

Lesson Study: A Site for Teachers' Professional Growth and Use of Instructional
Innovations in ELL Classrooms

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Abstract

This paper presents the findings of a lesson study research project undertaken by a team of teachers and researchers in the Center for the Mathematics Education of Latinos/as. We examined changes in teachers' understanding of mathematical content and of teaching mathematics to Latino/a students while incorporating in their instructional practices students' linguistic and sociocultural resources. The four teachers that participated in the project were from a middle school with high population of Latino students, which was ranked by the school district as underperforming for the past three years. In our approach of the lesson study cycle, we tried to accommodate the teachers' and school's needs and at the same time to create an activity system where the teachers can improve their knowledge-for-practice, knowledge-of-practice and knowledge-in-practice. Consequently, we changed the structure of each of the three cycles that were part of the project. Our paper presents the reasons that led to these modified versions of the Japanese lesson study cycle, and the change experienced by one of the teachers that participated in all three lesson study cycles of the project.

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Lesson study has been for the past decade of the educational reform in the United State a novel approach for improving mathematics teaching learning that captured the attention and the interest of many teachers and researchers. Addressing the problematical issues in the new reform in education, which requires a critical switch from direct and teacher-centered instruction toward inquiry and student-centered education, has found a valuable approach in lesson study settings. By its structure, a lesson study cycle builds a community of teachers that focuses its activities on exploring and improving the learning-teaching relationship. Therefore, based on social theory of learning, we can reasonably assume that any practitioner of lesson study will experience a positive change as an individual and as a professional. What becomes important at this point is to unveil and bring to the surface evidence that elevates this assumption to the level of reality. Research has been shown that by participating in lesson study, teachers can construct and expand the pedagogical content knowledge needed for reform-minded teaching (Fernandez, 2005). However, we need more systematic research of the opportunities, avenues and facets of learning that every teacher participating in lesson study experience. With this perspective in mind, we focused the analysis of the impact that the practice of lesson study has on participant teachers, and more specifically on the evaluation of their professional growth. As a consequence, the research question that guided our analysis

was: What are the changes in teachers' knowledge-for-practice, knowledge-of-practice and knowledge-in-practice while practicing in lesson study? We present the findings of our analysis by the case study of a teacher that participated in all the three lesson study cycles which were parts of our project.

The study from which we are presenting in this paper was conducted under the umbrella of the Center for the Mathematics Education of Latinos/as (CEMELA), a multi-university consortium focused on the research and practice of the teaching and learning of mathematics with Latino students. One of its goals is to develop a model of the mathematics learning and teaching that incorporates the cultural, social, and linguistic resources provided by the Latino communities. In this context, lesson study has become an important tool for investigating an overarching CEMELA-wide research question: what are the issues and challenges teachers face as they adapt or create instruction in mathematics to meet the needs of Latinos, particularly in light of language and culture?

Our goal for the lesson study research project is to identify and analyze the changes in teachers' understanding of mathematical content and of teaching mathematics to Latino/a students while incorporating in their instructional practices students' linguistic and sociocultural resources. Therefore, we aim to create a learning community in which the participants experience: the mathematical discourse endorsed by the collaborative planning of a research lesson; the challenges of teaching and observing the research lesson in order to improve its impact on students' understanding and learning of the mathematical content; and the reflective practice of the complex process which is teaching mathematics.

The project started in Fall 2005 with a group of four teachers from a middle school situated in a low-income Latino community in a southern town of Arizona. From the beginning, the project was considered to be a collaboration between researchers and teachers. Since each of the participants was novice to lesson study, our first attempt was to structure the cycle by following the Japanese model described by Takahashi & Yoshida (2004). However, there were three initial factors that shaped our first cycle. The first factor was the researchers' intent to provide information that would advance teachers' knowledge-for-practice. Therefore, the planning part of the cycle became a sequence of readings provided by researchers followed by discussions. The planning of the research lesson was based on decisions reached in our group meetings. The second factor was the diversity of the teachers. The group covered all the middle school grade levels: two teachers were teaching 8th grade mathematics, one was teaching 7th grade mathematics, and one was teaching 6th grade mathematics. For this reason, the group considered that the research lesson has to be taught at each level. This factor influenced the selection of the goal for the cycle and the topic of the research lesson by reflecting on problematic teaching areas common to all three grades. The third factor that was influencing the whole logistic of the cycle was the school's characteristic. The lesson study was taking place in a middle school with 86% Latino students out of which 24% were identified as English language learners, and 84% of the students were eligible for free or reduced lunch. Therefore, the social and cultural aspects involved in this particular educational setting were strongly emphasized during planning, teaching and debriefing the research lesson. Moreover, for the school year 2004-2005 the school was ranked as underperforming by the Arizona Department of Education. In order to improve the

school's situation, the district made considerable changes to the school's organization, and the teachers were given extra activities and responsibilities. Because of this, to schedule the meetings for lesson study became heavily problematic.

