AAAS/NSBA Science, Mathematics, and Technology Education Seminar

Seminar Report
23 June 2007

NSBA

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SCIENCE, MATH & TECHNOLOGY
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Acknowledgments

We thank the Kansas and Missouri board members and administrators who attended the seminar, the Missouri School Boards Association (MSBA) and the Kansas Association of School Boards (KASB) for their help in preparing the seminar, the seminar speakers for sharing their expertise, and the Ewing Marion Kauffman Foundation whose generous support made this event possible. We also thank Elspeth Suthers of AAAS who transcribed the seminar presentations and condensed them for this report.

About AAAS

The American Association for the Advancement of Science (AAAS) is the world's largest general scientific society and publisher of the journal Science (www.sciencemag.org). AAAS was founded in 1848 and serves some 265 affiliated societies and academies of science, serving 10 million individuals. Science has the largest paid circulation of any peer-reviewed general science journal in the world, with an estimated total readership of 1 million. The nonprofit AAAS (www.aaas.org) is open to all and fulfills its mission to "advance science and serve society" through initiatives in science policy, international programs, science education, and more. For the latest research news, log onto EurekAlert!, the premier science-news Web site and a service of AAAS, at www.eurekalert.org.

About NSBA

The National School Boards Association is a not-for-profit Federation of state associations of school boards across the United States. Its mission is to foster excellence and equity in public education through school board leadership. NSBA achieves that mission by representing the school board perspective before federal government agencies and with national organizations that affect education, and by providing vital information and services to state associations of school boards and local school boards throughout the nation.

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Introduction

This document reports on a seminar on science, mathematics, and technology education for local school boards in Kansas and Missouri held by the American Association for the Advancement of Science (AAAS) and the National School Boards Association (NSBA) on June 23rd 2007. The seminar is part of a larger effort, funded by the Ewing Marion Kauffman Foundation, to provide information and resources about science, mathematics, and technology education to local school boards across the country.

The day consisted of opening remarks by representatives of AAAS and NSBA, a short video celebrating the importance of science, mathematics, and technology education, and presentations by expert speakers addressing: current issues in science, mathematics, and technology education; literacy and the nature and use of standards; and public perceptions and engagement on these issues. The day concluded with an interactive session to help attendees begin to design an action plan to address science, mathematics, and technology education in their districts. This report provides summaries of each presentation, detailed answers to questions posed by the audience, and resources referenced by each speaker. Further resources for board members will be available through the project Web site, www.smartschoolboards.org, set to go online in May, 2008. Information on the project can also be found at: www.aaas.org/spp/dser or www.nsba.org.

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Attendees

Kansas district representatives:

District	Name	Position
Andover Schools	Mark A Evans	Superintendent
Blue Valley	Lori Hisle	Board Member
Bonner Springs/ Edwardsville	Steve Cook	Administrator
	Kristi Hoffine	Administrator
Canton Galva	Judy Seidl	Chemistry teacher
	Bill Seidl	Superintendent
De Soto	Janine Gracy	Board Member
	Sandy Thierer	Board Member
	Sharon Zoellner	Superintendent
Kansas City	Vicki Meyer	Board Member
	David A. Smith	Assistant Superintendent
Kismet-Plains	Donna Argo	Curriculum Director
	Elton Argo	Superintendent
Labette County	Jennifer Mathes	Board Member
	Brent Mathes	Board Member's Spouse
Olathe	Nancy Hughes	Board Member
Shawnee Mission	Donna Bysfield	Board Member
	Marjorie Kaplan	Superintendent
	Anita Lundy	Technology Instructor
Wamego USD320	Doug Conwell	Superintendent

Attendees

Missouri district representatives:

District	Name	Position
Ash Grove	Don Christensen	Superintendent
	Bill Duncan	Board Member
	Kim Metcalf	Board Member
	Lisa Reece	Board Member
	Doug Renshaw	Board Member
Blue Springs	Dale Falck	Board Member
Branson	Peter Marcellus	Board Member
Center 58	Robert Bartman	Superintendent
	Merrell Bennekin	Board Member
	John Tancredi	Board Member
	Greg Westfall	Board Member
Dunklin	Susan Hartman	Board Member
Fair Grove	Mike Gilbert	Board Member
	Austin Miller	Board Member
Grain Valley	Jan Reding	Board Member
	Phil Hutchinson	Board Member
Hickman Mills	Robert Bonard	Board Member
	Scott Jennings	Board Member
Hollister	Debbie Redford	Board Member
Independence	Bob Clothier	Board Member
	Susan Jones	Board Member
	Ed Streich	Assessment Administrator
	Jana Waits	Board Member
Kansas City	Duane Kelly	Board Member
Kearney	Chris Belcher	Superintendent
	Ed Haney	Board Member
Knob Noster	Margaret Anderson	Superintendent
Liberty	Greg Dufoe	Assistant Superintendent
	Bob Young	Board Member

Missouri district representatives (continued):

District	Name	Position
Logan Rogersville	Lisa Spragg	Board Member
Mehlville School District	Larry Felton	Board Director
	Ken Leach	Board Member
North Kansas City	Tom Cummings	Superintendent
	Spencer Fields	Board Member
	Kathleen Harris	Board Member
	Joe Jacobs	Board Member
	Jan Kauk	Board Member
	Chace Ramey	Board Member
Oak Grove	Ruth Pirch	Board Member
	Chuck Sears	Board Member
Park Hill	Gina Chambers	Assistant Superintendent
	Judy Dale	Teacher
Platte County	Dave Holland	Board Member
Pleasant Hill	David Burge	Board Member
Raytown	Dale Houck	Superintendent
	Cathy Mack	Board Member
	Rick Moore	Board Member
	Bobbie Saulsberry	Board Member
Sedalia	Stan Bowlin	Board Member
University City	Robert Elgin	Board Member
West Platte	Kyle Stephenson	Superintendent
	Jeff Vandel	Board Member
Worth County	Linda Gray Smith	Superintendent

Other Invited Guests

John L. Burch, Bioscience Investor, Lawrence, Kansas
Rex Cone, Camera Technician, Missouri School Boards' Association
Joel D. Denney, Associate Executive Director, Missouri School Boards' Association
Mike DeSantis, Camera Technician, Missouri School Boards' Association
Blake Godwin, Senior Director Video Productions, Missouri School Boards' Association
Scott Joftus, Observer, Cross and Joftus
Tom Krebs, Kansas Association of School Boards
Brett Manie, Director, Creative Video Services, Missouri School Boards' Association
Sheryl Spalding, Representative, Kansas State House of Representatives
Joy Torchia, Communications Department, Ewing Marion Kauffman Foundation
Bill Wagon, State Board Member, Kansas State Board of Education

Introductory Remarks

Joe Villani

The purpose of this project is to provide school board members with the tools and knowledge necessary to strengthen science, mathematics, and technology education programs in their districts. Science, mathematics, and technology education is a critical area of concern, and one which school board members can play a large role in addressing. The project is being overseen by AAAS and NSBA, with the further cooperation of the Missouri School Boards Association (MSBA) and the Kansas Association of School Boards (KASB), and is funded by the Ewing Marion Kauffman foundation.

Connie Bertka

The American Association for the Advancement of Science is an international non-profit organization dedicated to advancing science around the world by serving as an educator, leader, spokesperson and professional association. In addition to organizing membership activities, AAAS publishes the journal Science, and spearheads programs that raise the bar of understanding of science worldwide.

Founded in 1848, AAAS serves some 262 affiliated societies and academies of science, serving 10 million individuals. Science has the largest paid circulation of any peer-reviewed general science journal in the world, with an estimated total readership of one million. The non-profit AAAS is open to all and fulfills its mission to “advance science and serve society” through initiatives in science policy, international programs, science education and more.

AAAS seeks to “advance science and innovation throughout the world for the benefit of all people.” To fulfill this mission, the AAAS Board has set several broad goals, including fostering communication among scientists, engineers and the public; fostering education in science and technology for everyone; enhancing the science and technology workforce and infrastructure; and strengthening support for the science and technology enterprise. AAAS has several programs focusing on science education, including Project 2061, a long-term initiative to advance science literacy, which has created a number of resources for science educators, both online and in print format.

The objective of this AAAS/NSBA project is to help school board members effectively articulate and implement the vision of their districts around sound science, mathematics, and technology education. To that end, the project design falls into two phases the first of which focused on developing this seminar, and the second of which will produce resources with a national reach. Research in the Kansas City area, conducted by Public Agenda, reveals that controversial issues such as evolution are not the primary concern of school board members. Rather, they are more interested in how to address issues in science, mathematics, and technology education with parents and the community, choosing curricula, forging community partnerships, illustrating real-life benefits, integrating technology, and evaluating recommendations. This seminar should enable board members to start work on an action plan for their district, based on the *Key Work of School Boards*, and should improve their understanding of: current issues in science, math and technology education; literacy and standards; and the principles of public engagement. Following the seminar, phase two of the project will focus on developing a training CD-ROM and a Web site that will be available to school boards across the nation. The development of these resources and supplementary materials will involve input and assistance from AAAS, NSBA, the National Council of Teachers of Mathematics, the International Technology Education Association, the Missouri School Boards Association, the Illinois Association of School Boards, and the Maryland Association of Boards of Education.

Session I: Current Issues in Science, Mathematics, and Technology Education

Current Issues in Science Education
Joan Abdallah, AAAS

- What is science?
- What are some benefits of studying science?
- What problems face science education?

Science seeks to understand and explain phenomena occurring in the natural world and the laboratory. Science is a human endeavor which permeates our lives. Its products and processes are intrinsic in much of what we do and what we think.

In many places science is being removed from schools as a result of the current emphasis placed on achievement in math and reading by the *No Child Left Behind* legislation, yet it is essential to include science in school curriculum. Engaging students in doing science helps students in a variety of ways — it provides them with the skills, knowledge and processes that they can use to develop a way of thinking. As they gain proficiency in examining the living and physical world, they develop the skills to think critically, solve problems and make informed decisions. Students need to be engaged in manipulating materials, technology, and computer technology, and utilizing and analyzing data in the life, physical and earth sciences in order to gain some sense of the natural world, and develop the habit of using evidence to support explanations and engage in discourse.

