

MENTORING

Linking Student Interests to Science Curricula

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Attraction and retention of science majors remain difficult in the fields of chemistry and biology (1–6). The usual sequential and extensive curriculum often does not allow undergraduate students to exercise their curiosity in selecting these subjects, as the starting point of most courses is their technical content rather than students' interests.

To strengthen this weak link between students' interests and science curricula, we began in 2003 a course called "The Chemistry and Biology of Everyday Life" (CBEL) (see figure, right), using students' interests in everyday life as the starting point for instruction. The course content and activities were designed to match each student's background and interests with other courses and research group activities. The course mimics a scientific research group. Students develop skills through literature review (journal club), special topic discussions, and research assignments. Peer mentoring engages students from freshmen to seniors. Visits to laboratories and attendance at scientific meetings broaden students' horizons. Assessment through the Classroom Undergraduate Research Experience (CURE) survey indicates that students who took CBEL believe they have progressed in a number of areas valuable in scientific research. Students following their own interests are more motivated to learn (3, 4, 6–11). CBEL elicits student interests, links those interests to existing science courses, and sustains their interests through independent investigations.

Large-scale changes to traditional curricula often seem costly (12) or disruptive (13). Rather than changing existing courses, CBEL works within the existing infrastructure and helps students to navigate more than 7500

courses and 2000 research groups at the University of Illinois, assisting them to identify courses and groups that match their interests (see figure, below). In doing so, CBEL allows instructors to experiment with pedagogy with-

Explicit networking helps undergraduates get the most out of the diverse curriculum available at a large university.

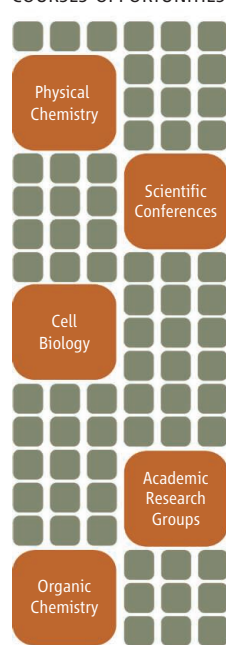
survey (14) is conducted each semester to identify students' interests and to build mentoring groups with common interests.

Programs that feature mentorship of novices by experts, whether faculty, graduate students, or undergraduates, have been successful (15, 16). We found that mentoring by students of similar class standing and experience is also effective for two reasons. We have observed that because peers have no control over the mentees' grades, students are more open with one another [see also (17)]. Also, undergraduate students have experiences not shared by faculty and graduate students. For example, undergraduate mentors can offer firsthand advice on courses they have taken or laboratories they have worked in. Our students trust and appreciate the advice from undergraduate mentors; each semester, students respond most favorably to guest lectures by former classmates who now have a successful career in the scientific enterprise.

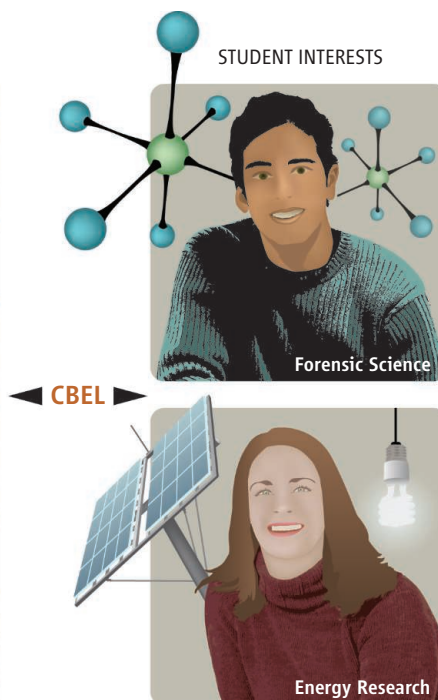
Modeling a Research Group

America is a leader in graduate education; one main reason is that graduate students are placed in research groups. Our course is designed to mimic a scientific research group redesigned for undergraduates, with peer mentoring at its center. In any given semester, the course includes students of different levels of experience and areas of interest or expertise, similar to those of a research group. This class is divided into subgroups of 8 to 10 students, from freshmen to seniors, who have identified similar interests. The group works together all semester to help each other and to complete group projects. All returning students serve as mentors and are trained at the beginning of the semester through meetings with instructors using a textbook (18). The mentors and group activities are monitored through subgroup agenda minutes and discussions with instructors (14). Being a peer mentor, a senior student is more conscientious about his or her participation in the

COURSES-OPPORTUNITIES



Engaging students in science by harnessing their interests.



out disrupting existing courses. Although the CBEL design addresses concerns that may be particular to large universities, many of the course activities that help students explore their interests could be relevant to other educational institutions.

