Teaching the Behavioral, Social and Economic Sciences in K-12: Possible Options and Next Steps: Planning Meeting

Summary of Themes from Sessions 5 and 6: Strategies and Lessons from Other Disciplines, and Potential Next Steps and Remaining Questions

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In November 2011, the Board on Science Education conducted a planning meeting to examine issues around the teaching of social, behavioral, and economic (SBE) sciences in K-12 education. During one session of that meeting, representatives from four non-SBE disciplines — environmental education, engineering education, statistics, and earth science— shared their approaches, experiences, and lessons learned from their efforts to be included in meaningful ways in the K-12 curriculum. The insights from this session yielded common themes and specific examples of strategies that may prove useful to the SBE community as it moves forward with similar aims.

Panelists and participants used the analogy of a moving train throughout the meeting, referring to the processes and efforts already underway to establish frameworks and set standards in K-12 education. With their presentations considered together, panelists seemed to convey the overarching message: "start packing for the train ride now," developing the messages, documents, evidence, curricula and relationships needed to participate in these ongoing processes. Box 1-1 presents a summary of the key lessons that individual participants described during this session.

Summary of Key Lessons Learned

- Focus on developing the messages, documents, evidence, curricula and relationships needed to participate in ongoing processes of K-12 standards development.
- Determine how to define, frame and clearly convey the goals and rationales to varied audiences
- Clearly articulate and provide supporting evidence for the essential nature of the discipline
- Identify approaches to curricular inclusion
- Develop and strengthen key relationships
- Build capacity – standards, evidence, and professional development

Box 1-1 Summary of Key Lessons Learned

Cross-Cutting Themes

Cross-cutting themes from the panelists were focused on the following issues: 1) defining and articulating goals and rationales; 2) identifying approaches to curricular inclusion; 3) developing and strengthening key relationships; and 4) building capacity.

Panelists**:**

Environmental Education, Bora Simmons, University of Oregon
Engineering Education, Beth McGrath, Center for Innovation in Engineering & Science Education, Stevens Institute of Technology
Statistics, Roxy Peck, California Polytechnic State University
Earth science, Dan Barstow, Technical Education Research Center

Defining and Articulating Goals and Rationales:

Across presentations, panelists described their goals, conceptual approaches, as well as strategies for articulating their rationales about the discipline to others. Permanence or institutionalization in the curriculum, as well as meaningfulness evidenced by sufficient breadth and depth of the discipline were common goals. Each discipline's articulated goals were the drivers for the approaches each discipline took to be included in the K-12 curriculum.

Goals

Dr. Simmons indicated that North American Association for Environmental Education (NAAEE) has adopted a definition of environmental education as a "field" that cuts across disciplines. She described the goals of "environmental literacy" as being comprised of the knowledge, experiences, practices, skills, attitudes, and motivations that lead to understanding, application, good decision-making, and ultimately civic engagement. Beginning in 1993, they developed a framework and a set of guidelines for environmental education. Their agreed upon goals led the field to adopt an "integrationary fusion" approach where environmental education is integrated into existing subjects and activities.

The approach of the engineering field differed from that of environmental education. Dr. McGrath described a recent increase in demand for technical assistance, curriculum, professional development and other resources as schools desire to incorporate more technology and engineering in the schools. So, rather than "pushing" to have engineering included in the K-12 curriculum, engineering is currently experiencing a "pull." However, past efforts of some key leaders, as well as NRC reports, helped highlight the importance of technology and engineering to economic growth and were critical in raising the profile of technology and engineering over the years. Overall, those organizations focused on promoting engineering education focus on the goals of technical literacy for all students, addressing the shortages in the engineering workforce, and showing how technology and engineering can enhance general math, science, and problem-solving ability. These goals led to the belief that engineering cannot be simply an elective or extracurricular activity, but needed to be a "core aspect of what all students' education comprises."

The goal of the statistics education community was "statistical literacy for all." Achieving this goal required starting statistical education at the K-12 level. Over a more than two decade process, the American Statistical Association worked not only to increase the implementation of statistics in the curriculum, but also to improve the quality of instruction in the area as well.