The underperformance of US students on both national and international tests emphasizes that there are considerable problems with our science education. Perhaps the most significant of these are parents who minimize the importance of science and mathematics because they themselves did not do well in science and mathematics, and the lack of qualified and experienced teachers. It is important to educate parents about the importance of science and, in particular, to help them understand that the science students are doing today is different — more interactive, hands-on, and accessible — than the science they did, so that their experiences are not necessarily relevant to those of their children. To better attract teachers, it has been suggested that states implement a comprehensive package of science and mathematics teacher education and recruitment strategies, starting in Pre-K, and extending through graduate school, which would include incentives such as scholarships, signing bonuses and differential pay. Research indicates that new teachers who stay in the schools for 5 years usually remain on the teaching force. The recommendation is, therefore, to improve the retention of both new and experienced teachers, and address the causes of teacher dissatisfaction, by developing and implementing research-based induction programs, as well as implementing comprehensive policies and programs that address the leading causes of teachers' job dissatisfaction, including inadequate compensation, lack of administrative support, and professional isolation.

The essential challenge for boards in working with their districts is to make a compelling argument for the importance of science, and teaching students to think scientifically, and then to provide the policies that really support quality science, mathematics, and technology programs.

Questions for Ms. Abdallah

Q: How can science scores be going up in elementary schools if we are decreasing science teaching?

A: The decrease in the amount of time devoted to teaching science has been pronounced in the past couple of years due to Adequate Yearly Progress (AYP), an accountability measure in reading and mathematics required by the No Child Left Behind Act (NCLB). However, science is not required for AYP and school systems report that there is an increase in the number of minutes devoted to language arts and a reduction or elimination of the number of minutes for science. The National Assessment of Educational Progress (NAEP) will be administered again in 2009 and there is a movement to require science to be included in the AYP measures.

Many people speculate that any improvements are related to increased out-of-school opportunities for engaging with science, such as television programs, science and technology centers, the internet, etc. The issues of standards and the level of learning remain unaddressed.

Q: How do you engage a board that believes that all curriculum ideas and discussions should be left to staff?

A: The National School Boards Association should be a first step. Through the NSBA, various seminars are conducted to address these issues and topics. Some school systems have professional developers who may be considered to facilitate opportunities to promote new ideas, understanding of issues, and accomplishment of beliefs and goals.

In addition, the board should be led to discuss the kind of overarching goals it believes that schooling should provide (e.g. citizenship, employment, life skills, etc.) That then opens up the discussion of what curricular focus is needed to support reaching those goals.

Q: How detrimental to the advancement of science, mathematics, and technology is the state of reading skills in urban schools today?

A: The often low level of education in urban schools today is hugely detrimental to the prospects of those students both in general and with respect to science, mathematics, and technology education.

However, SMT can actually enhance reading instruction because the text becomes meaningful when students are given a purpose for reading based on experiences. All too often, by denying students access to science in urban schools from the earliest grades, we deny students opportunities not only to utilize the tools of science and to wrap their minds around concepts and skills that require them to think about answers to questions about phenomena, but also to practice to practice their reading skills in different contexts. Boards may want to consider using science as a way of learning mathematics and reading and writing. A growing body of research has found that mathematics and reading scores increase when reading and mathematics are integrated with an inquiry-based science program. See Mike Klentchy's report on his results in El Centro, CA (http://www.carolina.com/carolina_curriculum/stc/publications/evidence/vips.pdf) as well as the data from Pittsburgh's ASSET Program (http://www.ebecri.org/custom/assetresults.html). Inquiry-based science programs provide motivation to read as well as a context for learning.

Q: How can language arts programs and SMT programs partner together to improve the success of students in science?

A: Collaboration among the various departments (science, mathematics, technology, and language arts) within the school system will augment efforts to provide a multidisciplinary program that does justice to each area's learning. Our project Web site, www.smartschoolboards.org, will feature districts that have come up with innovative solutions to improving SMT education, including those where language arts and SMT programs are working together. The Web site will go online in May 2008.

Q: Which is more important, hands-on science or science instruction? Which should take up more of the education year?

A: Both are clearly important, and the National Science Teachers' Association supports the notion that inquiry (or hands-on) science must be a basic approach in the daily curriculum.

The National Science Education Standards (NSES p. 23) defines scientific inquiry as "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world." The Science as Inquiry Standard in NSES includes the abilities necessary to do scientific inquiry and understanding about scientific inquiry.

Scientific inquiry reflects how scientists come to understand the natural world, and it is at the heart of how students learn. From a very early age, children interact with their environment, ask questions, and seek ways to answer those questions. Understanding science content is significantly enhanced when ideas are anchored to inquiry experiences. The National Science Teachers Association (NSTA) recommends that all K-16 teachers embrace scientific inquiry and is committed to helping educators make it the centerpiece of the science classroom. The use of scientific inquiry will help ensure that students develop a deep understanding of science and scientific inquiry.

Q: How does higher pay for science and math teachers affect the morale of other teachers?

A: Morale may be affected negatively since teachers in other fields may believe that they should be compensated equally. However, teachers of science, mathematics, and technology can command higher salaries in the private sector. One must understand the need to respond to the market. It may be possible that science-related business or area universities and colleges can assist in providing work or research in summer to levels so that the salary gap between teacher pay and private sector compensation can be reduced.

Q: Is there a movement among these groups [AAAS and others] to have science become part of AYP?

A: Yes. Many organizations, including AAAS and NSTA, have urged Congress to make science a required component of the adequate yearly progress (AYP) measure under Title I of the No Child Left behind Act.

Q: Has there been any involvement from ACM (Association for Computing Machinery), IEEE (Institute of Electrical and Electronics Engineers) or NASA in the technology literacy efforts?

A: Yes. You may check their websites to obtain information about their efforts: www.acm.org/education, www.ieee.org/web/education/home/index.html, http://education.nasa.gov/home/index.html

Q: There is a shortage of qualified science teachers at the secondary schools, grades 7-12, in our country. What is being done to attract more quality science teachers nationally?

A: There is a movement underway to attract STEM majors to teaching, to attract retired STEM professionals to teaching, and to bring retired military to teaching. Other strategies include: Teach for America, increased pay and bonuses, and attracting teachers from overseas. The National Science Foundation also published a report in August 2007 outlining an action plan to address this issue. The report is available online at: www.nsf.gov/nsb/edu_com/report.jsp

Q: Is there a school district with a science education model that we could emulate?

A: A model should be based upon the needs of the school system. However, The National Science Foundation and NSBA are excellent sources from which to obtain information regarding programs that have sustained increases in the achievement of students in science. Additionally, our project Web site, www.smartschoolboards.org, will feature districts that have innovative and successful SMT programs.

Current Issues in Mathematics Education
Rita Barger, UMKC

- What are the main issues concerning mathematics curriculum?
- What are the main issues concerning mathematics instruction?
- What are some solutions?

The National Council of Teachers of Mathematics (NCTM) represents mathematics teachers nationwide and sets the vision for what should be taught in mathematics classes. NCTM published the first set of standards for any discipline in 1989, and since then has revised and republished their standards, most recently in 2000. The newest standards document is *Curriculum Focal Points* which highlights three big ideas from the standards for each grade level.

The most pressing issue in mathematics curriculum is reformed versus traditional curricula. Traditional mathematics curricula are very heavily focused on skill-development and solving problems: Students are presented with examples, work a set of problems on their own and move on. In reformed mathematics curricula students are presented with situations, there is something intended to engage them, and then they explore and develop their understandings. Reformed mathematics curricula help students to think mathematically and understand the processes of mathematics, rather than viewing math as something simply to be memorized.

The National Council of Teachers of Mathematics has published five content standards, and five process standards. The five processes of mathematics are problem-solving, communication, reasoning/proof, representations, and connections. Both the traditional and the reformed curricula address some of these issues well, while not focusing on others. It is important for school board members to examine their curricula and ensure that all five processes are addressed.

In terms of instruction, mathematics is facing a teacher shortage. One way to address that is through alternative certification programs, such as the one Missouri has adopted. It considers professionals from related fields, such as engineering, to have the content knowledge needed to teach mathematics, and allows them to teach and receive their certification simultaneously.

In mathematics, learning styles are also very important. While some students think very linearly, and are likely to enjoy arithmetic and algebra, other students, typically the students who understand geometry readily, do much better with a holistic approach. Historically, teachers of mathematics have done a very good job of teaching to the left brain, the sequential, the step-by-step people; but many students who are more right-brained or holistic have struggled in mathematics. It is important to address the needs of both groups in considering your policies regarding mathematics education.

One of the major issues in math education is how much assessment schools should have. Especially since *No Child Left Behind* has come into effect, there has been a great increase in assessment, and sometimes there is too much. School board members need to be concerned with whether or not their districts spend a disproportionate amount of time testing and are therefore not allowing students enough time to learn. The correct approach to teaching will enable students to learn math through the processes and eliminate the need for such extensive review time; and the correct approach to assessment will turn the tests into a tool for learning, rather than something which only generates grades.

Professional development is also important in mathematics. Professional development for teachers should be focused and ongoing. General or one-time trainings do motivate teachers and put them in touch with current ideas and issues, but in order to be truly effective, trainings must be tailored and take place over a period of time. However, there is a need and a place for both types.

Educational partnerships with institutions of higher education can also be very beneficial to a mathematics program. There is a good deal of federal money available for partnerships between K-12 schools and institutes of higher education. Communication between the schools that are receiving new teachers or student teachers and the programs that are training them is also very important for the educational community.

Finally, a comment on beliefs about mathematics: Our society generally does not believe that everybody can do mathematics or that everybody should do mathematics. This is unacceptable we cannot afford to have our students, our future, hearing that it is okay not to be able to do mathematics.

Questions for Dr. Barger:

Q: Are math textbooks still necessary?

A: Absolutely. There are far too many important mathematical concepts and procedures that must be learned to expect teachers to create a full, balanced curriculum without some support in the process. While there is no “perfect” textbook, it is much easier for a teacher to supplement and reorganize an existing textbook or related set of materials than to develop everything from scratch.

Q: Are universities and colleges doing a good job of training math teachers how to provide appropriate instruction to students with different learning styles? Are we expecting K-12 to assist teachers in developing these skills?

A: In general, I think that universities and colleges do a good job of broadly training pre-service teachers in theories about diversity and learning styles. However, the specific research I spoke about in the seminar has not been widely disseminated. I’m afraid that often pre-service teachers receive general information and strategies rather than specific information about how to apply those theories in their mathematics classrooms.

K-12 definitely needs to assist teachers in developing the content background and instructional strategies to reach students with a variety of learning styles and needs. Teacher education programs at colleges and universities work hard to prepare pre-service teachers to meet the needs of diverse learners; however, much of what these pre-service teachers learn becomes more meaningful once they enter the classroom and actually experience students who learn in different ways. The transition from being a student to being a teacher is a big one — one that is not easy for young professionals to make. So K-12 institutions and higher education institutions need to work collaboratively to help teachers continue to learn and become more effective in the classroom throughout their careers.

Q: How do you find the time within the school schedule to include more upper-level math classes?

