National Dropout Prevention Center/Network
Volume 24 Number 1

NEWSLETTER

STEM Education

Integrative STEM Education—Developing Innovators, Educating Creative Learners

The ability of PK-12 schools to foster student interest and learning in STEM (science, technology, engineering, and mathematics) is critical to the long-term economic health of the United States. The job market in the U.S. continues to demand greater numbers of employees with training and/or postsecondary degrees in STEM-related fields. Schools and universities in the U.S. continue to be challenged to generate the student interest and achievement levels, as well as the necessary number of postsecondary credential holders, to meet workforce demands. For this and other reasons, STEM education continues to obtain momentum, and U.S. STEM education has rapidly become an emphasized part of the PK-12 school experience.

Children who are coming through PK-12 learning environments now expect real-world connections to what they are learning or else they disengage. As a means of learning, action-oriented, hands-on technology and engineering education can bring relevance into the classroom. Children's lives are being enriched by the active study of STEM content, thus promoting the natural curiosity and innovation of students, who learn best by doing. Additionally, academically underprepared students can thrive through enriched, problem- and or project-based learning experiences and challenges.

Learners benefit from action-based, hands-on-activity learning that is core to integrative STEM education. Project-based learning is a dynamic and activity-based approach to teaching that allows learners to explore real-world problems and challenges, simultaneously developing cross-curriculum skills while working in small, collaborative groups.

Together, we can educate our students to be lifelong, creative learners who can thrive in today's competitive global economy. We can introduce them to technology and engineering skills and concepts that fuel innovation. We must provide opportunities for our learners to identify problems, design solutions, do testing, and improve the designs. We can help learners apply their math, science, and technology knowledge to solve problems, while making use of English, art, history, and social sciences. STEM education gives shape and meaning to our human-made world and can open doors for all kinds of learners.

In this newsletter, we will more fully explore topics involving integrative STEM education, including STEM/engineering labs and design challenges/competitions.

William Dugger makes a case for how STEM can better educate students and help motivate them to stay in school through graduation. He also presents concerns and opportunities for incorporating STEM into all of our schools (PK-12).

Barbara Nesbitt presents how teachers in South Carolina are finding success with at-risk students by engaging those students in STEM challenges.

Melida Reeves shares how the elementary school in which she teaches has created an engineering/ STEM lab where all students can become creative learners and problem solvers.

Mark Sanders presents a definition for integrative STEM education.

Next, National Aeronautics and Space Administration (NASA) astronaut Pat Forrester shares his experiences this past year working with students, teachers, administrators, and business/industry leaders in promoting integrative STEM education.

Finally, Steven Barbato, International Technology and Engineering Educators Association (ITEEA) Executive Director/ CEO, shares his view that the key to retaining students is to engage them early and often.

—Bill Havice, PhD
Guest Editor

Note: References cited in this newsletter may be found on the last page of the online copy @ www.dropoutprevention.org/sites/default/files/newsletter-v24n1-2013.pdf

Winding Up STEM

by William E. Dugger, Jr.

In the past few years, the integration of science, technology, engineering, and mathematics (STEM) has gained importance in education in the United States, partly because of increased emphasis on STEM by the NSF and federal funding of STEM activities. Some states and localities have begun to include the "T" and "E" in STEM by teaching "Technology and Engineering."

STEM Is Gaining Importance in the U.S.

Increasing graduation rates and reducing dropout rates are important goals in education because those numbers are directly tied to the nation's economy. As reported in the Spring 2013 issue of the *Virginia Tech Magazine*, between 2008 and 2018, the number of STEM jobs is expected to increase 17%, compared to 9.8% growth for non-STEM jobs (U.S. Department of Commerce, 2011). The mean annual wage for all STEM occupations was $77,800, and only four of the 97 STEM occupations had mean annual wages below the U.S. average of $43,460 (U.S. Department of Labor, Bureau of Labor Statistics, 2009).

There is a disconnect in the education arena, however. Rodger Bybee, Executive Director Emeritus of Biological Sciences Curriculum Study, National Academy of Engineering, says the following about the lack of relevant education in technology and engineering in our schools today: "For a society so deeply dependent on technology and engineering, we are largely ignorant about technology, engineering concepts, and processes, and we have largely ignored this incongruity in our educational system" (Bybee, 2000).

