

**THE EVOLUTION OF PROFESSIONAL DEVELOPMENT ACTIVITIES
DESIGNED TO MEET THE CHANGING NEEDS OF GRADUATE STUDENT
TEACHING ASSISTANTS**

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ABSTRACT

The preparation to teach that graduate student teaching assistants (TAs) receive is critical for a number of reasons. TAs are responsible for a considerable portion of undergraduate instruction in the U.S. Furthermore, future mathematics faculty come from the current population of graduate students, who are likely to carry habits they develop as TAs into their careers. In addition, recently undergraduate mathematics instruction in the U.S. has experienced some changes. As a result, now TAs may be asked to teach in ways that they did not themselves experience as students (for example, using collaborative group learning). The preparation and support TAs receive, especially early on, has the potential to shape instructional experiences for a substantial number of undergraduates now and in the future, and is especially important during this time of change.

In this paper I describe how a learn-to-teach course evolved in response to TAs' needs. These TAs taught classes where students spend significant time working challenging mathematical problems in small collaborative groups. In contrast to "traditional" teaching assignments (where TAs may be expected to answer homework questions and present solutions), these TAs assisted students as they worked in groups, provided problem solving support, and led whole-class discussions. As more was learned about challenges TAs faced and difficulties they encountered, activities were designed and revised. The activities were designed to promote reflection on issues of teaching and learning. These activities included TAs viewing videotape of their classes and observing groups of students for extended periods of time as they worked on problems in collaborative groups.

Keywords: calculus instruction, teaching assistants, mathematics graduate students, teacher professional development, collaborative groupwork,

Introduction

In this paper I describe the design and revision of two professional development activities used in a course for mathematics graduate students who were teaching for the first time. First, I provide some background information about undergraduate instructional reform and the role of graduate student teaching assistants (TAs) in these instructional contexts. Next, I describe the courses the TAs were teaching and the semester-long class where the professional development activities were used. In the subsequent sections, I describe the origin of activities, the difficulties that arose when using them, and the revision that occurred as a result. In particular, I discuss classroom videotaping and observation of student groupwork as opportunities for TAs to reflect on issues of student learning. In the final section, I discuss what I believe professional developers might learn from the problems that arose and from the solutions that were devised.

Over the past two decades, there has been an increase in the attention paid to the state of undergraduate instruction in the U.S.. In particular, low enrolment and retention rates in introductory mathematics courses have been the cause of considerable concern (National Science Foundation, 1986; 1989; Seymour & Hewitt, 1994). In addition, the level of understanding that mathematics students demonstrate has not been what faculty might wish (Douglas, 1986; Steen, 1987). As part of the response to this situation, some institutions have worked to alter the content and modes of instruction in their introductory courses.

One such response has been to incorporate the use of collaborative groupwork into calculus courses. The aim is for students to engage with the material in more active and extensive ways than might be traditionally common. Utilizing this highly interactive form of instruction effectively is challenging for any teacher and may pose particular challenges for new instructors whose knowledge and skills for teaching are just beginning to develop. Indeed, these teachers are being asked to teach in ways that may differ substantially from the ways in which they were taught, and may deviate substantially from what they envisioned as their role as a teacher.

At some universities, graduate students are responsible for a considerable portion of the undergraduate instruction. Consequentially, graduate students as well as new faculty are in need of professional development and support as they learn to teach— even moreso to teach in these new ways. In addition, future faculty will come from the current pool of graduate students. Thus, current graduate students play important roles in implementing reform as well as shaping the nature of future instruction. Because of these factors, in recent years there has been an increase in the attention paid to the preparation and support that graduate students and new faculty receive for their teaching responsibilities. Little is known about mathematics graduate students and faculty in their capacity as teachers or about their experiences as they learn to teach. Although the K-12 research and professional development literature has much insight to offer into the design and use of activities to help people learn to teach, there is much we do not know about how TAs or new faculty will respond to such activities, and how their experiences will relate to the challenges they face as they learn to teach. This paper is one effort to examine these issues in the context of reform-oriented calculus courses.