A: Most high schools find that they can offer one or two classes of advanced mathematics for upperclassmen. Typically this is done in districts that use a subject-based sequencing of courses. If that's the case, students who take Algebra I as 8th graders are able to take Geometry and Algebra II in the first two years of high school. This leaves the junior and senior years for Pre-Calculus, Calculus, Statistics, Trigonometry, Discrete Mathematics, and other advanced math classes. An integrated approach to high school mathematics (very common in most countries around the world) is also becoming prevalent in today's classrooms. It is designed so that many of the pre-calculus concepts are included in the third book of the integrated series, leaving the senior year for students to enroll in more advanced courses. It is also possible for some students to "double up" by enrolling in both Geometry and Algebra II during the same year, thus opening up the opportunity for more advanced mathematics courses during the senior year. Finally, districts with more than one high school might want to consider hiring one teacher who travels between buildings to teach these advanced courses. Alternatively, the district could set up a schedule where these courses are offered at one location either the first or last hour of the school day allowing students to be bused to the same place for the advanced classes.

Q: How do we let parents know what the essential math skills are for every student and how they can reinforce those skills at home (especially in a diverse community)?

A: The state departments of education have defined the essential skills and concepts at each grade level (e.g., Grade Level Expectations in Missouri and Tested Indicators for Kansas). Within your district, the administrator in charge of curriculum should be the one to compile a document for parents that will identify and describe these essential skills. He/she can use state expectations in developing the documents and then add further explanations that might be needed by parents. In the fall of 2006, the National Council of Teachers of Mathematics (NCTM) released their *Curriculum Focal Points*. The *Focal Points* discuss areas of emphasis, content-wise, for grades PreK–8. The *Focal Points* as well as the documents compiled by your Director of Curriculum could be shared with parents in a variety of ways including newsletters, brochures, Web sites, and information fairs.

Q: Does professional development for SMT teachers need to be implemented or structured differently than for teachers of other disciplines?

A: Each discipline has its own special professional development needs. Some instructional strategies cross disciplines (Kagan structures or cooperative learning, for example). However, there is a danger that schools and districts will concentrate on these broad cross-disciplinary strategies to the exclusion of the specific needs of each discipline, and this should be avoided. Teachers need time within a discipline to strengthen their content knowledge and their pedagogical knowledge. While a highly motivational speaker is good for the beginning days of the school year, Boards of Education need to also make sure that teachers have access to specific information and professional development that will help them do a better job within their own subject matter. Schools and districts should create a multi-year professional development plan that is discipline-specific, appropriate for both new and veteran teachers, and ongoing throughout each teacher's career. In the same way that teachers must differentiate instruction for their students, districts must differentiate professional development for their teachers.

Q: Is it feasible to teach algebra skills early enough so that algebra-based physics can be taught in 9th grade ("Physics First" — instead of biology)? What will it take to get there from here?

A: In a district that offers Algebra I to 8th graders, the algebra skills needed to follow the Physics First curriculum will have been taught. Part of the decision to be made is whether all 9th graders take physics. If so, then all 8th graders would need to take Algebra I, and this typically doesn't (and really shouldn't) happen. It might also be necessary for the 9th grade mathematics teachers to work closely with the 9th grade Physics First teachers to develop the algebra curriculum that will support the science. In any case, the elementary school curriculum should be designed to present algebraic thinking throughout grades K-8 so that students will be fully prepared to successfully complete an Algebra I course.

Q: How do we help society change the mindset that "not being good at math" is no longer acceptable?

A: We have to start with the people we know the best — the ones we interact with on a regular basis like administrators, teachers, support staff, friends and colleagues. Here are some possible beginnings:

- Never allow friends, colleagues, acquaintances, etc. to voice the idea that they were "not good at math" or that "math was their weakest subject" without challenging the statement.
- Let everyone know how damaging these types of comments can be for students of all ages.
- Teachers need to be prepared to address the issue with parents at parent/teacher conferences.
- Teachers in non-math subjects must be encouraged not to say or imply that mathematics is hard or unnecessary or that only "some" people are good at math.
- Point out that everyone uses math every day.
- Point out that no teacher is satisfied with a student who can't read. Then emphasize that the same should be true of mathematics.

Changing beliefs is not easy, but we can't ignore them. If we don't address unhealthy beliefs each time they come up, we won't make a difference, and we'll continue to have students who use them as an excuse for not succeeding. We have to continue to advocate for more and better mathematics for all students.

Q: Test review is a real balancing act (for state tests). Define what you mean by "too much review."

A: Any time a teacher has to completely stop teaching in order to review for the state test, something is wrong. Students should be learning mathematics with understanding. If they understand, then they don't need to remember what the teacher said or did. Most reviews for state tests involve too much focus on remembering and on specific test taking strategies. I've heard of districts that shut down learning as much as six weeks before the testing window. During those six weeks, students work only on math and communication arts to prepare for the state test. If this is necessary, then the problem is much deeper: students didn't really learn the concepts when they were taught previously. Those six weeks represent a sixth of the school year during which no new concepts or topics are taught. There is not enough time for teaching necessary mathematics in a regular school year, much less in only five-sixths of the school year.

Instead of stopping instruction and spending concentrated time on review, teachers need to teach reasoning, critical thinking, and problem solving. If students believe they can figure out mathematics problems, and if they have been taught to reason and communicate, and if the curriculum has presented them with information about the topics being tested, then the students should be able to do well on the state tests. Practice theory does say that we need to re-visit concepts and topics on a regular basis, so I'm not saying teachers shouldn't help their students review. I'm just saying that review should be part of every lesson, and new teaching should not disappear during the weeks before the state test.

Current Issues in Technology Education
Barry Burke, ITEA

- What is technology?
- What is technological literacy?
- Why is technological literacy important?

The International Technology Education Association, ITEA, represents approximately 36,000 technology teachers nationwide. ITEA creates and publishes standards-based curricula for technology education programs, materials on standards for technological literacy, and materials on advancing excellence in technological literacy, including *Engineering by Design*™.

In considering technology and engineering education, the first question is: What is technology? It includes computers, engineering (with both a large "E" and a small "e"), design, and human innovation in action. Engineering (with a large E) is used to mean the noun, whereas engineering with a small e is used as a verb meaning to teach students to use engineering concepts, design or think in like an engineer. Technology involves a generation of knowledge and processes to solve problems and expand human capabilities.

Technological literacy is the ability to use, manage and understand technology. The ability to use technology involves the successful operation of the key systems of the time. The ability to manage technology involves insuring that all technological activities are efficient and appropriate. Understanding technology involves more than facts and information, but the ability to synthesize the information into new insights, and recognizing that using technology, or managing technology, can have a number of different impacts.

There is a widening gap between the knowledge, capability and competence of the technologists, inventors, and researchers who revolutionize the technological world and the users of that technology. Furthermore, students of today who are growing up to be innovators have a different understanding of technology and a different understanding of how they can do multiple things at one time than prior generations had.

There is a need for technologically literate decision making. Technological problems have more than one viable solution, and society and individuals need to decide how and when to develop the use of various technological systems. These decisions depend on a basic level of technological literacy, the ability to use, manage and understand technology.

Technology education is the basic general education that deals with creating a technologically literate citizenry through the study of TIDE — Technology, Innovation, Design and Engineering. Technology education is important because students use the concepts of design and engineering to identify problems and solutions, re-engineer products, and create solutions to technological problems. Students apply science, technology, engineering and mathematics to discover and develop individual talents.

As demonstrated by a pair of Gallup polls, the public understands the importance of technology in our everyday lives and understands and supports the need for technological literacy. They do tend, however, to define technology more strictly in terms of computers than do people in the field, so there is a need to broaden the public understanding of what technology education is or should be.

There are five main ways in which administrators can become involved: Develop business and industry partners; when considering school improvement or reform, consider organizing schools in feeder patterns around themes; develop technological literacy, making sure that the district has some theme for technological literacy that goes beyond how to use a computer; implement a cost-effective, standards-based model; and promote and encourage district and state involvement in online student assessments.

Questions for Mr. Burke:

Q: In Kansas, there is a big push to put money toward vocational technical education in high schools. How does a STEM model fit with that group of programs and vice versa?

A: Programs in vocational-technical education are designed to be a sequence of high school courses (4 credits) that articulate with post-secondary education and integrate academics. The reauthorization of the federal Carl D. Perkins Act provides funding for program improvement to support these approved programs. Traditionally funding has been spent on equipment, but recent changes to the legislation make professional development and curriculum based on national skill standards a higher priority based on a district's program meeting identified performance measures. In some states, this federal funding applies to the technology education program, while in others it does not. Generally, funding is used to support the high school approved programs. Implementing a STEM model in this context would require local school districts to identify a program or series of courses that support STEM workforce needs and is standards-based.

Q: Please clarify "smaller learning communities." Do we need fewer students per school building?

A: The research says that schools with more than 900 or 1000 students are too big to encourage student learning. The smaller learning-communities model was developed with that in mind as a way to enable students to interact with a smaller peer group with similar career interests. Smaller learning communities as defined by the U.S. Department of Education are "structures such as freshman academies, multi-grade academies organized around career interests or other themes, "houses" in which small groups of students remain together throughout high school, and autonomous schools-within-a-school, as well as personalization strategies, such as student advisories, family advocate systems, and mentoring programs." (More information can be found at http://www.ed.gov/programs/slcp/index.html or by Googling *"Smaller Learning Communities."*)

As an example, a smaller learning community could be created through the restructuring of a high school using a school-within-a-school approach with each school addressing a "theme." Examples of themes related to STEM might include engineering, architecture, aerospace/aeronautics, etc. The concept would involve developing a series of themes (engineering, information technology, performing arts, biotechnology, transportation, etc) and providing students the ability to register for one of these "schools-within-a-school." Themes are generally identified using student feedback, community needs, and staff expertise. A high school of 1200 students might create 4 or 5 smaller schools within it, each around a different theme. Teachers would then deliver curricula based on the themes provided by the smaller school.

Q: Does a particular school scheduling model (standard/traditional schooling, block, modified block) lend itself to better learning opportunities for students in regard to SMT?

A: While any scheduling model will work, the block/modified block tend to have the larger blocks of time. Because the Technology Education (STEM) courses are generally problem-based learning and have students developing and creating solutions to technological problems, a longer period of time for students to be engaged in these activities is recommended — but not required.

The advantages to these longer periods are directly related to the laboratory environment where students become engaged in the lesson and the work and are more likely to grasp the "big ideas" that the teacher is facilitating. More information may be found at: http://eric.uoregon.edu/publications/digests/digest104.html or by Googling "Advantages of Block Scheduling"

Q: What should all school districts be teaching in the area of technology? What do companies expect all employees to know before they apply for a job?