The project included three complete lesson study cycles. The first cycle had as its research lesson topic: "Adding fractions with unlike denominators" which was taught three times in 6th, 7th, and 8th grade classrooms. The debriefing and revising of the lesson took place each time right after the lesson and lasted 30 to 45 minutes. For the second lesson study cycle, the topic of the research lesson was: "Analyzing Games of Chance." It was taught again in 6th, 7th, and 8th grade classrooms and we debriefed for 30 to 45 minutes after each lesson.

A very critical point for our practice and development of the lesson study was that after the second cycle, the teachers had to prepare a presentation of their experience for the NCTM-2007 conference. To make the presentation, the teachers used the same approach as a lesson study cycle. They met regularly to reflect on their practices of the lesson study cycles and to plan the presentation. They gave two presentations in front of two different audiences, debriefing and making revisions after each presentation. The higher level of critical analysis and thinking that was initiated by this experience, led us to think of extending the lesson study cycle model with a new stage in which the participants reflect on the entire lesson study process.

The group had already planned for the third cycle when two of the teachers moved to other schools and another teacher was unable to continue due to new duties at the school. In this situation the 6th grade teacher organized a lesson study cycle with another 6th grade teacher with the goal to create a lesson that would help low performing students

understand the long division algorithm. The research lesson was taught twice and after each lesson we had debriefing and revising sessions for 45 to 60 minutes. This was the third lesson study cycle included in our project.

Theoretical framework

To analyze how our teachers changed during their participation in our lesson study project, we combine two key aspects of teachers' professional growth: the nature of knowledge needed for teaching and a measure for the change in each type of knowledge. First, we consider that the knowledge needed for teaching can be classified into three categories: knowledge-for-practice, knowledge-in-practice, and knowledge-of-practice (Cochran-Smith & Lytle, 1999). Second, the structure of a lesson study cycle allows us to historically construct activities (planning a research lesson, teach the research lesson, and debrief and revise after each lesson taught) in which zones of proximal development (ZPD) ("the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers." Vygotsky, 1978, p. 86) can be identified while teachers are participating in these activities. Therefore, to measure our teachers' development, we use activity theory to explain the intellectual growth as the process in which each participant gains knowledge through external mediation within a community where he/she follows established rules while performing a specific part of the whole group activity (Cole, 2003). In this framework growth is represented through the process of appropriation. For each category of knowledge: knowledge-for-practice, knowledge-in-practice, and knowledge-of-practice, we consider five levels of appropriation: lack of appropriation, appropriating a label

(knowing a tool's name but none of its features), appropriating surface features (knowing some or most features of a tool but not being able to use them as a "conceptual whole"), appropriating conceptual underpinnings (understanding the theoretical basis of a tool and being able to use it occasionally in new contexts), and achieving mastery (using the tool effectively) (Grossman, Smagorinsky & Valencia, 1999).

Under the arch of the theoretical perspectives described above, we focus our analysis on the teacher that was part of the lesson study group in each of the three cycles of our project.

Methods and Data

This study is based on data collected in three stages: before the lesson study project started, during the project, and after the third cycle in a setting different from lesson study.

Before starting lesson study, all our teachers were participating in a professional development cohort for middle school mathematics teachers organized by the CEMELA project. During this time, the researchers of the CEMELA project conducted an interview on teachers' view and concerns about learning and teaching mathematics. Moreover, during the same period of time, the CEMELA project was trying to adopt an observation protocol as a common instrument used to examine classroom environments, and a series of observations was done for this purpose. Therefore, in order to create our teacher profile before her participation in lesson study, we combine the data provided by these two sources.

During lesson study we video-taped every planning meeting, every research lesson, and every debriefing session. From the analysis of these videos we were able to identify instances of teacher growth.

The third stage of the data collection was facilitated by a small project required by a teacher education graduate course. For this project, the teacher was interviewed once and her classroom practice was observed three times. The audio recorded interview and the field notes collected during the classroom observations were also included in our qualitative analysis in order to recognize if any of the experiences that the teacher had with lesson study were transferred to teacher's current practices.

