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## NSF Highlights

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## The Workshop Chemistry Project: Peer-Led Team Learning

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*My first day! At first, the butterflies in my stomach were all I could concentrate on. So I took attendance and said a few words about myself and organic chemistry so that the students would see me as part of the group and not some unapproachable Orgo genius.*

*I definitely have to say that my first day as a workshop leader taught me a lot about being an effective leader. There is more preparation than I had anticipated, and more patience required than I had thought. How could I get them to see that I was not there to dictate answers, but to act as their peer mentor?*

*I was shocked to see my most shy student taking a very active role.*

*I'd like to note my feelings as a workshop leader. The students encounter their first test Friday, and I'm nervous for them. Is this normal?*

*Since most of my students did not do well on the first exam, they were afraid of the second exam. I told them what happened when I took general chemistry a year ago. In my group, I got the lowest grade. Encouraged by my workshop leader, who told me that if I studied hard I could be a leader too... I started to study harder, so I did well in the course and now I am trying to help other students as I was helped.*

These comments, and many others like them, appear in the reflective journals kept by our peer leaders as they trace their experiences guiding students in Workshop Chemistry. A coalition of faculty, students, and learning specialists, the Workshop Chemistry project is developing a peer-led team-learning model for teaching and learning chemistry (1). The Workshop Chemistry model embraces dimensions of student experience that are essential for learning: the freedom to discuss and debate chemistry in a challenging but supportive environment, the connection to mentors, and the power of working as part of a team. The workshop model calls for the traditional recitation, or a modest amount of lecture, to be replaced by a *new curricu-*

*lar structure: a two-hour student-led workshop. In the first two and a half years of the project, more than 6000 students have participated in workshop courses in allied health, general, and organic chemistry, conducted by 27 faculty and more than 800 workshop leaders.*

### The Workshop Model

In the workshop model, the class is divided into groups of six to eight students who work together throughout the term under the guidance of an undergraduate peer leader (2). The peer leader, called the Workshop leader, is a student with good communication and people skills who has done well in the course previously. The leaders receive a modest stipend in recognition of their participation. In the Workshop model, the faculty reallocate some of their time and energy from presenting information to shaping a peer-led learning environment in which students are actively engaged with the subject. The Workshop model builds on earlier work and shares elements of group or team learning with other efforts (3–5), but has the unique characteristic of peer leadership as an integral part of the course structure.

### Role of the Workshop Leader

The workshop leader is there to actively engage students with the materials and with each other. This facilitation can take many forms: organizing “round-robin” style problem solving, creating subgroups or paired problem-solving groups whose members can compare results, offering timely assistance when a group is stuck, and providing encouragement and guidance in the study of chemistry. The workshop leader needs to set a tone for the discussion in which individual points of view are respected, the criticism is constructive, and all members have an equal opportunity to participate. As the term progresses and as the leaders guide their students through the trials and tribulations of a difficult course, they often become mentors and role models for the members of the group.

### Recruiting Workshop Leaders

Although it requires an investment of time, it has turned out to be a pleasure to recruit and train new leaders because it gives us a mechanism to provide new opportunities for our best students. We find most of our leaders for the next semester by inviting our top students to an interest meeting. During this session, we and our experienced leaders

#### NSF Highlights Feature Editors' Note

This is the first of a series of reports on the Chemistry Initiative projects supported under the National Science Foundation, Division of Undergraduate Education, Course and Curriculum Development program.

describe the project as a whole and outline the benefits and responsibilities of being a workshop leader. Although most of us were concerned at the outset that we would not locate a sufficient number of leaders to sustain the project, we have not found this to be the case. Instead, we generally find a previously untapped enthusiasm for taking on this kind of role and responsibility.

### Training Workshop Leaders

Each semester our new leaders are energetic, smart, and eager to begin meeting with their own group of students. However, despite their natural talents and enthusiasm, it is important that we guide the development of their leadership skills. The natural inclination for many new leaders is to fall back into familiar patterns of instruction; we need to help them understand that their role is not to serve as an additional lecturer for the course or as a group tutor. Because the Workshop Chemistry consortium includes a wide range of colleges and universities, we have worked toward a flexible leader training format that ranges from a series of staff meetings between chemistry faculty and their leaders to credit-bearing training courses, team taught by chemistry faculty and learning specialists.