A: In the area of technology, it is recommended that districts incorporate the teaching of TIDE (Technology, Innovation, Design, and Engineering.) Through these four big ideas, students become:

- Motivated
- Proficient at using technology tools
- More confident
- Effective problem-solvers
- Technologically literate — they gain the ability to use, manage, and understand technology

The *Standards for Technological Literacy (ITEA 2000, 2001)* provides content standards for the delivery of technological literacy. These standards identify what a student should know and be able to do by grade bands (Grades K-2, 3-5, 6-8, and 9-12) to be technologically literate. Therefore, technology education should be offered at every level (Grade bands K-2, 3-5, 6-8 and 9-12) to ensure a technologically literate student that is prepared for the global world in which they are growing up.

Companies across the nation have different needs with regard to their workforce. However, in 1992 the Secretary of Labor issued the report titled: *Secretary's Commission on Achieving Necessary Skills (SCANS)* (http://wdr.doleta.gov/SCANS/) which identified major areas of need. These hold true today. The commission identified 5 competencies:

- Resources: Identifies, organizes, plans, and allocates resources
- Interpersonal: Works with others
- Information: Acquires and uses information
- Systems: Understands complex inter-relationships
- Technology: Works with a variety of technologies

The Business Roundtable for Education also has published many reports on Workforce needs (http://www.businessroundtable.org/taskForces/taskforce/issue.aspx?qs=6555BF159F849514481138A6DBE7A7A19BB6487BF6B39) The Council on Competitiveness also has many reports that may be of value: (http://www.compete.org/). Additionally, in the STEM area, the report: *Preparing for the Perfect Storm* provides an overview of the workforce needs for STEM education. This report may be printed from http://www.iteaconnect.org/Publications/Promos/NAE.pdf

Q: What policies can promote and support technology in all of its forms?

A: Policies that can promote and support technology in all of its forms would include some programmatic requirements by the district to ensure that the components of technological literacy are built on constructivist learning theory. While the Gallup poll (http://www.iteaconnect.org/TAA/PDFs/GallupPoll2004.pdf) shows that there is a misconception of what technology is, it is clear that students entering our schools today have more technology skills than those of ten years ago. For example, a student by Grade 3 already knows how to navigate Windows, and may even know many applications. Districts should be mindful that the best way to teach technology applications in-depth is by integrating it throughout every content area. Programs such as Engineering byDesign™ integrate the use of all computer applications and in fact teach the applied use of computer applications as well as design applications. Districts should understand the technology skills of incoming students and present policies that present content across all curricular areas. (A course in keyboarding in high school is 6-9 years too late.)

School districts should develop and adopt policies that prepare students for tomorrow and deliver technological literacy in the broader sense. A program in Technology Education should be required at every grade level, at the high school level, a one credit in Technology Education required for graduation would help to ensure that students leave high school technologically literate. This credit should focus on technology in the broader sense, and be the culmination of the elementary and middle school programs dealing with innovation, design and engineering. Some states do require technology education at the middle and high school level. One such state is Maryland, (http://mdk12.org/instruction/curriculum/technology_education/).

Q: Are you familiar with the "High Tech High School" in San Diego, and what is your impression of the concept?

A: Information about the High Tech High School in San Diego can be found at http://www.hightechhigh.org/ and is consistent with the smaller schools — focused content strategy to improve student achievement.

The concept of helping students to achieve their potential through hand-on, minds-on study is one that helps all students, but is a significant strategy for improving student achievement. Smaller schools focused on themes that interest students, help students at risk to see the value of learning. Applications of academic concepts through hands-on learning are an integral component of technology education coursework. Students are engaged in *problem-based* learning.

Q: Math, science, and other disciplines are assessed in subject-specific tests. Does this provide for continued resolution of disciplines? When will we move to truly integrated teaching and assessment as is found in the "real world"?

A: The recent addition of the Engineering by Design™ (EbD™) end-of-course assessment and design challenge moves away from assessing only the one content area. The EbD™ programmatic philosophy is that there is a body of knowledge that students need to know and be able to do, but that it should not be learned in isolation of the other disciplines. In fact, as EbD™ was developed, it was based on three sets of content standards — technological literacy, mathematics and science. It has also been cross-walked with the Pre-Engineering Knowledge & Skill Statements (www.careerclusters.org) and the Information Technology Knowledge & Skill Statements. Therefore, as the assessments have been developed, the questions and the design challenge (problem-based learning) measure are able to isolate math, science and pre-engineering content that is achieved.

Session II: Science, Mathematics, and Technology Literacy and the Nature and Use of Standards

Jo Ellen Roseman

- Why do we need to increase SMT literacy?
- What is the role of standards?
- How well do textbooks address standards?

Project 2061, AAAS's long-term education initiative, began in 1985 with the last appearance of Halley's Comet, to answer the question: "What kind of an education do students need in science, mathematics, and technology to participate in a world that is increasingly shaped by these endeavors when Halley's Comet returns in 2061?" School board members and administrators play a crucial role in overseeing both the fiscal and educational policies in their school districts. Three essential areas of their responsibility regarding educational policies are: learning goals, which some refer to as standards — what is it that students should learn? Curriculum and instruction — how can they be helped to learn? And assessment — how can we monitor their progress and use that information to improve programs?

The need for an integrated understanding of science, mathematics, and technology — what Project 2061 refers to as science literacy — can be illustrated by examining responses of children and adults to the following question: a tree starts out as a small seed that grows into a large tree of enormous mass, where does the mass of that tree come from? When asked this question, fourth graders say that the seed needs to be planted, and if it gets water and light, it will grow into a tree. What the fourth graders are not expected to know is that the trees, like all matter, are made up of molecules, and that a tree grows by carrying out chemical reactions in which atoms from the carbon dioxide and water molecules the tree takes in are rearranged to form new molecules — glucose and oxygen — and that these new molecules are used to make larger molecules — such as cellulose — that make up the tree's structures, so that trees get their mass almost exclusive from carbon dioxide, a gas. This is the so-called "Lego model" of matter. Given research reports on the difficulties that even university students have in understanding these ideas, it seemed ambitious enough to expect students to understand these ideas by the end of the eighth grade.

When the same question about the mass of a tree was put to students graduating from Harvard and MIT, they used a much larger vocabulary to describe what trees do, and though some had clearly taken biochemistry classes, none of them were able to answer the question any better than the fourth graders. The conclusion to take from this, and one that has been recognized in developing national science education standards, is that learning is not always an outcome of teaching, and that if students are to be scientifically literate in a way that has meaning for them, science education must be connected to real-world events.

In this particular case, it is important that students understand the origins of a tree's mass because other vital knowledge depends on it. For example, to understand the effect of plants on the Earth's atmosphere, one must understand that plants are taking carbon dioxide out of the atmosphere. Then, when people burn trees, coal, or anything else that comes from plants, including oil, they put carbon dioxide back into the atmosphere. Climate change is the result of carbon dioxide going back into the air faster than plants can absorb it. And so this knowledge is important for understanding consequences of our actions.

Research on student learning has also shown that most learners do not spontaneously make connections among ideas and that attention needs to be given to helping them do so. For example, students need to be helped to relate food-making in plants and the growth of a tree to ideas about rearranging atoms in molecules taken in from the environment to make new molecules that become part of body structures and, hence, contribute to increases in mass.

Project 2061 has worked to lay out guidelines for what all students should know at various points in their education. The Project's first publication, *Science for All Americans*, describes what students should know in science, mathematics, and technology by the time they graduate high school. It is organized around the nature of the fields — what are science, math and technology, and how do they work? It presents a coherent set of facts that can help us make sense of our world in each of five different fields of science — life science, earth science, physical science, and social science — along with technology, engineering and mathematics. It presents some cross-cutting themes that are applicable across disciplines, historical perspectives, and habits of mind. The recommendations included in *Science for All Americans* came from panels of scientists, who were convened from a broad range of disciplines, and asked to write 15-page recommendations for each of five fields, each of which summarized the core knowledge that could help students make sense of everyday events, make informed personal and social decisions, and serve as a foundation for a lifetime of learning.

After *Science for All Americans*, the Project worked with teachers and education researchers to develop *Benchmarks for Science Literacy*, which unpacked the learning goals of *Science for All Americans* to identify what knowledge and skills are appropriate for students to have at the end of second, fifth, eighth and twelfth grades to help them make progress towards adult science literacy. After *Benchmarks*, came the *Atlas for Science Literacy*, which uses maps to represent K-12 connections among learning goals within and across topics. For example, maps on important episodes in the history of science show connections between science ideas and the history of their discovery and between ideas about the history of discovery and the nature of science. For each of the nearly 100 maps, the two-volume *Atlas* provides an introduction that explains why its topic is important and very briefly summarizes what students should be learning in elementary school, middle school and high school based on the available learning research.

States have used the national benchmarks and standards to varying degrees in crafting their own standards, and several states are now undertaking revisions. In considering the usefulness of existing state standards and the kinds of revisions to make, states should ask the following questions:

- Do the standards really focus on the most important science ideas?
- Are they clear and specific enough so that they can be used to guide textbook selection?
- Do they hang together as a set?
- Do they tell a story, or merely present isolated bits and pieces?
- And, are the expectations for any particular grade appropriate for students?

Because standards are intended to guide the design of curriculum, instruction, and assessment, it is very important to take standards seriously, and think about what they mean and what the implications are for the kind of instruction that students should receive.

Textbooks are, of course, also crucial to a good education program. Project 2061 has examined the most popular and most innovative science and mathematics textbooks for middle school science and math, high school biology and high school algebra. Findings from these textbook evaluation studies indicate that existing materials have a long way to go in supporting the teaching and learning of the ideas and skills recommended in national content standards and benchmarks and in the state standards that are based on the national recommendations.

The most common textbook deficiencies were: a lack of attention to the well-documented and predictable difficulties that many students have in grasping key science concepts; illustrations and other graphic representations that are too abstract, complex, or inadequately explained to be useful for clarifying science ideas; insufficient firsthand experiences with natural phenomena that provide opportunities for exploring the natural world and that help make scientific ideas real to students; and few efforts to guide students in making sense of the experiences with the natural world that are provided.

Project 2061 is developing supplementary materials to help teachers make up for the shortcomings of the textbooks. These include detailed clarifications of the scientific ideas that the national content benchmarks and standards intend students to learn, descriptions of phenomena and representations that can illustrate the ideas and their usefulness in making sense of the world, summaries of research on how students think about the ideas, and questions that can help students' think through, make sense of, and use the ideas to explain real-world events and observations.

In the end, there are three important things to keep in mind:

- What students are expected to learn should be important, appropriate, and clearly articulated.
- For students to achieve lasting and useful knowledge, curriculum and instruction need to be well-aligned with learning goals and provide adequate support for students and teachers.
- Assessments must be well-aligned with the learning goals that you've chosen so that you can effectively monitor progress and obtain feedback to inform needed program revisions.

