U.S. House of Representatives

Committee on Science and Technology

Hearing on

"Engineering in K-12 Education"

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Testimony of

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Texarkana Independent School District

1. Please describe the establishment of the Martha and Josh Morriss Mathematics and Engineering Elementary School. What was the impetus for its development?

A growing gap between the supply and demand for professionals in engineering and mathematics careers has alerted stakeholders across the nation. At the national level, resolution of this dilemma has been identified as a federal priority via appropriation of the Science, Technology, Engineering, and Mathematics (STEM) project and the American Competitiveness Initiative unveiled by President Bush in his January 2006 State of the Union Address. Texas Senator Kay Bailey Hutchison publicly recognized the growing need for engineering education and research in Texas when she announced the creation of the Texas Academy of Science, Engineering, and Medicine in San Antonio in January 2004. 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 Texas A&M-Texarkana as the number one community priority. The need for more regionally available engineers, coupled with the need for an increase in the quantity and quality of United States grown and educated engineers, sparked the development of the Texas A&M University-Texarkana – Texarkana ISD K-16 Engineering Collaborative.

Although the effectiveness of a K-16 engineering collaborative as a means of improving 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 – Texarkana ISD K-16 Engineering Collaborative is a unique, sustainable, and replicable model that sets a gold standard for public schools and universities.

What role did partnerships with local businesses and institutions play in the development of the school?

In January 2005, Texarkana ISD convened the first meeting of the Blue Ribbon Committee, a group of parents, community and business leaders, and school district representatives. This panel's purpose was to review the school district's facilities, finances, and curriculum, and to make recommendations concerning future plans for the district. Following a series of planning sessions, the committee recommended the establishment of a new elementary school, a school that would become a national model for K-16 collaboration in how young children can become engaged in and educated for STEM careers.

The first concrete step to this concept becoming a reality occurred in spring 2006 when the Josh Morriss, Jr. family donated 10.6 acres of land near the new 375 acre Texas A&M–Texarkana campus site for the new elementary school.

Along with the contributions of the Blue Ribbon Committee and the Josh Morriss, Jr. family, Texas A&M University-Texarkana became an integral partner in the school's development. The university's involvement included consultation in the floor plan and architectural design, in integrated curriculum development, and in professional development for teachers.

Local business leaders have found it increasingly more difficult to find and recruit highly skilled people with a strong background in Science, Engineering, and Mathematics. They recognized and supported a strong STEM competency that can only be enhanced through the local school system and University.

2. What do you consider to be benefits of pre-college engineering education?

Benefits of a pre-college engineering education are produced through the delivery of an *integrated STEM* curriculum. When the curriculum is delivered through an inquiry based hands-on approach, students become the benefactors of becoming Critical Thinkers. A key component to delivering the curriculum at Morriss elementary, is teaching students to utilize the engineering design process (see appendix A). By imbedding the engineering design process as part of a project based learning concept, students learn to synthesize information and continually improve on their cognitive abilities.

The number of engineers that are being produced in this country has decreased drastically over the past few decades. Less than fifty years ago over half of all engineers in the world were produced in the United States, in 1999, America produced 12 percent of all engineers globally. This preparation for the world in which our students will be expected to compete must be held to a more rigorous standard. We are meeting that challenge at the Martha and Josh Morriss Mathematics & Engineering Elementary School.

Can Engineering be added to the classroom without sacrificing core competencies in math and science?

Engineering is the perfect accompaniment to math and science and we must also make sure that technology is included in the statement because STEM education is a **"meta discipline".** When people hear the acronym, STEM, they immediately focus on the four separate disciplines. STEM is actually an integration of the four disciplines thus producing a "meta discipline". *Integrated STEM education* refers to a new name for the traditional approach to teaching science and mathematics. *Integrated STEM education* is not just the grafting of "technology" and "engineering" layers onto standard science and mathematics curricula. Instead, integrated STEM education is an approach to teaching that is larger than its academic parts.

The following statement from the National High School Alliance on STEM education describes the **"meta-discipline"** as one that "removes the traditional barriers erected between the four

disciplines by integrating the four subjects into one cohesive means of teaching and learning. The engineering component puts emphasis on the process and design of solutions instead of the solutions themselves. This approach allows students to explore mathematics and science in a more personalized context, while helping them to develop the critical thinking skills that can be applied to all facets of their work and academic lives. Engineering is the method that students utilize for discovery, exploration, and problem-solving".

