

Graduate Teaching Assistant Training That Fosters Student-Centered Instruction and Professional Development

By Thomas C. Pentecost, Laurie S. Langdon, Margaret Asirvatham, Hannah Robus, and Robert Parson

A new graduate teaching assistant (TA) training program has been developed to support curricular reforms in our large enrollment general chemistry courses. The focus of this training has been to support the TAs in the implementation of student-centered recitation sessions and support the professional development of the TAs. The training includes discussion of the pedagogical basis for the reforms, review of key chemistry concepts, and practice leading student-centered sessions. Data from the TAs, students, and faculty suggests that the new training has had a positive impact on the TAs' ability to lead student-centered recitations and on their professional development.

Over the past 10 years, our department has introduced major changes into its first-year chemistry course. These include the use of student personal response systems (clickers) together with peer instruction (Mazur, 1997), interactive lecture demonstrations, a course help room staffed by instructors and teaching assistants, a student-centered recitation environment, and online homework systems. Since fall 2006 this transformation project has been supported by a university-funded course improvement initiative. As is typically the case at Carnegie-I institutions, our department relies heavily on graduate teaching assistants (TAs) for undergraduate chemistry instruction. Because these TAs are the primary student contacts for much of the course, it is critical that they be brought into the course transformation project at the earliest possible opportunity (Gutwill-Wise, 2001; Seymour, 2005). To this end, we have created a new TA training program for incoming graduate students. Key goals of this program are to have incoming graduate students review core concepts in general chemistry while being trained to lead student-centered recitation sections.

Background The Course

The target course for our efforts is the first semester of the typical two-semester General Chemistry sequence. This course typically enrolls ~950 students each fall, most of whom are majors in a natural science. Engineering majors do not usually take this course; instead, they enroll in a one-semester General Chemistry course taught in the College of Engineering. Three lecture sections of General Chemistry I existed in fall 2007 and fall 2008—one section of ~175 and two sections of ~400 students. Students attend three 50-minute lectures per week and a four-hour recitation/laboratory section. The first hour of this section is devoted to recitation activities. These recitation/lab sessions are limited to 20 students. Beginning in the fall 2008, undergraduate learning assistants (LAs; Otero, Pollock, & Finkelstein, 2010) were integrated with TAs to cofacilitate recitation activities.

TA responsibilities and existing training

General Chemistry I TAs are expected to facilitate two recitation/lab sections per week, grade weekly

laboratory reports, and proctor large group exams. Other duties include two hours per week of drop-in tutoring in the course help room and attending weekly meetings to prepare for recitation and laboratory.

The Chemistry Department has had a TA training program in place for over 20 years. This program was used for all TAs, not just new graduate students. Training activities typically occurred during the week prior to the start of fall classes. This program included an administrative orientation to the course, laboratory/safety training, and presentations by experienced TAs. These presentations covered classroom management and frequently occurring student–TA conflicts. New TAs were required to carry out a videotaped microteaching experience, which was critiqued by a senior TA. Although some pedagogy was discussed, the focus of this training was not specifically on any pedagogical training or content review.

New TA training

New training was first implemented in fall 2007. Incoming graduate students with high probability of teaching General Chemistry I were invited to come to campus two weeks before the semester started, which is one week earlier than new graduate students normally report. This allowed TAs to complete both the new three-day TA training and the existing training previously described. Twenty-five incoming TAs participated, of which 19 were assigned to General Chemistry I for fall. The five additional General Chemistry I TAs used in fall of 2007 were experienced graduate students. The remainder of TAs who participated in the training were assigned other courses or departmen-

tal duties. The program expanded to include all 31 incoming graduate students in fall 2008. In both years, participants received a \$500 supplemental stipend for completion of this expanded training.

Goal 1—Facilitate implementation of student-centered recitation model

Before fall 2007, the responsibility for running recitation sessions fell to individual TAs. Problem sets were available for their use, and most recitation sessions featured the TA at the board working problems. Although a few TAs used small-group activities on their own, the majority of the recitations were not student focused. In addition, TAs often faced student pressure to finish recitation early in order to start on the three-hour laboratory activity.