Questions for Dr. Roseman:

Q: This session has focused on detailed information that we don't know, but should know. I am not sure about the application of this session. It was far too detailed for most laymen, including school board members, to be able to know what to do with the information except to simply tell our administrators to "do a better job of teaching science" which isn't going to be very meaningful to them. What is the main thing I should be taking away from this session as a school board member?

A: The main message of this session was to drive home the importance of high-quality science education and to help board members understand what it takes for students to learn science so that it is meaningful and useful to them over the long term. To summarize, good SMT education requires:

- a coherent set of important ideas for all students to learn (content standards),
- textbooks and other curriculum materials that can help students grasp the ideas and connections among them, and
- aligned assessments that can be used to monitor student progress and to inform improvements in curriculum and teaching.

We also wanted to provide busy school board members with a better sense of where to turn for expert and credible information and advice on key issues related to SMT standards, curriculum, instruction, and assessment.

Q: How do I apply this information as a board member?

A: As part of their school oversight responsibilities, board members can be sure that their administrators, principals, science specialists, and curriculum supervisors are aware of and make use of the resources that are available from science and science education organizations such as AAAS's Project 2061 and others. As community leaders, they can also draw on these same resources to help build public support for making improvements in their local science programs.

Q: Knowing now the information regarding textbooks (science) how can a superintendent, in good conscience, recommend spending hundreds of thousands of dollars on a textbook series? What is the solution?

A: It would not be crazy to postpone textbook purchases until better ones become available; however, this may not be an option in some school districts. No matter which textbooks are being used — whether newly purchased ones or those already in the classroom — the key is for administrators and teachers to know exactly what their textbook's strengths and weaknesses are and how to compensate for those weaknesses. For example, textbook adoption committees could use Project 2061's textbook evaluation criteria and procedures to analyze and compare texts that are being considered for adoption. A CD-ROM prepared for a series of Project 2061 conferences on science textbooks (www.project2061.org/events/meetings/textbook/literacy/cdrom/index.htm) provides explanations of the criteria and examples that can help districts use them effectively. The insights that come out of the analysis process will give everyone involved a much better idea of exactly where their textbooks need to be augmented with specially targeted instruction, activities, or professional development for the teachers. Project 2061 is currently identifying a variety of instructional resources that are aligned to national benchmarks and standards and expects to make them available on its Web site next year. We are also working with two curriculum development teams funded by the National Science Foundation to do a better job of targeting national benchmarks and standards and to support teaching and learning of them. One of these teams has completed and published a physical science course for use in grades 7-8 (see http://www.interactionsinfo.net for more information on the *Interactions in Physical Science* curriculum), and another is working on an integrated science course for grades 6-8 (see http://hi-ce.org/iqwst/index.html for more information on the *IQWST* curriculum).

Q: How does Project 2061 line up with Kansas standards and assessments?

A: Project 2061 has not done a systematic analysis of each state's standards and assessments in comparison to the national standards documents. We have done a careful comparison of the content standards in *Benchmarks for Science Literacy* and *National Science Education Standards* (www.project2061.org/publications/rsl/online/COMPARE/NRC/NRCTOC.HTM), and states and districts could use it to guide their own comparisons. We are also exploring the possibility of hosting a working conference to bring state teams together to help them use these and other resources to examine the quality (coherence, importance, clarity, etc.) of their standards and to gain insights about how to strengthen them.

Q: Should districts be looking at books on CD or continue with hardback books?

A: From Project 2061's point of view, the format of the instructional material is not nearly as important as the quality of the material's science content and the instructional strategies used to help students grasp that content.

Q: National and state standards are often a mile wide. What can/should local board members do to change and/or work around this so that kids learn what they need to learn?

A: While science textbooks (as well as the science standards in many states) are often criticized for being "a mile wide and an inch deep," we would not characterize the national learning goals in *Benchmarks for Science Literacy* or in *National Science Education Standards* in that way. Indeed, a principal aim of both of these national documents was to reduce the sheer number of concepts and vocabulary terms to be learned so that students would have time to learn the most important ideas deeply and well. Because current curriculum materials do not help students achieve these important learning goals, we don't yet have a sense of what is really possible. Without data that provide a basis for making informed decisions about what to keep and what to eliminate, I think it is premature to randomly delete learning goals from the national documents. It would certainly be helpful for states to work together to identify a subset of topics that they all agree are essential for all students to learn. By focusing on these high-priority topics, states could then start to improve their teaching and learning. By showing which ideas contribute to which other ideas, the maps in *Atlas of Science Literacy* (www.project2061.org/publications/atlas/default.htm) could be valuable in informing their decisions about where to start.

Q: If the textbooks are not teaching what we believe students need, why do they cost so much?

A: Unfortunately, textbook publishers do not set their prices based on the effectiveness of their products! The textbook market is one in which *caveat emptor* should always be the guiding principle.

Q: What has been accomplished by Project 2061 since its inception 22 years ago? Isn't it discouraging that our students know* less *about science than they did in 1985?

A: Whether or not we have good data on what students knew 22 years ago is an open question. But even if such data exist, there are many factors — both within the education system and in society at large — that can advance or obstruct efforts to improve science education. That said, Project 2061 has played an important role in laying the foundation for education reforms through its publications such as *Science for All Americans*, *Benchmarks for Science Literacy*, and *Atlas of Science Literacy*; in developing tools and resources for aligning curriculum, instruction, and assessment to benchmarks and standards; in conducting research to inform the work of teachers, curriculum developers, and policy makers; and in promoting science literacy for all as a national goal. Visit Project 2061's Web site at www.project2061.org for more details.

Q: What is the long-term (10 years) viability of physical textbooks vs. online material that can be updated and maintained more efficiently?

A: This has not been a focus of Project 2061's work. The school division of the American Association of Publishers (www.aapschool.org/) is likely to have relevant information on this topic.

Q: Are the* Atlas *diagrams stored in a database, where dependencies and flows can be examined?

A: We are at the beginning stages of developing interactive digital versions of Atlas maps that will enable the user to zoom in and out of a map and also to access a variety of resources — instructional activities, assessment items, research summaries, etc. — that are aligned with the key ideas and their precursor ideas that make up a map. Eventually, we hope to make all of these interactive maps available online.

Q: Do you agree that the way you ask a question should depend on student age? For, example, if you ask a high school student in biology this question. What is the* mass of all organic organisms primarily made up of (such as a maple tree)*? is this asking the same question?

A: It is true that designing good questions that can help students think through their ideas and inferences must take into account the age of the students and their prior knowledge. As part of our assessment work, Project 2061 researchers are finding that how a question is asked does indeed make a difference in how students respond to it. Unfortunately, as we design questions that are clearer to students and more focused on the precise understandings we are trying to measure (including, for example, the use of answer choices that can reveal whether students hold some of the most common misconceptions about the idea being tested), we are also discovering that students actually understand less science rather than more.

Q: High stakes testing, in my opinion, does not test understanding. The questions are basically factlets. How do you accurately assess understanding with useable data?

A: While multiple choice tests have been deservedly criticized, it is possible to design multiple choice test questions that are actually quite precise measures of what students do or do not know about important science ideas. Based on our research at Project 2061, we are able to construct multiple-choice test items that ask students to think through complex situations and to analyze, explain, and predict phenomena. Although a considerable amount of effort is required to construct such test questions, when done well they provide educators with important information about what students know and can do.

Q: How do we create effective professional development to achieve student literacy as a balance between content and thinking? Is literacy a balance between content and thinking?

A: Effective science teaching focuses on both the "content" and ways of thinking. Students should not only understand the fundamental ideas about how the world works (such as that all matter is made up of atoms that are linked together in molecules and that most of what goes on in the universe — such as the collapsing and exploding stars, biological growth and decay, the operation of machines and computers — involves one form of energy being transformed into another) but also have a sense of how we know at least some of the ideas. In other words, students should come to understand that scientific ideas are both durable and subject to change, that science demands evidence and logical arguments, and that because of this process increasingly accurate approximations can be made to account for the world and how it works. These and other ideas about the nature of science can only be learned in the context of specific ideas. Thinking is always about something.

How students best come to learn ideas about the nature of science is an empirical question. To understand the role of scientific investigations in producing evidence to justify claims, students will need to be involved in carrying out investigations, making claims, and defending their claims with evidence (and possibly learning that people are not likely to believe claims that cannot be defended with an evidence-based argument). First hand experiences can also be supplemented with discussions of major episodes in the history of science, which ably illustrate how science works. Most teachers have not been adequately prepared to provide their students with these kinds of experiences nor, for that matter, are they likely to have had these experiences as part of their own education. While professional development designed to address these critical areas is badly needed, there is much that high-quality textbooks and other kinds of instructional materials can do to provide teachers with support where and when they need it most — every day in their classrooms.

Q: Is this an accurate* simple *description of science literacy curriculum content (specifically for grades 9, 10, 11)?
(1) The core theories — most well-established as basis for new research, unlikely to change much.
(2) Active frontiers of knowledge and research — where knowledge is still changing.

A: My preference is the definition of science literacy proposed in *Science for All Americans*, which encompasses mathematics, technology, and the natural and social sciences and includes:

- being familiar with the natural world and appreciating its unity;
- understanding some of the key concepts and underlying principles of science;
- having a capacity for scientific ways of thinking;
- being aware of the ways in which mathematics, science, and technology depend upon one another;
- knowing that science, mathematics, and technology are human enterprises and what that implies about their strengths and weaknesses; and
- being able to use scientific knowledge and ways of thinking for personal and social purposes.

Session III: Public Attitudes and Community Engagement

Kansas City Background Research
Alison Kadlec

- What do business and academic leaders think about SMT education?
- What do parents think about SMT education?
- What do students think about SMT education?

Public Agenda is a non-profit, non-partisan public opinion research and civic engagement organization, started in 1975, which mainly does in-depth, non-partisan, public opinion research, with a particular focus on education issues.

In our work, the first step is listening — gathering information on public attitudes in regards to an issue and coming to understand public values and the level of public understanding of the issue. Over the past year, Public Agenda has been conducting research in the Kansas City region on attitudes towards science, mathematics, and technology education. We have conducted roughly 15 focus groups with parents, teachers and students in the five county region, in urban, suburban and exurban areas, covering a range of demographics; we have also done 20-25 leadership interviews with business leaders, and community leaders, and have produced a qualitative report of these findings called *Opportunity Knocks*.

