Seven Myths of STEM

By Karen Ansberry and Emily Morgan

Are you an elementary teacher challenged with integrating STEM into your already full instructional day? Are you wondering how to give equal weight to all four of the STEM disciplines, how to fit an engineering design challenge into every lesson, how to obtain all of the expensive, high-tech materials necessary to teach STEM, and how to prepare each and every one of your students to enter a career in the STEM fields? No worries … these are just a few of the many myths that surround the teaching of STEM. In this article, we share seven common myths of STEM education—and then bust those myths!

MYTH #1:

In every STEM lesson, the four disciplines should be *equally* weighted.

Integrating science with technology, engineering, and mathematics is a fairly recent phenomenon in the elementary grades. Historically, these four disciplines have been taught independently (with engineering often overlooked completely). But with the advent of the *NGSS*, engineering design has been elevated to the same level as scientific inquiry in classroom instruction. As educators across the country begin to integrate engineering design in their classrooms and implement STEM programs in their schools, one worry that many have is, "How do I give equal weight to all four disciplines within one lesson?" We say, "You don't have to (nor should you try!)" STEM education should involve making natural connections among the four STEM disciplines as students investigate and problem-solve within a meaningful context. Science and engineering standards provide the learning framework, while reading strategies, technology, and mathematics are used as tools within this framework to support and extend student learning. It is important that the connections among the four disciplines are natural, not forced. For example, mathematics should be applied where it fits within the overall goal of the lesson (not simply to meet a mathematics objective). So, don't worry if you are not giving all four STEM disciplines equal emphasis in every lesson.

When creating a STEM lesson, we recommend choosing standards from one or two of the STEM disciplines to serve as the focus of the lesson. Then consider where natural overlap occurs and how connections can be made to other disciplines (including reading, writing, and the arts). We like how the Early Childhood STEM Working Group describes STEM integration: "Each discipline warrants subject-specific attention to ensure that children build their foundational subject-matter knowledge systematically and to highlight the creativity, beauty, and unique features of the discipline itself. And yet, there are rich and valuable opportunities for integration across STEM disciplines. The best 'integration' typically involves one discipline in the foreground (i.e., the focus of the activity) and one or more other disciplines serving as background" (2017, p. 7).

You might think of it as one or more letters in the STEM acronym being bolder than the others. For example, a lesson that focuses on science standards might be considered a **S**TEM lesson, while a lesson centered on an engineering theme could be seen as a ST**E**M lesson. Using this thinking ensures that the standards you have selected are being appropriately emphasized, without the lesson losing the interdisciplinary, real-world application component that is a feature of good STEM instruction.

MYTH #2:

All STEM lessons should include an engineering challenge that follows a standard design process.

This myth can be addressed in two parts:

1. It is not necessary for every STEM lesson to include a start-to-finish design challenge. Rather, the engineering component of a lesson can be addressed in a number of ways—by simply identifying the criteria and constraints of a design challenge or a previously designed solution, exploring existing technologies that apply the science your students are learning about, brainstorming design solutions, or comparing and evaluating design solutions.
2. One standard design process does not exist. Instead, there are a multitude of approaches that follow the same basic pattern—a series of steps completed iteratively to solve a problem. The *NGSS* make it clear that these steps do not always follow in order and that "at any stage, a problem solver can redefine the problem or generate new solutions to replace an idea that is just not working out" (NGSS Lead States 2013, p. 2). Figure 1 shows three examples of design process models commonly used in STEM education.

We recommend introducing your students to more than one design process so they don't develop the misconception that there is a single lock-step method all engineers use when approaching an engineering challenge.

MYTH 3:

STEM education is all about careers.

In part, this is not a myth: STEM education gained prominence as a result of efforts to keep the United States competitive globally, with the argument that most jobs (and some of the best-paying jobs) in the 21st-century workforce will require knowledge of the STEM disciplines. The future of the U.S. economy is in STEM. According to recommendations from the bipartisan STEM Education Caucus for Members of Congress, two of the three kinds of "intellectual capital" needed by our country are directly career-related:

1. *Scientists and engineers who will continue the research and development that is central to the economic growth of our country, and*
2. *Technologically proficient workers who are capable of dealing with the demands of a science-based, high-technology workforce.*

But is STEM education *all* about careers? Consider the third kind of intellectual capital outlined by the members of the STEM caucus:

3. *Scientifically literate voters and citizens who make intelligent decisions about public policy and who understand the world around them.*

In this technology-intensive 21st century, all citizens need some degree of STEM literacy. According to MIT's Dr. Richard C. Larson, in his blog post *STEM Is for Everyone*,

"A person has STEM literacy if she can understand the world around her in a logical way guided by the principals of scientific thought. A STEM-literate person can think for herself. She asks critical questions. She can form hypotheses and seek data to confirm or deny them. She sees the beauty and complexity in nature and seeks to understand. She sees the modern world that mankind has created and hopes to use her STEM-related skills and knowledge to improve it."

