EVERAL YEARS AGO many science teachers in the Los Angeles Unified School District (LAUSD) were concerned over the low number of students electing to take a third year of science. It seemed like only those few who had decided early on to become doctors, dentists, and engineers were taking advanced science courses, and most importantly, the excitement and wonder of science was not reaching enough students. Motivated by these concerns and other issues affecting the teaching and learning of science, teachers from 10 LAUSD high schools decided to reform the current science curriculum to actively involve more students in science for longer periods of time.

As a first step, the teachers applied for and received funds from the California division of an NSF-funded nationwide science reform effort called the Scope, Sequence, and Coordination of Secondary School Science Project (SS&C). The funds supported teacher leave time for the difficult conversations and planning necessary for any meaningful changes to occur. To guide the planning process, participating schools used the Benchmarks for Science Literacy and the California Science Framework, along with NSTA’s The Content Core and The Relevant Research as the essential documents to create the foundation for reform (AAAS, 1989; California Department of Education, 1990; NSTA, 1993 and 1992).

It became apparent early on in the planning that the philosophical underpinnings described in these documents could lead to structural and lasting changes in the high school science programs. In fact, schools in the SS&C project adopted a powerful slogan: every science, every student, every year. Based on the idea of reaching all students all the time, the schools developed comprehensive standards-based science programs that provided a seamless transition from middle school through twelfth grade for all students, not just those who were already in the “science pipeline.” In the LAUSD, the SS&C-based reform effort evolved into a six-year sequence of integrated/coordinated science (ICS) classes in middle and high school preparing students for entrance into the University of California (UC) system and other two- and four-year institutions of higher education. The three-year high school sequence of ICS classes was granted college preparatory status from the UC system, resulting in nationwide acknowledgment of ICS’s equivalency to traditional college prep courses in life and physical sciences.

The ICS curriculum used by the LAUSD connects concepts from the science disciplines in a meaningful and coherent fashion designed to help students understand the links and interdependencies among physics, chemistry, biology, and Earth and space science. In addition to using inquiry to teach the connections among the content from the four science disciplines, ICS relies on a research base that indicates the value of revisiting important scientific ideas over time. This does not mean re-teaching the same thing in the same way in subsequent years, but rather using a scientific principle to explain different phenomenon, developing a quantitative understanding of the principle, and showing how it may be used in other science disciplines. This approach is similar to the way science is taught in Europe, where students receive instruction in subjects like physics every year.
DEVELOPING THE ICS PROGRAM

Despite the success of the program, by 1995 the SS&C project was winding down. Only three of the original high schools in our district still offered ICS, mainly due to a lack of funding from the state. In fact, schools learned a difficult lesson to not expect lasting reform if they receive only start-up funds. To counter this problem the LAUSD was awarded an Urban Systemic Initiative grant, which became known as the Los Angeles Systemic Initiative (LA-SI). A group of teachers, called resource teachers, were selected by their peers and administrators to implement the grant’s goals. During the winter of 1995 the secondary science resource teachers devised a plan for science reform in the LAUSD’s 49 comprehensive high schools and 72 middle schools. The science reform plan addressed one of the most important goals of the grant, which was to increase the number of underrepresented groups of students in college preparatory science classes, by building on the SS&C efforts. ICS was a viable approach to meeting this goal and LA-SI used the foundations of SS&C as outlined in volumes 1 and 2 of Scope, Sequence, and Coordination of Secondary School Science to revitalize secondary science and offer a standards-based alternative pathway in our district.

LA-SI disseminated the plan districtwide early in 1995, and 17 high schools volunteered to begin the long-term process of reform at their sites. During the winter and spring months this group of schools, called Cohort I, elected lead teachers, who undertook an intensive training and planning program before implementing the reform plan. These reform plans varied since each school site was free to develop their own plan as described below. Joining Cohort I in the reform effort during the second year were an additional 20 high schools, Cohort II. These teachers also undertook a year of planning.

During the preparation year, teachers used the essential documents mentioned earlier—which now included the new National Science Education Standards (National Research Council, 1996)—as the basis for their reform plans. The teachers assembled curricular materials from a variety of sources including texts used in existing biology, chemistry, Earth and space science, and physics classes. However, most schools had to develop some of their own materials. When the program was initiated, one or two of the lead teachers from each school were given an extra planning period to help other teachers, troubleshoot labs, and prepare and modify materials. Additionally, LA-SI started a lab specialist program in which retired teachers were hired to train students to prepare labs for ICS teachers. Although other high schools joined in subsequent years, forming Cohorts III and IV, the 37 schools in Cohorts I and II are the core of LA-SI’s voluntary high school reform effort and constitute the basis for evaluating the effectiveness of the ICS program.

It should be noted that most of the core schools continue to offer biology, chemistry, and other traditional science courses. More importantly, many of the teachers involved in the reform effort continue to teach one or more of these courses along with ICS classes, bringing some of the new strategies and materials into the traditional classes. Therefore, all of these teachers’ students have benefited to some degree by the training.

