



Professional Development





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Students of science deserve to be taught by teachers who have both the scientific knowledge and teaching ability to provide skillful instruction. The professional development of teachers is important to raise the quality of science instruction and ensure that science instruction is aligned with the content standards that are the basis of the state assessment system. Professional development programs serve many different types of teachers, but all such programs must strive for improved student achievement as the primary objective. To that end programs must be focused on science instruction at each teacher's specific grade level or content strand (e.g., physics, chemistry, biology/life sciences, earth sciences) and the standards associated with that grade level or strand.

Teachers' collegiate backgrounds vary. Therefore, the professional development needs of an elementary school teacher who may not possess a baccalaureate degree in science will certainly differ from the needs of a single-subject high school chemistry teacher who may have a graduate degree in chemistry. Although some teachers may need to be briefed only on the changes in science that have occurred since their postsecondary-level study, others may

lack even basic knowledge of science. Programs must be designed for both types of teachers and provide them with the breadth and the depth of knowledge that are required to support successful standards-based science teaching. As explained in the report of the Glenn Commission, "High-quality teaching requires that teachers have a deep knowledge of subject matter. For this there is no substitute."¹ The standards are the best organizing device for professional development programs and need to be at the center of any planning effort.

For kindergarten through grade eight, the State Board of Education adopts instructional materials after a careful review by panels of expert scientists and teachers. Professional development programs that work with elementary and middle school teachers need to provide them with specific training in the use of the state-adopted instructional materials that have been locally selected. State-adopted instructional materials reflect the best practices for instruction aligned with the content standards and provide:

- Comprehensive coverage of the science content in the standards
- Sequential organization that allows teachers to convey the science content efficiently and effectively

- Strategies for assessment of students
- Information and ideas that address the needs of special student populations
- Information on instructional planning and support

These materials also provide curricular units with investigations and experiments that have clear procedures and explanations of the underlying concepts behind the state standards. The programs have been reviewed to ensure that they support understanding of the standards and that activities demonstrate scientific principles, produce meaningful data, and can be safely and inexpensively conducted.

The State Board of Education does not adopt instructional materials for grades nine through twelve, but local educational agencies may use many of the State Board-approved criteria for evaluating materials at the high school level in physics, chemistry, biology/life sciences, and earth sciences. For example, high school texts need to provide accurate and up-to-date science content and use scientific vocabulary correctly. Standards-based laboratory and field activities need to build investigative skills and judgment, logical thinking, and understanding of scientific principles. The instructional program needs to help teachers evaluate the progress of students toward measurable goals and ensure that students master the content standards. Professional development programs that serve teachers in grades nine through twelve should include examples of outstanding instructional materials that are aligned with the *Science Content Standards*.²

Teachers with single-subject credentials in science may have baccalau-

reate degrees in the subject or subjects they are teaching, may have completed a substantial number of collegiate units in the subjects, may have qualified by successful passage of challenge examination(s), or may have any combination of these qualifications. Currently, the minimum requirements by the Commission on Teacher Credentialing for single-subject credentials in science include a breadth of course work in biology, chemistry, geoscience, and physics in addition to a depth of course work that is focused on one of those areas. Additional information about state credentialing for teaching may be obtained at the Web site of the commission <<http://www.ctc.ca.gov>>. Where possible, science teachers need to be encouraged to work with scientists in industry and postsecondary institutions. Toward this end many companies and collegiate science departments are broadening their outreach to schools and teachers.

What Is Professional Development?

Professional development means “a planned, collaborative, educational process of continual improvement for teachers”³ that helps them to develop the following proficiencies:

- Enhance their capacity to help students master the standards, using State Board of Education-adopted instructional materials that have been selected locally for students in kindergarten through grade eight or are aligned with the standards (grades nine through twelve).⁴
- Deepen their knowledge of the subject(s) they are teaching.

- Sharpen their teaching skills in the classroom.
- Keep up with developments in their fields.
- Increase their ability to monitor students' work, so they can provide constructive feedback to students and appropriately redirect their own teaching.

Professional development programs should not expect teachers to develop their own curriculum units or use “hand-me-down” units that have been informally produced. Those units may not have been adequately reviewed for accuracy by content experts, or they may inadvertently include activities that are unsafe. Teaching is a challenging job that needs to be skillfully performed by professionals. Similarly, curriculum development requires a special type of expertise. The standards-based accountability system in California is a new experience for many teachers, and ensuring that every child receives a standards-based education is a challenge. Teachers need to have outstanding programs developed so that they can be assured that all the content material is covered comprehensively and in the appropriate sequence.

Who Should Teach the Teachers?

The ultimate goal of professional development is to improve students' academic performance. To that end it is essential that the faculty of a professional development program be experts themselves in the science content called for in the standards. In designing a professional development program, organizers need to seek the help of col-

legiate faculty in academic science departments and the professional scientists in industry. Although many academic scientists are busy professionals, they are also committed to serving the schools in their communities and may even have children in public schools. Whenever possible, scientists need to be more than just visiting speakers. Professional development programs must be logical and coherent in organization, and collegiate-level scientists can play a key role in their successful design.

Individuals who are not experts in science should not be called upon to teach teachers. Just as students deserve to have competent instruction and standards-aligned curricular materials, so too do their teachers deserve to have the very best program of development. Nonscientists can play significant and important supportive roles in a professional development program and should be used in ways that add to the success of the teachers.

When Is a Program Aligned with the Science Content Standards?

Professional development programs need to focus on the content that teachers are called on to teach. It is important that teachers know the background underlying the standards and know how the content is applied in more advanced study. Teachers must be knowledgeable about a wide range of examples that illustrate the standards they are helping students to master and the models that can be used in the presentation of those standards. Experimental activities used in the process must provide a clear demonstration of the content being studied

and be built on a solid foundation of prior knowledge.

Elementary and middle school teachers need to be trained specifically in the grade-level standards applicable to their classes. A fifth-grade teacher, for example, would receive minimal benefit from a program designed for second-grade teachers. Similarly, single-subject teachers in middle and high schools need to be developed as experts in their teaching fields. An understanding of the standards will provide teachers with knowledge of what has been taught to their students in previous grades and what will be taught to their students in future grades, but this concern is secondary to the current needs of their students. Professional development must always be highly focused on the grade level (or subject specialty) of the teacher, not be a holistic study of the standards for many grades (or content strands), a course that lacks necessary depth.

When Is a Professional Development Program Deemed Successful?

The academic achievement of students must be the main indicator of

success in professional development programs. An effective program of professional development is one in which adequate attention is paid to classroom follow-up. Program organizers need to track the extent to which teachers apply what they have learned in the classroom and observe how the professional development lessons are implemented.

How Will Tomorrow's Science Teachers Be Developed?

Today's teachers need to encourage students (at the elementary, middle, and high school levels) who are interested in science to pursue both collegiate study and careers in teaching. Moreover, students now completing baccalaureate degrees in science need to be directed toward teaching, and transitions to the field of teaching need to be facilitated for individuals who are contemplating midcareer changes and who have professional experience in science. Only through this multifaceted approach can the demands for science teachers be met for forthcoming generations.

Notes

1. *Before It's Too Late: A Report to the Nation from the National Commission on Mathematics and Science Teaching for the 21st Century*. Washington, D.C.: U.S. Department of Education, 2000.
2. *Science Content Standards for California Public Schools, Kindergarten Through Grade Twelve*. Sacramento: California Department of Education, 2002.
3. *Before It's Too Late*.
4. Ibid.