Chapter 2

Improving Kindergarten through Grade 12 Education in the SBE Sciences

From the earliest grades, students should experience science in a form that engages them in the active construction of ideas and explanations and enhances their opportunities to develop the abilities of doing science.[6]

Current Context

Key Needs

The social, behavioral, and economic (SBE) sciences are largely absent from the K-12 curriculum, despite the fact that science competencies are best learned early and in developmentally appropriate ways. Each year, some 53 million students attend elementary and secondary schools in the United States. Yet, they receive almost no exposure to the theories, concepts, or methods of the SBE sciences, nor are they made aware of the interconnectedness of social, biological, and physical phenomena. Although more SBE science courses are available in high schools, they are few in number in comparison to natural science offerings. Furthermore, when SBE content is part of the K-12 curriculum in social studies or elective courses, the materials too often emphasize facts rather than the study of social and behavioral processes as science.[7]

Data on Advanced Placement (AP) courses indicate the limited presence of the social, behavioral, and economic sciences in the high school curriculum and their secondary status. In the 37,000 public and private secondary schools in the United States, SBE Advanced Placement courses may be the only offering in one or another of the SBE fields, and they are rarely capstone courses preceded by prerequisites. In 2002, AP psychology, economics, and geography courses were taken, respectively, by 52,000 students in 2,400 schools, 32,000 students in 2,000 schools, and 3,250 students in 400 schools. In comparison, AP biology, chemistry, and physics courses were taken, respectively, by approximately 98,000 students in 6,900 schools, 61,500 students in 5,500 schools, and 37,500 students in 3,350 schools. Even in a field like psychology where more students take AP courses than in physics, AP physics is taught in 50 percent more high schools than is psychology (3,350 schools in comparison to 2,400).

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[6] National Research Council, *National Science Education Standards* (Washington, DC: National Academy Press, 1996), p. 121.

[7] The need to improve the quality of pre-college education has received considerable attention by scientific societies in the social and behavioral sciences. In 2001, for example, the American Sociological Association launched a task force to develop an Advanced Placement course—with considerable attention being paid to the development of scientific literacy skills and an understanding of social processes and dynamics.

The relative paucity of the SBE sciences in grades K-12 presents a complex challenge. In formal education, major investments in curriculum, materials, and faculty development are required to meet current and future needs. Strategies need also to be developed that better incorporate the social, behavioral, and economic sciences into K-12 education, emphasizing their connections to each other, to other fields, and ultimately to school or work transitions. Outside of school, in the informal settings where science education occurs (e.g., science museums, media programming, after-school community programs), important opportunities could be nurtured to integrate the social, behavioral, and economic sciences into science learning.

Introduction of the social and behavioral sciences early in and as a part of the elementary school science curriculum provides an excellent context for science learning more generally. Exposing young students to science on phenomena familiar and of interest to them offers an effective framework for learning how to ask testable questions, collect systematic data, inspect and test hypotheses, and produce insights and information. Also, early and frequent exposure to the social and behavioral sciences can avert the misconception that social and behavioral phenomena are not amenable to systematic study and explanation.

Impediments and Challenges

There are serious impediments to the meaningful inclusion of the SBE sciences in the K-12 curriculum. These are typical of the challenges faced in making organizational change in any institution with longstanding practices of behavior, distributed decision making (in this instance, at the federal, state, school district, and school levels), and well-established structures of power and authority over content and resources.[8] A number of challenges are particularly worthy of note:

First, there is the challenge of where and how the SBE sciences should be situated in the K-12 curriculum. As areas of science, the SBE sciences fit logically in the broad science curriculum, and approaches need to be developed to infuse SBE concepts and content. Yet, a well-established history exists of including social and behavioral science content in the social studies curriculum. In general, however, social studies education is not directed to the development of scientific reasoning or literacy.

Second, because K-12 education is a sequenced process of learning, age- and grade-appropriate materials will need to be developed for the SBE sciences in order to integrate these fields effectively into general science courses in elementary or middle schools. The materials and work products developed for SBE courses in high school cannot merely be simplified if they are to be aligned with the cognitive development of younger children.

[8] The neglect of social science in the K-12 curriculum has been a long-term pattern reflecting a complex set of historical forces that have limited the development and presence of these fields. The singular emphasis on reading and writing, mathematics, and the natural sciences have eclipsed nurturing the links and connections to the SBE sciences. Also, ignorance or inhibition about seeing human behavior, interactions, and institutions as amenable to scientific study contributes to its absence in pre-college education.