A snapshot of parent perceptions of STEM education in the U.S. was released recently following a survey conducted by Public Agenda titled, *Are We Beginning to See the Light?* (Johnson, Rochkind, & Ott, 2010). Parents surveyed said they would like to see their local schools spend more money on up-to-date and well-equipped science labs (70%), more equipment for hands-on learning (69%), and more equipment to help students learn computer and technology skills (68%). Half or more of parents with children in Grades 6–12 said they want to see more emphasis in their child's school on STEM topics, such as computer programming (65%), basic engineering principles (52%), and statistics and probability (49%).

Integration Versus Isolation for STEM Disciplines

There are a number of ways that STEM can be taught in Grades PK–12. One is to teach each of the four STEM disciplines individually. Some refer to this as "S–T–E–M," or teaching each discipline in a "silo," as an independent subject with little or no integration. Another way is to teach each of the four STEM disciplines with more emphasis going to one or two of the four (which is what is happening in most U.S. schools today), for example, "SteM." A third way is to integrate one of the STEM disciplines into the other three being taught. For example, engineering content can be integrated into science, technology, and mathematics courses: E / S T M .

A more comprehensive way is to infuse all four disciplines into each other and teach them as integrated subject matter or "iSTEM." This is accomplished best by a STEM licensed or credentialed teacher.

There are many delivery models and teaching strategies that can be used in teaching STEM. However, more work and research needs to be done as to which model or strategy works best in a given school or community.

Summary

In many respects, STEM is in its infancy in the U.S. Currently, there is considerable effort underway by the federal government, many states and localities, professional associations, and educators on what STEM is and how it can be best implemented in schools.

The dominance of science (S) and mathematics (M) in STEM education and the tendency to say STEM but really mean science and/ or mathematics is contrary to fully-integrated STEM. The S, T, E, and M are separate and not equal. Currently only science, technology, and mathematics have national standards; however, the Next Generation Science Standards (National Research Council, 2013) will include both technology and engineering in their structure.

The success or failure of the STEM movement will depend on the acceptance and buy-in that schools and teachers give to the integration of these four disciplines in an already crowded curriculum. As Friedman writes in *The World Is Flat*, "The world may be flat but our educational system is as mountainous as ever" (Friedman, 2005).

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National Dropout Prevention Center/Network

NEWSLETTER

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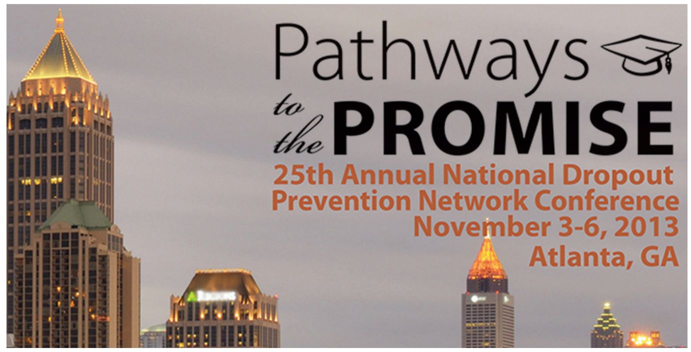
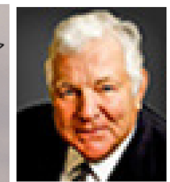
Meet Our Guest Editor

Bill Havice, PhD, DTE, is Professor and Associate Dean in the College of Health, Education, and Human Development at Clemson University, Clemson, South Carolina. Dr. Havice has taught numerous K-20 courses in technology and instructional technology. He has earned the honor of Distinguished Technology Educator (DTE).

Recently, Dr. Havice was awarded the prestigious Technology Teacher Educator of the Year by the Council on Technology and Engineering Teacher Education. He has received the Lockette/Monroe Humanitarian Award by the International Technology and Engineering Education Association. Dr. Havice's scholarly work includes published articles, professional presentations, inventions, book chapters, an edited book, and other published and nonpublished works, all of which have focused on technology and engineering in the K-20 classroom and the integration of technology to enhance learning.





Register Now for the 25th Annual National Dropout Prevention Network Conference Atlanta, GA, November 3-6, 2013

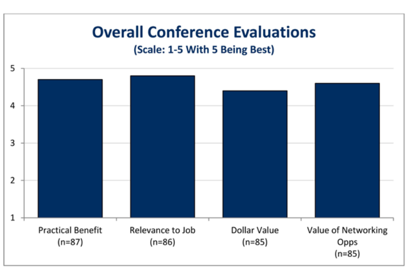
The 2013 NDPN conference will celebrate 25 years of bringing the best in professional development and cutting edge dropout prevention resources to participants. NDPN, Georgia Department of Education, the Georgia Regional Educational Service Agencies, and Communities In Schools of Georgia will present a dynamic professional learning opportunity for school board members, superintendents, educator teams, counselors, administrators, educators, and anyone working with youth. Over 100 different sessions, including a special school board and leadership track, will be offered.

