Who's Minding the Store?—Or How a Team of Undergraduate Teaching Interns Rejuvenated an ACS Certified Program

Judith M. Bonicamp

Department of Chemistry, Middle Tennessee State University, Murfreesboro, TN 37132, bonicamp@mtsu.edu

Received February 6, 2002. Accepted February 28, 2002.

Abstract: Improvements resulted at all levels in an ACS-certified chemistry program when a team of undergraduate teaching interns began consulting in the laboratories. The author describes the problems and teaching philosophies that led to the institution of the Chemistry Instruction Internship Program, the goals of the program with some preliminary assessments, and how to recruit outstanding undergraduate teaching interns.

Introduction

I have coordinated the sophomore-level quantitative analysis course and laboratory (Quant) for 20 years, and over time the assistance in the laboratory of graduate students has become as burdensome as it is helpful. This results from (1) an increase in students enrolling in our graduate program without having had Quant, (2) an increase in graduate students with poor spoken-communication skills in the English language, and (3) a developing attitude in the minds of graduate and undergraduate students alike that laboratories are not important because the professors do not teach them. Similar staffing issues exist in our freshman laboratory programs as well. Training and motivating of graduate students have been addressed in this *Journal* [1, 2] and elsewhere [3–15], but none of these articles presented an apt solution for our situation in Quant. The fifteen citations do provide some fruitful guidance to one responsible for setting up an instructor training program for traditional GTAs. But we were experiencing a learning crisis in which the traditional laboratory teaching model was perceived to have failed.

Were a learning crisis to crop up in an industrial company of 20,000 (our current enrollment), it is likely that management's response would be to hire a team of consultants to solve it. In essence, this is what I did. I asked for the advice and assistance of some of my talented and enthusiastic former Quant students and then talked our department chairman into hiring them in a consulting role, taking the place of GTAs in the Quant laboratory. The Quant laboratory stays open Monday through Thursday from 8:00 am. until 5:00 pm. and an undergraduate consultant is always on hand to help students with new techniques and to answer questions about the course materials. This was the genesis of the Chemistry Instruction Internship Program.

Some aspects of our program resemble the learning models described in *Student-Assisted Teaching: A Guide to Faculty-Student Teamwork* [16], a compilation about undergraduate student-assisted teaching partnerships that focus on making learning more student-centered, effective, and productive. A model with its origins in chemistry is peer-led team learning (PLTL) [17, 18] supported by the NSF Division of Undergraduate Education through a multi-year grant. In the PLTL model students who have done well in a course previously are recruited to become leaders who guide and facilitate the interactive work of small teams of students in weekly problem-solving workshops. The PLTL program was instituted at 14 institutions to replace passive modes of instruction with the workshops. In most cases the two-hour workshops replaced lectures or recitation time, but in some universities the extra time was added to the week's work or time was subtracted from the laboratory instruction.

Increasing the hours required of students to accommodate workshops in our Quant course (already a five-semester-hour course) or taking time from the highly interactive Quant laboratory would have been a hard sell among our analytical faculty. I, therefore, incorporated only the aspects of peer-augmented instruction that could be adapted to the laboratory setting. This allowed our learning problems in the laboratory to be addressed directly and immediately by the Quant consultants.

How Are the Quant Consultants Different from Vanilla?

Quant consultants do not grade papers, do not keep grade books, and do not make up unknowns. They differ from instructors in that they have no responsibility for laboratory briefings or for assigning grades. Neither are they educational consultants, like those who design laboratory experiments or write teacher manuals. They are facilitators who see that learning occurs in the Quant laboratory. They spend all their time interacting with students in an advisory capacity on both lecture material and laboratory practice. Quant consultants are empowered people. They make informal judgments about the extent to which students understand the laboratory and course material and conduct ad hoc tutoring as needed. The consultants decide how much help to give the students with experiments and are especially busy when an exam is approaching. Consultants can answer questions directly, or they can suggest where students will find the answer in their textbook, or give hands-on assistance with laboratory projects depending on what the consultant believes would provide the best learning experience for the student with the least frustration or loss of the analyst's time (Figure 1). Just like professional consultants, they sometimes make faulty judgments and give poor advice. But Quant laboratory is structured to allow students time for learning from their mistakes, and the consultants must learn from their mistakes also. They have the opportunity to test and refine their

Figure 1. Quant student Emily Cook (right) discusses the infamous gravimetric determination of sulfate with consultant Virginia Mattie.