Much of the work Public Agenda has done on this issue is to find out more clearly what public sentiment is on issues relating to science, mathematics, and technology education. The results of this research show that the business and academic opinion is already familiar: “we have to do better.” Business leaders expressed the feeling that if students do not develop a strong base in science, math and technology they will be "relegated to jobs in the service industry." This general sentiment is in good agreement with the somewhat alarming statistics that have been produced recently about student achievement in these areas, including a US Department of Labor report which says that 60% of the jobs of the 21st century, are going to require skills that only 20% of the workforce currently has. Parents and students, however, see science and math as being less crucial; this is the so-called urgency gap.

Parents are markedly less concerned about science, mathematics, and technology achievement than leaders and experts. They do understand that the world is changing and that science and math are becoming more important than they have ever been before, but from the research it is not clear that they understand the consequences of or the opportunities made available by this changing world. Because of increased testing and requirements, there is a sense among parents that the schools are doing a good job of preparing students for success after high school, in either college or the job market. However, research demonstrates that as many as half of high school graduates are not prepared for basic college-level math.

Students are even further disconnected from the attitudes of higher-education and business leaders. In the first round of focus groups Public Agenda conducted, nine out of ten students irrespective of urbanicity, socio-economic status, race, or gender named higher-level science or math as the most useless subject they were studying in school. There is no widespread understanding amongst students and parents that this need for more science, mathematics, and technology is an enduring trend and not merely a passing fashion, or that a higher level of education is necessary for all students, not just those with a particular affinity for science and math or those who plan to go into highly technical fields.

Another finding is that the students who enjoy mathematics are not always those who enjoy science, and vice versa. Many students who excel in math enjoy the processes and the definitive nature of the subject, whereas many students who preferred science like it precisely because of the higher level of uncertainty inherent in scientific knowledge. It is thus important to consider these different affinities when trying to develop ways to get students more engaged with the material.

Questions for Dr. Kadlec:

Q: What did students find most relevant among the subjects they study?

A: Students cited the basics in reading, writing and mathematics as being the most useful subjects — things that would help them communicate, write a résumé and balance a checkbook.

Q: How were students selected for the focus groups?

A: Students were selected to be representative cross samples of their districts. The students were paid for their participation.

Q: What are parents' attitudes towards technology investment?

A: Parents were generally supportive of investments that would give their children basic computer skills, but were more skeptical about the long-term value of investment in more advanced or non-computer technology.

Q: How comparable are the Kansas City results to national findings?

A: The results were very comparable.

Q: How did demographic factors affect the results?

A: There was virtually no correlation between any demographic factor and the perceived importance of science, mathematics, and technology education, but minority parents and students were less satisfied overall with schools, teachers, resources etc.

Community Engagement
Will Friedman

- Why engage the community?
- How should you approach community engagement?

Once a school board decides to begin conversations with the wider community about science, mathematics, and technology education, it is time to start thinking about how to approach those conversations. Many people are understandably nervous about including the community in the decision-making process. The basic argument for community involvement is that if more people are involved, despite the fact that the process may be difficult to manage at times, there will be a higher quality of ideas produced, and more involvement will lead to a sense of shared responsibility for results, which in turn will generate more people invested in success, and therefore a more sustainable output, and a more sustainable policy in the end. Public engagement from this point of view is about creating opportunities for greater public understanding of problems, and greater public involvement in solutions. This also works to help mitigate the impact of controversial issues. Engaging the broader public around education reform issues is the greatest way to inoculate against the politicization of issues. It is when people are disengaged that education issues are vulnerable to unnecessary politicization and may be easily co-opted by special interest groups or the loudest and most extreme voices.

Bringing people in early on is what creates a sense of legitimacy around a new effort, and creates momentum and a shared sense of responsibility. So the question is: what is the most skillful way to do that? It is important to recognize some less effective means of engagement, which fall into two broad categories: One is the "expert panel," where engagement is treated as a training session for the public; they are provided with a lot of information, as though they have come to a seminar for education professionals. Meetings like that will simply fail to engage most of the audience, and therefore do not tend to be very effective. The other main type of ineffective public engagement strategy is the public hearing, where there is typically a lot of venting and not much exchange of ideas.

We have found that the most effective public engagement begins with knowing your public, understanding their values, and becoming familiar with their level of knowledge and level of urgency about the issue you wish to address. With SMT, for example, an important consideration is the urgency gap issue, which may present obstacles to getting community participation. The next step is to consider how people will process the information, taking care to avoid jargon and overwhelming people, and generally making sure that whatever approach is selected is appropriate for the knowledge level of the target audience. Third, it is important to frame issues using language that resonates with the public. For example, parents and students tend to be much more interested in how SMT education can improve their own (or their child's) individual prospects than in how SMT can enable America as a country to compete globally. Roughly half of all students in the focus groups said that if they knew higher-level science and math would help them get a better job they would work harder, and the other half said the same if they knew it would help them get in to college. In short, using the language of opportunity and making opportunity concrete is important for engaging parents and students around the issue of improving SMT education.

Another key factor is including a diverse cross-section of the community, not just those who go out of their way to get involved. In order to be more effective it is important to set up different lines of two-way communication to explore community concerns instead of merely announcing information. Some options to consider are help lines, surveys, Web sites, interactive scenarios, and especially having face-to-face dialogues or community conversations.

There are several elements which are crucial to the success of a community conversation. These include asking the right questions and framing issues carefully for deliberation and engagement so that citizens from a wide range of backgrounds and starting points can get involved with them. It is often fruitless to engage the community on highly technical questions, but broader questions about the direction the district should be heading, or about collective values for education are easy to engage with and often produce much better results. To frame issues for deliberation, Public Agenda creates and uses a discussion starter tool called "Citizen Choicework." Each "Choicework" discussion starter presents a problem along with several approaches to that problem, and solicits opinions. This approach tends to work better than taking a completely unstructured approach and simply asking the public "how do we improve science, mathematics, and technology education?", which often results in experts or people with a vested interest in specific topics monopolizing the discussion. It also works better than presenting one idea to be approved or rejected, since the public then becomes a collection of critics, and does not engage and become problem solvers. When the public is presented with several different ideas in the context of trying to synthesize them into the one that would be best for the community, they are more likely to engage critically with the ideas, and to develop a sense of shared responsibility for addressing problems.

When conducting a community conversation, it is important to break the attendees down into small groups, so that they can discuss an issue in some depth, talk to others, and hear different points of view before reconvening with the larger group to share ideas. Diversity in the groups is also a key element. Feedback that Public Agenda has received from other conversations suggests that participants greatly enjoy the chance to speak with other community members that they would not normally meet. It is also always useful for school districts to partner with other community entities to sponsor community conversations. Finally, the guidance of non-partisan, neutral, skilled moderators is essential for the success of an engagement event or initiative.

Follow-up to community conversations is also important. In conducting follow-up, it is best to make everything as concrete as possible, to say again what was said, what was suggested, and what action will be taken on those suggestions, and, if they cannot be exactly followed, why not. Also, there must be a role for the public in developing solutions, so that they are part of an ongoing process of creating a problem-solving community.

Public Agenda has created a video about the five-county Kansas City area to be used as a discussion-starter for community engagement in science, mathematics, and technology education issues. It is meant to convey some ideas, without suggesting any solutions, in order to give communities some background and something to react to in their own discussions (http://www.publicagenda.org/ImportantButNotforMe/).

Questions for Dr. Friedman:

Q: What experience can you speak from to help us reach out to specific communities that may have some resistance — the religious community, for example?

A: One of the best strategies is to approach them in lots of different ways, and as a coalition of groups, not as a school board alone. Doing small-scale outreach, and including those communities as early as possible on some issues is a good solution for many districts.

Q: Is there a nationwide effort to publicize data about how poorly the United States performs in the fields of science, mathematics, and technology as compared to other countries?

A: It has been the experience of Public Agenda that the public does not respond strongly to comparisons between American students and those in other countries, with the most common response being that American students are somehow better rounded than those in other countries, and that this greater breadth of learning is ultimately more important.

Q: Are employment opportunities going outside our country due to available ability or expense?

A: To us, it seems like the latter.

Q: In the community engagement process, how do you include local newspapers which are hostile to the school district?

A: As we discussed in the presentation, one of the keys to successful engagement is establishing a diverse sponsoring coalition. If the district itself does not have a positive relationship with the local press, one of the partner organizations in the coalition that does have good relations with the media should be more up front in the presentation of the process and in executing media relations. If handled carefully, public engagement initiatives tend to get very positive media coverage.

Q: Is this focus getting in the way of those who are professionally trained to make the decisions that need to be made to improve our schools? We don't have focus groups which help the medical, legal, or other professions solve their problems.

A: We are certainly not suggesting that the public should be micro-managing the school, and we agree that professional educators should be at the center of any efforts to improve results for students. However, the history of school reform strongly suggests that parents and the community taxpayers can make or break reform effort. We would argue as well that if we're really talking about "public" schools, the public has a right to a say in how they are run, and that school professionals are to create conditions and opportunities that allow the public to exercise that constructively — or else people will simply force their way into the process in less constructive ways. When done well, public engagement can bring numerous benefits that can strengthen the work of professionals. For example, talking with parents, students, future employers and other community members can bring important insights that can sharpen the effectiveness of a school improvement initiative. Second, effective public engagement creates shared ownership for success and can sustain a policy initiative through the bumps in the road. Third, including the broad public can neutralize the power of extreme interest groups who would monopolize school policy for their own ideological ends.

Session IV: Using the *Key Work of School Boards* as a Framework for Assuring High-Quality Science, Mathematics, and Technology Education: An interactive session

Facilitated by Joe Villani

- What is the *Key Work of School Boards*?
- How does the *Key Work* apply to SMT education issues?

This session examines science, mathematics, and technology education through the prism of the *Key Work of School Boards*. The *Key Work* is a framework articulated by NSBA through which local school boards can effectively address their responsibilities. The elements of the *Key Work* are: vision, standards, assessment, accountability, alignment, climate, collaborative partnerships and continuous improvement. These eight elements are defined as follows:

- **Vision:** "Vision" is what we want for our students and community in terms of quality math, science, and technology programs. It is important to have a clearly articulated vision for these programs and to convey that vision to the community.
- **Standards:** Once the vision has been established, the next step is to decide what standards need to be in place for student performance. Those standards should describe what students should know and be able to do in terms of math, science, and technology.
- **Assessment:** An assessment process is necessary to determine if established standards are being applied successfully. Assessment is not restricted to testing; testing is assessment, but assessment is not necessarily testing. Some testing might be necessary, but it is important to use a variety of assessment measures to gauge effectiveness, and to ensure that all assessments yield information for accountability purposes.
- **Accountability:** The essence of accountability is making judgments and then making changes, and a key question is what kind of data are necessary in order to make changes when appropriate? There are two kinds of data: lagging indicators that tell you what happened, and leading indicators that tell you what is likely to happen.
- **Alignment:** Information resulting from these data enables the alignment of resources. A district's resources and money need to be put where its vision is. A district's resources include: curriculum, staff development and technology resources.
- **Climate:** The district's climate is a critical component to consider: An essential quality of a successful school program is the ability to motivate students — no student starts out wanting to fail, and no teacher wants to fail their students, but students in particular need an environment which enables and rewards success. It is the role of a school board to create a climate in the schools that motivates students, makes connections between what they are learning and their futures, and enables them to succeed.
- **Collaboration:** Building relationships with businesses, higher education, the media, and politicians in the community is an essential part of a school board's work.