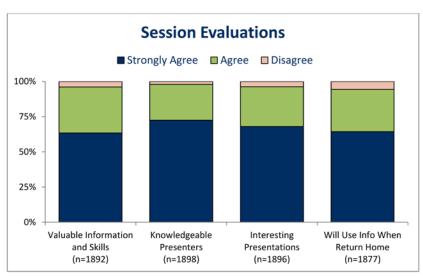
Keynote speakers include Bill Bennett, author, political theorist, radio host, and former U.S. Secretary of Education; and Bill Milliken, founder and Vice Chairman of Communities In Schools. Usher's New Look Foundation will host a student panel, and a special leadership track will be led by Karen Pittman, author, former director of President Clinton's Crime Prevention Council, member of the executive team of the International Youth Foundation, and co-founder and CEO of the Forum for Youth Investment.

Visit www.dropoutprevention.org/conferences to register or for more information.

Conference Attendees Give Top Ratings to Our Conferences

The National Dropout Prevention Center/Network is proud that the information and networking benefits attendees receive from attending our conferences is valuable. Almost 1,900 session evaluations and 90 overall evaluations were collected and analyzed from last year's network conference in Orlando. On a scale of 1-5, the overall value of the conference approached a 5. Equally impressive were the responses related to session quality.





Join us this year, either in Atlanta for the Network Conference, in Myrtle Beach, SC, for the At-Risk FORUM, or in Prior Lake, MN, for our regional conference. Call 864-656-2599; visit www.dropoutprevention.org/conferences; or write ndpc@clemson.edu for more information.

Local School Board Training One Highlight of Atlanta Conference

The 25th Annual NDPN Conference in Atlanta will feature six hours of local board member training for school board members across the nation. This training will be offered at a greatly reduced price, and while the training is applicable and open to school board members from any state, Georgia is accepting this training toward completion of state requirements. For more information, including details on keynote addresses, luncheon discussion with national and state leaders, and other benefits, link to www.dropoutprevention.org/sites/default/files/uploads/conference/13.atl_school-board-training.pdf

Up for the Challenge

by Barbara J. Nesbitt

Engaged students stay in school, have better grades, and are more likely to take rigorous courses and complete high school on time (Archambault, Janosz, Fallu, & Pagani, 2009; Skinner, Kindermann, & Furrer, 2009; Walker & Greene, 2009). At-risk students, however, demonstrate a weak pattern of school engagement that often leads to dropping out of school—the ultimate form of disengagement (Alexander, Entwisle, & Kabbani, 2001). In the Anderson, Oconee, and Pickens (AOP) area in upstate South Carolina, we're finding success with our at-risk students by engaging them in three STEM challenges: Sailboat (ITEEA), JetToy (SAE), and Glider (SAE).

Our STEM Challenges

The Sailboat Challenge begins with second graders visiting a local marina to build understanding of the real world of sailing, wind, waves, and weather. Upon returning to school, students are challenged to build a Styrofoam sailboat that can float down a classroom "river" in 15 seconds or less. This project-based learning challenge is a chance to introduce physics, engineering, and problem-solving principles in a way that young children enjoy and understand. In addition to the design of the boats, students are responsible for keeping an engineering journal and a budget sheet to track progress. Teams work together to beat the clock. Some schools offer prizes to teams with the fastest sailboats. The Sailboat Challenge is part of an instructional guide, "Technology Starters," created by the International Technology and Engineering Educators Association (ITEEA).

The JetToy Challenge is for our fifth graders. This challenge uses "A World in Motion" kits designed by the Society of Automotive Engineers (SAE). In this challenge, a fictitious toy company asks students to design a balloon-powered vehicle that will appeal to other children. Students use inexpensive and recycled materials to design a balloon-powered JetToy capable of performing well in different events on a track. Working in design teams, students build and test model JetToys using different nozzles. Then, they collect and analyze data to understand the effect of nozzle size on the performance of the cars. The teams and their balloon-powered toy cars compete first in school-level challenges. Winners then progress to district-level competitions, and last to a regional AOP competition. Two winning teams advance to the international JetToy Challenge held each year in Detroit, Michigan, sponsored by SAE.