The site of this work was the University of California at Berkeley. On the Berkeley campus, calculus courses for physical science and engineering majors are taught with large (200-400 student)

lectures and accompanying smaller (20-30 student) discussion sections. Lectures are given by faculty and discussion sections are led by TAs, nearly all of whom are doctoral students in mathematics. In lecture, the faculty member presents ideas, solves model problems, and discusses theory and applications.

In recent years, changes were made to how time is spent during discussion sections. In the “old” discussion sections, TAs generally reviewed material from lecture, presented sample problems and solutions, and answered homework questions. By contrast, in the “new” discussion sections, the TA assists students as they work on problems in small groups. The problems are designed to be quite challenging (some similar in difficulty to the ones they might see on an exam) so that working collaboratively in groups is advantageous to the students. The students do their work at the blackboards and the TA circulates in the room and assists students. The goal is for the TA to act as a facilitator and a resource to the groups, but not to tell students directly how to solve the problems. The TA asks guiding questions, probes for deeper understanding of the ideas, and encourages students to explain and justify their solutions. The TA also holds periodic whole-class discussions about the problems and solutions. This format for running discussion sections was modeled in part on other programs that make extensive use of collaborative group work in calculus classes (Fullilove & Treisman, 1990; Treisman, 1985; Treisman, 1992).

All TAs in the mathematics department are required to take a semester-long course that provides professional development and support concurrent with their first teaching assignment. The course is organized around a series of in- and out-of-class activities. Here I will describe the evolution of two of the out-of-class activities. In one activity, TAs watch videotape of their classes. In the other activity, TAs observe in another TA’s class. While these activities had met the needs of TAs in the old discussion section context, in their original incarnation, they were less effective in addressing the issues that arose for the TAs working in the new format. In response to challenges that emerged in the new context, the activities were modified to focus on issues particular to collaborative groupwork.

Videotaping and teaching consultation activity

Over the course of the semester, all new TAs are videotaped as they teach their classes. Each TA has a “teaching consultant” (an experienced TA from the math department or a graduate student in education) who tapes the class and then meets with the TA to discuss the class and to help devise strategies for improvement. This particular activity had a long history in the class for new TAs and in similar courses found elsewhere on campus. The underlying belief is that TAs can learn a great deal from watching themselves teach. Variations of this activity are frequently used with much success in pre- and in-service professional development for school teachers. For the TAs, the process was relatively unstructured. Before being taped, TAs were asked to identify several areas in which they would like feedback. After the taping, they were given some information about watching themselves on tape designed to reduce the associated anxiety, but were not given specific directions for viewing their tape.

In the context of the “old” sections, TAs needed to learn to make clear written and oral presentations. This included, but was not limited to, summarizing material, reviewing ideas, presenting solutions to problems, and discussing problem-solving techniques. TAs also needed to be able to answer students’ questions effectively. In this context, the videotaping and teaching

consultation activity was very effective in helping them improve their instructional practices. For instance, by watching their tape, TAs had the opportunity to see themselves from the students' perspective, to see and hear their presentations and assess the clarity, and to reflect on the quality of their answers to student's questions. In most cases, TAs naturally focused on these issues as they watched their tape and were able to make observations about their teaching that were relevant to the major goals of the old sections.

Under the new format, however, the activity was not as productive. Although TAs still reported it was very useful in helping them develop their teaching practices, it did not appear to help them focus on the set of issues central to the goals of the new sections. Certainly attention still needed to be paid to issues of clarity and presentation, but the change in format made other instructional concerns more pressing. In particular, TAs often found offering assistance and suggestions to students in lieu of providing the answer to be quite challenging. Instead of asking a guiding question to assist students, the TAs often simply gave students the answer. When students had completed a problem, instead of asking for explanations or justifications, they often looked over the work and declared it correct or pointed out errors.