A high-quality STEM education from preK through graduate school prepares *all* students for today's world—and the future—even if they choose not to become a scientist or engineer.

MYTH #4:

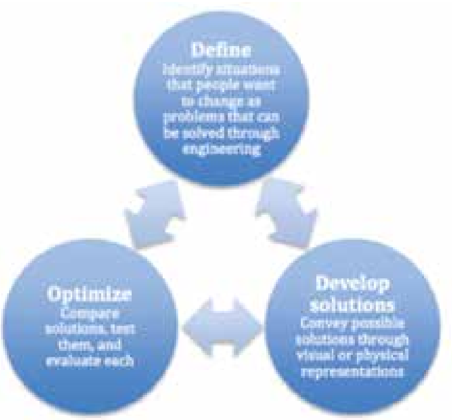
STEM education can wait until the upper elementary grades.

Young children are natural STEM learners. Whether it is counting toy cars, building with blocks, testing buoyancy in the bathtub, observing pendulums on the playground, or marveling at the changing Moon, children tend to demonstrate an affinity for STEM learning early in life. And no doubt you've noticed how readily young students embrace digital technology, from video games to tablets to computers. High-quality STEM experiences in the primary grades help to foster these early inclinations and set the stage for later success. If children do not have access to engaging and meaningful early STEM experiences, they may lose confidence in

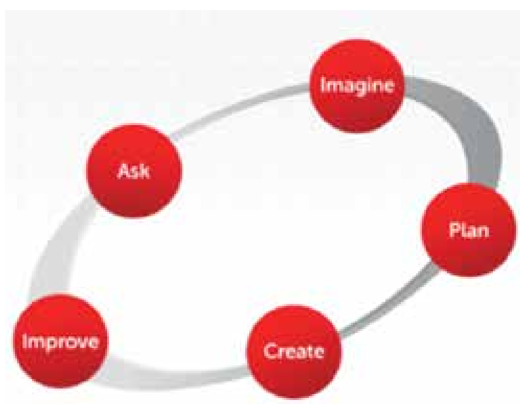
FIGURE 1

Engineering design models.

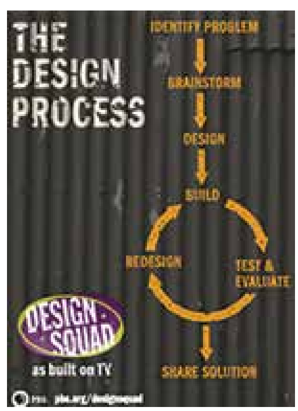
NGSS
www.nextgenscience.org/



Engineering is Elementary
www.eie.org/overview/engineering-design-process



PBS Design Squad
http://pbskids.org/designsquad/



their STEM abilities or lose interest in STEM altogether. And as outlined in Myth #3, STEM literacy is necessary for all learners, not just those who will someday enter the STEM fields. The authors of *STEM Starts Early: Grounding Science, Technology, Engineering, and Math Education in Early Childhood* put it this way: "Just as the industrial revolution made it necessary for all children to learn to read, the technology revolution has made it critical for all children to understand STEM. To support the future of our nation, the seeds of STEM must be planted early, along with and in support of the seeds of literacy. Together, these mutually enhancing, interwoven strands of learning will grow well-informed, critical citizens prepared for a digital tomorrow."

MYTH #5:
Adults' attitudes about STEM have little effect on children's attitudes about STEM.

Some adults may believe that STEM is only for older children or certain "types of kids;" or that ability in the STEM disciplines is fixed—based on innate talent, rather than on learning and other factors that can be impacted by an adult's influence (such as attitude and persistence). Parents with math anxiety may feel that because they didn't like or weren't "good at" math, their own children won't be successful. These attitudes and beliefs can profoundly affect children. In fact, parent beliefs about a child's math ability are a stronger predictor of the child's self-perception in math than the child's own previous math performance. Furthermore, many adults believe that they themselves are not competent to share in STEM activities with their children or that these topics can only be taught successfully in formal settings like schools. Some ways that you can help parents become more actively engaged in STEM with their children include:

- suggesting ideas for incorporating STEM learning in everyday situations—for example, identifying geometric shapes in household items, testing objects to see if they sink or float, reading about new inventions together, or designing creative solutions to everyday problems
- providing STEM activities they can do at home with their children, such as "STEM at Home" activities, STEM-related read-alouds, and take-home "science sacks" (see Resources)
- planning "STEM Nights" at school throughout the year, where parents and children can take part in STEM-related activities together.

