

The Mathematics Education into the 21st Century Project
The Future of Mathematics Education
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Lesson Study: A Student-Centered Professional Development for Teachers

Agnes Tuska, California State University, Fresno, agnest@csufresno.edu

Abstract: This paper argues for the need of recording, analyzing, and improving instructional practices in the classroom in order to improve student learning. It describes the process of conducting lesson study, and gives examples for the effective use of lesson study as a student-centered professional development opportunity for teachers.

In the past, most professional development opportunities for teachers were offered in a lecture format, where an expert provided the information with little or no active engagement of the audience. Teachers in this scenario could not observe how the strategies presented in the lectures really work in the classroom or how they affect students (<http://www.enc.org/features/focus/archive/lessonstudy>).

There was not much known about what was going on in the typical classroom for research analysis or for professional development purposes. One important study that was part of the Third International Mathematics and Science Study (TIMSS 1999 Video Study, see National Center for Educational Statistics, 2003) videotaped and analyzed 100 typical lessons in each of the 7 participating countries (Australia, Czech Republic, Hong Kong SAR, Japan, Netherlands, Switzerland, United States). The analysis of the lessons showed great differences in the practices and learning goals among the nations, and revealed correlations between certain national characteristics of the lessons and the mathematical achievement level of the nation's students.

These days there are several projects throughout the world with the goal of recording and analyzing classroom practices. For example, Hungarian and Finnish teacher educators work collaboratively in videotaping, comparing, and promoting effective instructional practices in their teacher training programs. In the United States, public release videos are promoted as part of professional development opportunities to teachers (see at <http://www.lessonlab.com>). International comparisons allow identifying practices we want to change, discovering alternative ways that may align better with our learning goals, and examining teaching in one's own country with a fresh eye by highlighting the most common practices. Some practices are so widespread in a country that teachers take them granted, could not even imagine other alternatives (Hiebert, 2004).

There is an effort that gains popularity in California to select the classroom itself as the place for the professional development of teachers. The name of this kind of action research is lesson study. By starting with lessons, the problem of how to apply research findings in the classrooms disappears (Stigler & Hiebert, 1999). Since Japanese students are consistently among the highest achievers in most international comparison tests in mathematics, the work of Japanese teachers gained particular interest. Lesson study was identified as the effective and widespread professional development practice in Japan, where a group of 3-6 teachers work collaboratively during regularly scheduled meetings for a few months. The involvement in lesson study groups and the study of the final reports of other groups is also an integral part of the induction of the novice teachers there.

The lesson study process includes the following steps (see <http://www.enc.org/features/focus/archive/lessonstudy>):

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1. *Focusing the Lesson:* The teachers determine a broad educational goal and choose the specific topic of the lesson in order to reach the goal. The choice of the topic is often specific to the learning difficulties of the particular students involved.
2. *Planning the Lesson:* The teachers research the topic of the lesson by reading the literature about the target concept. They collaboratively develop the lesson plan.
3. *Teaching the Lesson:* A teacher from the team presents the lesson in his or her classroom. The other teachers and possibly additional experts observe the lesson, taking notes on what the students and the teacher are doing and saying. The lesson is often documented through video, photographs, audiotapes, and student work.
4. *Reflecting and Evaluating:* The study group meets to discuss the lesson and their observations. The teacher who presented the lesson speaks first, summarizing the flow of the lesson and the difficulties faced. The observers contribute their own observations and suggestions.
5. *Revising the Lesson:* Based on the suggestions, the group revises the lesson. The changes should be responsive to the students' reactions and difficulties that were noticed by the observers.
6. *Teaching the Revised Lesson:* The revised lesson may be presented to a different group of students by a teacher of the team. Often, all the teachers of the particular subject or age group in the school are invited to observe the revised lesson. Teachers from outside the school may be also invited.
7. *Reflecting and Evaluating:* The teacher team along with outside experts participates in the second debriefing session, which may cover more general issues of learning and instruction.
8. *Sharing Results:* Teachers share the lessons they develop by creating a bank of meticulously crafted lessons to draw upon for the future. The teachers may publish a report about their study, including the teachers' reflections and a summary of group discussions.

The implementation of lesson study as professional development method in other countries requires the implementation of the lesson study culture, too. For example, interviews and videotaped sessions of the study groups revealed that many teachers in the United States who were new to the lesson study process had poor listening skills, and had a hard time to switch from an individual showcase of teaching skills to a collaborative group effort where the focus is on helping students to grasp the concepts.

