

## Chapter 2

# THE POWER AND PROMISE OF A STEM EDUCATION: THRIVING IN A COMPLEX TECHNOLOGICAL WORLD

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William Havice, DTE  
Clemson University

Throughout the United States, science, technology, engineering, and mathematics (STEM) education continues to gather momentum. STEM education is rapidly becoming part of the school experience. Technology and engineering (TE) activities are being infused in the learning experience, thereby integrating many areas of the curriculum.

Like never before, today's technology and engineering educators have an opportunity to play a lead role in transforming the K-12 classroom. However, the window of opportunity for our discipline to respond as leaders in transforming the school experience is getting smaller. It is critical that technology and engineering educators nationwide respond in a timely and effective manner.

Technology and engineering teachers can enhance student learning and excite and stimulate interest in learning science, math, and other school subjects through the use of projects in hands-on STEM education. The sharing of technology and engineering education practices and ideas is needed by all educators creating our future today.

STEM education has the potential to impact lives. Children who are coming through K-12 classrooms now expect real-world connections to what they are learning—or they disengage. As a means of learning, action-oriented hands-on technology and engineering education can bring the real world into the classroom. Children's lives are being enriched by the active study of technology and engineering, thus promoting students' natural curiosity. They learn best by doing.

### **STEM Education:** *Making a Difference*

Science, technology, engineering, and mathematics (STEM) education has the potential to make a difference in young peoples' lives. Without a diploma, they'll head down a path that leads to low-paying jobs, poor health, and the continuation of a cycle of poverty that creates immense challenges for families, neighborhoods, and communities.

STEM education can increase relevance in the educational experience while decreasing the dropout rate. Higher expectations and a more challenging curriculum, coupled with the support students need to be successful, have proven to be an effective strategy not only for increasing graduation rates but also for preparing students for

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work or advanced education.

In the United States, nearly a third of all high school students do not graduate on time; among Blacks, Hispanics, and Native Americans, the rate is almost half. The National Dropout Prevention Center (NDPC) at Clemson University reports that the graduation rate is not improving. Why are our children dropping out of school? According to the NDPC, dropping out of school is related to a variety of issues that can be classified in four domains: individual, family, school, and community factors. Youth leaving school early is a process that transpires over time. Further, we know children disengage from our schools very early. In the United States this year, an estimated 1.25 million kids will leave school without earning a high school diploma. That is approximately 7,000 students every day of the academic year.

Although the reasons for dropping out vary, the consequences of the decision are remarkably similar. Students who drop out of school earn less, suffer from poorer health, and are more likely to wind up in jail than their diploma-earning peers. These young people will earn much less than an “average” high school graduate over their lifetime, and they are more likely to rely on public assistance.

Our education system has a responsibility to prepare students for the challenges and opportunities of the 21<sup>st</sup> Century, the century in which these students will spend their adult lives. STEM education offers students the opportunity to analyze and develop questions to find answers. This approach to education does not require expensive equipment or facilities; however, it does provide learners the opportunity to enhance the knowledge of analyzing and answers. STEM activities can be introduced into the classroom with very little expense. Many elementary school teachers are using recyclables or inexpensive or scrap materials for creative STEM activities.

STEM education encourages young people to investigate their world and contribute to it. It can give real meaning to learning by integrating technology and engineering education into all areas of the curriculum. STEM can encourage students to think with flexibility and confidence. When children are interested in their learning, they learn more. Introducing very basic STEM



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topics early on in a student's school experience makes sense.

### **STEM Education:**

#### *Technological Literacy for Everyone*

The power and the promise of STEM education is based on the need for technological literacy. People need to be able to:

- **Use Technology** – successful operation of key products and systems of the time; knowing components of existing macro-systems, or human adaptive systems, and how the systems behave.
- **Manage Technology** – ensuring that all technological activities are efficient and appropriate.
- **Understand Technology** – more than facts and information, but also the ability to synthesize the information into new insights.
- **Evaluate/Assess Technology** – being able to make judgments and decisions about technology on an informed basis rather than an emotional one (ITEA, 2003).