Dr. Barstow of the Technical Education Research Center described earth sciences' goals as across not only the K-12 student population, but also the public and policymakers, based upon the belief that earth science is critical to planetary stewardship. He described goals of changing the nature of earth science education to focus on earth systems and the space age and to increase the numbers of people reached. Ultimately earth science education hopes to spark excitement over this field, to increase understanding of earth's current challenges, and develop problem-solving skills to address them. Earth science, like environmental education, is interested in developing scientifically educated citizens.

Framing the messages

Determining how to frame and to convey the goals and rationales to other audiences have been key tasks of the major organizations leading these efforts. Being able to clearly articulate and to provide supporting evidence for the essential nature of their discipline was important. Environmental education was sensitive to the political nature of its field, and thus adopted a frame of balance, decision-making, and process over specifically prescribed views and actions. This discipline also adopted various names, such as "place-based" education, stewardship education, or national resources education to avoid controversy when needed. In some cases, major curriculum developers have engaged in media campaigns to articulate the importance of the discipline. Connecting the effort to the national agenda appeared to be an important way to frame the issues of the discipline.

In several cases, NRC reports, such as *Rising Above the Gathering Storm* and others, were influential in creating opportunities to highlight the importance of the discipline. This point was emphasized in regards to engineering education as well as in earth science. Earth science has not only emphasized its importance as a "global strategic imperative," but also its centrality to trillion dollar industries, and the importance of fostering a spirit of exploration and discovery as "the ultimate lab science."

Identifying approaches to curricular inclusion

In various ways, presenters noted their desire to avoid being simply an "add-on" activity in the K-12 curriculum, but rather integral parts. Concerns about depth, breadth and quality were also noted. As Dr. Peck stated, statistical education needed to move beyond "another year, another graph," and Dr. Barstow noted the similar limited reputation of typical earth science, adding that earth science is not "an optional science." However, the existing demands on teachers and the focus on reading, math, and other sciences were widely acknowledged. Across disciplines, presenters described their efforts to improve their representation in the K-12 curriculum, preparing the materials needed for engagement into key processes and compatible components of the existing curriculum. The four disciplines used three primary conceptual approaches to becoming integrated into the K-12 curriculum:

1. *Integrating across the full curriculum* – Environmental education worked to be linked with existing goals and standards across the full curriculum. The NAAEE cross-walked their own environmental literacy standards with other national standards, such as "Project 2061" standards, as well as with standards in social studies, history, economics, science and others to demonstrate to outside audiences how feasible infusing environmental education could be. Dr. Simmons noted that this infusion approach can still leave concerns about comprehensiveness and cohesion in terms of addressing environmental content.
2. *Integrating into a particular component of the curriculum* – Statistics education approached inclusion into the K-12 curriculum by building a strong linkage with

mathematics. Engineering has been integrated primarily with science and mathematics, taking advantage of the recent national emphasis on STEM education.

3. *Changing the nature of the existing curriculum* – Earth science is a part of the existing K-12 curriculum, but is often subordinate to biology, chemistry and physics, out of date, and limited in its capacity to implement an earth systems and space age perspective. The aim of those focused on earth science education was to "revolutionize" the way that earth science is taught in K-12, rather than to infuse or seek an in-road through another discipline.

Overall, these approaches fit with the disciplines' goals for themselves (e.g., increased exposure and literacy for all K-12 students), but also took advantage of opportunities that arose allowing them to gain in a "foothold" in the process. Approaches for reaching all K-12 students can be discipline-specific courses, such as AP courses and electives, components of other areas of the curriculum, part of informal education and other activities that take place outside of school. Panelists advised that no one approach is best.

Developing and Strengthening Key Relationships

The relationships that each discipline cultivated with other organizations, state agencies, and individuals were key components of the successful efforts of all of the disciplines. Becoming an integral part of the K-12 curriculum, as opposed to a drop-in or "extra," as well as improving the content and instruction of the disciplines required developing important relationships in every case. These relationships include those between organizations with similar goals, as well as those with key stakeholders in the process, who may or may not be supportive of the discipline's aims. Dr. McGrath advised, "really understand the value proposition for the stakeholders to have a say in the process. Develop strong relationships in order to fully understand the positions of all the stakeholder groups who will be affected." Panelists' experiences indicate that this process can be time-consuming and challenging, but necessary to gaining an understanding of the system, developing partnerships, and identifying allies.

