

- **IPEDS enrollment, Fall 2010:** 15,745
- **Type of community:** Suburban
- **Number of campuses:** 7; only 2 have chemistry labs. A non-lab chemistry course is taught at a third campus.
- **Number of chemistry students, Fall 2011:** 924
- **Number of full-time chemistry faculty:** 3 (in the process of hiring 2 more in Fall 2011)
- **Number of adjunct chemistry instructors:** 4–7
- **Structure:** Chemistry is part of the Natural Sciences Department in the Division of Liberal Arts and Sciences
- **Focus of chemistry program:** Transfer
- **Sections of the Guidelines used:** 5.1, 5.3, 5.5, 5.10

Sture K. Edvardsson, the Natural Sciences Department chair at Santa Fe College and a chemistry professor, said the release of the *American Chemical Society (ACS) Guidelines for Chemistry in Two-Year College Programs* coincided with his and the full-time faculty's decision to re-examine the chemistry prerequisite course. The Santa Fe Chemistry Department used the Guidelines to

- Evaluate the alignment among Introduction to Chemistry, General Chemistry I and II, and Organic Chemistry I and II
- Guide the redesign of Introduction to Chemistry
- Encourage the use of process-oriented, guided-inquiry learning to teach Introduction to Chemistry

In 2009, the full-time chemistry faculty members at Santa Fe College recognized that the performance of students in Introduction to Chemistry needed to improve. Only 42% of the students who started the course completed it with a C or better. Even more troubling was the fact that many of the students who passed Introduction to Chemistry struggled to complete General Chemistry. While peer institutions in the region reported their students had similarly low success rates, the Santa Fe faculty felt they could do better.

Setting Improvement Goals

The curriculum development committee, comprising Edvardsson and all the full-time chemistry faculty members, agreed that during 2010–2011 they would revise the Introduction to Chemistry

course. The new version of the course was launched in Fall 2011. The committee members had many conversations about the details of the revisions, but they agreed at the outset to use the ACS Guidelines to set goals for what they intended the course to accomplish.

“One of the principal organizing factors was the ACS Guidelines that we used as a starting point,” Edvardsson said. The Guidelines were not the only resource the committee used, but he said they provided essential guidance about what the expectations should be for the course content, laboratory experiences, and student outcomes.

“The Guidelines came out at just about the right time in order for us to grab ahold of them and say, ‘OK Let’s start with this,’” Edvardsson continued. The college had used a previous version of the ACS Guidelines when it planned the renovation of its chemistry facilities in the late 1990s.

Revising the General Chemistry Curriculum

The curriculum committee worked backward from the existing Organic Chemistry and General Chemistry sequences to re-engineer the introductory course. Faculty members considered the expectations that students face when they advance to Organic Chemistry or move into quantitative analysis. They asked, “What does General Chemistry have to teach in order for students to be successful in Organic Chemistry?” Once the committee established what needed to happen in the two General Chemistry courses, they identified the concepts,

knowledge, and activities that students need to learn in the introductory course.

As part of this process, faculty members took a careful look at where their students encountered the most difficulty. Edvardsson said there are many reasons students do not do well, but the committee agreed that three deficiencies in particular had to be addressed in Introduction to Chemistry for students to succeed in subsequent courses. They were: 1) students' lack of math reasoning, in particular, their inexperience with applying algebra to solve contextual problems; 2) students' inability to visualize three-dimensional molecular objects; and, 3) students' low reading skills, which made it difficult for them to comprehend college-level chemistry textbooks.

The committee chose a new textbook and reformulated the course outline for Introduction to Chemistry. It also made sure the comprehensive departmental final exam aligned with the expected course outcomes.

Vice President of Academic Affairs and Provost Edward T. Bonahue said he considers the revisions to Introduction to Chemistry "a good example of the kind of continuous assessment that regularly takes place in the college."

Implementing Pedagogical Changes

Edvardsson explained that using the Guidelines led the faculty to talk about pedagogical techniques as well as the knowledge base students need.

"There's a good description in there about how to engage students," Edvardsson said, referring to the Guidelines' encouragement of open-ended laboratory investigations and accommodation of various learning styles.

The faculty agreed to move toward process-oriented, guided-inquiry learning rather than continuing to use traditional lectures. Two faculty members were sent to guided-inquiry seminars. Two other

faculty members attended a cooperative learning strategy program. When these individuals returned from the professional development programs, they shared what they learned with their colleagues.

Edvardsson explained that although the college values and respects individual faculty members' abilities to design their own classes, the expected learning outcomes identified during the curricular revisions require students to engage in lessons and to use processing skills. He went on to say that the committee working on the revisions decided the student-to-student interactions and guided-inquiry exercises were "the best and most obvious strategies to accomplish those goals."

According to Edvardsson, after the course outline was completed, Professor Mapi Cuevas led the faculty in developing a shell within the learning management system. It serves as a "course-in-a-box" for incoming faculty to get them started. This shell includes guided inquiry activities for the classroom and specific assignments designed to engage students in scientific inquiry.

During the orientation program for new faculty, the course activities are shared. New faculty members are also told of the college's expectations that they will incorporate the inquiry activities into their teaching. However, Edvardsson noted, that approach may not fit everyone's teaching style.

In addition to encouraging faculty to use the guided inquiry pedagogy, the college acquired additional equipment, including new software for students to use during laboratory exercises. This new software emphasizes observation, documentation, and analysis.

Santa Fe College launched the revised Introduction to Chemistry course in Fall 2011. The faculty hopes that at least 60% of the students who take the new course will pass it. The faculty will next revise General Chemistry I and II.

The content of this case study was provided by Sture K. Edvardsson, chairman of the Natural Sciences Department at Santa Fe College since 1990. He joined the chemistry faculty there in 1987. Edvardsson earned a bachelor's degree in chemistry from the Central University of Iowa and studied chemistry in the doctoral program at the University of Florida. During his time as a working chemist, he coauthored five articles on the degradation of aldicarb in soils.