Technologically literate people can change the natural world to fit desired needs and wants. They are able to analyze problems, issues, and trends and respond to challenges with adaptability and flexibility. STEM education is a key pathway to technological literacy for everyone.

### **STEM Education:**

#### *Project-Based Learning Activities*

Curiosity is at the heart of young people. By nature, they wonder about how things work. Early in a child's school experience, the child needs more opportunities to engage his/her curiosity and to be innovative. Children need to design, create, and experience hope for a future. Every student in K-12 grades needs to have opportunities to experience the study of STEM. By participating in STEM-related learning experiences, students can become technologically literate. Students today are our next generation of technology and engineering leaders.

By starting STEM experiences early in elementary education, we can help young people develop an

understanding of complex technological processes as well as the differences between the natural world and the human-made world. Children become more excited and confident in math and science when using technology, innovation, design, and engineering to make school subjects personally meaningful. We must help elementary educators engage creative minds and ignite young ideas. Because of the complexity of today's technological processes, children need to learn early in their school experience to explore the differences in the human-made world and the natural world so that, ultimately, our young citizens can succeed and add to the social capital of our communities.

The inclusion of innovation and design through STEM education should begin in early elementary school and be nurtured on through middle school, high school, college, and beyond. This will take a concerted effort on the part of educational partners at all levels of education. All of us who have a stake in the future of our society can personally take action to help make technological literacy a central concern for the educational system.

Action-based, hands-on-activity learning is at the core of technology and engineering education. Project-based learning in technology and engineering education is a dynamic and activity-based approach to teaching that allows learners to explore real-world problems and challenges, simultaneously developing cross-curricular skills while working in small collaborative groups. What better place to accomplish this than through STEM education?

Project-based STEM education can inspire learners to obtain a deeper knowledge of the subjects they are studying. Learners are likely to retain the knowledge gained through technology and engineering project-based learning more readily than through traditional textbook-based learning. Moreover, learners develop confidence and self-direction as they move through both team-based and independent work.

In the process of completing their projects, students can refine organizational and research skills, develop better communication with peers and adults, and often work within their communities while seeing the positive effects of their work.

Because students are evaluated on the basis of their projects, rather than by exams and essays, assessment of project-based technology and engineering work is often more meaningful to them. Learners quickly see how academic work can connect to real-life issues. Learners can be inspired to pursue a career or engage in activism that relates to the project they developed.

Learners are motivated to learn and do quality work on projects that are valued by audiences they have identified. Human beings desire appreciation. Learners take pride in their work when they know someone important to them is going to view and appreciate their work. What better place to create quality projects than through technology and engineering activities?

Learners thrive on the greater flexibility of project-based learning activities. In addition to participating in traditional assessment, learners might be evaluated on presentations to a community audience they have prepared for, informative tours of a local historical site based on recently acquired expertise, or screening of a scripted video production they have produced.

Additionally, project-based technology and engineering education can be an effective way to integrate educational or instructional technology into the curriculum. Typically, a project can easily accommodate computers, the Internet, interactive whiteboards, global positioning system (GPS) devices, digital, still, and video cameras, and related editing equipment.

Adopting a STEM project-based approach in the classroom or school can energize the learning environment, revitalizing the curriculum with real-world relevance and igniting learners' desire to explore, investigate, and understand their world. Students embrace learning through STEM projects, a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and tasks.

Project-based STEM education is a successful approach to instruction for a variety of reasons. STEM education can help students retain information; motivate and engage students' interest; encourage learners to explore interests and make connections to the world beyond school; encourage a deeper level of thinking by

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involving students in answering questions for themselves, make connections, and use analytical skills; and can possibly keep some children from dropping out of school.

Integrative learning of science, technology, engineering, and mathematics is not another thing to teach, but an excellent way to teach the current curriculum. Technology and engineering education is based on students' natural curiosity, providing opportunities for learners to experience how things work, how to put things together, and how to take things apart.