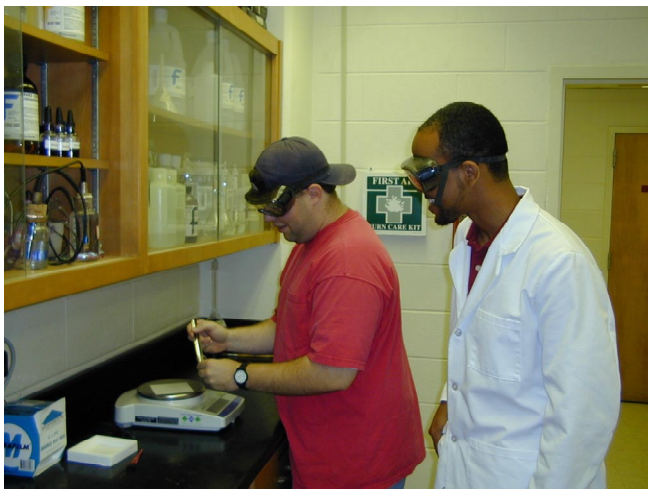

Figure 2. Consultant Cameron Cooley (right) and Quant student Robert Reasonover install a new balance.

judgments in this setting, and it is delightful how responsibly they react.

Future consultants for Quant begin imagining themselves in a consulting role long before formalizing the relationship. This results from my asking in lecture what the current students would do if they themselves were hired to improve the Quant laboratory. I start this dialogue during the first weeks of the semester, and by semester's end I am able to choose consultants from among the best applicants academically. When possible, I select consultants of diverse backgrounds, ethnicity, career plans, and ages. These consultants and the open laboratory are really making a difference for today's busy, often nontraditional students (Figure 2). The pay is low ($5.15 per hour), the hours are long, but everyone profits.

Upside–Downside

The enrollment in Quant has approximately doubled since the inception of the consultants program in 1998, from about 20 students in fall 1998, to about 50 students in successive fall semesters. At MTSU, Quant is a sophomore-level course, but until recently the enrollment has been about 10% sophomores and 90% juniors and seniors [19]. As word about the consultants program and open laboratory spreads, students are beginning to enroll in the course somewhat earlier. For example, about 30% of the recent fall classes were sophomores. This is an important change, because our data show that students who take Quant immediately after completing general chemistry have greater success. A study during the seven semesters preceding fall semester, 1998, showed that 70% of the sophomore Quant students earned grades of A and B, but only 40% of the senior Quant students earned an A or B. During these semesters, the failure rate for sophomores was 15% compared to 36% for juniors and seniors [19]. The grade statistics for the semesters since fall 1998 are similar, except that there are fewer seniors and the failure rate for seniors has dropped to about 10%. We believe that fewer students will drop out of the professional chemistry pipeline as a result of taking Quant as sophomores. It is too early to link the improvements statistically to the presence of the consulting staff, but the results are encouraging.

In the fall semester of 2000, the U.S. government refused entry visas to five foreign students admitted to our graduate program with teaching assistantships (GTAs). These GTAs represented a loss of 40 contact hours per week from our freshman laboratory program, 12% of the chemistry department's total workload and 23% of the teacher workload absorbed by GTAs. But, the freshmen had paid their fees and someone had to teach their labs—"who ya gonna call?"