Findings

Ms. John is a sixth grade teacher in her fourteenth year of teaching. She spent her entire teaching career in the same middle school which has always had a high percentage of Latino/a students. Despite her long experience with this population of students, she is continuously concerned by the fact that she is not able to overpass the language barrier which is between her and her ELL students, since she speaks only English. For this reason, her main interest in the professional development activities in which she participated, including lesson study, was to learn strategies that she can use when she feels that she is not communicating with her students. She especially appreciated our lesson study setting because she was able to collaborate with her Latino/a colleagues and observe them teach.

As mathematical background, she completed the required college level course for a bachelor's degree in elementary education and some courses beyond these. She describes her experience as a learner of mathematics in the following way:

“Math was not a strong subject, my grades were C’s and D’s. I spent my Sunday evenings with my grandfather. He was my tutor since he was a mechanical engineer professor at the university. This tutoring was imposed when I would receive a D for the home-works. I would have to continue the tutoring until the grade was brought up. I enjoyed the sessions because I adored my grandfather. When I took the college courses, I worked hard and probably depended on my children for help.”

Ms. John considers that she can handle basic math, but she thinks she does not have the kind of mind needed to do advanced math. For her, to be good at mathematics means to remember formulas, principles, procedures, and to think in a logical step-by-step manner. This view is reflected in her teaching style. A typical lesson taught by Ms. John involves a warm up problem on which students are asked to work on about 5 minutes, a review of the homework done usually by showing the correct answers on transparencies; then either she introduces new content followed by an application and students have to reproduce a similar one or she performs some exercises on transparencies and students are asked to work similar ones individually. However, Ms. John showed a real enthusiasm to try the new ways of teaching exhibited by lesson study.

As a mathematics teacher, Ms. John experienced a positive change by participating in lesson study. We analyze this change through the lenses of the three categories of knowledge needed for teaching: knowledge-for-practice, knowledge-of-practice and knowledge-in-practice.

Changes in Knowledge-for-Practice

Cochran-Smith and Lytle (1999) consider as being part of the knowledge-for-practice, all the general theories and research-based findings from all the domains included in the process of education. These domains are the content and subject matter, the foundation of education, human development and learners, classroom organization, pedagogy, assessment, the social and cultural context of teaching and schooling, and teaching as a profession. Even if it is not stressed in the structure of the lesson study that the participants in a cycle would explore the knowledge-for-practice domains, the CEMELA researchers considered from the beginning that the planning stage of the lesson study is the appropriate context in which teachers can improve their mathematical and pedagogical knowledge needed in the socio-cultural environment created by low income Latino communities. Therefore, the main goal of the researchers as members of the lesson study group was to provide theoretical information about the mathematical content, strategies of teaching, and theories of learning that would contribute to a profound and thoughtful analysis of the topic chosen for the research lesson.

In the first lesson study cycle the group of teachers wanted to create a research lesson that would help students to understand the addition of fractions with unlike denominators which they considered as being a crucial problem at all grade levels. The set of readings selected for this topic included *The Teaching Gap* by Stigler & Hiebert and several chapters from *Teaching Fractions and Ratios for Understanding* by Susan Lamon. These readings brought a perspective on teaching fractions that was new for Ms. John. To let students struggle, to make mistakes, and to guide them from there was not considered as a possible way to teach. She said that she “would not let them to make the mistake” and

she “would not set them up for failure,” in referring to her students. The readings lead Ms. John’s to see a new teaching approach: to let students make mistakes.

“The one that I like it here, which it was great, was adding two fractions, it was like $\frac{1}{4}$ and $\frac{1}{2}$, and if a kid comes out with $\frac{2}{6}$, explain how he got that. Does that make sense? Why does that happen? I like that, I thought let them to make the mistake and then explain to me. And then, once they see that, oh... I have to prove it, and that did not work, how many of them from then on will continue to add the denominator when you are not supposed to. That I thought was great. Let them make the mistake.”

In the second lesson study cycle, all four teachers agreed to plan a research lesson on probabilities. The topic of the lesson was “Analyzing Game of Chance” which is part of the Connected Mathematics Project curriculum adopted by the school district. This time, in addition to the readings related with the topic, we decided to play the “Roller Derby” game included in the lesson’s investigation, slightly modified, to allow a deeper approach of the game. This activity helped Ms. John to understand the meaning of the probability computations involved in the analysis of the game. She told us, in one of the following meetings:

“I probably would not be able to do that [a problem from a standardized test] if we had not reviewed them by playing that game ... because we sat out there and we said: oh ... how can we find out? Then right away, that was what we started to do it. I would not be able to do that problem, to show the students how to show their work”

Moreover, this event that happened in her classroom helped Ms. John to understand how beneficial it could be for a teacher to do each activity that will be presented to students. Once more, a new aspect of teaching was unveiled to Ms. John.

