Using Modified Lesson Study with Mathematics Post-Graduate Teaching Assistants

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This paper describes an effort on the part of seven post-graduate instructors, or teaching assistants (TAs), to work together to develop, implement and critique two lessons for a Calculus I course. The TAs were asked to develop lessons for a fifty minute Calculus I class on topics of their choice. As a group, the TAs decided to focus their lessons on procedural topics instead of conceptual ones. One TA was chosen at random to teach the group-developed lessons during a calculus class while the other TAs observed. Upon teaching and observing each lesson, TAs were asked to provide a short reflective statement about what they saw during the lesson and about the overall experience of planning the lesson and either implementing or observing it. Their written responses were analyzed using an open and axial coding method (Corbin & Strauss, 2008). A preliminary analysis reveals the reflections of the TAs be focused superficially, supporting previous work on K12 pre-service teacher reflective abilities. TAs can be considered pre-service faculty with the same low level of reflective abilities.

Keywords: post-graduate; graduate; teaching assistants; lesson study; reflective practice

Background

College mathematics courses are required for nearly all college degree programs and are foundational to the study of science, technology, engineering and mathematics (STEM). They are gates through which students must pass in the pursuit of STEM degrees (Ganter & Barker, 2004). Yet, success rates in these courses have been historically low and researchers are noting the impact that poor teaching has on students (Seymour & Hewitt, 1997).

In addition, researchers have found that novice instructors play a critical role in undergraduate mathematics education: it is estimated that 37% of undergraduates in the U.S. will have a post-graduate student, or teaching assistant (TA), as a mathematics instructor sometime during their degree program (Speer, Murphy, & Gutmann, 2009) and that TAs are instructor of record for as many as a half-million undergraduates each year in the U.S. (Lutzer, Rodi, Kirkman, & Maxwell, 2005). So, not only do many inexperienced college teachers interact with many mathematics learners early in the college-level experience, these new instructors may influence undergraduates' feelings and decisions regarding future mathematics study.

A crucial element of improving teaching and learning in undergraduate mathematics overall is the improved preparation of instructors, including TAs. In addition, most mathematics Ph.D. granting departments in the United States currently provide some sort of professional preparation for these novice instructors, but the quality and quantity of this preparation varies greatly from one department to another. For a summary of the current state of professional development of mathematics TAs in the United States, see Deshler, Hauk & Speer (2015). One feasible model for

creating an opportunity for systematic professional learning opportunities with mathematics TAs, within the work of teaching, is through a lesson study model.

Lesson Study

Lesson study is a form of long-term, collaborative professional development that was developed in Japan and has been increasingly used in the United States and has gained popularity in the context of undergraduate courses (Roback, Chance, Legler & Moore, 2006). Curcio (2002) describes the process as having *collaborative planning, teaching and observing, analytic reflection* and *on-going revision* as key components of the process. In this process, teachers work together to determine a lesson goal, a content focus and plan the lesson. One member of the group delivers the lesson while the others observe. They collaborate again after the teaching to reflect on the lesson and revise it, often re-teaching it to another class. Researchers have described lesson study as an opportunity for participants to develop their knowledge, classroom skills and techniques of instruction (Alvine, Judson, Schein and Yoshida, 2007) and "a process for creating deep and grounded reflection about the complex activities of teaching" (Fernandez & Chokshi, 2002, p.134). Stigler and Hiebert (1999) describe it thus: "lesson study is a new concept for teachers entering the profession. If … methods courses were restructured to introduce students to collaboratively planning and testing lessons, new teachers would be ready to assume leadership roles more quickly" (p.158). This suggests we should find ways to incorporate lesson study into more professional development programs to prepare teachers earlier on for collaborative and leadership roles.

Several studies utilizing lesson study methods have taken place at the undergraduate level. Some of those studies have investigated the use of lesson study as a professional development tool for pre-service mathematics teachers (Burroughs & Luebeck, 2010), mathematics graduate students (Kaplan, Cervello & Corcoran, 2009), mathematics faculty (Cooper et al., 2001) and instructors in other disciplines (Dotger, 2011). Still others have investigated using lesson study as a research tool for mathematics educators (Otten, Park, Mosier & Kaplan, 2009).

In one study, researchers identified several specific themes that emerged in the reflections of lesson study participants in the context of a calculus class: collaboration, ownership of the lesson, comfort zone of the teacher, visual presentation and teacher noticing (Kaplan, Cervello & Corcoran, 2009). In this study, results from the analysis of reflections gathered from mathematics TAs during a modified lesson study experiment teaching a lesson in a Calculus I class are presented. Themes emerged from the data and are described below. There is an indication that the reflective abilities of the TAs are low-level at this stage in their career, in agreement with previous research.

