INSPIRING the Next Generation of the STEM Workforce

By Sheila C. Boyington

The technical and trade industries face a continuing challenge to recruit qualified candidates for high-paying jobs. Evidence indicates that impetus of the skills gap originates early in a student's educational career, when attitudes about future pathways are formed ("Increasing student," 2011). The skills gap exists in part because of what we might call an "interest gap." Unfortunately, many students have inadequate information about the career choices open to them, and as a result cannot make the decisions that might lead to science, technology, engineering and mathematics (STEM) careers.

One possible way to address this is through a process that combines STEM career exploration with academic subjects in the context of socially relevant problems, leading to increased awareness of and intentions toward these pathways.

The Issue

The United States faces an increasing shortage in the workforce available for high-skilled, technology-based manufacturing. STEM workforce employment is expected to grow 17 percent by 2018, while the number of college graduates in STEM fields continues to decline (Langdon, McKittrick, Beede, Khan, & Doms, 2011). The US Manufacturing Institute and Deloitte estimate that there will be two million unfilled manufacturing jobs by 2025 (Giffi, Dollar, Drew, McNelly, Carrick, & Gangula, 2015). The situation in many trade and associate degree technical fields is even more dire, as students shy away from careers that they believe do not represent the new "knowledge" economy.

Even more alarming: The gender and racial gap within the STEM workforce continues to widen. While women comprise 49 percent of the college-educated workforce, only 14 percent of engineers are women and just 27 percent are working in computer science and math positions (Beede, Julian, Langdon, McKittrick, Khan, & Doms, 2011). Similar disparities exist for Hispanic and African American workers, who hold only six percent of STEM positions.

Our schools often are not meeting this challenge. Recent research showed that fewer than two percent of walls in middle schools contain messaging related to STEM or technical careers. When middle school counselors were asked to list their top five job duties, none of the responses involved career counseling (Kendall, 2017).

As a result, millions of students leave school without the skills and plans necessary for work and life, yet careers in the STEM industries provide solid career opportunities for today's youth, with higher growth opportunities and higher salaries. As ACT Inc. data indicates, there is a significant portion (23 percent) of students who have adequate STEM skills but lack interest in STEM careers ("The condition," 2016). A recent survey conducted by Emerson Electric showed that 42 percent of adults say they would have considered STEM courses if they had better understood the career pathways ("Science, math," 2016). Given the lack of resources and the amount of time necessary to develop a comprehensive exploration experience, most teachers do not have the understanding of the wide variety of careers available in industry, and of the types of skills required. Too few students are exposed to high-demand careers, and what exposure does occur usually happens late in the K–12 educational experience, when they are already making plans for postsecondary education. More students could benefit from exposure to careers at a younger age, when they are still forming opinions on careers and job opportunities.

The Strategy

To make a permanent and lasting impact in the quality of the STEM workforce, we must start in the years when students decide on their interests, general education and career pathway. Therefore, we must address attitudes in early middle school students through career awareness and preparation programs.

This strategy includes deploying a system that simultaneously:

- Introduces careers in STEM industries, creating awareness of the variety of occupations available
- Illustrates the impact of these careers and industries on society, demonstrating the benefits to both students and society, building interest in these career paths
- Ties these benefits to the skills and tools required to solve practical problems, creating relevance between academic studies in middle and high school and the solutions to these interesting problems
- Includes STEM careers that require four-year degrees, and also opportunities that exist with two-year degrees and credentials
- Integrates instruction on careers through both the technologies required to solve these problems and the application of middle and high school science, math and other skills in solving societal problems
- Does this in a way that begins with problems that students can relate to, and is simple for teachers to use and implement

While quality instruction in traditional science or math curriculum and project-based learning is essential, unique strategies to engage students in career awareness are needed. This career awareness component should be considered a supplement to, and not a replacement for quality science and math instruction.

Our Approach

Thinking Media became involved with the career readiness movement 20 years ago, creating the ACT-acquired KeyTrain and CareerReady 101 for the WorkKeys system. Learning Blade is an interactive, web-based supplemental system designed to increase interest in and attitudes toward STEM careers, in which students complete engaging, online missions to solve real-world STEM problems (e.g., helping an injured dolphin, preventing

