Integrated Science in a Restructured High School

To ensure that all students are scientifically literate at graduation, teachers at Littleton High School in Colorado created a two-year Integrated Science course to introduce students to the life sciences, physical sciences, and earth science.

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This fall, a special group of 9th graders entered Littleton High School. These students are the first to participate in the schoolwide restructuring project called Direction 2000, and they are the first to enroll in the new science course called Integrated Science.

Direction 2000 began in 1988 when the Littleton Public School District adopted a strategic plan with four priorities, one of which was restructuring. Subsequently, teachers in the district issued a report that called for the complete restructuring of the high school. That report became the springboard that, in March 1989, launched Direction 2000: Rethinking the American School.[1]

About that time, the American Association for the Advancement of Science (AAAS) initiated its Project 2061, a long-term, multiphase effort to reform science, mathematics, and technology education in the United States. The fundamental premise of Project 2061 is that, instead of teaching more content, schools need to focus on what is essential to scientific literacy and teach it more effectively.

AAAS recommends a broad array of content topics, but the treatment of these topics differs from the traditional in three ways: boundaries between traditional subject matter categories are softened and connections among the disciplines are emphasized; ideas and thinking skills are emphasized while the amount of memorized detail is reduced; and relationships between math, science, and technology and the social system, and some important episodes in the history of science, are included.

Toward Scientific Literacy

Direction 2000 is performance-based: Graduation from Littleton High School is based on demonstrations of what students actually know and can do, rather than on the number of credits or hours of "seat time" they accumulate. Project 2061 recommends changes in curriculums and teaching methods that contribute to a common core of learning for scientific literacy. These two different but related projects provided the impetus that led to the development of a course called Integrated Science.

When Direction 2000 was in full swing and our committees were working on curriculum, graduation requirements, staff development, and public relations, the high school science department became involved in restructuring the science curriculum, using Project 2061 as a guide. Having read a copy of Bill Aldridge's NSTA project on scope, sequence, and coordination of secondary school science,[2] we agreed that we needed a science program that would fit into the Direction 2000 restructuring process and also meet the challenges delineated by NSTA and AAAS. We wanted to ensure that our graduates would be scientifically literate and able to survive in our technological society.

Twelfth-grader Emily Stiles presents her science project to a panel of teachers, parents, advisors, and students. Concerned about the oil spill in the Persian Gulf War, Emily investigated the effects of varying amounts of oil on small plants and animals in different kinds of aquariums.

We started meeting in small groups after school to determine the content and concepts we considered essential for students' scientific literacy. This process helped us understand that by offering a science curriculum made up of several strict disciplines, such as biology, earth science, or physical science, and asking the 9th grade student to elect one of these, we were allowing students to graduate from high school with a very narrow background of knowledge.

We decided that an integrated science course would be the best offering for all students and that it would probably take a full two-year course to develop the necessary skills and cover essential concepts. Both junior and senior high students would also take semesters of aeronautics, biology, chemistry, physics, botany, genetics, and so on.

Integrated Science

Today our Integrated Science course is a two-year foundation program that introduces students to an integrated study of life science, physical science, and earth science. The course focuses on the four themes of Change, Interactions, Energy, and Patterns. These themes developed naturally as we attempted to combine our list of essential concepts into workable groups for teaching purposes.

Three units under the heading of Interactions are Interactions Among Living Organisms and Their Environment, Interactions of Climates and Biomes, and Interactions of Man with the Environment. The unit Interactions Among Living Organisms and Their Environment focuses on a natural greenbelt area near Littleton High School.

The students do a field study of this area that includes examination of living organisms and abiotic factors such as climate, soil, and water from the small stream. Within this one unit, students study life science concepts, earth science concepts, and physical science concepts. They can see the relationships between climate and plant types, plant types and animal life, soils and plant growth, rate of stream flow and sediment. And they look at these concepts as an interrelated whole, not as in separate disciplines.

None of the themes is unique, and many topics that fit under one theme could just as easily fit under another. This allows a certain amount of instructional flexibility for the teachers and further reinforces the idea that science is not the study of unrelated disciplines.

Beginning with the graduating class of 1995, Littleton High School will replace the current credit-hour-based graduation requirements with 19 performance-based graduation requirements.

In addition to covering the four themes, the students also spend a three-week unit on some aspect of technology. This part of the integrated science course was developed with the cooperation of Littleton High School's technology department. Teachers from that department take all or part of a science class and introduce the students to a unit on lasers, hydraulics, or robotics, for example. (These are units from another course offered at LHS entitled Principles of Technology.) Rather than try to fit students into selected classes, we have opted to fit the classes to the students.

Learning to See Relationships

The Integrated Science course reflects the AAAS emphasis on ideas and thinking skills. Within each unit, we work on developing students' skills of observing, communicating, comparing, ordering, categorizing, relating, inferring, and applying, beginning with the concrete and working toward the abstract. For example, in the field-study unit, students practice observational skills by looking for *evidence* of animal presence, not just the animals themselves. They sharpen their communication skills by working in groups or by making an oral presentation of their findings. They compute and compare rate and volume of stream flow, record and order sequencing of activities and events, and categorize and classify plant and animal specimens.

An important part of the unit is finding relationships: between climate and plant type, between stream flow and aquatic habitat, between predator and prey. Students begin the processes of inference and critical thinking as they determine what effect a fire or a change in the pH of the stream might have on the area. The final problem in this unit of study is to apply some of their new-found knowledge to the future: What will happen to the greenbelt area if the field next to it is built up into apartment houses? Are greenbelts worth preserving, and at what cost? Students will be able to face these kinds of decisions and judgments with confidence.

Self-Directed Experiments

The members of the science department determined what content to include in each year. The second year of Integrated Science continues with the same four themes, but with more difficult concepts and different content. Concepts such as "enzymes and catalysts in chemical reactions" are included in the second year under the theme Change.

The culminating activity of the second year is a self-directed experiment. In teams or individually, students design, implement, interpret, and analyze an experiment of their choice. This part of the course allows students to fulfill part of their performance-based

graduation requirement for science.

Beginning with the graduating class of 1995, Littleton High School will replace the current credit-hour-based graduation requirements with 19 performance-based graduation requirements. Each of these 19 requirements will involve demonstrations that will be evaluated against certain performance standards. Some of these demonstrations will be accomplished during the course of the student's four years of high school, and others will be reserved for the senior-year exit performance.

The successful completion of the experiment at the conclusion of the second year of Integrated Science will fulfill one of the demonstration requirements for graduation, and the skills students develop during the two-year course are an integral part of all the other 19 requirements.

The 9th-graders who entered Littleton High School this fall are the beneficiaries of almost three years of planning and development of the schoolwide restructuring process. They will be required to actually demonstrate their proficiency in academic skills in order to receive a diploma. And those students who choose to take only a minimum of two years of science will still be able to demonstrate a proficiency in scientific literacy that will serve them well no matter what future paths they take. □

References

[1] See D. Brickley and T. Westerberg, (April 1990), "Restructuring a Comprehensive High School," *Educational Leadership* 47, 7: 28-31, for a description of this restructuring process.

[2] See B. Aldridge, (1989), "NSTA Project on Scope, Sequence, and Coordination of Secondary School Science," *Colorado Association of Science Teachers Newsletter* 34, 2.

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