### **STEM Education:** *Implementation Support*

The International Technology Education Association (ITEA) can provide support for successful implementation of STEM activities in your school. You can make a difference in implementing STEM education by joining ITEA ([www.iteaconnect.org](http://www.iteaconnect.org)) and educators across the country in promoting the technological literacy standards and STEM education ([www.iteaconnect.org/TAA/PDFs/xstnd.pdf](http://www.iteaconnect.org/TAA/PDFs/xstnd.pdf)). The promise of the future lies not in technology alone, but in people's ability to use, manage, evaluate, and understand technology. Together we help our children realize that through quality STEM education they, too, can become participants who can literally change the world in which they live.

The American Society for Engineering Education's (ASEE) Engineering K12 Center ([www.asee.org](http://www.asee.org)) has created a website providing K-12 educators with engineering education resources. The website provides comprehensive data on outreach programs, career guidance materials, and access to hundreds of links and other materials related to engineering education. The ASEE Engineering K12 Center offers useful, easily accessible materials tailored to all parties with an interest in STEM education. The center works to enhance achievement in precollege science, technology, engineering, and mathematics (STEM) education by promoting the effective application of engineering principles to K-12 curricula. K-12 teachers can learn to teach engineering even with no exposure to the subject. With the help of ITEA and ASEE, teachers can learn the technology and engineering principles involved in educational units without knowing them in advance.

Hands-on activities and project-based learning are fun and effective ways to help students learn and retain more math and science concepts. By choosing STEM, educators can help students make the links among classroom learning, their everyday lives, and the broader world. Project-based learning can help students visualize abstract science and math concepts. Using hands-on activities, engineering design serves as the bridge to bring real-world relevance to math and science concepts. This bridge makes our designed world more understandable, relevant, and fun.

By promoting technology and engineering as viable career options, teachers help provide a stronger workforce in all fields of STEM, help create a technologically literate people/society, and provide students with the skills they will need to thrive in a technological society. By learning about technology and engineering in elementary, middle, and high school, students can see that it's one of the best ways to make our world a better place. Through problem-solving activities, students begin to see that we live in a designed world, and it's up to their generation to be creative and design better technological devices—like mobile phones, laptop computers, or video games.

### **Technology and Engineering Educators:** *Leading by Example*

Technology and engineering educators are in a perfect position to assist K-12 teachers in making sense of STEM education. Technology and engineering teachers can help other content area teachers understand the importance of the integration of STEM subject areas with other subject areas. Through the introduction of STEM, they can lead the way in exploring teaching and learning many school subjects.

By choosing to teach and promote technology and engineering education, we can help learners make the connections among classroom learning, their everyday lives, and the broader world. Technology and engineering can reflect creativity, innovation, and learner engagement. Hands-on activities and project-based learning are fun and effective ways to help students learn and retain more math and science concepts. Our goal should be to find new and exciting ways to promote technology and engineering career options.

In technology and engineering education, the role of the teacher needs to be that of a facilitator who guides students through the learning process. Teachers become learners themselves, focusing on assisting students in learning *how* to think, not *what* to think. Learners learn to evaluate processes and then revise the process to make it more efficient. Learners learn to think for themselves. Students learn that it is okay to fail and that they learn from their experiences.

Technology and engineering lessons connect real-world experiences with curricular content already taught in K-12 classrooms. By mapping to educational content standards, technology and engineering teachers are in a unique position to take a lead in developing comprehensive curricula that are hands-on, inexpensive, and relevant to children's daily lives.

A STEM education starts with a creative child's first lesson in social studies, science, or math. The teacher who delivers that lesson, and the lessons that follow, is a technology and engineering educator. Especially now, with U.S. science and math learning in decline and technology increasingly driving global change, the job of delivering this education is more difficult. It is also more important than ever before.

## Summary

The International Technology Education Association is calling for and implementing the educational reform necessary to ensure technological literacy for all. Together we can help to create a stronger workforce in all fields of science, technology, engineering, and math (STEM) and help to create a technologically literate society. Together, technology and engineering educators can provide students with the skills necessary to thrive in a technological society.

Our profession needs your unique leadership abilities and skills to make an impact in transforming education in the next decade. Each of us needs to consciously practice our leadership abilities. We all need to be positive role models in our discipline. Clearly, each of us needs to be a proactive agent of change. We all need to challenge ourselves to lead by example. Our actions will be the measure of our success.



