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Special Report

Organic Chemistry Made (Relatively) Easy—By Students' Own Peers

Every week the 300 undergraduates in Chem 203 separate into small 'workshop' groups to brainstorm their way through tough problems that have boggled students for 40 years. Not only do these workshops work, the brainstormers say, they're eve, note this, 'fun.' By Steve Bradt

Organic chemistry—typically one of the undergraduate curriculum's most formidable courses—is looking a lot less daunting to Rochester students these days, thanks to pioneering "workshop" study-sessions that help budding scientists learn from each other. The program's success has attracted the attention of educators around the nation.

Chemistry Professor Jack Kampmeier says the workshops have greatly improved students' comprehension and, consequently, their performance on exams. The students themselves describe the sessions as "thought-provoking," "comfortable," and, even, note this, "fun."

Early each week, the 300 undergraduates in Kampmeier's Chemistry 203 course separate into small groups (six or seven participants) to brainstorm their way through tough problems guided by upper-class undergraduates who have aced the course in past years.

Traditionally, lectures in organic chemistry have been supplemented by large "recitations" (30 to 40 participants) conducted by professors or grad students. It's a top-down ambiance that admittedly is not ideal for uncovering and thrashing out all the difficulties individual students encounter. Kampmeier, who has taught organic chemistry at Rochester since 1960, is convinced that the smaller brainstorming sessions have worked wonders. "Nothing else even comes close to the impact workshops have had on our undergraduates," he says.

"Students have always had far more trouble with organic chemistry than they should," he goes on. "The 'gas station' model—where students pull in, a professor or graduate student opens up their heads and pours knowledge in, and they drive off, filled up—just doesn't work. In workshops, students build their own understanding of the material by debating and discussing ideas and problems with their peers—a method that's in tune with theories of how they really learn."

For their part, Kampmeier's students agree that workshops are a big help in mastering

the tricky ways of organic chemistry.

"It's an active thinking session," says junior Melissa Glendening. "Recitations are often too large, and they can be intimidating. But workshops provide a small group of people that you feel comfortable with. And it's structured, so it keeps everyone on track."

Adds sophomore Jamal Mitchell: "Even though the two-hour workshops are time-consuming, every minute you spend there is worth it."

Kampmeier says that the success rate for Chem 203—which he defines as the percentage of students completing the course with a passing grade of C-minus or better—has risen 15 percent in the two years he has used workshops to replace the traditional question-and-answer sessions.

Workshops engage undergraduates with the material and with each other, he says, boosting confidence and minimizing competitiveness in the process: "When students study alone, they often build castles in the air. They used to come in to see me after doing poorly on an exam saying, 'But I knew this stuff forwards and backwards.' Well, really they didn't—they just thought they did. The workshops provide a mechanism for frequent reality checks on understanding."

He illustrates how it works, using a problem from Workshop # 2, Structure Properties —Acids and Bases:

Three dicarboxylic acids with the structure C2H2(CO2H)2, I, J, and K, are catalytically hydrogenated (react with H2 in the presence of a catalyst) to give dicarboxylic acids with formulas of C2H4(CO2H)2. Hydrogenation of both I and J gives the same dicarboxylic acid L. Compound K hydrogenates to form compound M.

Give structures for compounds I–M. Explain your reasoning, listing your observations and the deductions to be made from each.

The workshop environment, Kampmeier says, is ideally suited for wrestling to the ground a stumper like this. To solve it, and to know that you have solved it, he says, you must separate the information you've been given into its components: "Compound K hydrogenates to form compound M," for example, is the last of the six observations to be drawn from the problem above. Next, you identify what you can deduce from each observation.

Following a chain of logic—"if this is true, then that also must be true"—leads you to the solution. Asking students to explain their reasoning (which, Kampmeier says, the traditional question-and-answer approach doesn't do), "makes visible your thought process and gives you confidence in the answer."

On a basic level, the workshop approach pools what students know. And that's important, he says: "You can't just reason your way to the solution without having learned some empirical facts, as some seem to believe.

"But on a more interesting level," he points out, "one person's thought processes play off another's. And by virtue of that, each comes to understand something that they couldn't have individually. It becomes a truly cooperative kind of venture in which each is as interested in the others' success as in their own."

The workshops are a team effort in another way, involving also the University's office of Learning Assistance Services and with a healthy dose of input from the students and their workshop leaders.

"These workshops take advantage of all the University's talent—especially our undergraduates' teaching ability," says Vicki Roth, assistant dean for learning assistance. "Many schools miss out on a big opportunity when they overlook student skills in teaching each other."

Roth says the student leaders are "professionalized" through a for-credit training course that teaches them about learning theory and group dynamics, and how to guide, rather than teach, their workshops. "It feels like we're growing our own professors here," she says, noting that many students say their experience conducting workshops has nudged their career plans toward the academic arena.

The workshops are supported by a grant from the National Science Foundation to a consortium of 12 colleges and universities—public and private, large and small, two-year and four-year. Most have focused on workshops for first-year chemistry; Rochester has been a leader in developing the project in organic chemistry.

The College plans to continue using workshops in Chem 203, the organic chemistry course, after the NSF funding expires later this year, and is considering similar workshops for other undergraduate science and math courses.

And with good reason, says Kampmeier: "Questions that have stumped organic chemistry students for 40 years seem to be a piece of cake for this year's group," he reports.

Steve Bradt '96 knows whereof he speaks. He is a survivor of Chem 203, taught the traditional way.