Teachers' anxiety or lack of content knowledge around STEM topics can negatively affect students' attitudes as well. But educators who work to build their STEM content knowledge and who teach STEM with confidence and enthusiasm can positively affect their students' attitudes. Participating in well-structured professional development can be helpful in improving teachers' attitudes and confidence level and decreasing anxiety around teaching STEM. Teachers should experience STEM professional development in the same way students should learn STEM—in a positive, encouraging, and collaborative atmosphere with time for tinkering, exploring, and engaging in meaningful real-world STEM activities. By approaching STEM with excitement and enthusiastically learning alongside children, both parents and teachers can affect student attitudes toward STEM in a positive way.

MYTH #6:
STEM education requires costly or high-tech materials.

Most of us are not teaching STEM in a brand-new, multimillion-dollar STEM lab completely stocked with every state-of-the-art gadget and gizmo on the market. While it may be true that sophisticated science equipment, expensive robotics kits, high-tech 3D printers, and the like can raise interest and excitement in STEM learning, they are not prerequisites for an elementary STEM program. In fact, K–5 STEM teaching can be done on a shoestring budget. If your school is not quite "STEM-ready" and funding is scarce, be assured that many of the materials needed for STEM lessons in the elementary grades can be purchased cheaply at a home improvement store or are already in your classroom. Many items can even be found in the recycling bin! Here are some other ideas for free or low-cost STEM resources:

- NSTA's Freebies for Science Teachers at *www.nsta.org/publications/freebies.aspx* has dozens of ideas on obtaining free curricular materials and resources for your classroom.
- Code.org's completely free K–5 courses blend online, self-guided, and self-paced tutorials with "unplugged" activities that require no computer at all! Even the teacher workshops are offered at no cost.
- NASA for Educators at *www.nasa.gov* has a variety of free STEM resources.
- *www.teachengineering.org* has a searchable database of over 1,500 free lessons, activities, and maker challenges for K–12 teachers.

When teaching STEM at the K–5 level, the emphasis should be on getting students excited about STEM, showing the connections among the STEM disciplines through engaging real-world examples, and teaching the practices of science and engineering—all of which can be done in a low-tech and economical way. With a positive attitude toward STEM and a strong foundation in these practices, students will be ready to apply their STEM skills and knowledge in more high-tech environments as they progress through middle and high school.

MYTH #7:

STEM lacks emotion.

There are some pervasive, negative stereotypes about the men and women who work in the STEM fields. Scientists, engineers, and mathematicians are often viewed as highly competent but eccentric, socially isolated, lacking in warmth or empathy, or having limited interpersonal skills. Unfortunately, students who hold negative perceptions of people who work in STEM may be dissuaded from pursuing careers in STEM. But if you are intentional about showing the "warmer" side of STEM, you can help dispel the myth that STEM lacks emotion. For example, try sharing picture books that highlight ordinary people expressing a whole range of human emotions while doing extraordinary things in STEM. Some books to consider are the true stories *The Boy Who Harnessed the Wind; Solving the Puzzle Under the Sea: Marie Tharp Maps the Ocean Floor; One Plastic Bag: Isatou Ceesay and the Recyling Women of the Gambia; Wangari's Trees of Peace: A True Story from Africa;* and the fictional stories *Iggy Peck, Architect; Ada Twist, Scientist;* and *Rosie Revere, Engineer* (see Resources).

Another way to infuse human emotion into your STEM teaching is to focus on the role of empathy in design. David M. Kelley, founder of design firm IDEO, maintains that the main tenet of design thinking is empathy for the people you are trying to design for. When presented with a design challenge, students should be encouraged to put themselves in the end-user's shoes in order to understand their wants and needs. Sharing true stories to engage students' emotions and develop empathy before a design challenge can make the task more meaningful for the designers and the end product more beneficial to the users. For example, the narrative nonfiction book, *Winter's Tail*, which tells about a dolphin who lost her tail and the caring team of people who came together to help her, can be used to inspire students to put themselves in the role of a biomedical engineer and design a prosthetic limb for a wind-up toy animal. Fiction can also be a powerful tool for building empathy and giving purpose to a design challenge. *Orion and the Dark*, a story about a child who is afraid of the dark, can inspire a design challenge where students build a nightlight for someone who has this fear. A truly engaging story, whether fiction or nonfiction, can build empathy, ground an engineering challenge in a meaningful context, motivate students to work together for a common purpose, and ignite the imagination and creativity necessary to solve real-world problems. ●

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Karen Ansberry ***(karen@pictureperfectscience.com)*** and **Emily Morgan** ***(emily@pictureperfectscience.com)*** are science education consultants and the authors of the *Picture-Perfect Science* and *Picture-Perfect STEM* series from NSTA Press (*www.pictureperfectscience.com*).