The relationship between the American Statistical Association (ASA) and the National Council of Teachers of Mathematics (NCTM) was cultivated over a long period of time and resulted in the formation of a joint committee to "provide national leadership for the inclusion of statistics and probability in the K-12 curriculum." The result of this relationship was that even when the ASA was not invited to participate in key standard setting activities, NCTM was included bringing along with them documents from the ASA ("their luggage" in the train analogy). Further, the ASA encouraged its members to provide public comment on statistical mathematics standards. Through this mechanism, wording or approaches from ASA-developed materials were incorporated into the final standards.

In addition, relationships were critical for getting seats at important tables to foster credibility. These tables exist at national organizations, such as the National Council for Accreditation of Teacher Education (NCATE), which accredit most teacher education programs. "We knew that if [NAAEE] wanted to be taken seriously within K-12 education, we had to become a part of NCATE," said Dr. Simmons, adding, "so we got a seat at the table, that was a big push." As a result, the NAAEE has a chance to have input on the science teacher education standards. Similarly, engineering's relationship with the College Board in setting college and workforce settings proved important at the Common Core "table" where the College Board was invited and able to ensure the inclusion of engineering and technology standards.

In engineering, relationships with several organizations have been important. For example, at the National Science Foundation, the Math and Science Partnership grants have been broadened to include engineering. In addition, the Professional Society for Technology and Education teachers now includes engineering, and the American Society of Engineering and Education's K-12 division has been growing.

Dr. Barstow described the importance of relationships to helping the public understand the importance of earth science this way: "the issue is not providing more data to people; it's dealing with the economic, political and social issues. And so, any success has to involve that kind of large-scale collaboration." He added that these efforts require "missionary zeal," rather than an attitude of "this is an interesting topic." Attending conferences, such as the Council of State Science Supervisors, was an effective way to be engaged in state policy reform. Additionally, TERC was successful in developing a relationship with the creators of textbooks to create improved content and presentation of earth science, through projects funded by the National Science Foundation.

More than one presenter noted that SBE education might have natural linkages with their own efforts. For example, statistics could be a good fit as the SBE sciences can provide the context and content around the statistical content. In addition, the role of social, behavioral, and economic influences within topics of interest to earth science could yield an interesting partnership.

Building capacity

One message emphasized was the need to be proactive in building capacity within the discipline, and to anticipate what might be needed. This was especially poignantly described by Dr. Peck, who offered the following advice based on her experiences with the development of the Guidelines and Assessment and Instruction in Statistics Education (GAISE):

> "I think that you have to hang out around the right place, and sometimes you have to hang out there for a long time. And then you have to be ready when the right time comes, because you just don't know when these windows of opportunities are going to open up, or even how long the window is going to stay open. So the things I think contributed to our success is that we had very strong partnership between the statistics professional organization and the math teachers' organization NCTM. We had the foresight; we prepared these documents that we didn't think there was an audience for, and they were ready when we had – and they couldn't have been prepared in the month that we had that was notice that [a key standards meeting] was going to occur, and then we had strong advocates at the table, that had been developed through these partnerships, so even though we weren't invited initially, we had an impact."

Capacity can refer to the infrastructure needed prior to widespread incorporation of a discipline into the K-12 curriculum, as well as the mechanisms needed to support ongoing and future efforts. Building capacity includes work that a discipline may undertake on its own. Based on the presentations, disciplines are best positioned to make their case when they have clear goals, well-thought out and policy-relevant rationales, and the documentation and evidence to support their goals. Developing the means to ensure adequate professional development, addressing assessment needs, and forming networks through professional or other organizations are other key capacity building activities that may be needed. Goal setting and communication activities as presented appeared to be centralized either through one primary organization, such as the American Statistical Association, or the result of multiple initiatives (curricular and otherwise), such as those described in the engineering education discipline. Environmental education emphasized national level, state level, as well as curriculum level organization.

Inclusion in state and national standards

Achieving inclusion in the K-12 curriculum in practice means inclusion in learning standards at the national and state levels, coupled with what knowledge and skills are ultimately assessed. Panelists each described their efforts to be involved in various standard setting activities. A key step for statistics was developing the GAISE, a process which took several years of an internal consensus-building process. Environmental education created a similar set of guidelines through a national dialogue for the National Project for Excellence in Environmental Education. These guidelines spelled out characteristics of best practices, what students should know and do, along with benchmarks at 4^{th}, 8^{th} and 12^{th} grades. Each of these guidelines is cross-walked with existing standards in other traditional disciplines. This process was undertaken "to demonstrate how [they] are infused throughout the curriculum and how [they] can be used as a basis for a standards-based curriculum."