In fall 2007, a new model for recitation was implemented that placed a greater emphasis on the role of the student. This model was designed from a constructivist (Bodner, 1986) perspective and in accord with recent recommendations for instruction (Bransford, Brown, & Cocking, 2000). It draws on features found in Peer-Led Team Learning (Varma-Nelson & Coppola, 2005) and Tutorials for Introductory Physics (Finkelstein & Pollock, 2005; McDermott, 1993; Redish, 2003). Because the TAs are the primary instructors for recitation sessions, it is essential that they be given support to successfully implement the new model. Our new TA training program is intended to provide this support.

TA buy-in to course transformations has been identified as a factor in the success of the transformation (Gutwill-Wise, 2001; Seymour, 2005). Most incoming graduate students have been educated (and

successful) in traditional learning environments and as a result tend to view learning from a “transmissionist” perspective (Roehrig, Luft, Kurdziel, & Turner, 2003). To increase TA confidence and success in a nontraditional learning environment based on constructivist principles, we introduced this theoretical framework and made explicit the design of the materials (Nurrenbern, Mickiewicz, & Francisco, 1999). During the training, we structured learning activities to model the type of learning environment TAs were expected to foster in their teaching (Roehrig et al., 2003).

Materials developed for student-centered recitation sessions were developed in 2006/2007 with increased focus on conceptual understanding and molecular visualization. We expected all TAs to use the materials during their recitations, leading to standardization of the recitation experience for students and decreasing the time required of TAs to prepare materials. We used these materials during the training both to model facilitation of small group discussions and to refresh the TAs’ knowledge of the course content.

Goal 2—Support TA professional development

Teaching experience offers graduate students an opportunity to review basic chemistry knowledge while developing their teaching skills. In addition, fostering the development of graduate students’ teaching ability can enhance their abilities to communicate their research (Gilreath & Slater, 1994). Department faculty expressed concern that TAs were not getting the most from their teaching experience under the model then being used. The new training was viewed as a way

to emphasize the importance of and to provide support for this aspect of their professional development as graduate students. The dedication of departmental resources to this training provides tangible evidence that the department values this aspect of their graduate program.

Previous assessments of TA train-

ing have emphasized the importance of ongoing support for TAs during the semester (Birk & Kurtz, 1996; Nurrenbern et al., 1999; Roehrig et al., 2003). To provide this support we made use of the existing hour-long weekly TA meeting. This meeting had typically focused on the next week's laboratory experiment. In

fall 2007, time was allotted for a discussion of recitation during these meetings. The new three-day training will be described below. The topic of in-term support will be revisited in the discussion.

Structure of new TA training

Figure 1 shows the schedule for fall 2007 training. The training began with a brief overview of the teaching and learning literature in general and some chemical education literature in particular. The format was interactive with a mix of group activities and brief presentations. Our strategy was to engage TAs in the type of learning environment they would be expected to cultivate in their own sessions. Figure 2 details the first Learning Theory Session, in which we elicited TAs' learning experiences in an effort to ground the discussion of current learning theory. The content review sessions were modeled after our intended recitation structure. The training leader facilitated discussions among TAs as they worked through the recitation materials in small groups. Each session ended with a discussion of likely student ideas and difficulties.

The fall 2008 training followed a similar schedule with slight changes. One change was a reduction of the time devoted to learning theory. Feedback from fall 2007 participants indicated that they found this interesting but were not sure how to make use of it. This has been an issue in other TA training programs (Luft, Kurdziel, Roehrig, & Turner, 2004). The additional time was used to implement a suggestion from the fall 2007 cohort. TAs desired practice leading a recitation session and feedback about their facilitation. In 2008, participants were placed into

FIGURE 1

New teaching assistant training schedule—Year 1 (2007).

Day One

Time	Activity
9:00 – 9:20	Welcome and Introductions
9:20 – 9:45	Introduction to/Purpose of Training
9:45 – 10:30	General Chemistry I Concept Survey
10:30 – 10:45	Break
10:45 – 11:30	Introduction to Course Reform
11:30 – 12:30	Lunch With Experienced TAs
12:30 – 2:15	Learning Theory
2:15 – 2:30	Break
2:30 – 3:45	Learning Theory (cont.)
3:45 – 4:30	General Chemistry I Final Exam