Another AOP event is an eighth-grade Glider Challenge. In this challenge, also part of "A World in Motion" curriculum, students explore the relationship between force and motion and the effects of weight and lift on a glider. Winning teams from participating middle schools compete with their gliders in several categories, including distance, accuracy, and artistic design. This past year, the AOP Glider Challenge was held at a Lockheed Martin hangar, so students could experience a genuine career connection to flight.

Our Results

In all of our STEM challenges, students use principles that professional engineers use. It's awesome to watch their excitement as they plan, design, and sometimes struggle to figure it all out. They learn complex scientific concepts while being completely engaged. Most importantly, they learn how to work in small teams to solve problems and accomplish goals. While our challenges are academic, students are learning how to listen to other people's ideas and work together. We believe that this is especially important for at-risk students.

On nearly every winning team, we see special needs and at-risk students

Student teams compete in JetToy competition.

taking leadership roles. One of the JetToy teams that recently went to the international competition in Detroit had a special education student. This boy had never left the city, much less the state. His team went on to win the entire international competition. It was the first time he experienced something this positive and memorable at school, and his perception of himself and school will never be the same.

It's a lot of work to pull off these challenges. Teachers have to tolerate a certain degree of controlled chaos in order for real problem-based learning to occur. They also need support at the district and regional level. Our state test scores, however, show this type of learning pays off. In Pickens County, 91.4% of our fifth-grade students met state science accountability standards in the forces and motion unit, and over half scored exemplary (Palmetto Assessment, 2012). We're looking to add more challenges next year and believe our efforts will eventually impact our graduation rate. Our teachers are sold!

Are you up for the challenge?

—Barbara J. Nesbitt, PhD
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The Engineering Lab Challenge

by Melida Reeves

Teaching is my passion. A year ago, I was teaching third grade and felt that I had found my niche. My classroom was structured. I was organized, knew my standards, had a handle on classroom management, and could easily establish a sense of community in my room. As a result, my students were thriving both academically and socially. I knew how to help my struggling learners and how to challenge my gifted learners. My students' state assessment scores were the highest in the district and among the top in the state. I felt like I was an effective teacher and that I was doing right by my students. I was confident in my teaching ability. Then along came my engineering lab challenge.

When I was asked to create an engineering lab for grades K-6 at Mount Lebanon Elementary, I thought, "Sure! I can do that!" How hard could it be? After all, in my mind, I was an effective teacher who knew how to get the best from my students. I embarked upon this new journey with excitement and an open mind, not knowing exactly what to expect but feeling certain that I was up to the challenge.

Looking back, I realize that I really did not know how to most effectively teach my students or challenge them as I wanted. I could help them learn, but could I help them to change the course of their futures?

Year of Learning

The first hurdle was to undo some of the "teaching" that teachers like me had done. I needed to help the students realize that there is not just one answer to a problem or challenge, nor only one way to get there. I had to teach them to try new things without being afraid to fail. Our motto became, "We're engineers. We'll just modify it if it doesn't work." It took a long time for the students to realize that it is only failure if you give up. Students were not comfortable not knowing my exact expectations. My students wanted to do it "just right" and "just like you want it, Mrs. Reeves." I constantly reminded them that I had no preconceived notion of what a project should look like and this whole concept was new to me as well. As long as it met the criteria I had set forth, it was a success in my eyes. After a few weeks, my students learned that everyone's product/project would look different, and that it was perfectly okay. Students even began to value the differences, and through open discussion realized that they could adapt others' ideas to make their own project even better.

I had to dismiss many of my expectations. Each time I thought I knew what to expect during a lesson, students surprised me by taking the concept in a direction that I hadn't thought of during my planning. Once comfortable thinking outside the box, students consistently amazed me with their ideas and ability to problem solve. Their ideas and designs were far greater than I ever could have imagined.

I had to learn to talk less and observe more. My direct instruction became a five-to-ten minute presentation at the beginning of class, with the rest of the time being spent actively questioning students to push their thinking. I spent a great deal of my time observing and learning from the student explanations. Students quit asking how to do something because they realized my answer was either going to be, "What do you think?" or "Try several ideas and see what happens." They began to push their own thinking and creativity to new levels.