Engineering achieved a great deal of success in becoming incorporated into state and national science standards. Engineering is reflected in the recent NRC report, *A Framework for K-12 Science Education*, and approximately 38 states have engineering standards as part of their standards in science and/or technology and education. A particular process to develop engineering standards in New Jersey underscored the need to identify all of the stakeholders and their issues. In addition, the inclusion of assessments for engineering "raises the stakes considerably," according to Dr. McGrath. Dr. Peck echoed this sentiment, noting that the assessments of the skills do not match the depth and breadth of the curriculum or standards, then impact on classroom practices may be limited.

Dr. Barstow described earth science's "fight" and success in becoming co-equal with the other sciences in recent framework and standard setting activities. His organization, TERC, also reviewed and graded existing state standards from all 50 states, through a project funded by NOAA. In addition, the recently developed Climate Literacy Framework received endorsements from a wide range of agencies, from the U.S. Department of Defense to the Smithsonian Institute. One participant pointed out that arriving at this framework required two or three years to reach consensus within the earth science community, underscoring the large amount of work in can take to involve all needed partners and stakeholders.

Developing the research base

Several panelists indicated that more research was needed to understand the best approaches in general teaching and learning, as well as the outcomes of specific curricula. Panelists in environmental education and engineering indicated that a number of curricula have been heavily researched. Dr. McGrath recommended that SBE undertake a process of "hypothesizing about the value and impact of the discipline on student outcomes and the contributions to the national agenda, and then building an evidence base through research to support it."

Preparing teachers

More than one panelist noted the need to develop professional development capacities. For earth science, Dr. Barstow noted that only 31% of earth science teachers have a degree in earth science. Being able to deliver professional development on a large-scale and increase diversity are also issues. Dr. Peck described a large need for preparing mathematics teachers to teach statistics. She also indicated that professional societies and organizations are playing a role in this effort. This has been the case for environmental education in that the NAAEE has developed guidelines for environmental educators beginning with early childhood educators, and in formal and informal settings for older children. In addition, NAAEE developed a state-based professional certificate that teachers can obtain.

Summary

Lessons learned from environmental education, engineering education, statistics, and earth science indicate that an investment in an internal process to build consensus and documentation around key goals, approaches, frameworks or standards can yield progress in meaningful incorporation of a discipline into the K-12 curriculum. The SBE sciences can look to a range of approaches from being fully infused throughout the curriculum, to being linked with a particular discipline, to offering discipline-specific courses and opportunities in informal settings. The process of gaining inclusion in the K-12 curriculum also requires fostering partnerships and learning about existing systems and stakeholders. Finally, disciplines need infrastructure to support both the work internal to the discipline, but also to support professional development, curriculum development, and the research base. Key processes in science standard setting are underway, and in the words of Dr. Peck, it is possible for SBE to "flag down the train, even if it's left the station, but … do it fairly quickly before it gets too far away."

Box 1-2 presents a summary of individual participants' suggestions for potential next steps for SBE and remaining questions to be addressed to advance more meaningful inclusion of SBE in K-12.

Summary of Potential Next Steps

- Involve a broad group of partners and stakeholders and foster collaborations, aligning priorities
- Move forward with developing a framework Strengthen the research base that would underpin a developmental framework for SBE, building on what currently exists
- Develop concrete plans, in addition to standards, for what should be in the curriculum and in what form
- Drawing on the words of Kingdon, "Be ready when the policy window opens" by defining the problem, developing a policy solution, and working the politics. Create awareness of the essential nature of SBE and share the excitement of them with others
- Conduct targeted, ambitious demonstration projects linked to research, particularly at the early grades.
- Make the case about importance of interaction between traditional STEM and SBE to stakeholders in both SBE and STEM fields, but aim for seamless integration of sciences

Remaining Questions

- Who should take the lead on developing standards in SBE? Is there a collective enterprise that would be effective in bringing together SBE fields for this purpose?
- Should SBE be interdisciplinary? Should SBE be infused throughout the curriculum or offered in stand-alone courses or both? How can students learn science in a multidisciplinary way, while also gaining disciplinary depth and experience in multiple disciplines?
- What content do all students need? What content do only some students need?

Box 1-2 Summary of potential next steps and remaining questions