These issues related to their interaction with students in groups was not what TAs paid attention to while watching the tape of their class. It became clear from the consultations with the TAs that they were not focusing on the issues the consultants felt were most essential in learning how to teach in these ways. When reflecting on their tape, some commented on the clarity of the answer they gave, but rarely raised issues surrounding their decision to provide an answer. They would frequently make observations about the accuracy of the students' solution, but rarely attended to features of the discussion of the solution.

Due to the very general directions about watching the tape and the pre-taping consultation where they identified areas of concern, TAs were not using the opportunity to gain feedback about the aspects of class that we were most foreign, new, and difficult for them. These also happened to be the aspects of class most central to the success of this model of instruction. Even TAs who demonstrated an ability to teach in ways consistent with the goals of the course did not necessarily gravitate towards being reflective about their practice in new ways.

The basic idea of the videotaping and teaching consultation activity appeared to be very valuable, but needed to be tailored to the new context. We had observed that they were not asking enough questions of their students during class, they were giving away solutions too easily, and they were not requesting justifications from their students. How might the activities be modified to scaffold TAs observations to focus on these issues more?

To address these issues, specific reflection questions were given to the TAs. The questions focused on their interactions with students, their use of questions, their request for solutions, justifications, and other issues related to groupwork:

Student Questions

- a. What kind of questions are you asking your students? How often do the questions require more than a yes or no answer?
- b. Are you asking your students to explain the mathematics (by asking questions such as "How did you figure that out?," "How can we know if that's true?," "What do you think we should do next?," etc.)?

c. How do you determine if students have understood your explanations or suggestions? Do you listen carefully to students' questions and comments *in their entirety* before responding?

d. Do you ask the students to clarify their question when you aren't sure what they are asking?

e. When students ask a question, are you able to ask them a question in return that points them in the right direction?

Interacting with Groups

a. Are your discussions usually with one member of the group or are most of the students involved?

b. How can you tell if the group has understood the problem?

c. How do you figure out if the group has understood you? Can you tell when the students are puzzled or confused?

d. At what point do you end your discussion with a group and how do you do that?

The hope was that with the addition of the reflection questions, TAs would attend to issues that were more closely related to the instructional goals for the sections. As it turned out, they still paid attention to issues of presentation and clarity, but some portion of their attention was now also focused on their questioning practices and other aspects of interaction with students. The observations they made in response to the questions came closer to focusing on issues of particular relevance in the new context. TAs also made the criteria they used to judge student understanding explicit. This made it possible for the teaching consultants to discuss additional strategies for probing and enriching student understanding.

In terms of their teaching practices, during subsequent videotapings, TAs were more likely to ask questions and to support student learning without telling answers to the students than they had previously. TAs appeared to ask more follow-up questions and to request more extensive justifications of solutions from their students. Having focused specifically on these issues while reflecting on their videotape appeared to promote the use of these teaching practices in ways that were more consistent with the goals of the discussion sections.

Peer observation activity

In addition to watching their own class on videotape, TAs were paired and observed each others' classes. Subsequently, they met to provide each other with feedback. Previously this activity was rather unstructured. The TAs visited, observed, took notes, and met to discuss their observations. This activity was relatively successful given the instructional goals for the old discussion sections. TAs received feedback on presentation clarity and content, and often got new ideas of how to handle particular questions or topics. In the context of the new sections, however, something interesting happened. TAs made observations about their partner's teaching (mostly focused on the same presentational or clarity issues), but often also paid attention to the groups of students who happened to be working nearby. The TAs made very interesting observations about what happened in the groups and frequently expressed surprise at the nature of the students' conversation and the work they accomplished.

Since TAs seemed surprised by what students did when the TA was not around and appeared to find these observations enlightening, a “group observation” activity was added. In this activity, TAs spend time specifically watching a group’s interaction and taking notes. This activity provides one of the few opportunities TAs have to observe a group of students “in action” over an extended period of time and to see the kind of progress they are (or are not) able to make.

The peer observation activity handout was modified to include the following:

Group observation information (to be filled in during section):

- a. What problem are the students working on?
- b. How many people are in the group?
- c. Try to figure out what the student’s names are (are they written on the top of the board?) and refer to them in your notes. Knowing who said/did what will make your observations more meaningful for your partner.