Third, the comparative absence of materials, especially at the elementary school level, adds to the challenge of making change. There is a tremendous need for curriculum products that can enhance SBE science learning. For example, teachers need accessible materials that can help build understanding of the empirical basis of science; the differences between empirical and normative statements; the types of evidence needed for inferring causality; the difference between a concept, a variable, and an indicator; how to work with and think about data; the distinctions between individualistic and social explanations; and the like. The presence of such materials not only would facilitate the integration of the SBE sciences into the general science curriculum but also would enrich learning scientific reasoning in the general science curriculum more generally.

Fourth, greater attention needs to be paid to how the absence of SBE science content, especially in middle school, abates interest in taking SBE courses in grades 9 to 12, and even affects the availability of such courses. High schools are unlikely to field courses for which students are either not interested or unaware. Thus, the absence of SBE sciences in the general science curriculum has spillover effects on longer-term interest in the SBE sciences.

Fifth, there has been insufficient focus in the SBE sciences on the content of curricula for the earliest stages of learning and education. Overall, social and behavioral scientists have paid limited attention to science education at the K-12 level and to the ideas, techniques, and understandings that children need to develop and master. Within and across SBE disciplines, scientists and educators face the challenge of addressing the "what," the "how," and the "when" of learning in these fields.

Sixth, there is little teacher preparation in the SBE sciences, perhaps because SBE subjects are not considered to be core educational content. Training, skill development, and the enhanced professional identification of SBE science teachers within the K-12 community should be given high priority. Also, SBE scientists in higher education need to improve their attitudes and outreach to those teaching SBE science at the K-12 level.

Seventh, the absence of models for pre-service and in-service training of teachers in the SBE sciences, along with the paucity of support structures to attract and retain quality teachers in these fields, makes it difficult to introduce and sustain educational change.[9] At the broadest level, the next generations of teachers need to have sufficient exposure to the SBE sciences so that they can undertake their work with a solid grounding in the social, cultural, political, and economic foundations of education. At a more specialized level, there is the challenge of preparing teachers well trained and conversant in the SBE sciences.

Eighth, the current emphasis in the No Child Left Behind Act of 2001 on reading and mathematics, coupled with state-based assessment and testing of skill proficiency in these areas, has narrowed the focus on these competencies, seemingly at the expense of other subjects and

[9] Schools and colleges of education require faculty sufficiently well grounded in the SBE sciences to prepare teachers generally and SBE science teachers in particular to teach. The need for teacher training by faculty in schools and colleges of education is a challenge separate and apart from the need for doctoral training in education research.

skill sets. While mathematics and reading could be taught through the lens of other academic subjects or domains, the interest in improving education in the SBE sciences comes at a time when state performance standards and testing tend to constrict the curriculum and encourage teaching to or for the test.

Ninth, the National Science Education Standards released by the National Academy of Sciences in 1996 do not explicitly include the SBE sciences and make reference to human factors only from the perspective of a desire to understand individual and social dynamics that affect the conduct of science.[10] The symbolic and real impact of the SBE sciences being invisible in that document makes the effort to integrate and legitimize them far more formidable.

Best Practices

Relative to the need for improved education in the SBE sciences in K-12 education, best practices are few and far between. Nevertheless, SBE disciplines and national professional associations offer models of what can be done:

- The Council on Anthropology and Education (CAE), which is comprised of more than 800 anthropologists, has produced a series of teaching resources that help to integrate anthropology into the K-12 curriculum.

- In economics, *Framework for Teaching Basic Economic Concepts* was produced in 1995. It focuses on 21 basic economic concepts, including measurement concepts and methods. Guidelines recommend the grade level at which different concepts should be taught and how instruction should progress. The *Framework* has shaped materials for teacher preparation, curriculum guides, textbooks, and state tests. After the inclusion of economics in the Goals 2000 Educate America Act of 1994, national committees of some 26 economists and educators also developed the *Voluntary National Content Standards in Economics* (1997). The document specifies 20 standards and 211 benchmarks describing what students should be able to do at grades 4, 8, and 12.

- In 1992, the American Psychological Association (APA) established an affiliated organization—Teachers of Psychology in Secondary Schools (TOPSS). TOPPS produces unit teaching plans and workshops for teachers, operates national essay contests for high school students in psychology, and undertakes other education-related activities. In 1999, the APA Council of Representatives adopted the APA-approved National Standards for the Teaching of High School Psychology developed under the auspices of APA's Board of Educational Affairs and TOPPS.

