right there, you’ve changed somebody’s view of what can happen.” (Focus group interview, Mar. 24, 2009)

Enhanced use of technology

Over the two years of lesson study, the team focused on effective use of interactive whiteboards (IWB) in math instruction. The three teachers initially involved in the first year of the project each received an interactive whiteboard through project funding; these were the first IWBs to be installed in the school. In the second year, the primary teacher who joined the team also received an interactive whiteboard.

Since the installation of the first IWBs, staff outside of the lesson study project have been exposed to their use at staff meetings. The lesson study team has also presented their work at staff meetings and have been deliberate about offering to have other teachers in to their classrooms (holding classes in their rooms when they are in the gym or library, for example), as well as support in getting started in using the technology. Both the French teacher and the Child and Youth Worker regularly use the IWB when teaching in those classrooms. Since the installation of the first IWBs, the use of technology in the school has exploded. The principal has invested in several document cameras (which can be used with any LCD projector) and reports their regular use and enthusiasm from teachers, particularly surrounding the potential for sharing student work and teacher modelling of written work. And the principal has plans to find budgetary support to install more IWBs; as she put it, "I'd rather spend our money on interactive whiteboards than on textbooks, because they're so powerful." (Interview, Mar. 24, 2009)

The interactive whiteboard technology itself facilitates collaboration and sharing because of the ease with which information, lesson plans and tools may be shared. The lesson study team has found the interactive whiteboard to be a very effective tool for teaching in math as well as other subjects, when used purposefully. The primary teacher who joined the team in the second year was at first reluctant to use the IWB because she had only ever seen it used to present text or presentation slides and had not been exposed to the full range of its instructional potential. Since exploring the use of the technology through lesson study, she has become very enthusiastic about its use and its potential for addressing on-the-spot teachable moments (Focus group interview, Mar. 24, 2009).

Building positive professional relationships

My experience suggests that the professional growth of teachers is closely related to relationships within schools, between teacher and principal, and between teacher and teacher. I am convinced that great untapped opportunities for the professional development of teachers reside within the school and that the principal can be a catalyst assisting teacher growth." (Barth, 50)

Unfortunately, according to Bird and Little, "teachers and principals do not often work together on classroom teaching and learning. Principals are more likely to deal with students' failures than to promote their success. Few principals attend steadily to the important details of instruction." (502) This, fortunately, is not the case within this school. When asked to write a response to a journal prompt about the factors that are enabling success in lesson study, the first item teachers listed related to the support of their principal. One teacher wrote that "having such an involved, trusting and capable administrator, who will go to bat for us with full force" is an important factor in the success of their project (Journal entry, Jan. 15, 2009). Another teacher wrote that "our principal is always very supportive and has approved all the time

we've needed, provided resources for us (human and non).” (Journal entry, Jan. 2009)

There is ample concrete evidence of this administrative support. The principal has attended all of the public lessons that occurred in the two years of the project, taking an active part in discussions around student learning. For an upcoming public lesson, she secured funding to provide release time for most of the staff to attend. (Personal correspondence, Apr. 23, 2009) Clearly, lesson study is a priority for the principal as she is taking steps to engage other staff members in the lesson study process, with a view to expanding lesson study throughout the school in future years. She expresses a hope that lesson study will grow, and that the team will grow and group themselves into two or more teams in the near future (Interview, Mar. 24, 2009).

The principal recognizes that the teachers’ choosing of their learning goals led to ownership over the process, observing that “lesson study was something that they have *chosen* to work on specifically, they had more ownership in it.” (Interview, Mar. 24, 2009). This understanding caused her to define her role:

They were looking at the data, they were choosing what their goal was going to be. I wasn’t telling them what it was going to be. I’m there to provide support and facilitate the conversations and maybe asked some tough questions and get them thinking about things – that’s my role, it’s not to tell them. (Interview, Mar. 24, 2009)

In interviews, teachers have corroborated this supportive stance on the part of the principal. Time and time again, they have referred to the importance of the trust and confidence shown by the principal in allowing them the time to set and pursue their own goals, and the backing of this support with funds towards technology and release time. As one teacher put it: “I think she’s watched us work together in lesson study, she knows... okay, they’re going to accomplish what I’d need them to accomplish, even if they do it in their own way, I’m going to step back here.” This trust has been highly valued by the teachers.

Administrative support proves to be a major contributing factor to the success of lesson study, according to the PMENA working group. They considered the lesson study situation ideal when a lesson study teacher team is supported by an administrator who is involved from the beginning stages and continues to be a presence throughout the lesson study cycle. Researchers have consistently established a positive relationship between effective principal leadership behaviours and student achievement. Without effective leadership, even staffs with many dedicated and skilled teachers are not able to function as an effective school community to ensure high levels of learning. The administrator is also in a position to be able to use lesson study in order to respond to external mandates so that “lesson study is not one more demand on teachers but the primary means of addressing the many demands they face.” (Lewis *et al.*, 2006) This certainly appears to be the case at this school, as evidenced by the overlapping of goals of lesson study and divisional PLCs.

It is interesting to note that Lesson study at Highland has also had an effect on the wider educational community as the teacher team has presented their learning across the school district and the province of Ontario at various conferences and educational meetings.