I learned it wasn't good enough to possess a general knowledge of the standards. I had to thoroughly learn math and science standards for every grade level in order to effectively plan lessons that correlated with classroom content. When the activities in the lab utilized information that students were learning in class, it made things concrete for them. They began to realize that classroom information is not just for making a good grade on a test, but also has real-life applications.

Success Beyond My Imagination

The engineering lab success stories from this year are almost too many to name. They didn't happen because there was a wonderful teacher in the classroom. As I learned this year, I had "teaching" all wrong! The stories happened because students were given the freedom to make choices and exercise their creativity, encouraged to take risks by thinking outside the box, and provided an environment in which they were exposed to new experiences.

Obviously, the learning that takes place in the classroom is reinforced in the lab, but we are also discovering that the learning that takes place in the lab is being carried back to the classroom. Teachers comment that students are more comfortable speaking up with unique ideas and are more willing to try new methods and explain their thinking. Students are also using the lessons learned in the lab to help their peers in other classes.

Changing Their Future

This year has been an amazing journey for me as a teacher. As I reflect back, I keep thinking about all the experiences that my kindergarten students will have under their belts by the time they are in sixth grade. Those students will have been exposed to a wide variety of engineering fields, with hands-on experiences in most of them. As my students enter middle and high school, I hope they will continue to seek out opportunities in STEM because of the foundations provided at Mount Lebanon Elementary. Through the engineering lab, I hope that I can hook all kids on learning, even those students who may have once thought that "school isn't for me." Opportunities and experiences such as the ones provided in the engineering lab are the vehicles to keep our students engaged and eager to learn.

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Integrative STEM Education Defined

by Mark Sanders

In the late 1990s, NSF began using the term "SMET" (which later became "STEM") to refer to "science" *or* "mathematics" *or* "engineering" *or* "technology," with no implication of interdisciplinary connections among those fields. After all, they had each been taught in complete isolation from one another for more than a century. The first interdisciplinary STEM education projects emerged in the early 1990s, and were described by adjectives and narratives, not by "STEM." For example, the Technology/Science/Mathematics Integration Project (funded by NSF, 1991-1996) used "integration" in the project title and the project described its integration of STEM content and practice in considerable detail in each of its project-related publications, such as the *Technology, Science, Mathematics Connection Activities* (LaPorte & Sanders, 1996).

The fear that America was losing its global competitive edge, described in 2005 in Thomas Friedman's *The World Is Flat*, helped fuel STEMmania (Sanders 2008), a frenzy of *STEM education* rhetoric and funding, with the vast majority of dollars going to traditional (silo) math and science education. Though the integration of T/E concepts and practices with S/M education was exceedingly rare at that time, a groundswell of educators and the media began to suggest that calling it *STEM education* somehow made it integrated in one way or another; a practice that hopelessly confused the meaning of *STEM education*.

In 2005, Virginia Tech launched its STEM Education Graduate Program (Sanders & Wells, 2005) grounded in the core idea of situating S, T, E, and M teaching and learning in the context of technological/engineering design activity (Sanders, 2006, 2008). But, by 2008, the term "STEM education" had become so misused/ambiguous that we at Virginia Tech renamed our program "Integrative STEM Education" (Sanders, 2008) and published the following operational definition:

> *Integrative STEM education* refers to technological/engineering design-based learning approaches that intentionally integrate the concepts and practices of science and/or mathematics education with the concepts and practices of technology and/or engineering education. Integrative STEM education may be enhanced through further integration with other school subjects, such as language arts, social studies, art, etc. (Sanders & Wells, 2010).

Note that this definition (intentionally) excludes pedagogical approaches that do not situate the teaching and learning of STEM concepts and practices in the context of technological/engineering design-based activity. Furthermore, only technologies that are integral to designing/making/engineering constitute the T/E in this definition. For example, using instructional technologies to teach S/M concepts does not constitute *integrative STEM* instruction. Similarly, the common practice of using *STEM education* to refer to integrated S/M (sans T/E) is no more valid than using *STEM education* to refer to integrated T/E (sans S/M) (which to my knowledge has not been done). Moreover, *integrative STEM education*:

- is appropriate for all K-PhD students;
- is not intended to supplant S, T, E, & M instruction that is more effectively taught in nonintegrative ways;
- may be implemented by one or more S, T, E, or M teachers in one or more classrooms/class periods;
- may be implemented during and/or after the normal school day; and
- should be thoughtfully and effectively articulated across multiple school grades/bands (Sanders, 2012).