Morriss elementary employs a self-contained concept for the classroom setting. In other words each teacher is responsible for teaching all core subjects to the 22 students in their classroom. An example of a third grade schedule is shown below:

Morriss 3rd Grade Schedule						
8:00-9:15	9:15–10:45	10:45-11:30	11:30-12:15	12:15-1:10	1:10-2:15	2:15-3:00
Engineering	ELA	Science	Lunch /Recess	Conference /Activity Period	Mathematics	Social Studies

The daily schedule for Morriss elementary reflects all grade levels starting out the morning with one hour of engineering. Engineering is not a typical course taught at the elementary level and thus is unique to Morriss elementary; thus the engineering course is considered part of the core curriculum for the school. While the course schedule also reflects a normal block of time for the other core content areas, it is the instructional methods employed by the teachers that are uniquely different.

What are reasonable learning outcomes for engineering education at the elementary school level?

Engineering curriculum in the elementary classroom setting incorporates the *Engineering Design Process* which includes the steps: Imagine Plan, Design, Improve and Share. This five step system allows students to work through open-ended, hands on and project-based learning experiences that develop higher-order thinking skills in students. Following the methods delineated by Bloom's Taxonomy, students are able to identify problems that are to be solved, determine possible solutions, and evaluate their own work for improvements. Students will be able to:

- Reflect on attitudes toward engineers and engineering
- Develop professional relationships with engineers
- Teamwork through cooperative-learning
- Understand the tools, equipment, technology and procedures used in the design process
- Identify the problem
- Research scientific principles
- Brainstorm solutions
- Draw a diagram or schematic
- Decide which materials to use
- Create a cost-analysis based on a rubric
- Use mathematical problem-solving techniques
- Follow the plan to create a design
- Test their design
- Apply statistical analysis to data
- Modify and improve the design
- Evaluate Design and retest
- Apply statistical analysis to data
- Communicate their achievements

What do you consider to be the biggest challenges and barriers to incorporating engineering education in the elementary school classroom?

- Quality Integrated STEM education professional development
- Elementary education teacher preparation programs lack of math and science content
- Funding to help support professional development at the elementary level (beginning of the STEM pipeline)
- Buy-in of public and educators in preparing students for careers in engineering
- Females entering mathematical and engineering careers
- Student exposure to technological advances

3. What kind of curricula does the school use?

Morriss Elementary curriculum is standards-based, integrated and connected to the lives of learners. The curriculum is designed to be compelling-to move beyond information and support the transfer of learning. The goal of Morriss Elementary is to facilitate integrated, higher level critical thinking which promotes STEM education. Resources utilized in the curriculum: Engineering is Elementary from the Museum of Science in Boston, Sci-Tek, Scan-Tek, along with state-of-the-art technology and equipment. NASA engineering projects are also employed. NXT Mindstorm robotics are implemented to enhance the engineering program as well as compete in state competitions. Engineering is spiraled through a six weeks matrix that provides exposure to engineering concepts in areas of environmental, civil, earth & space, bioengineering, electrical & mechanical and manufacturing. In order to follow the Link-Learn-Extend model, students are guided through accelerated mathematics that extend into the next grade level. Envision mathematics is the state adopted curriculum, but that is a resource that is used along with other materials such as Hands-on Equations to advance the mathematics curriculum. Materials usage is supported through the Texarkana ISD's dedication to development of STEM education as well as support from local businesses and parents.

What percentages of your teachers have engineering degrees?

Although none of the teachers at Morriss elementary have an engineering degree, they all have an understanding of what engineers do because of a quality professional development model developed between the school district and Texas A&M University-Texarkana. Immersion was the key to understanding the engineering concepts that needed to be taught at the elementary level. Much like learning a new language, teachers were immersed in the culture of engineering through research and consulting with area engineers. Local engineers served as a sounding board during panel discussions to determine how to teach engineering at the elementary level. Many of the local engineers could not articulate what to teach at the elementary level, but were able to convey some simple concepts such as, more math and solving puzzles. Teachers quickly learned that the curriculum would have to be developed by working together in a collaborative atmosphere. By listening to engineers, Morriss was able to develop and accelerated math concept using a link-learn-extend model (see appendix A) which helped teachers push mathematics forward by a full grade level by the time a student reaches the 5^{th} grade. The accelerated mathematics will help us fulfill the pipeline of students who need to have calculus by the 11^{th} grade so they can enroll in the dual credit engineering courses currently taught by Texas A&M University-Texarkana.