Modified Lesson Study experiment

A Teaching Seminar course is required for all new TAs in the Mathematics Department at one large research university in the United States. The seminar is designed to be the first professional development experience that the TAs encounter as they become instructors of collegiate mathematics in preparation for academic careers. The goal of this seminar is to create an environment where the TAs can discuss teaching in general, teaching mathematics specifically, and study this profession. As part of their work in the seminar seven TAs enrolled in the Fall 2010 semester participated in two cycles of a modified lesson study experiment. Two of the

TAs were international and five were from the U.S., two were male and five were female, four were M.S. students and three were beginning their Ph.D. program. While the four stages of lesson study described above were part of the experiment, some were modified because of the level of inexperience of the TAs and the responsibilities of the instructors of the course in which the lesson would be taught.

The *planning* stage of the lesson study usually involves participants selecting a goal for the lesson and a content area. In this case, the TAs selected content areas for two lessons to teach in an on-going Calculus I course. The TAs chose the content topics to be taught, but the objectives of the class (and each content topic) were determined by the instructor and coordinator of the course. Once TAs chose the content areas, the objectives of each were communicated by the instructor to the TAs. The TAs explored the potential content areas on which they could focus their lesson study and it is interesting to note that they developed a list of seven topics they thought would be 'easy' to teach, and subsequently narrowed the list to two procedural topics as their choices: L'Hospital's Rule and Antiderivatives. The TAs spent approximately one hour per week for three weeks during the seminar and were free to get together outside of class to continue to work.

One TA was chosen at random from the ones who were eligible to teach (international TAs must have passed the University's English Language fluency test before being able to teach students) to implement the lesson while the others observed. During the next class period there was a follow up discussion (part of the *analytic reflection* stage) and then the process was repeated. There was no *on-going revision* or re-teaching of the lesson since only one class was available for implementation and all sections of the course were taught using the same schedule, so classes could not be staggered to allow for a revised lesson taught at the later time.

Data collection and emergent themes

The data collected in this study were a set of written reflections from each TA upon implementation of each lesson. TAs were asked to provide a short reflective statement about the lesson development (their participation in the lesson study activity) and about the implementation of the lesson. Their written responses were analysed using open and axial coding (Corbin & Strauss, 2008) for themes. In total, 13 reflections were collected that ranged between six sentences to one page in length.

Three of the five themes identified in Kaplan, Cervello & Corcoran (2009) were also present in the data in the current study: *collaboration, ownership of the lesson* and *visual presentation.* Coding the reflections revealed the additional themes of *mathematical content* and *pedagogical strategies and manoeuvres* (what activities students worked on during class, how to choose students for answering questions, etc.). Surprisingly, only four of the reflections addressed student understanding of the content, a primary consideration during the lesson study process. Of all the themes, perhaps the most interesting statements were centered on *ownership of lesson.* Some TAs indicated they were not entirely satisfied with the lesson, both in content and in implementation, apparent in statements such as "I would like talk more about …", "we could have done a bit better in hindsight" and "it would have been good to mention…" One TA stated "(the TA teaching the lesson) did not use the examples we had decided on, … [but] pretty much covered all the bases" indicating his ownership of the original lesson but also indicating a detachment from the implemented lesson.

Results and conclusions

The lesson study process is enacted to provide a mechanism for developing teaching techniques as well as reflective abilities. Researchers have noted the importance of professional development that focuses on critical thinking and reflection to "facilitate development of more sophisticated conceptions of the teaching and learning process" (Lee, 2008, p.117). Written reflections provide a way for teachers to question their own assumptions and raise their own awareness of teaching issues (Lee, 2008, p. 118). Lee (2008) combined reflection characterization frameworks first proposed by Lee (2005) and Hatton and Smith (1995) to develop a four-level framework. They are: *Level 1 (Non-reflection/pure description), Level 2 (Descriptive reflection), Level 3 (Dialogic reflection)* and *Level 4 (Critical reflection).* Using Lee's framework, the reflections collected in this study are categorized as primarily consisting of statements in *Level 1* (pure description) with TAs describing what occurred in the development and implementation processes. Some statements could be characterized as *Level 2* (descriptive reflection) with the lowest level of reflection. None of the written statements revealed higher-level reflection.

From this modified lesson study experiment, it became clear that TAs lack the reflective ability at this stage of their career to think critically about their teaching experiences. While lesson study can be used to create grounded reflection about the teaching among preservice mathematics teachers (Burroughs & Luebeck, 2010), and this idea can be extended to TAs, who are, in fact, preservice faculty members, it has also been shown that preservice teachers lack content knowledge that affects reflective abilities (Dubin, 2010). Reflection may also be too unfamiliar a practice for them to do well initially. Lee (2008) notes that providing writing prompts to teachers to promote reflectivity may help them become accustomed to reflection through journaling, and this suggests a similar importance for developing appropriate prompts for written reflections of classroom observations by TAs, specifically in the process of lesson study.

Reflection is a valuable skill that can help college mathematics instructors develop as teachers by promoting deep thinking about the various aspects of teaching including attending to student learning. Beginning TAs, the participants in this study, are novice instructors and have had very little professional preparation for their future careers as faculty members. Introducing the notion of reflective practice to TAs while in their graduate programs has the potential to become a life-long practice. Lesson study is a viable vehicle for providing this opportunity in professional preparation programs for TAs, though writing prompts should be constructed so that they elicit reflections at higher levels.

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