In operationally defining *integrative STEM education* in this way, we hope to avoid the gross confusion/ambiguity associated with *STEM education*. Those who wish to use *integrative STEM education* to describe instruction must be certain that instruction is grounded in the context of technological/engineering design activity.

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Resources

American Society for Engineering Education (ASEE)
ASEE is a nonprofit organization of individuals and institutions committed to furthering education in engineering and engineering technology.
www.asee.org

International Technology and Engineering Educators Association (ITEEA)
ITEEA is an international organization for technology, innovation, design, and engineering educators. Its mission is to promote technological literacy for all by supporting the teaching of technology.
www.iteea.org

NASA Education
In 2012 and beyond, NASA will continue to pursue three major education goals: strengthening NASA and the nation's future workforce; attracting and retaining students in science, technology, engineering, and mathematics, or STEM, disciplines; and engaging Americans in NASA's mission.
www.nasa.gov/offices/education/about/index.html

Events

November 3-6, 2013 Atlanta, GA
25th Annual National Dropout Prevention Network Conference: *Pathways to the Promise*
www.dropoutprevention.org

Feb. 16-20, 2014 Myrtle Beach, SC
26th Annual At-Risk Youth National FORUM: *Providing Hope and Support In and Beyond the Classroom*
www.dropoutprevention.org

March 27-29, 2014 Orlando, FL
ITEEA's 76th Annual Conference: *Technological and Engineering Literacy Core Connections*
www.iteea.org

June 15-18, 2014 Indianapolis, IN
121st ASEE Annual Conference and Exposition: *360˚ of Engineering Education*
www.asee.org/conferences-and-events/conferences/annual-conference/2014

Relevance in Education Fosters Success in Life

by Patrick G. Forrester

In 2008, I was invited to speak at a STEM Institute in Upstate South Carolina. It was an experience that would influence my thinking over the next several years and eventually bring me to Clemson University and the State of South Carolina. I began to consciously reflect on the impact that education had had on my life and how most of my career experiences were a direct result of that education. I began to better understand the tremendous investment that teachers had made in my life and the way that I had been shaped by experiences in my home. It was during this time of reflection that Dr. Bill Havice extended an invitation to spend time at Clemson University to promote integrative STEM education. I was intrigued by the offer to collaborate with the work he was doing in the surrounding school districts. The result is my journey through STEM education.

Ray McNulty, Chief Learning Officer at Penn Foster, says, “The primary aim of education is not to enable students to do well in school, but to help them do well in the lives they lead outside of school.” I realized that this was my story. Everything that my teachers had poured into my education had allowed me to do well in life. I now had the opportunity to do that for others.

Over time I broadened my knowledge of STEM. I began to grasp and embrace the concept of integrative STEM education which Mark Sanders defines so well. Integrative STEM is not another thing to teach, but is a way to teach that has the greatest potential to impact students’ education and their lives outside of school.

Student Engagement

Integrative STEM education, I believe, is the key to student engagement. Children become more excited and confident in math and science when using technology, innovation, design, and engineering to make school subjects personally meaningful or relevant. At the same time, project-based STEM education can inspire learners to obtain a deeper knowledge of the subjects and motivate them to do quality work. Finally, it can help students make the connection between classroom learning, their everyday lives, and the broader world.

At NASA’s Jet Propulsion Laboratory in Pasadena, California, the head of human resources said he was having trouble replacing his master problem solvers. He had top candidates from Harvard, MIT, Caltech, and elsewhere, but he found that even though they were brilliant, they weren’t innovative in dealing with problems the way their predecessors had been. He realized that his best problem solvers had been kids who were tinkerers, who built sand castles, and who took computers apart with their friends so they could understand their guts.

I grew up a tinkerer. My parents allowed me to take things apart and put them back together. After I turned 16, our driveway came to look like an auto shop as my 1966 Mustang was in a constant state of disassembly. I developed confidence and self-direction. I learned how and why things worked. This was integrative STEM in action, and it helped give shape and meaning to the human-made world I lived in. It would eventually open doors to all kinds of learning.

STEM Labs Bring Relevance

Unfortunately, not every child has the opportunity to learn about technology, engineering, and problem solving at home. But I think this type of learning is possible through the implementation of fully-functional integrative STEM or Engineering Labs in the elementary school environment. In fact, I observed it happening in two elementary schools. (One school’s story can be found in the article by Melida Reeves in this issue.)