Day Two

Time	Activity
9:00 – 9:10	Debrief From Yesterday
9:10 – 10:15	Conceptual Understanding and Problem Solving
10:15 – 10:30	Break
10:30 – 11:45	Content Session 1 – Thermochemistry
11:45 – 12:45	Lunch
12:45 – 2:15	Content Session 2 – Shapes of Molecules and VB Theory
2:15 – 2:30	Break
2:30 – 4:00	Content Session 3 – Equilibrium
4:00 – 4:30	Wrap Up

Day Three

Time	Activity
9:00 – 10:30	Content Session 4 – Stoichiometry
10:30 – 10:45	Break
10:45 – 12:15	Content Session 5 – Intermolecular Forces
12:15 – 1:15	Lunch
1:15 – 2:45	Content Session 6 – Nuclear Model of the Atom
2:45 – 3:00	Break
3:00 – 4:30	Closing Exercise

small groups and assigned a recitation topic. Within their groups, TAs worked through the materials and discussed strategies for leading the recitation. The next day, groups were scrambled and pairs of TAs facilitated a recitation with the other TAs serving as students. This allowed all TAs to practice leading a session, get feedback from their peers (and an experienced TA) about the session, and review all the same topics as in fall 2007.

We realized this model of a separate “special training” for incoming TAs was not cost-effective as a long-term strategy and wanted to ensure sustainability beyond the life of the course reform project. During Years 3 and 4 (2009 and 2010), permanent department faculty and staff assumed leadership roles in planning and leading the sessions alongside the project staff. Explicit links between the TA training program and the university’s Graduate Teacher Program have been forged, and we now involve experienced TAs and LAs in the recitation facilitation activities. Key activities from Years 1 and 2 have been incorporated into the more broadly focused department training, which reduced the total time commitment for the new TAs and department personnel from seven days to approximately three days.

Results

The new training and its effects were evaluated using multiple data sources from Years 1 and 2. TAs’ responses to questions about effectiveness and possible improvements were used both to evaluate the training and to inform modifications. Student surveys and faculty interviews served as data sources for analyzing effects of the TA training. Two main categories emerged from

FIGURE 2

Expanded schedule for 12:30–2:15 Learning Theory Session.

Introduction—Participants answer the following questions individually:

The class I enjoyed the most (got the most out of) as an undergrad was _____ because _____.

The class I enjoyed the least (got the least out of) as an undergrad was _____ because _____.

Get into groups of four:

Share your answers with each other.

What do all the enjoyable classes have in common?

What do all the nonenjoyable classes have in common?

Report to the entire group.

Presentation on Learning Theory:

Constructivism

Stages of Development

Applications to First-Year College Chemistry

these data: effects of training on TA professional development and implementation of the recitation model. Each of these is presented next. In the analysis that follows, data from students of any experienced TAs and new TAs who did not have the training that taught in fall of 2007 and 2008 were excluded so only data from students of TAs that completed training were used.

TA perspectives of the training

TAs evaluated the training as part of the closing exercise on Day 3. In general, feedback was very positive, and TAs indicated that the training was useful. One concern of TAs was putting the student-centered model into action. These concerns lead to the changes in fall 2008 described previously. Even with explicit practice in leading recitation, fall 2008 TAs’ main concern at the end of training still laid with implementing the model. In response to a question about what additional support was needed, TAs indicated a desire for

continued support from someone throughout the semester.

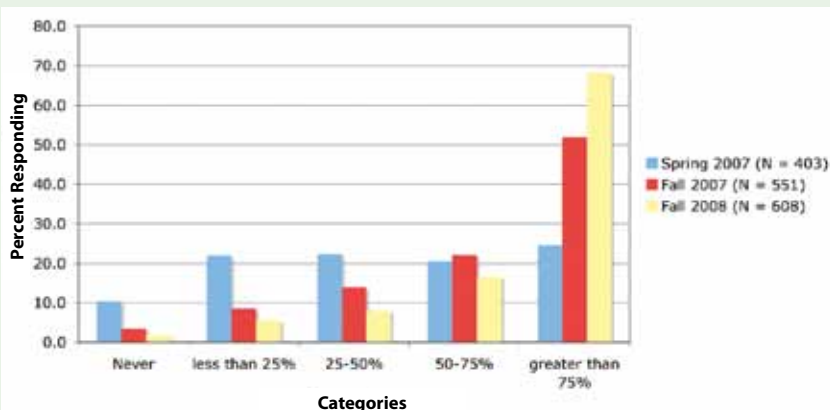
Goal 1—Implementation of “student-centered” recitation model

At the end of the semester, we ask students to evaluate various course components through a survey. The question most appropriate for evaluating TAs’ implementation of our recitation model asked students to report how often they work with other students in recitation. For baseline data, we compiled results from the spring 2007 General Chemistry II course, which was the first semester that this survey included recitation-specific questions. The spring 2007 course serves as a good control because neither the new recitation model nor the new TA training program had yet been implemented. We compared these results to those in fall 2007 and fall 2008, the first two years of the new TA training.

