U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY

HEARING CHARTER

STEM Education Before High School: Shaping our Future Science, Technology, Engineering and Math Leaders of Tomorrow by Inspiring our Children Today

Monday, May 12, 2008
1:00 p.m. - 3:00 p.m.
Martha and Josh Morriss Mathematics and
Engineering Elementary School
Texarkana, TX

1. Purpose

On Monday, May 12, 2008, the Science and Technology Committee will hold a field hearing in Texarkana, Texas, to receive testimony on efforts to engage students in math and science at an early age, to keep them interested throughout middle school and high school, and to translate that interest into rewarding careers that will be of benefit to the entire nation from a federal, school district, university, industry and teacher perspective. Further, we will examine the efforts behind and reasons for the establishment of a STEM-based public elementary school and the progress that it is making with its students, which could serve as a model for the nation.

2. Witnesses

- **Dr. Cora Marrett,** Assistant Director for the Education and Human Resources Directorate, National Science Foundation (NSF), Washington, DC

- **Dr. Roseanne Stripling,** Provost and Vice President for Academic Affairs, Texas A&M University-Texarkana, Texarkana, TX

- **Mr. James Henry Russell,** Superintendent, Texarkana Independent School District, Texarkana, TX

- **Mr. David Smedley**, Science Teacher, North Heights Junior High School, Texarkana, AR

- **Mr. Mike Leherr**, Plant Manager, Alcoa-Texarkana, Texarkana, TX

3. Brief Overview

- A consensus exists that improving science, technology, engineering, and mathematics (STEM) education throughout the nation is a necessary, if not sufficient, condition for

preserving our capacity for innovation and discovery and for ensuring U.S. economic strength and competitiveness in the international marketplace of the 21st century. Many reports, including those from the Council on Competitiveness, Business Roundtable, and the National Academy of Sciences' *Rising above the Gathering Storm*[1], placed a major emphasis on strengthening STEM education in the United States to ensure that the nation's workforce can compete globally in high-tech, high-value industries, such as information technology, biotechnology, semiconductor manufacturing, and nanotechnology. The President addressed these needs in his American Competitiveness Initiative and Congress, likewise, in the *America COMPETES Act*, which is now law (Public Law 110-69).

- Historically, NSF's mission has included supporting and strengthening science and math education programs at all levels. In the area of K-12, NSF carries out its mission by funding a variety of science and math education activities, including teacher training (both in-service and pre-service), curriculum development, education research, and informal education at museums and science centers.

- Critical transitions occur as students move from elementary schools to middle schools, from middle schools to high schools, and from high schools to postsecondary education. International data show corresponding shifts in students' achievement rankings internationally, where performance of U.S. students relative to that of students around the world generally drops from fourth grade to eighth grade, and then drops further in high school. And, the curriculum in mathematics and science may reflect significant jumps in complexity and demand as these critical transitions occur. For example, elementary school students who have been studying concepts and procedures in the area of numbers increasingly must meet the challenge of studying algebra in the middle grades. A related consideration that comes with the critical transitions is that students' interest in the STEM fields, and their enthusiasm for mathematics and science, also may decrease as they move from the elementary grades, to the middle grades, and beyond. Teachers have enormous responsibility to support students' growth and competency, stimulate their interest and enthusiasm, and ensure that they are prepared for assessments and higher level work in subsequent grades.

- The Martha and Josh Morriss Mathematics and Engineering Elementary School in Texarkana, Texas, is part of a vertical aligned K-16 engineering education collaborative between Texas A&M University-Texarkana and Texarkana Independent School District. It provides mathematics and pre-engineering integrated curriculum and pre-engineering electives for students in kindergarten through fifth grade. Students graduating from the elementary school will be able move into an advanced Math and Science program at Texas Middle School. This school serves as a national model for K-16 collaboration in how young children can become engaged in and educated for careers in mathematics and engineering.