Within these varied formats, the training highlights the following:

- Faculty and leaders review of the content and practice of the workshop problems.

- Instruction and practice in group dynamics and group leadership.

- Discussions about learning styles and intellectual development.

- Practice with new pedagogical methods and review of study tactics.

- Discussions about the impact of race, class, and gender on learning environments.

In the training sessions, new leaders have the opportunity to receive feedback from us and from their peers, to pursue special investigations of topics that interest them, and to explore how their workshop experience may lead them to future academic careers.

### Materials for the Workshop

Good workshop problems can reinforce the goal of promoting collaborative, active engagement with chemistry. The structure of the problem, or the manner in which it is phrased, can assist the group interaction. The faculty in the project have developed workshop problems on a topical basis to form a collection for other faculty to choose from or add to. Feedback and suggestions from the leaders about the problems under actual workshop conditions have been very useful. We have used a variety of approaches in designing workshop problems:

- Stepwise or structured problems, reflective problem solving
- Construction of concept maps, simulations using concrete models
- Interpretation of graphs, observation/deduction problems
- Problems involving the use of molecular models
- Workshops based on a laboratory experience
- Problems based on historical developments in chemical thought
- Problems related to important contemporary issues
- Creating strategies for synthesis, moving from data to structure and mechanism

We do not write answer keys for workshop problems. The existence of an answer key would undermine the philosophy of the workshop, which is to learn how to construct answers.

### Evaluation of The Workshop Chemistry Project

We have collected data from workshop courses at City College of New York, New York City Technical College, Borough of Manhattan Community College, Lehman College, Queens College (New York), Medgar Evers College, and The Universities of Pittsburgh, Pennsylvania, Rochester, St. Xavier (Chicago), and the Pacific. The evaluation to date demonstrates that the Workshop model and the training component are robust (6). We have tracked Workshop Chemistry students across a number of different sites, and have found statistically significant improvement in grades, retention, and levels of student satisfaction. We have administered questionnaires and held focus groups with workshop participants, their leaders, and the professors in charge of these courses. All three groups have enthusiastically endorsed the Workshop model.

The present focus of the evaluation is to determine the critical components of a successful workshop course. We have identified the need for leader training, coherent and challenging workshops, close involvement of the faculty with the leaders, and the integration of the workshop with other course components.

We have also conducted a preliminary test (7) of the theory of autonomy support (8, 9). In this theory, a learning environment that supports students' autonomy will promote their growth as learners. Our assessment work to date has borne this out; the degree of autonomy support reported by workshop students is positively correlated with their performance at the end of the term. It is this particular characteristic of peer-led support that is the heart of the Workshop model.

### The View from Industry

We want to ensure that the workshop model serves the needs of students as they enter the workplace. Our own survey of industry and other studies (9-11) indicate that communication skills and teamwork are prerequisites for success in the workplace. The performance requirements that companies face demand a quality that can often be achieved only through collaboration and teamwork (12). From an industry perspective, a *high-performance team* has been defined (13) as a *small number of people who are committed to a common goal, working approach, and to one another's personal growth and success*. The successful workshop experience shares these qualities of collaborative work, personal connection, growth, and high performance.

### Resources

The peer-led Workshop is a flexible and robust model for teaching and learning chemistry. It has been tested and validated throughout the Workshop Chemistry Consortium, at a wide variety of institutions. We invite others to adopt, adapt, and participate in the creation of materials and methods for Workshop Chemistry. The following materials are available through the Workshop Chemistry Project:

- Topical workshop units in allied health, general, and organic chemistry

- A guidebook for implementation of workshops

- Materials for the training of workshop leaders

To help others develop workshops in their own course, we offer interactive seminars at chemical education meetings on a regular basis, where our undergraduate leaders participate, leading workshops to directly illustrate the model to interested faculty and their students (15–19). In addition to such seminars in the future (20), we plan to host a series of more extensive four-day retreats in the summers of 1998 and 1999. To keep in touch with these and other developments, consult the Workshop Chemistry Home page at <http://www.sci.ccnycunyc.edu/~chemwksp>.

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