Implications

Just as potters cannot teach others to craft in clay without setting their own hands to work at the wheel, so teachers cannot fully teach others the excitement, the difficulty, the patience, and the satisfaction that accompany learning without themselves engaging in the messy, frustrating, and rewarding “clay” of learning.” (Barth, 1990, 49)

The ripple effects of lesson study have many important implications for understanding how the work of one small group of teachers in sustained collaborative venture can impact the culture of a school. It is also a story that helps us to understand the power and potential of lesson study for professional development in schools. The key implication we would like to point to in this paper is that lesson study can act effectively as a framework of teacher collaboration that emphasizes:

- a) developing common language and goals in mathematics teaching;
- b) bridging the gap between theory and practice; and,
- c) professional growth.

In these ways, lesson study is the stone in the pond that has the potential to cause ripples that move out in an ever-increasing circumference of collaboration and influence.

The result of the work of the lesson study team has been the development of a common language for talking about students, teaching, and learning. This phrase came up in interviews with the teachers and with the principal as a powerful theme. As Heather put it:

I think it gives us, when we’re giving our feedback, common language. We are better at giving feedback now. How do you have a professional dialogue about a lesson without it being taken personally? And just having blunt dialogues about what we do. We do this all day, yet we never talk about it. It’s like this private little thing that you do, all in the same building... but nobody talks about it. We all do our own thing, and it’s all productive, but nobody wants the details.

Lesson study has changed all that. Heather observes: “it’s given us more venues for actually discussing our craft, our professional craft that we do every day. We never had that before – I’ve never had that before.” (Focus group interview, Mar. 24, 2009)

The principal also noted this development of a shared language allowing professional constructive dialogue about teaching practice as a most important outcome of lesson study: “Getting that common focus is really, really important. The common language, and that ownership, is really really critical.” (Interview, Mar. 24, 2009) The principal saw the setting of common goals, the ownership teachers had over their learning, and the development of a common language to be critical to the success of lesson study and its ripple effect in the school.

This development of a common language is critically important because it allows teachers to share stories and expertise and to “accumulate a lore of teaching.” As Bird and Little write, teaching is the only profession in which its practitioners leave no mark: “teachers may leave their mark on many students but leave no mark on teaching” (503). Because of the nature of teaching, “teachers’ lore does not accumulate” to be transmitted from one generation of teachers to another (503). Teaching, by its performance-based nature, is intangible, difficult to trace (Bird & Little). The teachers at Highland *are* accumulating a body of knowledge: a collection of documented materials and a shared repertoire of best practices in teaching developed through their collaboration in lesson study.

Since teaching is performance, it follows, then, that “to understand or influence the main elements of teaching, one must be present and prepared to help.” (Bird & Little, 501) This is borne out in the story of lesson study at Highland, as the following conversation illustrates:

Lisa: two heads are better than one. And then afterwards you’ve got two people who can reflect on it and say, “okay, that part sucked. Let’s can that next time.” Or, “I found this worked really well, I did this instead and we didn’t even have that in our plan”... all this stuff to just make it the next time, that much better... you know though, working alone, if something sucks, the next time you go in you look at it and you go “oh, well, I’m not doing that again.” Or, “that was a whole waste of a period.” But nothing about, “how am I going to fix it?”

Heather: You know it didn’t work, but you don’t know what to do.

Lisa: That’s exactly right.

Karen: Or those little understandings that you get of kids that help the other person, because maybe they’re not on the same wavelength. ... That’s helpful when you can discuss what’s gone wrong in your class. (Focus group interview, Mar. 24, 2009)

Further, the collaboration of teachers and researchers in lesson study has helped to bridge the gap between theory and practice at Highland. Bird & Little (1986) bemoan the fact that “although research has much to offer teachers, teachers and researchers seldom share relations that would provide plausible support for the use of research findings.” (503) The researchers recognize that the flow of knowledge goes both ways, and are excited about what we are learning from the teachers at Highland. We hope that this research model brings value to the school, in the spirit of Bird & Little,

who write: “Researchers and faculties have considerably more to contribute to each other and to school organization than the findings that they write or read. They can promote school improvement by the way they do research in schools.” (508). We would add that teachers also have considerably more to contribute to each other and to researchers, and that lesson study provides an effective framework for this to occur.

The lesson study teachers along with the principal all see lesson study as a powerful vehicle for teacher growth. In fact, the school is at the cusp of expanding lesson study as a professional development model for more teachers, in the school. The fact that lesson study is affecting the culture of collaboration at the school has implications for student learning and student achievement. Balfanz & Byrnes (2006) acknowledge that whole-school reforms are expensive and difficult to implement, but acknowledge that they can affect student achievement. They studied multiple cohorts of middle school students and found that, not only did schools that implemented whole-school professional development models have higher student achievement in mathematics, but that these schools also were able to close the gap between advantaged and disadvantaged students. The reforms which Balfanz & Byrnes recognize as directly impacting classroom practice – strong instructional programs, better supported, trained and more knowledgeable mathematics teachers, and improved learning climates – can be achieved through lesson study.

There are very few examples of researched case studies and related publications in North America, especially in the Canadian context (Fernandez & Yoshida, 2004). The gaps in the research show a pressing need for expanding the knowledge base of lesson study beyond the existing case studies. The story of lesson study at Highland Heights can help address this gap by supporting teachers and researchers in their understanding of the mechanisms of lesson study that enable teacher professional development to occur. Because lesson study is not carried out in any large-scale systematic way in Canada, there is little opportunity given to teachers to influence national educational policy as there is in Japan (Fernandez, 2002). And yet, as we have seen, lesson study is a powerful vehicle for teacher growth and the expansion of collaborative cultures in schools; the documentation of the events at Highland and the sharing of their stories may contribute to the understanding of the potential of lesson study in the Canadian context.

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