Twelve Different "Mission" Stories for Individualized Context

Dolphin Rescue	Help rescue rehabilitate an injured dolphin, including creating an artificial prosthetic tail	Biomedicine, Marine Science
Haiti Orphanage	Design and build an environmentally-sound orphanage for children left homeless by an earthquake in Haiti	Construction, Sustainability
Heart Surgery	Conduct heart surgery and therapy for a child with a heart defect; evaluate the use of artificial hearts or heart components	Medicine
Energy Production	Evaluate alternative or upgraded energy sources for a city that currently has an old coal-fired power plant	Energy Production, Environment
Local Food	Consider methods to increase production of local foods in a community	Agriculture
Robotics Design	Explore technology used for robotics design, such as sensors, electrical circuits, industrial design and computers	Electronics, Computer Science
Flu Outbreak	How health and IT professionals can use data warehousing and analysis to predict flu outbreaks using GIS and social media data	Information Technology
Transportation Jam	Evaluate new transportation methods for a city that has a traffic congestion problem	Transportation
Manufacturing Concept	Use modern manufacturing techniques to design and build a new concept car	Advanced Manufacturing
Entrepreneur-ship	Set up a new business with a focus on entrepreneurship	Finance, Business
Lightweight Aircraft	Design a lightweight and easily maintained aircraft for distant missions	Lightweight Metals Manufacturing
Hack Attack	Learn about methods to create and protect website, apps and social media after a school's website and media are hacked	Computer Science

a web site hack, or solving energy and transportation needs in a new city).

The breadth of mission selections integrates human-interest stories so that students with diverse backgrounds can be engaged. For example, the Haiti mission expresses a goal to build an orphanage for children left homeless by an earthquake. To complete their missions, students take short academic lessons that describe the STEM careers involved and technologies used to address such problems in real life. The lessons provide individual snapshots of interesting aspects of the career or technology, highlighting the integration of fundamental learning concepts to better understand the basic math and science, and to spark, is the hope, an interest in those careers. Students earn points toward the mission score and advance on the leaderboard in a game-like setting by answering questions that demonstrate an ever-increasing understanding of fundamental principles.

Twelve missions expose students to 100 different STEM careers and technologies, which include medical and financial fields. These 100 units include approximately 400 different self-paced interactive lessons. Problems embedded in the lessons are individually linked to specific academic skills, and the lessons are aligned to academic standards in all 50 states. The system contains more than 100 hours of interactive content and produces detailed reports on classes or individual students.

In addition to self-paced lessons, Learning Blade includes coordinating teacher-ready exercises for hands-on experiments, teamwork exercises, and writing and presentation assignments. Mission challenges provide simple, hands-on activities emphasizing problem solving, critical thinking, teamwork and communications, and require simple, readily available materials. Additional materials include career video lessons, 3-D printing exercises, parent engagement activities and programmable calculator exercises.

The Results

Learning Blade has been adopted statewide in Tennessee and Arkansas, with pilot projects in many other states. Students have completed over one million interactive lessons on the Learning Blade platform amounting to almost 200,000 hours of engagement.

Battelle Education examined the data and concluded that this approach increased STEM career awareness and interest. Results are measured through pre- and post-use student surveys in addition to online usage records:

- A doubling of the number of students interested in becoming an engineer and/or scientist
- 79 percent increase in students recognizing how "math is helpful when solving interesting problems"
- 69 percent increase in students recognizing that "what [they] learn in school will be useful later in life"
- 57 percent increase in students interested in taking advanced math classes in high school ("STEM in the middle," 2016)

Wesley Hall, director of Battelle Education's TN STEM Innovation Network, remarked that "offering Learning Blade at no cost to schools across the state has resulted in a powerful initiative that has given students, particularly in rural areas, an innovative way to explore future STEM careers."

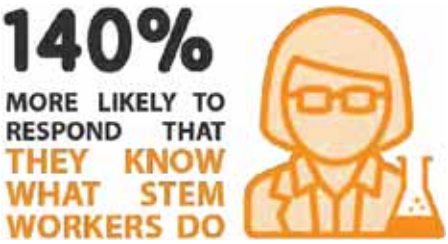
"It is critical that we empower today's students with education that is career relevant and contextual to the needs of 21st century, said Balaji Ganapathy, head of workforce effectiveness for Tata Consultancy Services. "Through Learning Blade's career missions, we are contributing to that overall goal in schools nationwide and it is truly rewarding to see the impact of increase in students' interest in STEM education and careers."

The system has also been used as part of Arkansas Governor Asa Hutchinson's nationally recognized efforts for computer science education in schools. Commissioner Johnny Key, Arkansas Department of Education, said, "Our vision is to transform Arkansas to lead the nation in student-focused education and nothing could be more relevant than computer science. To that end, in 2016 Governor Asa Hutchinson supported launching Learning Blade statewide so students would be able to learn about careers in computer science and STEM."

Additional research concluded that significant differences exist between middle school students who use and those who do not use the online learning platform Learning Blade (Kendall, 2017). Participants had improved STEM vocational aspiration, career development plans and STEM-related interpersonal interactions after using Learning Blade.