Results in Figure 3 clearly indicate that TAs who participated in the new

FIGURE 3

Time spent working with others.



training required more student–student interactions during recitation. A likely interpretation is that TAs spent more time facilitating small group interactions and less time at the board solving problems.

Goal 2—TA professional development

The impact of the training on the TAs professional development emerged from interviews with two faculty members who have significant interaction with the new TAs. Both were very positive about the training. They felt that the training had emphasized to graduate students the importance of their teaching experiences as part of their professional development. Both faculty members also felt that the training had helped create a sense of camaraderie among the new graduate students, illustrated in the following comments:

- “Having that sort of support and making it [teaching] less of a chore and more of a training and educational experience and feeling like there were people that cared how well they taught and

were willing to help them has really improved their attitude towards teaching.”

- “I feel very strongly that since we began the training I have had fewer complaints about TAs. . . . It really seemed that the TAs understood the chemistry better.”
- “I think they took everything more seriously. They were aware of the expectations and deadlines. It has definitely improved.”

In addition to the survey previously mentioned, students also complete an end-of-semester evaluation of their TA focused on laboratory and recitation. In addition to writing comments, students respond to supplemental questions that use a Likert scale that ranged from 1 to 6, with 1 being the lowest and 6 the highest. This particular set of questions had been used since fall 2006; thus student responses from fall 2006 were used as a control group to compare to fall 2007 and 2008. Only student responses from new TAs in fall 2006 were used. Note this is a different control than was used to evaluate Goal 1. The use of the data from

fall 2006 allows us to compare first semester TAs. If we were to use data from spring 2006, we would not be comparing TAs in their first semester of teaching. These questions ask students to rate their TAs in a variety of areas. For our analysis we selected questions that focused on TAs’ performance in the recitation portion of the course and TAs’ interactions with students. Questions about grading and laboratory-specific questions were omitted.

We also controlled for TA experience by only analyzing responses from students in the fall of 2006 who had a first-year graduate student as their TA (15 TAs) and in fall 2007 and 2008 a first-year graduate student who had completed the TA training—17 and 18 TAs, respectively. The university scored the responses and we received class averages for each question per TA as well as the number of students selecting each option. We calculated the average value of each question across first-year TAs in each semester and used these in further statistical analysis.

The averages of each question were compared using a one-way independent analysis of variance (ANOVA). A Levine’s test for homogeneity of variances indicated that the variances for many items were significantly different. To compensate for this violation of the ANOVA assumption, a Welch’s *F*-test was used to determine significant differences in the means (Field, 2005). The data for the selected questions are in Table 1. Note the values of *n* differ because some students did not answer all questions.

Results of this analysis tell an interesting story. It appears that the first implementation of the new three-day presemester training did not by itself change students’ perceptions

of their TAs' effectiveness. In fall 2008, however, students' responses to these questions indicate significant increases in perceived TA abilities. Two major changes occurred between fall 2007 and fall 2008 that may account for this. First, we used TA feedback from the first implementation to improve the presemester training in the second year. Recall that in fall 2008, we structured the training so that ev-

ery TA had an opportunity to prepare, practice, and receive feedback on implementing our student-centered recitation model. The other major change is that we integrated the use of undergraduate LAs with TAs in recitation in fall 2008. One component of the LA model is weekly prep sessions with faculty who teach the course. Thus, both TAs and LAs participated in weekly recitation-specific prep

meetings through the fall 2008 semester. This combination of intensive presemester training and ongoing support is in line with TA feedback from the training and may explain increased student ratings of TA preparedness and effectiveness in this setting. This is also supported by comments from faculty supervisors for the course that they have seen a marked decrease in student complaints about TAs.

TABLE 1

Results of student course evaluations.