The teachers completed four Graduate level mathematics courses and completed the Master Mathematics Teacher certification. The remainders of the three required elective courses in their Master's Degree program were science electives designed by the University to meet the needs of engineering implementation. The curriculum coach participated in a summer program (2006) through Texas A & M – College Station funded by the National Science Foundation (EBAT) that developed educator knowledge in biomedical engineering through live-animal research. She also served the National Science Foundation as a Science and Mathematics Specialist through the Texas Rural Systemic Initiative. In the summer of 2009, six teachers from Texarkana ISD attended the American Society for Engineering Education annual conference in Austin Texas and will attend the 2010 conference in Louisville, Kentucky. The Curriculum Coach and Counselor from Morriss Elementary attended the Engineering is Elementary Training for Trainers Fall 2008 to create a professional development opportunity for Morriss Elementary teachers.

Maintaining membership in professional learning communities allows Morriss teachers to share experiences and expertise with others pursuing STEM education.

What kind of teacher training and professional development opportunities do you provide for your teachers?

Providing a quality teacher professional development program for an integrated STEM curriculum was essential to establishing Morriss elementary. The essential foundation and approach to professional development for the Morriss teachers had been established through a district led commitment to seeking methods and strategies to support changing the way students learn, and to producing students who possess critical thinking and problem solving skills and abilities. Utilizing *integrated STEM education* to promote this shift in teaching values and teaching methods provided the district with the necessary framework for implementing a dramatically different approach to teaching. This has resulted in creating a school culture that embraces teachers as facilitators. The result has been the acceptance of *integrated STEM education* and an expectation of achievement and renewed commitment to educational excellence shared by the Morriss teachers. The following information describes the expectations for professional development through required course work in order to be employed at the Morriss school.

Teachers with a Master's Degree (K-5)

Teachers who already had a master's degree were required to take eighteen (18) hours of specific graduate level coursework with Texas A&M University/Texarkana within the first two years of assignment at the school. Graduate level coursework consisted of two courses in curriculum and instruction, and four courses in mathematics. The specified coursework lead to a Master Teacher Certification in Mathematics (EC-4).

Teachers without a Master's Degree (K-5)

Teachers who do not currently have a Master's Degree were required to complete a Master's Degree in Curriculum and Instruction within the first three years. Teachers without a master's degree were required to take eighteen (18) hours of specific graduate level coursework with

Texas A&M University/Texarkana within the first two years of assignment. The coursework consisted of two courses in curriculum and instruction, and four courses in mathematics. Finally, teachers had to complete the remaining 18 hours of graduate coursework needed to complete a Master's Degree in Curriculum and Instruction from TAMUT. The specified coursework led to a Master Teacher Certification in Mathematics (EC-4).

Two key courses were identified as being imperative to the teacher professional development program, *Curriculum Design and Curriculum Delivery*. The syllabus for each course presented new STEM teachers with a variety of tasks and exercises that included research and information gathering, exploration of curriculum and instruction methods, project-based classroom instruction, and self-evaluation. The courses were team taught, utilizing the expertise of the Curriculum Coordinator, Ronda Jameson, who is a former secondary mathematics teacher, along with the Curriculum Specialist, Lori Ulmer, who is a former elementary math teacher who brought experience and knowledge from outside the district to support the curriculum and instruction design process. The 4-week coursework was structured to foster team-work and collaborative curriculum development through the project-based outcomes designed for the course, and through modeling of these practices by the course instructors.

Emphasis on research and self-evaluation as a method for constant improvement are also an important dimension of the coursework that prepare teachers to actively use technology in the classroom to access new information and ideas. Additionally, the course instructors built the course upon the combined experience of both instructors in classroom teaching. Together with their experiences in providing teacher professional development to a broad range of teachers over a number of years, essentially fostering an approach that relied on the course instructors "to think like a classroom teacher". Utilizing a research-based approach, course instructors were able to provide answers and information to support the premise of *integrated STEM education*, and also provided modeling of this approach through the method of instruction. The resulting buy-in of the new teaching methods, and of the premise of STEM's focus on engineering and mathematics, provided a solid foundation for effective curriculum development during the first year of the Morriss school.