A dedicated STEM Lab can bring relevance to the student’s coursework as it focuses on project-based, integrated implementation of all of their subjects. The STEM Lab can be an amazing environment for learning and innovation that combines the design

process with math and science (and even the arts) to help students create and solve problems as they design and build just about anything.

The idea of incorporating a STEM Lab in the elementary school provides the opportunity to integrate multiple subjects into singular projects. The long-term relevance of the STEM Lab is apparent as it helps students develop life skills and opens their eyes to the world around them while preparing them for their futures.

Students around Clemson, throughout South Carolina, and across the United States need a school experience that prepares them for success in life long after they have left the classroom. They need to work on real-world, open-ended problems and projects. They need to learn the design process and creative thinking, how to work together in teams, how to solve problems, and how to accept and learn from failure. They need to be taught the skills they will need to excel in challenging college courses and survive and succeed in today’s job market. They need integrative STEM education, and I believe that the dedicated Engineering or STEM Lab is the best place for that to happen.

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Viewpoint

An average of 8,300 American high school students drop out every single day. Those who do not complete high school are locking themselves into a cycle of low opportunities, low wages, and all too often, crime and imprisonment.

ITEEA, the International Technology and Engineering Educators Association, promotes technological literacy for all by supporting the teaching of technology and engineering and promoting the professionalism of those engaged in these pursuits. ITEEA emphasizes the critical importance of truly integrating the four facets of STEM, thereby bringing STEM to life to engage children in learning.

Often, studying STEM components independently makes real-world connections difficult. How many students have wondered when they might actually use algebra or chemistry? By using technology and engineering in conjunction with math and science, we create opportunities to engage students with topics that have meaning to them and perhaps can even facilitate their ability to solve real-life problems. Projects might include designing a car with the most fuel efficiency or creating a portable shelter for a homeless person. The ultimate goal is for the students to identify and create design challenges from their own lives and then create learning around their ideas!

A student's exposure to integrative STEM education can have an enormous impact on his or her learning experience, but it can be even more effective if it begins early. Elementary-aged children are especially creative. Integrative STEM education allows them to tap that creativity in a way that has a lasting impact and can forge positive learning experiences that will carry over into the high school years. Middle and high school students can engage through activities such as the "TEAMS" (Tests of Engineering Aptitude, Mathematics, and Science) competition program managed by the Technology Student Association (TSA; www.TSAweb.org). This one-day competition is an opportunity for students to apply their knowledge of STEM in a real-world engineering challenge. The 2014 theme is based on the Academy of Engineering National Challenge "restore and improve urban infrastructure."

ITEEA's STEM⊕Center for Teaching and Learning™ has the only K-12 standards-based national model that delivers technological literacy in a STEM context. EngineeringbyDesign™ (EbD) is built on the Common Core State Standards as well as standards for technological literacy, math, and science. Additionally, the program has been mapped to the National Academy of Engineering's Grand Challenges for Engineering and integrates TSA cocurricular events as well.

Using constructivist's models, students in the program learn concepts and principles in an authentic, problem/project-based environment. Through an integrative STEM environment, EbD uses all four content areas as well as English-Language Arts to help ALL students understand the complexities of tomorrow.

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References

Page 2: "Winding Up STEM" by William E. Dugger, Jr.

Accreditation Board for Engineering and Technology. (2007-2008). *Engineering accreditation criteria*. Baltimore, MD: Author.

AAAS. (1993). *Benchmarks for science literacy.* New York, NY: Oxford University Press.

Aerospace Industries Association of America. (2008). *Launching the 21st century American aerospace workforce.* Washington, DC: Author.

Business Roundtable. (2005). *Tapping America's potential: The education for innovation initiative.* Washington, DC: Author.

Bybee, R. (2000). Achieving technological literacy: A national perspective. *The Technology Teacher*, *60*(1): 23–28.

Bybee, R. (2009). *K–12 engineering education standards: Opportunities and barriers*. Washington, DC: Unpublished paper given at a workshop on Standards for K–12 Engineering Education at the National Academy of Engineering, July 8, 2009.

Friedman, T. L. (2005). *The world is flat: A brief history of the twenty-first century*. New York, NY: Farrar, Straus, & Giroux.

Furger, R. (2008). How to end the dropout crisis. *Edutopia*, Dec/Jan 2008.