Peer Mentoring

Even though the possibility of matching students' interests with science courses exists, carrying out such a match is not trivial. Undergraduate students, particularly freshmen and sophomores, might not have enough experience to identify the courses and laboratories that interest them. Therefore, in our course, mentoring by upperclassmen has an important role. New students join the course in their freshman year and are encouraged to remain in the course until graduation, being mentored at first and becoming mentors later. A pre-enrollment

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course, providing a review and refreshing his or her understanding of previously learned content.

The subgroup is also the scaffold upon which several skill-building activities rest. In monthly journal club meetings, students present and discuss published articles in subgroups first. Each subgroup then chooses one student to present for the entire class. Another way to encourage critical reading and debate is through discussing a selected broad topic, such as “banning trans fatty acids in food” or “the safety of prescription drugs approved by the U.S. Food and Drug Administration.” Each subgroup investigates one area of the topic and makes a presentation as a group to the whole class, which is followed by a lively debate (14). Finally, research assignments allow each student to investigate a chosen topic of interest in increasingly complex formats. First-time takers of CBEL complete literature searches and write a report on a topic of their choice. Second-year students give literature seminars, and third-year students submit research proposals outlining how they would investigate their topic within a research laboratory. Fourth-year students, usually graduating seniors, give a thesis defense to the entire class on results of experimental investigations. Each assignment requires students to articulate a question that can be investigated in the literature and the laboratory. With each year, students’ topics of interest become more refined and their content knowledge improves as they move toward research within a laboratory (14).

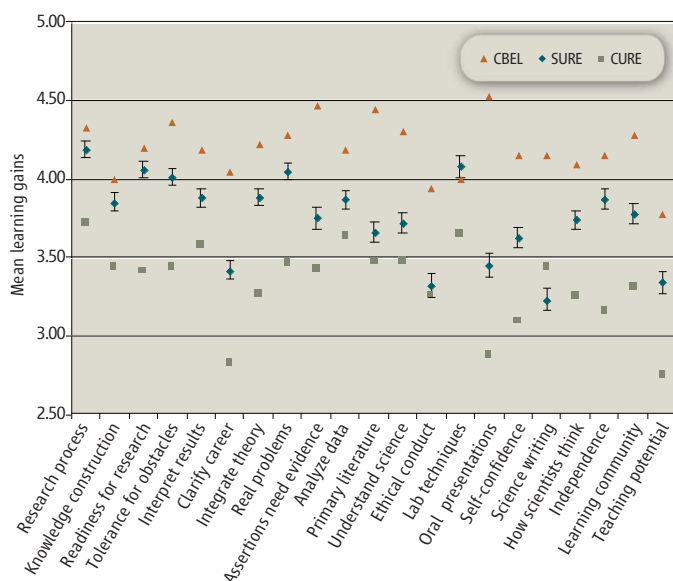
Another element in the course is students’ exposure to the excitement of discovery by

visiting academic and industrial laboratories, such as Abbott Laboratories and the Indiana State Police Laboratory, as well as scientific meetings, such as annual meetings of the American Chemical Society and the American Association for the Advancement of Science. These trips serve as an eye-opening and motivating experience for the students. Because these field trips build community among the students, we now do the scientific meeting field trip toward the beginning of the semester. Course activities after the trip become livelier as the students interact with each other more freely.

Assessment

The effectiveness of the course has been assessed through online CURE surveys conducted before and after the spring semester of 2007 (9, 14). The presurveys found no pattern of differences between our students and the benchmark group on background variables such as science attitude and learning style. However, opinions of their own learning gains at the end of the semester are higher among students who took CBEL than among the reference cohort of students who completed the CURE survey in the spring of 2007 at other colleges and universities (see figure below). The mean learning gains of students in our course are also compared with a national cohort of students who took the Summer Undergraduate Research Experience (SURE) survey in summer 2006. The general trends of the self-reported gains by our students resemble the national trends, even though the gains are higher for CBEL students. For example, the self-reported gain in

knowing the “research process” is higher than that of “knowledge construction” for both our students and the national average. There are exceptions, however. Although the national CURE/SURE gains in “lab techniques” are among the highest, our students did not rate themselves as high in this area, because most of our students are freshmen or sophomores who have not had time in the laboratory. Our students did report stronger gains in “oral presentation,” bucking the national trend, which may reflect our focus on



Student rating of learning gains. Students in CBEL from the CURE survey in spring 2007 compared with those of the reference cohort of students who completed the CURE and SURE surveys. Error bars represent 2 SEM.

oral presentations by freshmen.

The next challenge is to make our program adoptable and sustainable (19). The primary challenge is the resources it requires, especially time. Analyzing each student’s interests and giving individual attention require considerable time from teaching assistants and instructors. Furthermore, many students have difficulty fitting the course, which is not yet required, into their schedule. To address these issues, we are working on adopting small modules from this course into other existing courses, aiming to integrate our most successful ideas into the mainstream curriculum. If peer mentors can provide some of the individualized attention, the course model can be applied to other courses, in other disciplines or in other institutions.

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Supporting Online Material

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