The teacher professional development produced some non-negotiables that were to be inherent in the integrated STEM culture when designing and delivering the curriculum. The non-negotiables are:

- Hands on learning
- Constructivism
- Leadership and articulation
- Daily engineering instruction
- Alternative forms of assessment
- Concept-based instruction
- Algebraic thinking
- Cooperative learning
- Accelerated mathematics

Another key component is the monitoring and review process established to ensure the teacher professional development components are being supported. Through peer review, and collaboration during common planning time, feedback is provided on an on-going basis. This process is led by a curriculum coach, Denise Skinner, for the Morriss school. The curriculum coach is responsible for meeting with the Morriss teachers on a regular basis to continually tweak the design and delivery of the curriculum. Through classroom observations and research, the curriculum coach is able to adequately provide teacher support.

Because of the successful *integrated STEM education* professional development model with the Morriss teachers, it was replicated with the more recent secondary STEM Academy teachers which started in the summer 2009. Again the expertises of current ISD staff were utilized. Director of Curriculum and Instruction, Lori Ables, and Curriculum Coordinator, Ronda Jameson, delivered the content for the University based coursework. Working with Texas A&M University-Texarkana was a vital component as they provided the adjunct status for the instructors. The university realized the need for more staff with practicum experiences. The professional development model was captured in recent study on the Morriss school by Dr. Monica Hunter from the PAST foundation. A full copy of the study can be obtained by following the link below.

http://www.lulu.com/content/paperback-book/morriss-math-and-enginerring-elementary-school-a-case-study-of-k-5-stem-education-program-development/7488985

4. Once a student has completed the elementary grades at your school, do they have the opportunity to go on to a STEM-focused middle school? Are these programs in place to ensure these students maintain an interest in STEM subjects as they transition to middle school and high school?

Texas A&M University-Texarkana and Texarkana Independent School District have established a vertically aligned kindergarten-16 engineering education collaborative that will be executed at four levels:

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 (student-led, hands-on experiences shared with parents and the community), and pre-engineering thematic units (i.e., structures, forces, and gears) at each grade level (opened in fall 2007)

2) The Math, Science, and Engineering Academy, a pre-engineering school-within-a-school at Texas Middle School opened in fall 2008. Currently the STEM Academy services interested students in grades 6 and 7 with plans to expand to 8th grade in 2010.

3) Texas High School currently offers selected mathematics and science courses with pre-engineering content enrichment and dual credit engineering courses at Texas High School. A STEM Academy has recently been added to Texas High School in 2009 to service 9th grade students with plans to expand through 12th grade by 2012. The high school expansion of STEM Academies has been made possible through a grant sponsored by the Texas High School Project (THSP).

4) A choice of three engineering related programs of study at Texas A&M-Texarkana: BS in Computer and Information Sciences, BS in Electrical Engineering, and BS in

Mechanical Engineering. Texas A&M-Texarkana will be accepting their first freshman class into the college of engineering in 2010.