[10] The substantive areas of science in the Standards are physical science, life science, earth and space science, and science and technology. While there are Standards related to the history and nature of science and to science in personal and social perspectives, these topics are not depicted as scientific fields but as issues that are important for understanding science.

- With National Science Foundation funding, the Association of American Geographers developed curriculum materials that met the National Geography Standards for middle- and high-school use. Student activities and interactive CD-ROMs constitute the core of the materials.

From these illustrations, it is evident that organizational leadership yields results and that course development must be accompanied by materials development and teacher training. All three components were part of the process by which Advanced Placement courses were established. AP courses themselves are best practices of sorts that enhance high school curricula, directly and indirectly. In the SBE sciences, AP courses are currently offered in psychology, economics, political science, and geography. Sociology is developing a prototype course with the active engagement of high school teachers of sociology. The national professional associations in the SBE sciences have usually led or been major players in bringing about these advances.

Components of an Action Plan

The National Science Foundation is well situated to lead efforts to improve social, behavioral, and economic science education in the K-12 curriculum. NSF's presence would itself send a signal to the scientific and education communities about the importance of including the SBE sciences in the "family" of science. Moreover, the sustained funding that only NSF can provide is essential to the development of curricula, materials and products, as well as pre- and in-service training programs.

Much can be done to advance SBE science education within the contours of existing NSF programs. The Directorate for Education and Human Resources (EHR) has important programs already in place that could play a key role in improving K-12 SBE science education. Not unexpectedly, the most relevant programs for K-12 SBE science education are in the Division of Elementary, Secondary, and Informal Education (ESIE). In addition, the SBE Directorate can collaborate with EHR and invest in strategic innovations at the K-12 level to enhance the presence and quality of SBE education. Existing programs, new opportunities, and immediate action steps are addressed below.

Enhanced SBE Presence in and Funding through Existing EHR Programs

1. A competition to support a Center for Learning and Teaching with a specific concentration in the social and behavioral sciences could produce K-12 educators better prepared in the content and methods of SBE sciences and in innovative instructional practices to incorporate these sciences into the K-12 science curriculum. Fusing a doctoral degree-awarding university (including its SBE departments and school of education), one or more school districts, and a partnering organization with expertise in the SBE sciences, child development, or education research could provide a conducive working environment to train a cadre of high-quality professionals to work in the schools and assess programs.

2. The Instructional Materials Development program could offer critical support for producing SBE materials that advance teaching disciplinary content, scientific methods, reasoning skills, and instructional technologies appropriate for the K-12 curriculum. Especially at the elementary

school level, there is little available. NSF projects like the materials development award to teach mapping and spatial skills and to develop the tools to assess competencies in children need support across many areas of SBE science.

3. The Teacher Professional Continuum program could play an important role in supporting projects related to the recruitment, preparation, enhancement, and retention of K-12 teachers in the SBE sciences. There is enormous need in the SBE sciences to improve the quality and coherence of the learning experiences that prepare teachers (including the development of resources to support teachers, their schools, and their school districts). Projects that enhance skill and provide essential materials (e.g., an NSF project directed to middle- and high-school teachers to provide learning units, workshops, and coaching in using geographic information systems) are far too absent. Teacher recruitment, pre-service and in-service training, and the development of a school support structure for faculty are high priorities for SBE capacity building at the K-12 level.

4. The Informal Science Education program offers an appropriate venue to advance understanding of the knowledge, methods, and science underlying the study of social, behavioral, and economic phenomena. The Directorate of Education and Human Resources wisely recognizes that much education takes place informally—outside of the school. Given the commonplace misperceptions about the social and behavioral sciences, informal science education should be a key component of any SBE science education plan. Exhibits, media programming, and films provide important opportunities to present SBE knowledge and methods to children, youth, and the public more generally. They also offer an opportunity to show the interconnectedness of social, biological, and physical phenomena. Such awards often include traveling lectures, teacher guides, interactive websites or web-based curricula, and other strategies that enhance their value, visibility, and impact.