The goal of the third lesson study cycle was to design a lesson that would help the low-performing students understand the long division algorithm. As in the previous two cycles, we started with a discussion of the research done on teaching the long division algorithm. Ms. John was very surprised, and she looked confused by the fact that the research stressed that understanding place value of the digits is critical for performing the long division algorithm. She confessed that she has never thought of place value when she divides two numbers. She would even delete the same number of zeros from the end of the numbers if both numbers happen to end with zeros.

All the instances described above are evidence of Ms. John's ZPDs development while participating in lesson study related to the knowledge-for-practice domain. First, the pedagogical strategy of letting students struggle and make mistakes which was at the lack of appropriation level before the lesson study, reached the conceptual underpinnings level since this strategy was used by Ms. John while she was teaching the research lesson. Second, Ms. John's understanding of the meaning of probabilities computed in the analysis of the "Roller Derby" game increased from appropriating a label to appropriating surface features. Some mistakes made by Ms. John while teaching the research lesson of the second cycle show that she was not at the conceptual underpinnings level of appropriation. Finally, the level of appropriation for the place value role in performing the long division algorithm went from lack of appropriation up to appropriating a label

since she was arguing that deleting the zeros from the ends of the numbers does not change the answer.

Changes in Knowledge-of-Practice

Knowledge-of-practice comes from a teacher's own experience by direct interaction with the process of teaching. As Cochran-Smith & Lytle state: "teachers across the professional life span play a central and critical role in generating knowledge of practice by making their classroom and school sites for inquiry, connecting their work in school to larger issues, and taking a critical perspective on the theory and research of others."

In a lesson study cycle, teaching the research lesson provides a unique and valuable experience. The uniqueness comes from the fact that the teacher has to follow a lesson plan that contains only partially her/his ideas. The teacher that teaches the research lesson has to interweave her/his style, personality, and knowledge with the ideas, strategies and approaches that were imbedded in the lesson plan by the other participants. This non-easy task creates the challenge that can bring teachers to their ZPDs. For this reason, we consider it important to have each teacher teach the research lesson at least once.

Ms. John taught each of the three research lessons. In the first and second cycle she was the second teacher to teach the research lesson. In the third cycle she was teaching first. In each of the lessons taught by Ms. John, we were able to identify moments of her professional growth. In "Adding fractions with unlike denominators," by letting students struggle she was able to identify that there are students that can have an incomplete understanding of adding fractions with unlike denominators. While observing students trying to figure out the correct answer for adding $\frac{2}{6}$ and $\frac{1}{4}$, Ms. John heard the

conversation between two students who were confused about the new numbers of the numerators. They seemed to understand that the common denominator 12 is the least common multiplier of 6 and 4 but they wondered why the numerators were then 4 and 3. This discovery pushed her to think about the need to point out the change of the numerators at the same time as the change of the denominators. During the debriefing Ms. John expressed her observation and thinking to us:

“I think that would be the next lesson. We see how we find the common denominator. Now, how do we find the numerator that goes with the common denominator?”

Therefore, for her, it was important to reopen the discussion with the whole class in their next meeting to clarify and reorganize the knowledge that the students partially acquired in the research lesson that she taught.

Teaching the probability research lesson “Analyzing game of chance” facilitated another learning moment for Ms. John. One of the goals of the lesson was to have the students visualize the connection between the experimental data and the theoretical data. Therefore, during the planning, the teachers decided to collect the data that students generated when they played the game, to make a chart with these experimental data, and then to compare this chart with the theoretical data. The chart with the experimental data was supposed to have a bell shaped form similar to the chart of theoretical data. When Ms. John taught the research lesson, she was having only a surface-features appropriation of the meaning of the charts and consequently she wrongly created the graph of the experimental data. First, she did not maintain a straight horizontal line for the bottom of

As we tried to depict in this section, by teaching the research lessons, teachers experience challenges that can situate them into their ZPDs. During her teaching of the first research lesson, Ms. John became aware of the fact that there may be students who have an incomplete understanding of addition of fractions with unlike denominators. The ZPD created through this event improved Ms. John's knowledge about student understanding of adding fractions with unlike denominators. The new aspect of incomplete understanding was at the lacking of appropriation level before she taught the research lesson and she appropriated surface features after the lesson. She did not have a conceptual underpinnings appropriation because she was considering that the cause of the incomplete understanding is the fact that the students do not know that: "What you do with the denominators you have to do with the numerators". Through this statement, Ms. John showed that she cannot go beyond the procedure to the conceptual meaning of adding equivalent fractions that have the same common denominator.