However, the analysis of the results of a successful lesson study initiative in the United States (Lewis et al., 2004) showed that teachers benefited from increased knowledge of subject matter, increased knowledge of instruction, increased ability to observe students, stronger collegial networks, stronger connection of daily practice to long-term goals, stronger motivation and sense of efficacy, and improved quality of available lesson plans. Lesson study did not only improve a lesson. It challenged teachers to improve their classroom instruction.

According to Joyce & Showers (2002), "four conditions must be present if staff development is to significantly affect student learning:

- (1) A community of professionals comes together who study together, put into practice what they are learning, and share the results.
- (2) The content of staff development develops around curricular and instructional strategies selected because they have a high probability of affecting student learning – and, as important, student ability to learn.
- (3) The magnitude of change generated is sufficient that the students' gain in knowledge and skill is palpable. What is taught, how it is taught, and the social climate of the school have to change to the degree that the increase in student ability to learn is manifest.
- (4) The processes of staff development enable educators to develop the skill to implement what they are learning." (p. 4)

Lesson study as a form of staff development may satisfy all these conditions, therefore, has the opportunity of positively affecting student learning.

In a student-centered lesson study, the choice of the goals and the selection of means of delivery must heavily depend on the students' background, motivation, and needs. For example, in order to strengthen collaboration among fifth grade students in Japan, the teacher team developed a lesson on the physics of

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levers. The challenge that student teams have faced was to lift an object that had a mass of 100 kilogram. The motivation came from then current news reports: there was a large earthquake in Turkey that destroyed several homes. Many people were strapped under the ruins. Rescue workers had to move heavy pieces in order to free these people. The videotaped lesson (“Can you lift a 100 kilogram?” video shown in a workshop on lesson study in California) showed students struggling with the problem in the school’s gym and revealed valuable information to the observing team about the work ethics and leadership-, collaborative-, and communication-skills of their students. Of course, 100 kilogram is too heavy for an average fifth grader to lift alone or even in a team without appropriate tools. That is why learning about levers became important and meaningful. Students had to explore, formulate hypotheses, and test their hypotheses about the ways levers worked in order to solve the problem. They were practicing the scientific method of knowledge building. The observers could pinpoint various difficulties and misunderstandings of students that they could target by devising the best follow-up activities in their revision, making the lesson much more effective.

Listening to students and analyzing their work is not an easy task. The teacher is many times too busy with the instruction in order to pay enough attention to record and understand the ways students respond. One of the key strength of the lesson study process is that each observer can have a responsibility of providing feedback about individual students or about student groups on various aspects. In addition, the recording of the lessons and the collection of student work and artifacts, including diary entries from students that require students to reflect on their own learning, can provide evidence to the analysis of students’ progress.

Finally, the focus on student learning may improve the teacher’s understanding of key concepts, too. As a personal example, let me mention a case when I was invited as outside expert into a lesson study group. The focus of the lesson was to introduce the concept of probability in a sixth grade mathematics class. During the previous period, students in groups rolled dice, recorded the results, and displayed them in charts. During the observed period, each student group had to calculate some ratios, such as the ratio of the number of times they rolled a 6 to the total number of rolls they made, or the number of times they rolled an odd number to the number of times they rolled an even number, etc. Then, the same ratios were calculated using the data set of the whole class. Students were asked to argue for the likeliness or unlikeliness of certain ratios. Many students were able to give reasonable explanations.

At this point, the teacher introduced a new question: “*What do you think, what should be the ratio in an ideal world?*” She continued talking about imperfections, possible mistakes in our everyday world in order to contrast it with the “ideal world”. The use of the “ideal world” expression has confused many students. They started to talk about fairness or possibilities of making errors, and many of them felt guilty of doing something wrong in their group for getting a ratio that was far from the “ideal ratio”. This confusion was reflected in the written summary statements about what they have learned that day at the end of the period. Yet, some students gave very clear explanations, using such words as “expectations” and “most likely”.

During the discussion of the lesson, the instructing teacher first has not realized that something went wrong. Her concept of theoretical probability was a mix of “wishful thinking” and “well-controlled environment” for doing the experiments. Only when others were quoting and interpreting the writings of her students did she realize that there can be large differences between theoretical and experimental probabilities without “doing anything wrong”, and found the real meaning of probabilistic statements. The lesson study process helped her learning deeper and understanding better a key mathematical concept that she had taught before for years.

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