Learning Enhancement in Large Organic Chemistry Classes

A Funding Request for Round 3 of the Madison Initiative for Undergraduates

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Abstract

This proposal requests funding to add TA-led, problem-oriented discussion sections to all sections of Chemistry 343 (Introductory Organic Chemistry) and Chemistry 345 (Intermediate Organic Chemistry). These courses have total enrollments in excess of 3000 student-semesters per year. Only two of the 15 lecture sections currently have organized discussion sections; in 13 of 15 sections the professor in charge is the sole content provider. The Chemistry Department has long recognized that this was insufficient support for courses which are the “gateway” for many majors in the physical and biological sciences, as well pre-medical, pre-dental and pre-pharmacy programs.

The Problem

Introductory (Chem 343) and Intermediate (Chem 345) organic chemistry lectures are large, gateway classes for students in the biological and physical sciences, including almost all students pursuing careers in health-related fields (pre-medical, pre-dental, pre-pharmacy, and pre-veterinary). They are currently taught as 3-credit courses using standard lecture format (three 50-min or two 75-min lectures per week). Multiple sections of both courses are offered in fall and spring semesters, as well as one section of each in the summer. With the exception of the two lecture sections of Chem 343 offered during the spring semester, the instructor is the sole individual responsible for delivery of the course content to a class of 250-350 students. There is clear evidence that for at-risk students, long-term academic success is highly correlated with success in such key gateway classes. Much more needs to be done in support of student learning in these courses, which are commonly considered by students to be the most challenging that they have encountered up to that point in their undergraduate career.

These difficulties are exacerbated by the fact that the 1700 students who take Chem 343 in fall and the 1380 students who take Chem 345 during the fall and spring semesters combined do not have assigned teaching assistants. Instead, in the fall semester a "pool" of TAs formally assigned to Chem 344 (organic chemistry laboratory) currently holds office hours to help the 1600 students from five different Chemistry 343 lectures and two different Chemistry 345 lectures. This is highly problematic. While the TAs are able to address general questions, they are not able to address lecture-specific issues from the seven different classes, nor can they provide a learning context which enables group discussion and peer interactions.

The problems in meeting student needs in these courses have long been recognized by the Chemistry Department. Over a decade ago, the NSF Chemistry curriculum reform project “New Traditions” funded TAs to support an experimental called "Organic Chemistry Workshops" in Chem 345, as taught by Prof. Charles Casey. The experience gained in this temporary NSF-funded experiment, which ran from 1995-2000, provided the impetus for a small step in the right direction. When the Chemistry Department introduced a streamlined undergraduate curriculum
in 2002, a new track was created for students entering the program with a solid background in science and mathematics. Rather than enrolling in a two-semester sequence of ‘general chemistry’, these students take one semester of general chemistry during the fall semester, and jump directly into organic chemistry (Chem 343) during the spring semester of their freshman year. Some of the TA resources that had been previously committed to the second-semester of general chemistry were redirected to this organic chemistry course. Weekly discussion sessions were introduced for the two sections of Chem 343 that are offered in the spring semester. This is the “off semester” for this course (there are five sections in the fall), and we felt the limited TA resources available were best used for this mostly younger group of students, still often struggling with the transition from a high school to college teaching environment.

Student members of these classes have given us their views:

“...I am a second year undergraduate student in biomedical engineering. Last semester (spring 2009), I took Organic Chemistry 343 with Dr. Ieva Reich. Organic chemistry is a very challenging subject and requires a great deal of practice to become comfortable with the material. Because I took this class in the spring, I had one discussion led by a teaching assistant each week. I found this time to be very beneficial to my class experience due to the extra practice problems offered. The TA was able to reinforce what Professor Reich lectured on and guide my classmates and me through difficult problems. To me, this extra guidance was immensely helpful and part of the reason why I excelled in the class. This semester, I am enrolled in Organic Chemistry 345 which has no discussion section. I miss the weekly discussions and the extra one-on-one guidance. With discussions in Organic Chemistry 345, I would learn the material more thoroughly and have more confidence in my own abilities to solve problems on quizzes and exams. I believe many of my fellow classmates would agree.”

“I am currently taking Chemistry 345 from Ieva Reich. When I was enrolling last semester, I was surprised to see there was no longer a discussion for Chemistry 345 or 343. These organic chemistry classes have an enormous amount of information and having a small group with a knowledgeable teacher’s assistant significantly helps our success as students. Last year not only did it help me to have direct feedback anytime I was confused by a problem or a concept, but it also gave me the ability to easily meet with other students who are facing the same challenges. I urge you to give the chemistry department the resources to hire enough TA’s to have required discussions for these classes and give us back this invaluable asset.”

These TA-led discussions, which are currently available to less than 20% of all the students in these courses, have been overwhelmingly popular – to the point where the popularity is now having an undesirable or perturbing effect on enrollment trends that impact time-to-degree. Some students who would be eligible to enroll in Chem 343 during the fall semester are postponing their enrollment in order to take advantage of the discussion sessions that are offered during spring semester. Instructors who have taught Chem 343 with and without TA-led discussion sections repeatedly find a higher level of student learning and student satisfaction in the courses with TA-led discussion sessions.