Hiebert, J. (1999). Relationships between research and the NCTM standards. *Journal for Research in Mathematics Education*, *30*(1): 3-19.

ITEA. (2000/2002/2007). *Standards for technological literacy: Content for the study of technology*. Reston, VA: Author. Retrieved from www.iteea.org

ITEA. (2003). *Advancing excellence in technological literacy: Student assessment, professional development, and program standards*. Reston, VA: Author. Retrieved from www.iteea.org

Johnson, J., Rochkind, J., & Ott, A. (2010). Are we beginning to see the light? *Public Agenda*. Retrieved July 15, 2010, from http://www.publicagenda.org/pages/math-and-science-ed-2010

National Academy of Engineering (NAE), & National Research Council (NRC). (2002). *Technically speaking: Why all Americans need to know more about technology*. (G. Pearson & T. Young, Eds.). Washington, DC: National Academy Press.

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

National Research Council. (1996). *The national science education standards*. Washington, DC: National Academy Press.

National Research Council. (2013). *Next generation science standards*, Washington, DC: National Academy Press.

The National Academies. (2007). *The internationalization of U.S. science and engineering*. Washington, DC: Author.

Denise Young (2013). Full STEM Ahead: Educating the next generation's brightest minds. *Virginia Tech Magazine (VTmag)*, *35*(3): 30-37. Retrieved from www.vtmag.vt.edu

U.S. Department of Labor, Bureau of Labor Statistics. (2009, May). "Science, Technology, Engineering, and Mathematics (STEM) occupations, May 2009." T*he Editor's Desk*. Retrieved from www.bls.gov/opub/ted/2011/ted_20110615.htm

U.S. Department of Commerce, Economics and Statistics Administration. (2011, July). *STEM: Good jobs now and for the future. (*ESA Issue Brief #03-11).

Page 4: "Up for the Challenge" by Barbara J. Nesbitt

Alexander, K., Entwisle, D., & Kabbani, N. (2001). The dropout process in life course perspective: Early risk factors at home and school. *Teachers College Record*, *103*(5), 760-822. doi: 10.1111/0161-4681.00134

Archambault, I., Janosz, M., Fallu, J., & Pagani, L. (2009). Student engagement and its relationship with early high school dropout. *Journal of Adolescence*, *32*(3), 651-670. doi:10.1016/j.adolescence.2008.06.007

Skinner, E., Kindermann, T., & Furrer, C. (2009). A motivational perspective on engagement and disaffection: Conceptualization and assessment of children's behavioral and emotional participation in academic activities in the classroom. *Educational & Psychological Measurement, 69*(3), 493-525. Retrieved from Education Research Complete database.

South Carolina State Department of Education. *Palmetto Assessment of State Standards (PASS) test scores.* (2012). Retrieved from http://ed.sc.gov/data/pass/2012/show_district_pass_scores_standard.cfm?ID=3901

Technology Starters: A Standards-Based Guide, Standards for Technological Literacy: Content for the Study of Technology (Standards for Technological Literacy/ STL) (ITEA/ITEEA, 2000/2002/2007).

Walker, C., & Greene, B. (2009). The relations between student motivational beliefs and cognitive engagement in high school. *Journal of Educational Research, 102*(6), 463-472. Retrieved from Education Research Complete database.

Page 6: "Integrative STEM Education Defined" by Mark Sanders

LaPorte, J. E., & Sanders, M. E. (1996). *Technology, science, mathematics connection activities*. Peoria, IL: Glencoe/McGraw-Hill.

Sanders, M., & Wells, J. (2005, September). *STEM graduate education/research collaboratory*. Paper presented to the Virginia Tech faculty, Virginia Tech, Blacksburg, Virginia.

Sanders, M., & Wells, J. (2010). *Integrative STEM education*. Retrieved from www.soe.vt.edu/istemed/index.html

Sanders, M. E. (2012). "Integrative STEM education as best practice. In H. Middleton (Ed.), *Explorations of best practice in technology, design, & engineering education*. Vol. 2. (pp. 102-117). Gold Coast, Australia: Griffith Institute for Educational Research.

Sanders, M. E. (2006, November). *A rationale for new approaches to STEM education and STEM education graduate programs*. Proceedings: Mississippi Valley Technology Education Conference, Nashville, TN.

Sanders, M. E. (2008). STEM, STEM education, STEMmania. *The Technology Teacher, 68*(4), 20-26.