Student course evaluation item	Original training (fall 2006)	New TA training (fall 2007)	New TA training (fall 2008)	Welch <i>F</i> <i>df</i> 1 <i>df</i> 2	<i>p</i> -value
	Mean SD <i>n</i>	Mean SD <i>n</i>	Mean SD <i>n</i>		
Questions were handled well.	4.75 1.067 444	4.80 1.161 576	5.04 1.109 604	10.702 2 1046.552	0.000*
Teaching assistant came to recitation prepared.	5.17 1.075 448	5.29 1.066 577	5.56 0.734 611	27.592 2 966.490	0.000*
TA explained concepts and principles in addition to solving problems.	4.79 1.076 448	4.75 1.129 579	5.04 1.146 611	10.765 2 1060.805	0.000*
TA provided enough time for students to ask questions.	5.02 1.051 447	5.03 1.139 579	5.20 1.058 610	5.056 2 1049.304	0.007*
TA clarified the material presented in lectures and texts.	4.50 1.213 448	4.53 1.353 579	4.78 1.302 609	7.726 2 1059.628	0.000*
TA interacted effectively with the students.	5.13 1.086 447	5.12 1.253 578	5.20 1.231 610	0.762 2 1065.788	0.467
TA was interested in the course and had knowledge of the subject.	5.22 0.935 448	5.31 1.008 578	5.53 0.775 611	19.170 2 1012.369	0.000*
TA was enthusiastic about teaching.	4.85 1.198 447	4.77 1.309 577	5.12 1.100 611	14.030 2 1032.589	0.000*
TA took an active interest in the progress of his/her students.	4.69 1.203 447	4.67 1.383 577	4.98 1.158 609	12.087 2 1040.684	0.000*
Overall effectiveness as a teacher	4.85 1.085 446	4.91 1.236 575	5.15 1.101 610	11.058 2 1047.801	0.000*

Note: TA = teaching assistant.

*difference significant at the $\alpha = 0.05$ level

Summary

The new training program seems to have provided TAs with more confidence and skills in implementing a student-centered recitation model. Students are spending more time working in groups and seem to value this experience. The faculty interview data suggest that the new training is fostering the development of the TAs by providing support for them in their teaching. The TAs might be interpreting this support as an indication of the importance of this aspect of their graduate education training.

TAs appreciate the rationale behind the training; however, even after our modifications in Year 2, they are unsure about how to make use of the educational theory in their own teaching. This concern has been expressed by TAs in other environments (Luft et al., 2004). It is likely that the incoming graduate students do not have enough experience in the role of instructor for the educational theory to have meaning. This suggests that this material would be more suited for the ongoing weekly meetings, as TAs are encountering student difficulties and other challenges in their teaching. The usefulness of ongoing teaching strategy discussion has been proposed by others (Nurrenbern et al., 1999; Roehrig et al., 2003). In fall 2007, we intended to provide this type of support during the weekly TA meetings, but it was often the case that discussions of the laboratory experiments and other procedural matters took the majority of the time. Even the additional 50-minute weekly recitation prep meeting for TAs and LAs in fall 2008 did not provide enough time to bring in extra theoretical connections. Much of that time was spent having TAs and LAs work through

the recitation, identify likely student difficulties, and discuss how to ask good guiding and probing questions.

One benefit of the TA training has been to bring together the first-year graduate students prior to their first week of classes. Several TAs noted this as the most valuable part of the training for them. It seems that this initial grouping of TAs creates connections that expand beyond their TA assignments into their classes and friendships outside of school. This has also been helpful as the TAs engage in discussions during meetings in order to help their fellow teacher through a tough situation with a student or to debate the best way to present an idea. This creation of a community has benefitted more than the students and TAs; it has helped those in the general chemistry program to feel as if they are a team.

From the start of the TA training project, an effort has been made to produce a program that is sustainable within the department without the continued assistance of the special staff. Laboratory staff and departmental faculty have been increasingly involved to take over the training program from the project staff, ensuring the program's continued growth and persistence in years to come. The program is now at a point at which it is sustainable using only departmental funds and personnel. In addition, what started as a seven-day total training ("new" plus "standard") has been streamlined to about three days total.

Overall, the TA training has contributed to the creation of a vibrant teaching and learning community within the department, within which faculty, graduate students, undergraduate students, and staff are regularly involved in activities devoted to increasing the effectiveness of our general chemistry instruction. ■

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