Student pleas for TA-led discussion sessions are common written comments on departmental course evaluations for Chem 343 (fall semester) and Chem 345. In preparation for this proposal Dr. Allen Clauss, who currently teaches Chem 343, emailed his students to ask their opinion on the desirability of TA discussion support for their course. He received over 50 responses within a few hours. Many of the student responses highlighted the widely held view among students that Chem 343 is one of the most challenging courses in the undergraduate pre-professional science curriculum and discussion sections are necessary to master such a challenging subject. Following are some representative student responses:
"I would be willing to write whenever is in charge of funding because a discussion is NEEDED for this class! Attending professor or TA office hours, even multiple times weekly, simply is not enough to get the consistent one-on-one help that most students need. I don't see why some 100 level courses make discussion mandatory when most people don't need the help at that level, and then 300 level courses get shorted when students are really in need! These are the courses we need for our majors, applications, and future careers so we should put the most money into them! I hope this helps get a discussion for 343!"

"Ask any student on campus, regardless of the major, what the top three hardest classes are at Madison and I bet chem 343 will be one of them. Although the professors do a fine job lecturing, it would be impossible for him/her to answer every student's questions in such a large lecture hall. I think having a discussion section would make a world of a difference!"

"I think organic chemistry is one of the most intricate and complex classes I've taken so far, but I can tell that if I TRULY understood the content, it would be incredibly beneficial to me. In many academic areas and professions, a thorough understanding of organic chemistry could give students additional and deeper understanding on said area/profession. Since being taught in lecture helps me so much (as opposed to the reading assignments), I feel an additional discussion would be incredibly helpful!"

"I think for a course of this type, with this much information there should absolutely be a Discussion section. You also have to take into account the importance that this course carries for a lot of people as far as post-graduate school and such. They should have the opportunity to increase their understanding of the material past the point of just performing well on the exams. So I believe a discussion section would facilitate this."

"I strongly feel that discussions for Chem 343 and 345 would be invaluable. Organic Chemistry is a very difficult class and many struggle through it. When I've talked to those who took Organic Chemistry in the spring, they said the discussion sections made a huge difference. More questions being answered, clearing up of confusion, and more guidance in the class can only improve grades. If the education system here wants students to be as successful as they possibly can, discussion sections are a must."

"I think Organic Chemistry can be one of the most challenging courses on campus. Moreover, it is also one of the most important classes on campus because our world is based on chemistry. Therefore I think it is a wise decision for the MIU to spend some extra money in order to help students that struggle to understand O. Chem. Thanks for listening!"

The Solution

We propose the creation of TA-led "workshop-discussion" sections for all sections of Chem 343 and 345 as a cost-effective way to substantially improve academic support for all students in these courses. Our experience with the TA-led discussion sections for Chem 343 in spring semester guarantees a strong positive impact from the new workshop-discussion sections. These workshops, which were pioneered under the NSF "New Traditions" grant a decade ago, have students working together in small groups, under the guidance of instructors, on challenging chemistry problems that reinforce the lecture material. The students share their answers with one another as the TA facilitates discussion and answers questions. The TA also administers quizzes, holds review sessions in advance of the exams, answers questions concerning exam grading, etc.

Such workshop-discussion sections are very different from traditional discussion sections in which TAs work problems while students listen and watch passively. In addition to active learning opportunities, they also provide social interactions that help minority students get to know majority students and better connect with the class. They encourage students to use the language of organic chemistry out loud while working together to solve problems. This helps them to learn a language whose mastery is crucial to understanding the lecture material, to integrating factual knowledge, and to gaining new insights. Teaching assistants play the role of guide to the material and methodology, not that of graduate student lecturer. For those students
who are reluctant to seek assistance from the instructor – and they are numerous – the TA is the personal connection between the student and the challenging subject of organic chemistry.

An important benefit of achieving better academic outcomes in Chem 343 and Chem 345 should be a decrease the number of students who repeat these courses. Presently, about 16% of students who enroll in Chem 343/345 drop the course during the semester due to difficulties in grasping the material, and a significant number get Ds or Fs. Many of these students re-enroll the next semester, reducing access to other students and extending the time to a degree. We anticipate that TA-led workshop-discussion sections will increase the overall number of students who successfully complete these courses on their first attempt and thereby improve access overall.

The Chemistry Learning Center was expanded a few years ago to provide academic support for at-risk students enrolled in organic chemistry courses, and is currently receiving additional funding from MIU. The CLC staff does a fantastic job, but their resources represent a drop in the bucket compared to the magnitude of the need for providing adequate support for these large-enrollment classes. The current proposal provides a baseline measure of academic support for everyone in the course.

**Innovation**

Adequate TA support from the MIU initiative would provide the opportunity to implement Best Teaching Practices, including group-based learning, time on task, frequent feedback, and positive classroom climate, for literally thousands of students per year in Organic Chemistry. These same elements are known to enhance learning among targeted minorities and socioeconomically disadvantaged groups.