4. Background

[1] *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter EconomicFfuture*, National Academies Press, Washington, D.C. (2006)

K-12 Science and Math Education at the National Science Foundation

Science and math education is a cornerstone of the historic mission of the National Science Foundation. *The National Science Foundation Act of 1950*, which established NSF, directed NSF to support and strengthen science and math education programs at all levels. NSF carries out its K-12 mission by supporting a variety of science and math education activities, including teacher training (both in-service and pre-service), curriculum development, education research, and informal education at museums and science centers.

Examples of NSF programs designed to improve teacher performance, enhance understanding of student retention of scientific content, and develop and assess curricula include the Centers for Learning and Teaching, which provide professional development opportunities for K-12 teachers; the Advanced Learning Technologies program, which supports cognitive science research on the use of technology to enhance learning and teaching; and the Instructional Materials Development program, which supports the development of curriculum as well as research into the most effective means of teaching math and science material.

In addition to these programs, other NSF education programs focused on improving K-12 education include the Math and Science Partnership (MSP) Program and the Robert Noyce Scholarship (Noyce) Program, both reauthorized as part of *The America COMPETES Act*. The MSP Program funds partnerships between universities and local school districts to strengthen the science and math content knowledge of K-12 schoolteachers. The grants are awarded to support the creation of innovative reform programs that could be expanded to the state level if successful. The Robert Noyce Scholarship Program is designed to help recruit highly-qualified science and math teachers through grants to college and universities to give scholarships to science and math majors in return for their commitment to teach at the elementary or secondary school level. *America COMPETES* strengthened and expanded the Robert Noyce Teacher Scholarship Program to provide scholarships to students majoring in science, math or engineering who commit to teaching two years in return for each year of aid. The program provides money to colleges and universities both to award and administer the scholarships and to provide programs to help prepare the students for teaching. The expansion of this program was modeled on the UTEACH program at the University of Texas.

Texas A&M University-Texarkana and Texarkana Independent School District PreK-16 Collabortive[2]

Texas A&M University-Texarkana and Texarkana Independent School District established a vertically aligned kindergarten-16 engineering education collaborative that will be executed in four stages: (1) a K-5 public elementary school (Martha and Josh Morriss Mathematics & Engineering Elementary School) that provides a mathematics and pre-engineering integrated curriculum, "Engineering Encounters" (culminating projects), and pre-engineering electives (i.e., circuitry, forces and gears) at each grade level (opened fall 2007); (2) a pre-engineering "school-within-a-school" at Texas Middle school (planned for fall 2008); (3) selected mathematics and

[2] TIDS-TAMU-T K-16 COLLABORATIVE MORRISS ELEMENTARY SCHOOL (http://www.tea.state.tx.us/p16/council_mtg_attach/presentations/feb08/feb08_regionalp16_texarkana.pdf)

science courses with pre-engineering content enrichment and dual credit engineering courses at Texas High School (fall 2006); and (4) a choice of three engineering related programs of study at A&M Texarkana: BS in Computer and Information Sciences (fall 2005), BS in Electrical Engineering (planned for fall 2008), and BS in Mechanical Engineering (planned for fall 2010).

The overarching goal of the engineering collaborative is to increase the quantity and quality of United States grown and educated engineers. The goal will be accomplished by exposing young children to exciting mathematics and engineering concepts and providing a rigorous and seamless pre-engineering and engineering education curriculum through the completion of a baccalaureate degree. A growing gap between the supply and demand for professionals in engineering and mathematics careers has alerted stakeholders across the nation. The regional need for more engineers was documented in the late 1990s when Texarkana area businesses (e.g., International Paper, Domtar Paper Mill, and Alcoa) identified the need for an engineering program at A&M-Texarkana as the number one community priority. Their expressed need has been manifested in contributions of almost $7 million to date for an engineering degree program at the university.