APPENDIX A

Martha and Josh Morriss Mathematics & Engineering Elementary School

Engineering Process

Imagine

- *Identify the problem.*
- *Brainstorm solutions.*

Plan

- *Draw a diagram.*
- *List materials.*

Design

- *Follow your plan to create the design.*
- *Test it out.*

Improve

- *Modify and improve your design.*
- *Test it out.*

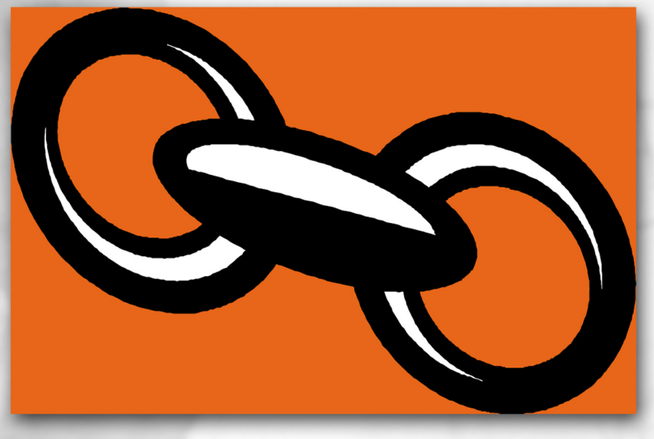
Share

- *Communicate your achievements.*

Texarkana Independent School District

Martha and Josh Morriss Mathematics & Engineering Elementary School

Mathematics Process



Link

Learn

Extend

Texarkana Independent School District

Grades	1st 6 Weeks	2nd 6 Weeks	3rd 6 Weeks	4th 6 Weeks	5th 6 Weeks	6th 6 Weeks
	Environmental Engineering	**Civil Engineering**	**Earth and Space Engineering**	**Bioengineering**	**Electrical and Mechanical Engineering**	**Manufacturing Engineering**
K	What is an Engineer? The Engineering Process: DSM III Investigating Water Sink or Float	*Tunnels*	Wind: Windvanes, Windsocks	*Engineering Animal Parts*	Heavy Machines Hydralic Dump Trucks and Crane pulley systems	Houses: Lincoln Logs and Legos
1	*What is an Engineer? The Engineering Process Rube Goldberg DSM Sink or Float*	Walls: EIE: A Sticky Situation:The Great Wall of China	Solids and Liquids: EIE: A Work in Process	*Animals as Engineers*	Heavy Machines Hydralic Dump Trucks and Crane pulley systems	A Chair for Little Bear (Lego Education)
2	What is an Engineer? The Engineering Process DSMIII Forces and Motion	*Pyramids*	Weather: DSM III Weather Instruments	Insects and Plants EIE: The Best of Bugs: Designing Hand Pollinators	Magnetism and Transportation: EIE The Attraction is Obvious	Transportation Vehicles (Boats, Cars, Airplanes)
3	What is an Engineer? The Engineering ProcessThe Design Process EIE: Thinking Inside the Box: Designing a Plant Package	*Lego Towers Texarkana Towers*	Balloons, Parachutes and Airplanes: DSM II Amazing Air	Organisms: EIE: Just Passing Through Designing Membranes	Energy Transfer, Conduction, and Circuitry: EIE: An Alarming Idea	*Domes and Arches*
4	What is an Engineer? The Engineering Process: EIE:Water, Water Everywhere Designing Water Filters	*Teach Engineering: Parking Garage Native American Structures*	NASA: Rockets	The Physics of Sound: EIE: Sounds Like Fun ScanTek	Melanie Kit: Carousels EIE: Catching the Wind	Exploring Force and Motion: EIE: Marvelous Machines
5	What is an Engineer? The Engineering Process Aquifers & Landfills	Geotechnical Engineering EIE: A Stick in the Mud	Space: Lunar Rovers	*Prosthetics Arteries & Heart Valves*	Roller Coasters Rube Goldberg Force & Motion	Balances and Forces: EIE: Get To The Other Side: Designing Bridges and KNEX Bridges

RICK SANDLIN
BIOGRAPHICAL SKETCH

Rick Sandlin serves as Principal of the Martha and Josh Morriss Mathematics & Engineering Elementary School and is a Senior Administrator for Texarkana Independent School District (TISD) in Texarkana, Texas.

He began his career with TISD in 1974 as an elementary teacher at Highland Park and Kennedy Elementary Schools. He became Assistant Principal of Wake Village Elementary School in 1992, served as Principal of Highland Park Elementary School from 1993-1996, Principal of Nash Elementary School from 1996-2003 and was Principal of Wake Village Elementary School from 2003-2006.

In 2006, he was asked to lead the construction and development of TISD's newest state-of-the-art elementary campus - Martha and Josh Morriss Mathematics & Engineering Elementary School – which opened in August 2007. This new and innovative campus has instructional opportunities specifically in the areas of math, engineering and technology and is the foundation of TISD's collaborative effort in the development of a nationally recognized K-16 educational plan with direct ties to Texas A&M University – Texarkana College of Arts & Sciences and Education and College of Engineering.

Rick is a distinguished member of the Tiger Family and is a proven and experienced principal. He brings wisdom and a strong desire for the educational betterment of children to the district that serves as an asset for students, parents and faculty.

Rick graduated from East Texas State University at Texarkana which is now Texas A&M University at Texarkana with a B.S. in 1973 and a MBA in 1977. He is also an Adjunct Faculty member for Texarkana College where he teaches Accounting.

Rick is a member of First Baptist Church Texarkana where he serves as a Deacon.

He has been married to Kay, also an educator, for thirty-four years and they have 2 sons - Taylor who is the Pastor of Southland Baptist Church in San Angelo, Texas and Erick who is an attorney with the law firm of Bracewell and Giuliani located in Houston, Texas. He has two grandchildren, Sophie age 4 and John Curtis age 2.