While the high schools were developing their programs, some middle school teachers were already trying to achieve the “ideal curriculum” described in the Science Framework for California Public Schools, which called for coverage of all science disciplines every year. The district and LA-SI called upon these reform-minded teachers to help revise the district guidelines for middle school science. Department chairs from the 72 middle schools met and planned how to implement these updated guidelines.

MEASURING SUCCESS

In 1995 there were approximately 2700 students enrolled in the ICS classes offered by the three remaining SS&C high schools. By 1997, almost 22 000 students were enrolled in ICS. During this accelerated growth phase
the percentage of students earning a C or better remained a constant 52 percent. We attribute this consistency in grades to the planning before implementation and to the extra period lead teachers were allotted.

One of the benchmarks for evaluating the success of the ICS program in our district is the number of students who choose to take a third year of science. As we increase the number of students taking ICS 2, we are encouraged to note the percentage of students taking a third year of science has slightly increased. In 1997, 582 students, or 53 percent, of the 1107 students who earned a C or better in ICS 2 chose to enroll in an advanced science class. In the following year, 1998, 1947 of the 3404 (or 57 percent) who earned a C or better chose to take a third year of science.

But how do these figures compare with those from the traditional sequence? Advanced physical science (APS) and chemistry are the most heavily enrolled second-year science classes in LAUSD. Students complete the two-year science requirement for graduation by passing one of these classes after they have passed biology. Those who pass the second-year course may then choose to enroll in a third-year science class. A comparison of two possible pathways, ICS 1 to 2 and biology to APS, may highlight the success of ICS to date. In 1998 there were 5140 students who earned a C or better in APS, yet only 1421 or 28 percent enrolled in a third-year science class. In fact, as the table in Figure 1 shows, combining the number of students in this course with data from students enrolled in chemistry indicates that only 47 percent of all of these students elected to take a third year of science compared to the 57 percent of students in ICS 2.

Disaggregating enrollment data by ethnicity, as displayed in Figure 2, shows that success in ICS 2 is particularly high for traditionally underrepresented students in advanced science classes. The table shows that a greater percent of Hispanic and African American students, 18 and 16 percent respectively, are entering advanced science classes through the ICS pathway than through the traditional portals of APS and chemistry.

In 1997 the LAUSD mandated that all schools administer the Stanford 9 Achievement Test (SAT 9). The SAT 9 is a norm-referenced assessment that includes a science subtest designed to assess student understanding of knowledge from life, physical, and Earth and space sciences. Science was included in the battery of tests given in grades one through ten, and in following years, in grades one through twelve. Figure 3 shows science SAT 9 normal curve equivalents (NCEs) for all ninth and tenth grade students in LAUSD. The algorithm sets 50 as the mean score of the norming population. The NCEs are for the same students in subsequent years, called matched cases.

Figure 3 compares students taking ICS 1 as ninth graders and ICS 2 as tenth graders. It is likely that the greater NCE gain shown by ICS 1 ninth graders compared to tenth graders in ICS 2, 6.0 to 3.1 respectively, is influenced by the following factors:

- Teachers have one year more experience teaching ICS 1 than 2.
- Teachers have taught more ICS 1 students than ICS 2 students.
- Teachers have had an additional year to work together to analyze and modify the materials and their teaching approaches to ICS 1.

LA-SI has collected evidence to dispel the idea that major reform efforts such as LA-SI do not influence student achievement. Figure 4 shows a significant difference in NCE gains in schools that participated in the reform effort for biology and ICS 1 students. In Figure 4, Year 1–4 participating schools include all schools that joined the reform effort from the first through the fourth year. Schools that did not participate in the reform effort but started ICS 1 or continued their biology classes are shown in the last columns. Because participation in the reform effort was voluntary, some schools did not choose to take advantage of the re-
sources provided by the reform effort. Figure 4 shows that students from these nonparticipating schools did not perform as well as students from schools that joined the reform effort.

**POSITIVE IMPACTS**

Integrated/Coordinated Science in the LAUSD has positively affected student achievement as measured by the norm-referenced Stanford Achievement Test and increased student enrollment in advanced science classes. The success of this program is tied to prior work supported by the National Science Teachers Association (NSTA, 1992 and 1993) and curriculum funding from the National Science Foundation.

The success of the ICS program should be based not only on data presented in this article but also in relation to how it addresses issues raised by the Third International Mathematics and Science Study (TIMSS). One such issue is the relatively poor showing of students in the United States on the physics assessment. A possible remedy is to teach more physics over a longer period of time, which ICS actually does. This is similar to the way the countries in the TIMSS study that outscored the U.S. approached the teaching of physics and the other science disciplines. Also, ICS provides opportunities for students to improve their quantitative skills by including more in-depth mathematical analysis of data. As this quantitative aspect of ICS is more fully developed, it will be interesting to see if it helps students improve their understanding of and achievement in mathematics.

---

**REFERENCES**