Learning Blade users were:

- 59 percent more likely to be interested in a STEM career
- 84 percent more likely to want a job that designs or builds things
- 140 percent more likely to respond that they knew what STEM workers do



Interestingly, there was not a difference between participants and non-participants when asked if science was interesting (61 percent), indicating that an interest in science alone does not necessarily translate into an intent to pursue STEM careers. (Note the schools were otherwise comparable in race, gender and free and reduced lunch.) Additionally, users were 70 percent more likely to like to talk about science with others.

This work shows the benefits of career awareness in encouraging and preparing the next generation of the STEM and technical workforce, and strides made to help close the interest gap. Career awareness should go hand-in-hand with quality instruction in science, math and technical skills. By demonstrating the social impact and academic relevance of science and technology, we can help students succeed in school, and to choose a pathway that will meet the needs of both themselves and the future workforce. ■

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> “Career awareness should go hand-in-hand with quality instruction in science, math and technical skills.”

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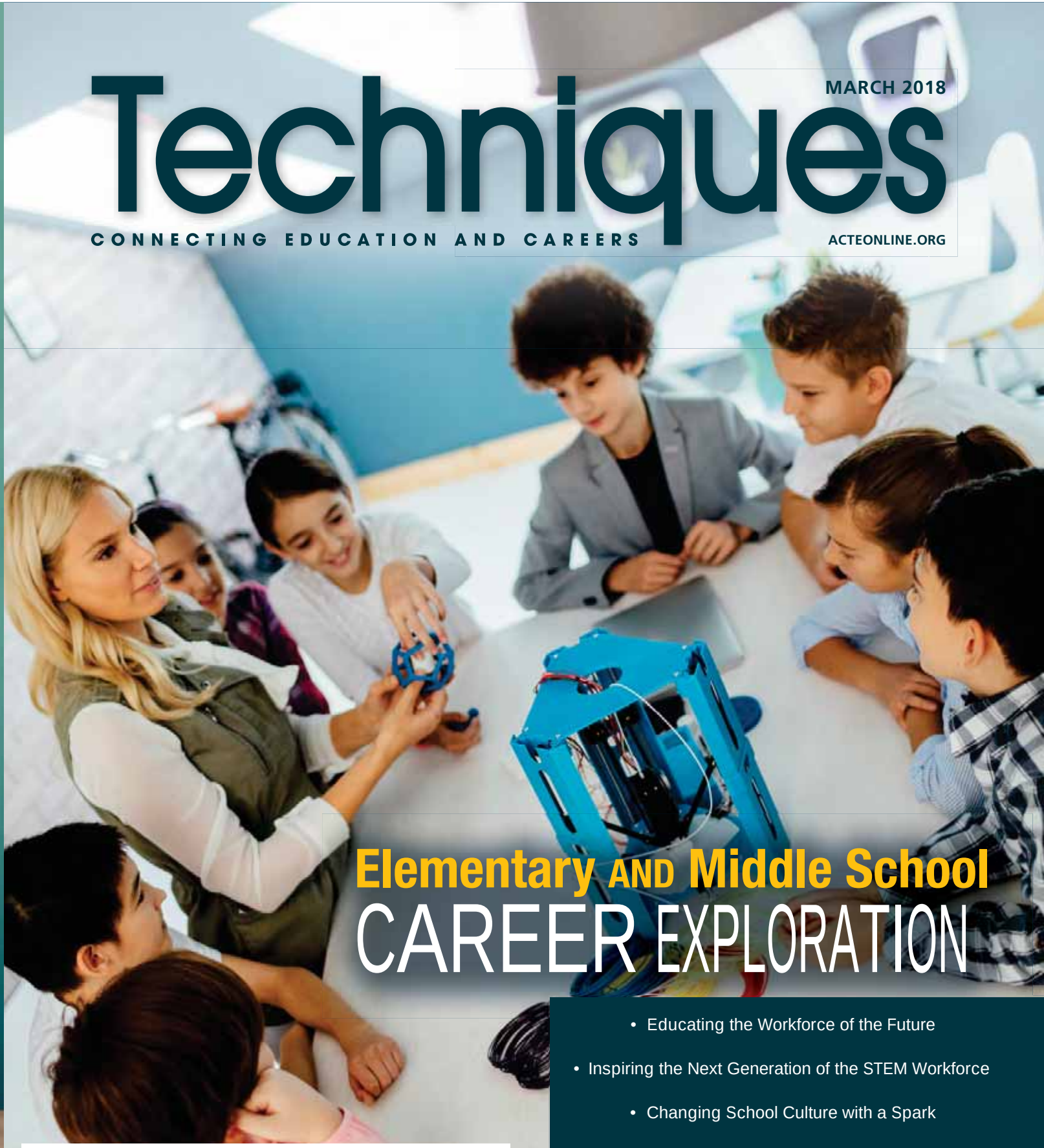

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