In the probability research lesson, by wrongly recording the data, Ms. John was appropriating surface features of the understanding of the probabilities computed in the analysis of the "Roller Derby" game. When she noticed the mistake and tried to mend it, we considered this evidence of the nascent stage of her conceptual underpinnings appropriation.

From the third research lesson taught by Ms. John, we are able to identify her appropriation levels for the place value role in performing the long division algorithm before and after the lesson. Before the lesson she was appropriating a label, after the lesson she was appropriating surface features since she was able to correctly rework the strategy but she did not make any direct connections with the long division algorithm.

Changes in Knowledge-in-Practice

Knowledge-in-practice includes all the knowledge that a very competent teacher has and they are directly reflected in their practice. It is assumed that “teachers learn as they have opportunities to examine and reflect on the knowledge that is implicit in good practice – in the ongoing actions of expert teachers as they choose among alternative strategies, organize classroom routines, and make immediate decisions as well as set problems, frame situations, and consider/reconsider their reasoning” (Cochran-Smith & Lytle, 1999, p. 262).

The structure of lesson study creates a valuable source for knowledge-in-practice. We make a distinction between two features of this source. The first one is provided by observing an open research lesson which implies that the lesson was already revised several times before it was open to the public. The second feature comes from observing the other members of the group teaching the research lesson that was designed during a lesson study cycle.

Ms. John was not able to observe any of the open research lessons taught by more experienced practitioners of lesson study but she observed every research lesson taught in our lesson study cycles. We came to believe that each time Ms. John observed a lesson she improved her knowledge, generated new ideas, and gained new perspectives about teaching. For example, when Ms. John observed the probability research lesson revised after she taught it, she was able to see the correct chart of the experimental data and to fulfill the conceptual underpinnings stage of appropriation for the understanding of the meaning of probabilities computed in the analysis of the “Roller Derby” game.

Changes across the Domains

Ms. John experienced a cumulative growth across all three domains as evidenced by the previous example. In the knowledge-for-practice domain Ms. John's understanding of the meaning of probabilities involved in the "Roller Derby" game went from appropriating a label to appropriating surface features, in the knowledge-of-practice domain it went from appropriating surface features to appropriating a nascent stage of conceptual underpinnings, and in the knowledge-in-practice domain, the conceptual underpinnings appropriation stage was fulfilled.

At this point of our analysis, we consider that the lesson study has a strong potential to support teachers cumulative growth which should be our aim for a more effective professional development program. We should mention that the order of the domains does not always follow the same sequence as illustrated by our example and also may not include all the domains. For example, Ms. John's knowledge about the use of the white board to store students' answers started at appropriating a surface feature while she was observing another teacher teaching the research lesson of the first cycle. She noticed that by collecting verbally the answers of the problem, there were students that were repeating what was already said and for her this was time consuming. Consequently, when she taught the revised lesson, she tried to avoid this situation by storing students' answers on the white board. Therefore, the use the white board was only for a better management of the time. However, during the lesson, the answers stored on the board became references for students, captured their attention, and initiated mathematical discourse. This experience surprised Ms. John and led her to the conceptual underpinnings level of appropriation on the use of the white board.

Conclusions

The purpose of this paper was to highlight the complex nature of the professional growth experienced by teachers who participate in lesson study cycles. We consider that a socio-cultural approach through activity theory would enhance our understanding of the strength of lesson study in the development of teachers' education. Moreover, the theoretical framework that we used can also guide our thinking about how we facilitate the growth of the teachers.

Ms. John's example brings evidence that by a thoughtful design of the lesson study structure, all the facets of the teaching-learning process can be addressed. Lesson study has the potential to accommodate the needs of students, of teachers, of school, and of the new educational reform. This is evidenced by the growing number of teachers and researchers attracted to the process. As a consequence, a constellation of interpretations and approaches to the process has developed. Therefore, there is a need for research to identify what new trends and characteristics of lesson study are.

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