Quant Consultants Answer the Call to General Chemistry

In the minds of the freshman chemistry faculty and our department chairman, being a Quant consultant had served as a "credentialing" process for the undergraduate trainees. Those consultants who had spent a semester or two in Quant laboratory had their pick of freshman-laboratory assignments in our chemistry department when the five aforementioned GTAs did not enroll. All of us ultimately profited, because the consultants were proud of their preparedness and wanted to pitch in, and the freshmen experienced enthusiastic laboratory instruction from the teaching interns under the direction of faculty mentors. Interns in the freshman laboratories are not asked to grade the papers of their undergraduate peers or to give briefings, as GTAs would do. Freshmen, some of whom may be nervous, even frightened, about beginning chemistry laboratory, can thus have a learning buddy to assist them.

The downside is that there are fewer consultants returning to the Quant laboratory now because of their placement as teaching interns in the freshman laboratories. However, in future years when the current freshmen enroll in Quant, I will have the pleasure of teaching students who are better-prepared for the course and more comfortable in laboratory as a result of their interaction in the freshman laboratory setting with these experienced undergraduate teaching interns.

Addressing the Lack of Appeal of the ACS Chemistry Program

During a recent review of the two undergraduate chemistry tracks at a faculty retreat, we resolved to increase the relative appeal of the ACS-approved (professional) chemistry program using little fixes to make a big difference. We realized it was of the utmost importance to get students into the proper sequence of courses as early as possible. Students were postponing Quant, physical chemistry, and instrumental

analysis until too late to complete the professional program in four years. Now, I send a letter to each freshman chemistry student, cosigned by the department chairman and their current chemistry teachers, telling potential students about Quant and the chemistry consultants working in the laboratory, and encouraging the freshmen students to enroll in Quant early.

Our strategy to retain our majors included convincing students to declare themselves as chemistry majors at the earliest possible date. Some of our brightest students were missing out on major-specific honors, awards, and much needed scholarships as a result of filing their chemistry major status late. Advisors make a greater effort now to inform highly qualified students about funding opportunities within the department. Faculty advisors discuss opportunities for ACS chemistry degree holders and for ACS majors at informal meetings during See Your Advisor Week prior to registration and at chapter meetings of the Student Affiliates of the ACS.

To Co-op or Not to Co-op

An additional tactic aimed at retention of our ACS majors was to discourage co-op work of the part-time type. I do not refer to the well-crafted co-op arrangement of alternating semesters as a full-time employee. Herein, the student has the opportunity to see chemistry as it is applied in a real-life situation. That benefits both the student and the employer. But some of our students work half time to three-fourths time each semester as "co-op" students; really they are just working at low-paying, part-time jobs under a co-op label, and spending a lot of time commuting. We decided to hire more students away from their part-time jobs to work in the department as chemistry instruction interns in our freshman chemistry program and to schedule their assignments around their lecture/laboratory schedules. We had to raise extra money to do it, but from this cadre of talented students with a strong work ethic have come the replacements for the missing GTAs. Most of our ACS majors are graduate- or professional-school bound and it is our belief that the chemistry instruction internship will enhance the appeal of our graduates to graduate and professional schools.

Formalizing the Chemistry Instruction Internship Program

We do not expect the chemistry instruction interns to have the level of discipline-specific knowledge that one would expect from a GTA or a faculty member. The formal training covers laboratory rules, accident prevention and reporting, emergency procedures, a safety quiz, and general tips about such matters as conflict resolution. It consists of one afternoon at the start of the semester. Interns are provided teaching materials and notebooks that describe the laboratory exercises, notes about particular hazards, and copies of the written exercises the freshman students will be asked to complete. The faculty member who coordinates the freshman chemistry program leads this training session.

A lot of informal training goes on during the semester as interns interact with the faculty mentors in charge of the various laboratories. As the faculty director of the internship program, I maintain an open door policy to interns wishing to discuss opportunities for improvements in the laboratory instruction. We actively discuss the laboratory learning goals and accomplishments as the semester progresses.