Watch and listen carefully to the students. Observe only; don't involve yourself in the group's discussion! Try to figure out how they are approaching and trying to solve the problem.

- d. Describe how they started the problem, what the difficulties were that they encountered and how/if those difficulties were resolved.
- e. If your partner (the TA) comes over and talks with the group, describe what happens. Did the students have a question or did the GSI just approach the group? How did your partner handle the students' questions? What kinds of things did your partner say and ask? Also, describe what happens *after* your partner leaves the group.

This activity gave TAs an opportunity to focus on what can go on in groups in a way that is not possible when they are responsible for running the section themselves. They could see how different hints, suggestions, and information are and are not helpful to students. The activity also gave TAs an opportunity to learn about how students were thinking about problems and to develop a better understanding of what learning in these ways is like for their students. For example, TA were impressed by students’ abilities to work through difficulties they encountered without assistance from the TA. They were also surprised by how challenging it was sometimes for students to make progress even after the TA had spoken with the group.

This activity appeared to help TAs modify their thinking and teaching practices in several ways. During subsequent videotapings and consultations, TAs seemed less likely to assume that they knew what the students were thinking based only on the written work they had produced. TAs also appeared less inclined to believe that the information they provided to students would automatically resolve confusion that students were experiencing. TAs also expressed more curiosity about how their students were learning and were more eager to come to understand how students thought about the mathematical ideas.

These changes were reflected in their teaching practices in several ways. Since TAs were not as quick to assume they knew what students were thinking based only what they wrote, TAs appeared to ask more questions and to probe more deeply into how their students were making sense of the problems. TAs were also more likely to question students after providing them with information or a hint to find out if they had understood the ideas being discussed.

Conclusions

In the case discussed here, activities that had been very effective in the context of traditional discussion sections were less useful in the context of sections involving collaborative groupwork. The basic premise of the activities was still valuable, but they needed to be modified in order to be effective in helping TAs meet the challenges of teaching a class where students spent considerable time working in collaborative groups on challenging problems.

By providing specific reflection questions, the videotaping activity encouraged TAs to direct some of their attention to issues that shape the nature of the learning experiences that students have in these classes. For example, TAs were directed to pay particular attention to the questions they asked and to the nature of the interaction among students in the groups. In the case of the peer observation activity, a group observation component was added after TAs spontaneously made interesting and useful observations about what was happening in groups during class. Although TAs can learn from interacting with groups in their own classes, this activity provided them with an opportunity to observe students for an extended period of time and in a manner not possible in the midst of teaching their own sections.

Several conclusions can be drawn from these experiences. First, it appears that with fairly minimal scaffolding, it is possible to support TAs in ways that enable them to focus more extensively on substantive issues of student learning. It remains to be seen what additional support TAs would need to make similar observations on a regular basis and in “real time” in their classrooms, but the fact that it is possible to assist them in being somewhat reflective in this context should provide encouragement to those who wish to find ways to support TAs in becoming consistently reflective teachers.

Second, in the case of the group observation activity, the need for it actually arose spontaneously. Although the hope was that TAs would learn about students and how they think about mathematics from the interactions they have during class, it was possible for them to learn even more by stepping away from their role as TA and observing students in another TA’s class. These and similar activities are likely to be an essential part of professional development programs that help TAs and other beginning teachers develop teaching practices that support student learning in highly interactive instructional contexts such as collaborative groupwork.

Third, there is a great deal that people responsible for support and professional development of beginning teachers can learn from observing and talking with the teachers with whom they work. Had the videotaping and consultation activity not existed, it might not have been possible to discover that TAs were failing to reflect on the groupwork component of class and needed support in doing so. If there had not been substantial discussion after the peer observation activity, the group observation component might never have been developed. The mathematics education community is most likely to meet the substantial demands of providing support for teachers who are learning to teach in innovative ways if we find ways to truly listen to, learn from, and respond in substantive ways to the challenges these teachers face.

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