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*Together, we can educate our students to be lifelong learners who can thrive in today's competitive global economy.*

Several years ago, Price Pritchett, Ph.D. wrote *The Employee Handbook of New Work Habits of the Next Millennium*, outlining ground rules for job success. He stated that we must “think and see differently.” The marketplace simply will not accommodate a lot of old belief systems about business, careers, and such. Prichett recommended that we change our minds to think from the angle of new realities. This will help position us to win in the new game of STEM education and technological literacy. Prichett recommended that we migrate to the fourth level of change, called “possibilities mentality.” If you are a level-four performer, you are proactive, not reactive. Instead of waiting for change to happen, you make it happen. You’re not content to cope with, adapt to, or even exploit change—you create it. We partner with the world of tomorrow and co-create change. We don’t fight the future, we create it.

Together, we can educate our students to be lifelong 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 technological knowledge to solve problems while making use of the English language, 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.

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### Supplemental Resources for Technology and Engineering Education

- <http://edc.nasa.gov>
- <http://manufacturing.stanford.edu> – An introductory website for kids and adults showing how various items are made. It covers over 40 different products and manufacturing processes and includes almost four hours of manufacturing video.
- [www.coe.uga.edu/ingear/](http://www.coe.uga.edu/ingear/) – **Ingear** – Provides teachers and teacher educators with access to materials that will enhance their own understanding of gender equitable classroom practices and access to materials that can be used to help teacher-education students address issues of gender equity in their teaching.
- [www.edequity.org](http://www.edequity.org) – **Educational Equity Center** – Promoting bias-free learning through innovative programs and materials. It strives to decrease discrimination based on gender, race/ethnicity, disability, and level of family income. Includes information on programs and materials as well as training.
- [www.iteaconnect.org](http://www.iteaconnect.org) – **International Technology Education Association**
- [www.nctm.org/equity.aspx](http://www.nctm.org/equity.aspx) – **National Council of Teachers of Mathematics: Equity Resources** – Features equitable resources to encourage teachers and students to value and respect the work of all members of the classroom community and to believe that all students can make important contributions.
- [www.ncwit.org/ghit](http://www.ncwit.org/ghit) – **National Center for Women & Information Technology (NCWIT): Gotta Have IT** – A computing resource kit designed with K-12 educators' needs in mind: a select set of high-quality posters, computing and careers information, digital media, and more, the resource kit builds awareness and inspires interest in computing.
- [www.preK-12engineering.org](http://www.preK-12engineering.org) – Resource for educators and administrators seeking to integrate engineering concepts and activities into Pre-K through twelfth grade.
- [www.sallyrides.com/for\\_educators](http://www.sallyrides.com/for_educators) – **Sally Ride Science: For Educators** – Features innovative science content dedicated to supporting girls' and boys' interests in science, math, and technology. A key part of the mission is to make a difference in girls' lives and in society's perceptions of their roles in technical fields.
- [www.stemtransitions.org](http://www.stemtransitions.org) – **STEM Transitions** – At the heart of the project are the six science, technology, engineering, and mathematics (STEM) career clusters that will provide the context for instructional materials demonstrating the convergence of academic and technical content.
- [www.swe.org/iacl](http://www.swe.org/iacl) – **The Society of Women Engineers Internet Activities Center** – Grade-appropriate materials on science or engineering.
- [www.teachengineering.com](http://www.teachengineering.com) – A K-12 teacher resource for hands-on technology and engineering.
- [www.tryengineering.org](http://www.tryengineering.org) – A resource for students (ages 8-18), parents, teachers, and school counselors.
- [www.tryscience.org](http://www.tryscience.org) – A gateway to science and technology centers worldwide.
- [www.washington.edu/doit/Stem/](http://www.washington.edu/doit/Stem/) – **AccessSTEM** – Where K-12 teachers, postsecondary educators, and employers learn to make classroom and employment opportunities in science, technology, engineering, and mathematics (STEM) accessible to individuals with disabilities, and share promising practices.