We already have experience with these methods. The NSF Chemistry curriculum reform project “New Traditions” funded TAs to support the pioneering experimental "Organic Chemistry Workshops" in Chem 345, as described above. MIU funding for Organic TAs would enable this project to be reconfigured and begun anew. We also hope for cross-fertilization from the Chem 103 educational experiments already in progress. In collaboration with Dean Aaron Brower, the Chemistry Department has engaged in a project called "Closing the Achievement Gap in General Chemistry Courses: A two-pronged approach". We plan to incorporate the same methods in the training of new organic TAs for the enhanced workshop-discussion sections they will lead.

We are also interested in exploring on-line methodology in both problem sets and help sessions. In a recent innovation, Prof. Tehshik Yoon used text messaging to communicate directly with students who have questions. This could include “face-to-face” interactions with students whose computers have web-cams. Yoon reports that today’s students are much more likely to engage in these forms of communication than to appear in person at official office hours. Another intriguing idea is to bring TAs to the large undergrad dorms for problem-solving sessions. Again, students are much more likely to participate if the event is easy to attend.

**Interdisciplinary Impact**

This request, by its very nature, is not a cooperative effort between Departments or Colleges. However, the students who populate these courses come from dozens of other departments in Letters and Sciences, as well as from the College of Agricultural and Life
Sciences and College of Engineering, among others, so improving the teaching environment for Chemistry 343 and 345 will benefit many parts of the campus community.

Evaluation

We will monitor and assess progress and success in several ways:

1. We will gather and track student opinion about the efficacy of the new workshop-discussion sections. Ms. Emily Wixson in our Department is experienced in designing web-based evaluation forms that are user friendly and that facilitate analysis of response data.

2. We will provide data for the ongoing UW-Madison statistical analysis of outcomes for at-risk students in large introductory courses.

3. We will work with the Chemistry Learning Center to assess the impact of these reforms on learning outcomes for all students.

4. We will monitor the number of students who initially enroll in Chem 343/345 who complete the class on their first attempt, and compare these with historical averages.

5. The standard course evaluation form used by the Chemistry Department elicits student feedback concerning the course and the instructor. Historical data are available for each course and each instructor. These historical data (for courses without discussion sessions) will be compared to new data (for courses with discussion sessions) for lecture sections taught by the same instructor. These comparisons will provide both direct and indirect information concerning student satisfaction and student outcomes.

The Budget

We propose TA-led workshop-discussion sections for all lecture sections of Chem 343 and Chem 345 in fall, spring, and summer. We anticipate that each TA will be responsible for 100 students, comprising 4 sections (2 sections in the summer) with 25 students each. Using the 2009-2010 academic year as a snapshot, there were 1750 students who took Chem 343, and 1380 who took Chem 345 during the academic year, for a total of 3130 student-semesters. In addition, 300 students took Chem 343/345 in the summer. Two of the Chem 343 sections (650 students) already have TA-led discussions. This leaves 2470 student-semesters, requiring 25 semesters of 50% TA support. In addition, six 50% TA positions will be needed to cover the summer Chem 343/345 sections.

- **Academic year:** 12.5 TAs (50% time) in both semesters (25.0 TA-semesters total).
- **Summer:** 6.0 TAs (50% time).

The only additional expenses will be duplicating and other incidental expenses, which can be absorbed in the Chemistry Department budget.

Staffing and Organization

The TAs who will be appointed to the positions will, to the extent available, be advanced graduate students (2nd year and beyond) majoring in organic chemistry. The lecturer in charge of the course will provide guidance to the teaching assistants, and the TA will be required to attend the course lectures, help with grading, and hold office hours. Each TA will be responsible for holding one discussion session a week for each of 4 sections of 25 students each.
MEMORANDUM

December 1, 2010

To: Provost Paul DeLuca

From: Gary Sandefur, Dean

Re: MIU Round 3 proposals

We are pleased to submit proposals from the College of Letters and Science for MIU Round 3. We solicited two page pre-proposals and received over 40. We reviewed these pre-proposals in the Academic Planning Council and in Senior Staff. Based on these reviews, we invited 15 submissions of full proposals. These proposals were reviewed by Senior Staff and we decided to forward these 15 to you for consideration. All are worthy of funding and would help meet critical needs in the University.

The proposals are grouped into three tiers in order of their importance in meeting the goals of the MIU, with tier 1 being the most important. Importance is based somewhat on the quality of the proposals but primarily on undergraduate educational needs. We also took into account losses in faculty numbers prior to the MIU and the success or lack thereof of departments in previous rounds of the competition.

Tier 1: Communication Arts, English, French and Italian, School of Journalism and Mass Communications, Philosophy, Political Science

Tier 2: Anthropology, Chemistry, Math, Sociology, Statistics

Tier 3: Communicative Disorders, Religious Studies, Service Learning, Undergraduate Research Scholars

We did not carefully assess the budgets of the proposals since we assumed that this would be done by the office of the Vice Chancellor for Administration and Finance.

xc: Associate Vice Chancellor Aaron Brower
Associate Dean Nancy Westphal-Johnson
Academic Associate Deans
Associate Dean Anne Gunther
Sheila Voss, Office of the Provost

Office of the Dean

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