These relationships are critical in order to get the support necessary to make students' success in math, science, and technology a top community priority. That support can be monetary support, or it can take the form of time and expertise, which can be even more valuable.

In applying the *Key Work* framework, the general principle is that board members provide the policy, the resources, the community engagement, and the oversight. The superintendent helps the board identify options, implements the decision, and is responsible for providing the information and the data the board needs to evaluate their success and continue to improve their programs.

The remainder of this session was spent using a worksheet (Appendix C) to guide board members in developing an action plan for addressing SMT issues. The following ideas and suggestions come from board members' comments and group discussions at the tables as they went through the worksheet exercises. They provide a representative sample of the ideas and topics discussed.

Comments about vision:

- Everything has to begin with the board, but creating a vision should also include teachers, administrators and superintendents, as well as parents and students.
- Older members of the community should be included.
- Key employers, including hospital staff, are important stakeholders.
- Recent graduates have a useful and often untapped perspective.
- "It runs downhill." The board has to be convinced first.
- Many teachers still using outdated methods and are resistant to change.
- Often teachers are overworked already and unable to devote more time.
- There is a pervasive public perception that this emphasis on science, mathematics, and technology is a fad.
- Sustainability is another characteristic of good board policies, so it is important to consider what decisions board members can make that are far-sighted and have some permanence.

Comments about standards, accountability and alignment:

- Standards are what we should achieve, but we have to work hard to get there.
- It is important to review standards regularly.
- There should be a survey of recent graduates in order to detect what areas of their education prepared them best for the "real world" and where it fell short.
- State and national standards must be taken seriously and implemented properly, but standards in a given district are under the board's control, and can be set higher than state standards.
- An evaluation for each department would help to assess how they are doing, especially if it included teachers, parents, students, etc.
- It would help to give teachers a framework to assess each other and their classes.

Comments on climate and collaboration:

- Anheuser-Busch and Dow Chemical are examples of resources that are being underused. Others include Stowers Institute and Marion Laboratories, and there are probably smaller resources in every community.
- Honeywell is a corporation in Kansas City that has been very helpful.
- It is as important to get people's expertise from businesses as it is to get material resources.
- People in the local chamber of commerce should be involved.

Appendix A: Speaker Biographies

Dr. Joseph S. Villani is the deputy executive director at the National School Boards Association. He is responsible for the daily operations of the association and for supervising the Senior Staff of the organization. He led the development of the *"Key Work of School Boards"* framework for school board leadership for student achievement. He has conducted numerous workshops with school board members and state School Boards Association trainers around the country on the role that school board members should play in governing their school districts. He joined NSBA after a 26-year career in the Montgomery County Public Schools in Maryland, where he served as a teacher, principal, and associate superintendent. He earned his Ph.D. in Human Development from the University of Maryland.

Dr. Connie Bertka is Program Director of the American Association for the Advancement of Science (AAAS) Program of Dialogue on Science, Ethics, and Religion. The program facilitates exchange between the religious community and the scientific community in order to both improve the level of scientific understanding in religious communities, and to encourage collaboration among the two communities to address critical multidisciplinary issues. Connie received her Ph.D. in Geology from Arizona State University in 1991. The focus of her research in Planetary Geology has been exploring the origin and evolution of terrestrial planets. Connie was a Senior Research Associate at the Geophysical Laboratory of the Carnegie Institution of Washington from 1993 to 2000. Much of her work at the Geophysical Laboratory focused on modeling the interior structure and composition of Mars utilizing data from high-pressure laboratory experiments. She also directed the laboratories educational outreach program for undergraduates. In addition to her scientific work, Connie has had a long term interest in the relationships between science and religion and their influence on public understanding of science. She also holds a Master of Theological Studies degree from Wesley Theological Seminary in Washington DC. While at AAAS Connie has initiated projects that encourage constructive interaction between the scientific community and society at large on a diverse range of topics including astrobiology, bioresponsibility, science education and evolution.

Joan Abdallah is program director of K-12 programs in the Education and Human Resources division of AAAS. She served as project director for a National Science Foundation (NSF) program in mathematics and science in the District of Columbia Public Schools and prior to that, project director for a NSF Local Systemic Change effort in Seattle, WA. Currently, one of her major responsibilities is to serve as program director of a middle school science leadership program in partnership with George Washington University. Ms. Abdallah has extensive and varied educational experience as a classroom teacher, principal, and science and mathematics supervisor. She has taught at the K-12 and college levels in the U.S. (New York City; Howard County, Maryland; and Seattle) and abroad (Hong Kong and Sri Lanka).

Dr. Rita Barger is an assistant professor of mathematics education at the University of Missouri-Kansas City. She is a 25-year veteran of the public schools, teaching mathematics and serving as mathematics department chair at the middle and high school levels. She has worked in higher education for 10 years where her research focuses on the teaching and learning of mathematics at all levels, and professional development for pre-service and in-service teachers. She is a past president of the Missouri Council of Teachers of Mathematics, and has served as Local Arrangements Chair and member of the Program Committee for NCTM national and regional conferences. She was part of NCTM's delegation to the 10th International Congress on Mathematics Education in 2005 in Copenhagen, Denmark. She earned her Ph.D. from the University of Missouri, Columbia.

Barry Burke is currently the Director of the International Technology Education Association's Center to Advance the Teaching of Technology and Science (CATTS.) He is responsible for the association's professional and curriculum development, research initiatives and a 12-state Consortium for curriculum development and leadership. His current work includes the development of the K-12 standards-based program, Engineering by DesignTM and the national dissemination through online learning and regional workshops. His background includes middle school teaching, curriculum

Appendix A: Speaker Biographies

coordinator (Technology Education), and most recently as the director of Career and Technology Education for the Montgomery County Public Schools in Rockville, MD. In these roles he has served on Workforce Investment Boards, Association Boards, and provided leadership to schools on school improvement. He has participated in the development of the Standards for Technological Literacy (ITEA), Benchmarks for Science Literacy (AAAS), and Pre-Engineering Standards (NASDCTE) for K-12. He has a Bachelors of Science in Education from the University of Maryland, and a Masters of Science in Technology from The Johns Hopkins University.

Dr. Jo Ellen Roseman is director of Project 2061 at AAAS and oversees its programs and activities aimed at improving education in science, mathematics, and technology for all students. Dr. Roseman joined Project 2061 for the release *Science for All Americans* in 1989 and has been involved in the design, testing, and dissemination of its subsequent tools, including *Benchmarks for Science Literacy*, *Resources for Science Literacy: Professional Development*, *Atlas of Science Literacy* and its current effort to design assessments of science literacy. She directed the Project's development and application of a valid and reliable procedure for evaluating both the content and instructional design of science and mathematics textbooks in light of national standards and continues to work with curriculum developers to help them design courses and materials that meet the content and instructional criteria. Dr. Roseman is the Principal Investigator for the Center for Curriculum Materials in Science, funded through the National Science Foundation's (NSF) Center for Learning and Teaching program, and the Principal Investigator for a five-year study examining the relationships among professional development, the quality of teaching and student learning of important mathematics ideas that is funded jointly by NSF, the Department of Education, and the National Institutes of Health. Prior to joining Project 2061, she was involved in scientific research and teaching at Johns Hopkins University, where she directed two graduate degree programs for secondary science teachers and prospective teachers, and at the National Institutes of Health. Dr. Roseman received her Ph.D. in Biochemistry from Johns Hopkins University.

Dr. Alison Kadlec works on the management and implementation of Public Agenda's public engagement and opinion research projects. She is active in the development and evaluation of research tools and reports, and in training and evaluation for public engagement projects. Previously, Alison has been a visiting professor and lecturer at the University of Minnesota, Macalester College, Baruch College and Hunter College, covering a variety of courses including American Political Thought; Race, Ethnicity and Politics; Feminist Political Theory and American Government. She holds Bachelor's degrees in Political Theory & Constitutional Democracy and English Literature from Michigan State University, and a Ph.D. in Political Science from the University of Minnesota. Alison is the author of a forthcoming book on the political philosophy of John Dewey.

Dr. Will Friedman has been involved in the theory and practice of public engagement and dialogue for fifteen years, and has designed and led dialogue and public engagement projects on dozens of issues in scores of communities and regions across the country. Prior to founding Public Agenda's public engagement department, Will served as Public Agenda's Associate Director of Research and has been actively involved in researching, analyzing and writing numerous Public Agenda studies. Previously, Will was Senior Vice President for policy studies at the non-profit, non-partisan Work in America Institute, where he directed research and special projects on workplace and workforce issues. His academic background includes a Ph.D. in political science with specializations in American politics and in political psychology.

Appendix B: Seminar Agenda

AAAS Science, Mathematics, and Technology Education Seminar

The Westin Crown Center, Kansas City, MO

23 June 2007

8:30 – 9:00
Continental breakfast

9:00 – 9:30
Introduction

1. Welcome from AAAS/NSBA staff and summary of preliminary information-gathering

Speakers:
Joe Villani, Deputy Executive Director, NSBA
Connie Bertka, Program Director, AAAS *Dialogue on Science, Ethics, and Religion*

2. Video presentation

9:30 – 11:00
Session I: Introduction to Science, Mathematics, and Technology Education

1. Science education: Current issues and challenges in K-12 science education

Speaker: Joan Abdallah, Program Director, K-12 Programs, AAAS Education and Human Resources

2. Mathematics education: Current issues and challenges in K-12 mathematics education

Speaker: Rita Barger, Assistant Professor, Curriculum Instructional Leadership Department, University of Missouri, Kansas City

3. Technology education: Current issues and challenges in K-12 technology education

Speaker: Barry Burke, Director, Center to Advance the Teaching of Technology & Science, International Technology Education Association

11:00 – 11:15
Break

11:15 – 12:30
Session II: Science, Mathematics, and Technology Literacy and the Nature and Use of Standards

Speaker: Jo Ellen Roseman, Director, AAAS Project 2061

12:30 – 1:30
Lunch

1:30 – 3:00
Session III: Public Attitudes and Community Engagement

1. Public attitudes about science, mathematics, and technology education
2. Engaging communities on science, mathematics, and technology education
3. Navigating controversial issues through effective public engagement

Speakers:
Alison Kadlec, Senior Research Associate, Public Agenda
Will Friedman, Director, Center for Advances in Public Engagement, Public Agenda

3:00 – 3:15
Break

3:15 – 4:45
Session IV: From Information to Action: Using the *Key Work of School Boards* as a Framework for Assuring High-Quality Science, Mathematics, and Technology Education.