New Opportunities and Initiatives

Collaboration of SBE and EHR Directorates on an SBE Science in High School Initiative. Paralleling the innovative partnership between research directorates and EHR on Nanoscale Science and Engineering (NSEE), the SBE and EHR Directorates should consider establishing a new, integrated initiative to advance education in the social, behavioral, and economic sciences at the high-school level. Many of the barriers to infusing SBE sciences in the high school curriculum could be addressed by fostering collaborations between the talent pool in colleges and universities in the SBE sciences and their counterparts in education and science education. Such an initiative should aim to develop effective strategies and interventions that can be implemented and assessed. Such strategies include the development of instructional materials and courses; the alignment of SBE science courses with other high school science and social studies courses; the enhancement of teachers' skills, knowledge, and pedagogical methods; and the deepened appreciation by parents and other relevant publics of the SBE sciences, the knowledge and methods they provide, and their synergism with other fields of science.

Collaboration of SBE and EHR Directorates on a Teacher Training Initiative. This initiative would fund workshops, a sabbatical semester or year in an academic or research setting, summer training in existing programs, or the design or development of tailored programs.

Such an initiative would extend and complement the ESIE program in Teacher Professional Continuum. It would provide an opportunity to recruit teachers to SBE science teaching as well as to enhance the SBE knowledge and skills of teachers already teaching in this area. It also could support the development of courses and programs oriented to K-12 teachers at sites such as the Inter-university Consortium for Political and Social Research (ICPSR).

Collaboration of SBE and EHR Directorates on a "Bridges to SBE Science Education" Program. Similar to the joint "Bridges" program between the EHR and Engineering Directorates, this initiative would offer planning grants to institutions, including scientific associations, for proposals to improve SBE content in K-12 education, enhance teacher training (from social studies and social science), and articulate standards (concepts, frameworks, skills, and benchmarks) in the SBE sciences within and across disciplines and fields. Funds could be used for the support of working groups or workshops designed to yield full project proposals.

An SBE Initiative on Research Experiences for High Schoolers (REHS). This initiative would parallel the Research Experiences for Undergraduates (REU) program. REHS supplements could be provided to existing grants to provide hands-on research experiences for high school students. Also, REHS site proposals could be submitted by investigators in or across SBE departments, centers, or research institutes seeking to provide summer research experiences on an ongoing research program or project to six to twelve students from high schools in a local geographic area. Applicants would be encouraged to include such developmental activities as participation of students in science fairs and competitions, science competitions, relevant scientific association meetings, and in-school presentations of research results (after the summer experience). Also, transition back coordination with the high schools to facilitate students' continued engagement during the subsequent academic year would be desirable.

Immediate Steps

Most of the above recommendations can be readily accommodated within existing or expanded programs. The most serious barrier to the inclusion of SBE science at the K-12 level is the long-term entrenched absence as well as the pervasive confusion and misperception about the place and presence of the SBE sciences in science as a whole. Some immediate steps could help start the process of reshaping understandings in the K-12 and science communities. Examples include:

- Publish an article co-authored by the Assistant Directors for the EHR and SBE Directorates in *Education Week* or a similar prominent publication on the importance of and opportunities for integrating SBE science education into the K-12 curriculum. A parallel article in a publication like *Science* or the *Chronicle of Higher Education* could also be important in changing the mindset of the scientific community.

- Request that the National Research Council's Committee on Science Education K-12 (COSE K-12), a standing committee of the Center for Education Standards, revise the National Science Education Standards so that the "processes of science" are set forth for SBE sciences (appropriate to grade level) in the same way that they are already specified for physical science, life science, and earth and space science. If this task cannot be integrated into ongoing

Phase III work of COSE K-12, it could be done as a supplement to the Standards. Continued NSF funding would help accomplish this task. COSE K-12 might draw on expertise in the NRC's Division of Behavioral and Social Sciences and Education (DBASSE).

- Work with the American Association for the Advancement of Science (AAAS) to integrate the SBE sciences into Project 2061.[11] This project is dedicated to reforming K-12 education nationwide so that all high school graduates are science literate when Halley's Comet returns in 2061. It will take resources to alter the work of this major program (ongoing since 1985—the year that Halley's Comet was last visible from earth). NSF could request that AAAS review priorities, products, and ongoing initiatives of Project 2061 and consider short- and long-term strategies and support needs to integrate the social and behavioral sciences into Project 2061.

[11] Project 2061 calls for inclusion of the history of science as a field of inquiry, but it does not appear to be given consideration in curriculum materials or learning outcomes. If the history of science were incorporated as a social science, it could provide one vehicle for learning about the SBE sciences. See American Association for the Advancement of Science, *Science for All Americans* (Washington, DC: American Association for the Advancement of Science, 1989), chapter 13.