Although the effectiveness of a K-16 engineering collaborative as a means of ameliorating the supply and demand gap of engineers is a very logical, research-based approach, a comprehensive search has not identified another partnership of this kind across the United States. The Texas A&M-University - Texarkana ISD K-16 engineering collaborative is a unique, sustainable, and replicable model that sets a gold standard for how public schools and universities can maximize the investment return on human and financial resources to attain an important and shared goal—to "close the gap" between participation and success in secondary and higher education in a manner that effectively addresses a growing professional and career demand if the United States is to continue its position as a global power--engineering and mathematics.

The Martha and Josh Morris Mathematics and Engineering Elementary School[3]

The Martha and Josh Morriss Mathematics & Engineering Elementary School, serving children in grades K-5, is the eighth elementary school in Texarkana Independent School District opened in the fall of 2007. The school does not have an attendance zone, and any elementary-aged student living in the state of Texas is eligible to apply for enrollment on a first-come basis without charge. Once a student has been accepted for enrollment, certain academic and behavior standards are required for continued attendance. The school is designed for approximately 396 students (three sections each in grades K-5). As of September 30, 2006—eleven months prior to the opening of the new school—100 percent of the available positions at grades K-4 and 89 percent at grade 5 were committed, with 49 percent of the student enrollment to date being female. A waiting list has been established for most of the primary grades, and over 80 kindergarten applications for the 2008-2009 and 2009-2010 academic years have been submitted.

The floor plan and architectural design of the new school facilitates the delivery of an inquiry-based mathematics and engineering integrated curriculum for all subjects in grades K-5, including fine arts, foreign language, health and physical education as well as the four core subject areas. The mathematics and engineering embedded Texas Essential Knowledge and

[3] Ibid.

Skills (TEKS) curriculum is enhanced by "engineering encounters"—cross-grade level, theme-based authentic assessment projects completed and presented by students to the public each six-weeks (See Examples). The K-6 grade mathematics and science TEKS is accelerated into grades K-5 (and grades 7 and 8 content into the 6th grade at middle school), allowing students to take Algebra I and advanced science in grade 7 to provide opportunities for advanced mathematics, science, and engineering courses in high school. Further, engineering electives (content beyond the TEKS) will be taught at each grade level. Extended school-year enrichment activities such as a two-week summer Circuitry Camp provide a "value added" element to students' learning.

Texas A&M University-Texarkana Arts and Sciences and Education faculty assist the Texarkana ISD curriculum personnel and teachers to design the mathematics and engineering integrated curriculum and electives. University faculty develop content and pedagogy courses to train the elementary teachers to deliver the curriculum using effective teaching strategies that promote mastery of the curriculum by all students. All of the Morriss Elementary teachers are required to obtain a Masters Degree and either the Texas Master Mathematics Teacher Certification or Texas Master Technology Teacher Certification through preparation programs offered at A&MTexarkana.

The Martha and Josh Morriss Mathematics & Engineering Elementary School has become a national model for K-16 collaboration in how young children can become engaged in and educated for careers in mathematics and engineering.

5. Questions for the Witnesses

Dr. Cora Marrett

- What evidence is available from NSF-funded projects to help us better understand how students develop interests in STEM fields in the pre-K through 12 years, and how can those interests be sustained across the high school to postsecondary education transition? Are there model programs or approaches to curriculum and instruction that have demonstrated how to engage students successfully in STEM areas and that lead to choice of STEM careers? What is the role of out-of-school learning in encouraging STEM career participation? What factors affect students' choice of STEM majors or programs and their retention at the postsecondary level?

- How do NSF programs support the improvement of the teaching and learning of the STEM disciplines in the pre-K through 12 years? What programs are available to improve teachers' knowledge and abilities, and what does research tell us about the best ways to enable teachers' effectiveness in promoting learning? What types of programs and models for STEM teacher preparation, induction, and professional development show the most promise for supporting STEM teachers' learning, and what can be learned from the implementation of such programs and models?