Our funding has come from a variety of sources, principally from release-time funds from faculty grants in aid of research and from student materials fees for laboratory supplies. On one occasion, the costs were covered using money from the discretionary fund of the Dean of Basic and Applied Sciences. On another, the funds were transferred from those budgeted for adjunct faculty pay. None of these sources of revenue is permanent, and we are seeking a line item in the department's budget to cover the costs permanently using University funds. A private donor has purchased lab coats and name badges for each new intern and consultant since 1998.

We have rarely had a complaint from a faculty member whose laboratory was taken over by one of the teaching interns. The freshman students have been complimentary of the interns and seek to change to their laboratories. As evidenced by their comments in lab, freshmen are keenly aware of the Chemistry Department's efforts to improve their educational experience. The beginning students greatly prefer the new teaching arrangement and appear to look on the chemistry instruction interns as partners in their learning experience. Student comments are available in a separate supporting file (stucomnt.pdf). We have approximately 20 undergraduate teaching interns in the program now and plan to expand it.

I recommend our Chemistry Instruction Internship Program as a novel way of addressing staffing problems even if your department is not experiencing problems similar to ours. There is the additional specter of further restrictions on graduate student visas resulting from the war on terrorism following the attacks of September 11, 2001. This climate may force chemistry faculty to create innovative solutions for undergraduate laboratory instruction.

Supporting Materials. A supporting file, s00897020629b.zip, containing student comments is available (http://dx.doi.org/10.1007/s00897000629b).

References and Notes

1. Bodner, G. W.; Hunter, W. J. F. *Chem. Educator* [Online] **1998,** *3*(3); DOI 10.1007/s00897980214a.
2. Fisher, L.; Holme, T. *Chem. Educator* [Online] **2000,** *5*(5); DOI 10.1007/s00897000418a.
3. Gardner, M. *J. Chem. Educ*. **1970,** *47,* 821.
4. Birk, J. P.; Kurtz, M. J. *J. Chem. Educ.* **1996,** *73,* 615–616.
5. Brooks, D. W.; Kelter, P. B.; Tipton, T. J. *J. Chem. Educ.* **1980,** *57,* 294–295.
6. Seiler, W. J.; Garrison, J. P.; Brooks, D. W;. Sikora, F. K.; Tipton, T. *J. Chem. Educ.* **1978,** *55,* 170.
7. Renfrew, M. M.; Moeller, T. *J. Chem. Educ*. **1978,** *55,* 386–388.
8. Pickering, M. *J. Chem. Educ*. **1978,** *55,* 511–512.
9. Marsi, K. L. *J. Chem. Educ*. **1978,** *55,* 574–576.
10. Pickering, M. *J. Chem. Educ*. **1976,** *53,* 313–315.
11. Mellon, E. K.; Dence, J. B. *J. Chem. Educ*. **1971,** *48,* 674–675.
12. Garland, J. K. *J. Chem. Educ*. **1969,** *46,* 621.
13. Bertaut, E. F. *J. Chem. Educ*. **1965,** *42,* 565.
14. Lippincott, W. T. *J. Chem. Educ*. **1959,** *36*, 84–85.
15. Caldwell, W. E. *J. Chem. Educ*. **1959**, *36,* 86–87.
16. *Student-Assisted Teaching: A Guide to Faculty-Student Teamwork;* Miller, J. E.; Groccia, J. E.; Miller, M. S., Eds.; Anker Publishing: Bolton, MA. 2001.

17. Gosser, D.; Roth, V.; Gafney, L.; Kampmeier, J.; Strozak, V.; Varma-Nelson, P.; Radel, S.; Weiner, M. *Chem. Educator* [Online] **1996,** *1*(1); DOI 10.1007/s00897960002a.
18. Gosser, D. K.; Roth, V. *J. Chem Educ*. **1998,** *75*(2), 185–187.
19. Lee, T. A. Middle Tennessee State University, Murfreesboro, TN, Personal communication, 2000.