1. Review of *Key Works* principles
2. Developing a community vision
3. Standards, assessments, accountability, and alignment
4. Climate and collaborative partnerships
5. Continuous improvement

Speaker and moderator: Joe Villani, NSBA
Panelists:
Joan Abdallah, AAAS
Rita Barger, UMKC
Barry Burke, ITEA
Will Friedman, Public Agenda

4:45 – 5:00
Closing Remarks

Speaker: Connie Bertka, AAAS

Appendix C: NSBA *Key Work* Worksheet

Vision:

1. Who are the key people (both by NAME and by ROLE) who must be involved in developing and articulating our district vision for science, mathematics, and technology education?
2. What barriers to engagement should we anticipate? What resistance to program change? What can we do to overcome the barriers?
3. Who is responsible for planning the details of our visioning and engagement process, including a timetable?
4. When will the Board review the process proposed, and what is the projected completion date for Board action on a vision statement?
5. How should we address the issue of what policies need to be in place to support this vision?

Standards:

1. How will we assess our current standards (what students should know and be able to do) in comparison with "best practices"? What resources should be consulted? What do we do if our standards come up short?
2. Who is the responsible leader for this process? Who should be involved?
3. What is the potential resistance to this process? How can we mitigate it?

Assessment, Accountability and Alignment:

1. How do we know if our students are achieving the standards we set? Do we need to develop a system for doing so, or is our current system adequate? If we need to develop or revise a system, how do we start?
2. How frequently should we review data to know whether our program is effective?
3. Who is responsible for presenting data and analyses for the Board's review?
4. What do we do with the data and analyses? Do we discuss? Do we question?
5. How do we know what training and other resources teachers need to enable them to help students meet the standards?
6. What policy implications are there for us related to assessments, accountability, and alignment?

Climate and Collaborative Partnerships:

1. How can we best assess the current climate in our schools to determine teacher and student readiness and motivation for high levels of science, mathematics, and technology programs?
2. What can the Board do to model the enthusiasm and commitment to science, math, and technology programs it expects from staff and students?
3. Who are the key political, business, and higher education leaders in our community that we need to involve in this initiative?
4. What do we want to get from each of these leaders and how will we recognize their involvement and support?
5. How will we involve the local press and other media as we work through this initiative? Who will have the lead responsibility for this involvement?
6. What policy implications are there for us related to climate and collaborative partnerships?

Continuous Improvement:

1. Do we have appropriate data-collection systems to tell us how our initiative is working? If so, how will we use them? If not, what do we need to do to create them?
2. How do we encourage our teachers to use data regularly to strengthen instruction?
3. How do we measure our success compared to standards? Compared to others? Compared to ourselves (over time)?
4. How do we recognize our successful teachers, students, and schools?
5. What plan should we have to revisit the vision and standards after reviewing results?
6. What are the policy implications for us regarding continuous improvement?

Appendix D: Referenced Resources

Session I

Joan Abdallah

Publications:

AAAS, Project 2061 (1994) *Benchmarks for Science Literacy* New York: Oxford University Press.
Full text online: http://www.project2061.org/publications/bsl/online

Committee on Science, Engineering, and Public Policy. (2007) *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Academic Future.* Washington, DC: The National Academies Press
Full text online: http://www.nap.edu/catalog/11463.html#orgs

The American Imperative: Transforming the Recruitment, Retention, and Renewal of our Nation's Mathematics and Science Teaching Workforce. BHEF, 2007.
Full text online: http://www.bhef.com/solutions/anamericanimperative.asp

Rita Barger

Publications:

NCTM. (2000) Principles and Standards for School Mathematics. Reston, VA.
http://standards.nctm.org/document/index.htm

Web sites:

www.nctm.org Official Web site of the National Council of Teachers of Mathematics

Barry Burke

Publications:

International Technology Education Association (ITEA). (1996) *Technology for All Americans: Rationale and Structure for the Study of Technology.* Reston, VA: Author.
Full text online: http://www.iteaconnect.org/TAA/PDFs/Taa_RandS.pdf

ITEA. (2006) *Technological Literacy for All: Rationale and Structure for the Study of Technology.* Reston, VA: Author.
Full text online: http://www.iteaconnect.org/TAA/PDFs/Taa_RandSSecond.pdf

ITEA. (2000/2002) *Standards for Technological Literacy: Content for the Study of Technology.* Reston, VA: Author.
Full text online: http://www.iteaconnect.org/TAA/PDFs/xstnd.pdf

ITEA. (2003) *Advancing Excellence in Technological Literacy: Student Assessment, Professional Development, and Program Standards.* Reston, VA: Author.
Full text online: http://www.iteaconnect.org/TAA/PDFs/AETL.pdf

Addenda to technological literacy standards (links to sample pages online):

Appendix D: Referenced Resources (continued)

ITEA. (2005) *Realizing Excellence: Structuring Technology Programs*. Reston, VA: Author.
http://www.iteaconnect.org/TAA/PDFs/Addenda/RE_Appendix_H_Sample.pdf

ITEA. (2005) *Planning Learning: Developing Technology Curricula*. Reston, VA: Author.
http://www.iteaconnect.org/TAA/PDFs/Addenda/PL_Appendix_G_Sample.pdf

ITEA. (2005) *Developing Professionals: Preparing Technology Teachers*. Reston, VA: Author.
http://www.iteaconnect.org/TAA/PDFs/Addenda/DP_Appendix_F_Sample.pdf

ITEA. (2005) *Measuring Progress: Assessing Students for Technological Literacy*. Reston, VA: Author.
http://www.iteaconnect.org/TAA/PDFs/Addenda/MP_Appendix_F_Sample.pdf

National Council of Teachers of Mathematics (NCTM). (2006) *Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics*. Reston, VA.
http://www.nctm.org/standards/content.aspx?id=270

NCTM. (1989) *Curriculum and Evaluation Standards for School Mathematics*. Reston, VA.

National Research Council. (1996). *National Science Education Standards*. Washington, DC: National Academy Press.
Full text online: http://www.nap.edu/catalog/4962.html

Rose, L.C., & Dugger, W.E. (2002). ITEA/Gallup poll reveals what Americans think about technology. *The Technology Teacher*, 61(6).

Rose, L.C., Gallup, A.M., Dugger, W.E., & Starkweather, K.N. (2004). The second installment of the ITEA/Gallup poll and what it reveals as to how Americans think about technology: A report of the second survey conducted by the Gallup organization for the International Technology Education Association. *The Technology Teacher*, 64(1).

AAAS, Project 2061 (1994) *Benchmarks for Science Literacy* New York: Oxford University Press. Full text online: http://www.project2061.org/publications/bsl/online

An American Imperative: Transforming the Recruitment, Retention, and Renewal of our Nation's Mathematics and Science Teaching Workforce. BHEF, 2007.
Full text online: http://www.bhef.com/solutions/anamericanimperative.asp

Web sites
www.iteaconnect.org Official Web site of the International Technology Education Association
www.engineeringbydesign.org Web site with detail information and resources for the Engineering by DesignTM Standards-based Program Model
www.iteaconnect.org/cc.htm Colleague Connection – a free resource for educators (sign-up required)

Appendix D: Referenced Resources (continued)

Session II

Jo Ellen Roseman

Publications:

American Association for the Advancement of Science. (1989) *Science for All Americans.* New York: Oxford University Press.
Full text online: http://www.project2061.org/publications/sfaa/online/sfaatoc.htm
Describes what everyone needs to know and be able to do in science mathematics, and technology—that is, what it takes to be science literate.

AAAS, Project 2061 (2001) *Atlas of Science Literacy.* AAAS Press.
A collection of nearly 100 maps that show how ideas in important science topics relate to each other across and within grade levels. Sample maps are available online: http://www.project2061.org/publications/atlas/default.htm.

NCTM. (2000) *Principles and Standards for School Mathematics.* Reston, VA.
http://standards.nctm.org/document/index.htm

Project 2061 Textbook Evaluations, 2000-2005
Reports on Project 2061's evaluations of more than 40 of the most widely used middle and high school mathematics and science textbooks are available online at http://www.project2061.org/publications/textbook/default.htm.

Committee on Science, Engineering, and Public Policy. (2007) *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Academic Future.* Washington, DC: The National Academies Press
Full text online: http://www.nap.edu/catalog/11463.html#orgs

National Research Council. (2004) *On Evaluating Curricular Effectiveness: Judging the Quality of K-12 Mathematics Evaluations.* Washington, DC: The National Academies Press.
http://www.nap.edu/catalog/11025.html
Provides guidance on the kinds and quality of evidence needed to draw conclusions about the effectiveness of K-12 curriculum materials.

AAAS, Project 2061 (2007) *Communicating and Learning About Global Climate Change*. http://www.aaas.org/news/press_room/climate_change/mtg_200702/climate_change_guide_2061.pdf

Web sites

http://www.project2061.org/
The project's Web site includes many free resources for science educators and the public, as well as background information and regular updates on Project 2061's research and development activities.

"Biology's Big Bang." *The Economist.* June 16, 2007.
http://www.economist.com/printedition/displayStory.cfm?Story_ID=9339752

Appendix D: Referenced Resources (continued)

State curriculum standards: http://www.statestandards.com

Temperature and Expansion explanations:
http://sol.sci.uop.edu/~jfalward/temperatureandexpansion/temperatureandexpansion.html

Thermal expansion science kit:
http://www.sciencekit.com/category.asp_Q_c_E_429628

Session III

Will Friedman and Alison Kadlec
Publications:
Public Agenda (2007). *Opportunity Knocks: Closing the Gaps between Leaders and the Public on Math, Science, and Technology Education: A Qualitative Research Report on the Kansas City Region.*
http://www.publicagenda.org/pubengage/pdfs/opportunity_knocks.pdf

Web sites
www.publicagenda.org Official Public Agenda Web site.
http://www.publicagenda.org/ImportantButNotforMe/

Session IV

Joe Villani
Publications:
NSBA. 2002. *The Key Work of School Boards Guidebook.* Alexandria, VA.
Full text online: http://www.nsba.org/keywork2/guidebook/KeyworkGuidebook.pdf

Web sites
www.nsba.org Official NSBA Web site
www.esgn.tv Education Solutions Global Network, streaming video on a variety of education topics.
www.msbanet.org Official MSBA Web site
www.kasb.org Official KASB Web site