- What instructional tools, resources, materials, and technologies has NSF supported to enable STEM learning? Under what conditions, and for whom, are such resources for learning most

effective? Does research provide insight into what kinds of instructional materials and tools are most useful in supporting learning at various levels, and for various groups of learners?

Dr. Rosanne Stripling

- How was Texas A&M Texarkana involved with the creation of the Martha and Josh Morriss Mathematics and Engineering Elementary School? What other pre-K through 12 schools does Texas A&M Texarkana support and how? Please describe any other work or partnerships that Texas A&M Texarkana is doing with regards to STEM education for pre-K through 12 schools.

- What are the major problems that limit the performance of students and teachers, and what do you feel is the single, most important step that the federal government should take to improve pre-K through 12 grade math and science education? What involvement have you had with math and science education programs at the National Science Foundation or other federal agencies as well as those in the state of Texas? What are the most important and effective components of these programs?

- How can we attract, educate and retain the critical mass of talent necessary to keep the state of Texas – and the country as a whole – at the forefront of research, development and groundbreaking advances in science and technology? In addition to providing a technically literate workforce, why is it important to improve public support and understanding of math and science?

- How can we ensure that we provide sufficient opportunities to allow students and researchers, educators and employees to become and then remain current and competitive in our rapidly evolving world?

Mr. James Henry Russell

- What is the overall state of STEM education in Texarkana? Why is it important for all students to achieve proficiency in these subjects? What was the motivation behind establishing the Martha and Josh Morriss Mathematics and Engineering Elementary School? What role did parents, the community and local businesses play in the establishment of this school? Is there a plan in place to keep these students motivated in STEM subjects as they make the transition to middle school and on to high school?

- What are the major problems that limit the performance of students and teachers, and what do you feel is the single, most important step that the federal government should take to improve K-12th grade math and science education? What involvement have you had with math and science education programs at the National Science Foundation or other federal agencies as well as those in the state of Texas? What are the most important and effective components of these programs?

- How can we grow and educate, attract and retain the best and brightest scientists and engineering students? What do you feel is the single, most important step that the federal government should take to improve pre-K through 12 STEM education?

Mr. David Smedley

- What are the major problems that limit the performance of students and teachers, and what do you feel is the single, most important step that the federal government should take to improve K-12th grade math and science education? What involvement have you had with math and science education programs at the National Science Foundation or other federal agencies as well as those in the state of Arkansas? What are the most important and effective components of these programs?

- How can we spark a greater student interest in math and science education? What can we do to ensure that student interest in math and science does not wane as they progress through our formal system of education? Specifically, how do you keep your junior high students motivated and excited about STEM?

- What challenges do you face in improving student achievement in math and science education? How can parents, businesses, the community, and the government better support you in your efforts to raise student proficiency in STEM?

- What elements of your pre-service or in-service training have been most helpful in meeting the daily demands of working with students, developing innovative classroom strategies, and delivering content-rich instruction to students of all levels and abilities? As a professional teacher, what partnerships or collaborations with local colleges or universities have been most helpful to you in terms of access to materials or professional development?

Mr. Michael Leherr

- Why did Alcoa choose to become involved with the creation of the Martha and Josh Morriss Mathematics and Engineering Elementary School? What other schools does Alcoa support and how? Why is it important for Alcoa to be interested in pre-K through 12 education?

- How do we avoid a disconnect between the jobs we want to keep in the U.S. and our workforce's ability to perform those jobs? How is Alcoa working with pre-K through 12 schools as well as colleges, universities and training programs to avoid that disconnect?

- Please describe what Alcoa Texarkana does? What percentage of your workforce has a STEM background? Are you able to recruit locally for these positions and if not, why not? How do you work with the local colleges and universities to support your workforce? If you have mentoring programs in place to encourage your engineers to help out in STEM classes at the pre-K through 12 levels or even in college courses, please provide information on these programs or similar activities Alcoa supports?