

# Why STEM in Elementary?



## THEN AND NOW

When I was a little girl, can you guess what I wanted to be when I grew up? Yep! I wanted to be a teacher. When I got home from school, I would go to my grandparents' house and make my very patient granddaddy sit on the side of the guest bed with a bed tray on his lap, as if he were sitting at a desk. I would teach him letter sounds, and how to blend letters into words, and the combinations of letters that made an exception. I wrote out math problems and graded his papers with a fat, red marker. I taught him the names of the planets (back when there were nine of them). And I told him stories from my history book (never realizing he had lived through some of those stories on the beaches of Normandy during World War II because he never talked about that). He faithfully sat and "learned" everything I had learned at school that day. Even at the end of my granddaddy's life, when Alzheimer's disease had taken hold and he did not remember my name anymore, he called me his "school teacher." And for years after that, I dreamed of what it would be like to be a real teacher.

But in all those dreams, I never imagined it would be like this. As a little girl in Granddaddy's guest room, I envisioned myself teaching in the front of the room, writing on the board with kids in rows. I dreamed of making assignments and knowing exactly what I expected my kids to produce in return. I dreamed of teaching my students the same things I had been taught. I had no idea I would teach in a world where most of the knowledge on earth is available from the Internet on the phone I carry in my pocket. I could not have dreamed of a classroom where all of my students have their own iPad. It never occurred to me that the information I was taught in school would be only the baseline of knowledge I provided for my students to build innovative solutions to real-world problems. The idea of a classroom with the constant hum of collaboration is so different from my childhood experience of silent seatwork. And yet, that is the progress education has made in the past quarter of a century.

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And you know what? The dreams our kids have inside their heads represent only a shadow of the future careers they will have too! None of us can imagine the future our kids will live in. Some will have jobs that do not exist yet. Others will have existing professions but with unfathomable technology they will help invent. This is exactly why STEM-infusion is essential for elementary-school kids. We must prepare kids to be successful in an unknown future and to actively participate in the building of that future. And because we do not know what that future looks like, our only course of action is to raise problem-solvers, collaborators, innovators, and risk-takers.

## 21st CENTURY READINESS

The Partnership for 21st Century Skills has identified four “learning and innovation skills” that are essential for the 21st century workforce: creativity, critical thinking, communication, and collaboration. According to its website, “Learning and innovation skills increasingly are being recognized as the skills that separate students who are prepared for increasingly complex life and work environments in the 21st century, and those who are not.” Let’s break that statement apart and see how it applies to an elementary STEM-infused classroom.

### “Learning and Innovation . . .”

Elementary STEM-infusion gives students constant opportunity to foster each one of these skills:

- **Creativity.** In each design challenge, students use their existing knowledge to come up with a creative solution to a problem. Their ideas must be original, well thought out, and flexible in response to the outcomes of their testing. Because students must test and improve their design several times within a challenge, they are constantly exercising their creativity.
- **Critical Thinking.** It does the students little good in terms of preparing them for their future if we just teach them the facts listed within our standards. They could find those online. Instead, we have to teach them to apply their learning to new and unpredictable circumstances. In a STEM-infused classroom, the teacher is constantly providing the students with authentic scenarios to which students have to apply their content knowledge. Student misconceptions become evident when an idea does not work and students are given the opportunity to self-correct as they improve.
- **Communication and Collaboration.** In a STEM-infused classroom, students are sharing more than they are silent. This type of classroom stands on the principle that students have more to learn from each other than they can learn from the teacher. Therefore, throughout the day, students will be discussing, debating, presenting, blogging, emailing, web chatting, etc. to gain and distribute the information they use and gather throughout their day. As you will see in Chapter 9, the teacher must demonstrate, foster, and scaffold communication and collaboration skills in order to maximize their effectiveness.

### “Separate Those Who Are Prepared . . . and Those Who Are Not”

In his book *World Class Learners: Educating Creative and Entrepreneurial Students*, Yong Zhao criticizes the educational paradigm, which dominates most societies,

that says we are only preparing students with skills that help them fit in to the current society. This type of education was useful in mass-producing workers for an industrial economy, but that is not the type of economy we live in. Because of **globalization** and technology, our kids will not grow up in a world where industry dominates American economy. That ship has sailed . . . literally . . . as many industrial jobs have moved overseas. But he goes on to say that “America’s success in creativity is the outcome of its ineffectiveness in forcing conformity and standardization” (Zhao, 2012). In other words, the United States continues to excel at innovation. And innovation is what will allow our students to compete in a technology-rich, global society.

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A STEM-infused elementary classroom cultivates creativity instead of conformity. In these classrooms, students practice thinking skills instead of rote memorization of a list of standards. This style of learning will serve our students well as we consider the following statement made by Andreas Schleicher, OECD education directorate:

We live in a fast-changing world, and producing more of the same knowledge and skills will not suffice to address the challenges of the future. A generation ago, teachers could expect that what they taught would last their students a lifetime. Today, because of rapid economic and social change, schools have to prepare students for jobs that have not yet been created, technologies that have not yet been invented and problems that we don’t yet know will arise. (Schleicher, 2010)

### **“. . . Increasingly Complex Life and Work Environments . . .”**

According to Dr. James Appleberry, president of the American Association of State Colleges and Universities,

The sum total of humankind’s knowledge doubled between 1750 and 1900. It doubled again between 1900 and 1950, again from 1950 to 1960, again from 1960 to 1965. It’s been estimated that the sum total of humankind’s knowledge has doubled at least every five years since then. It’s been further projected that by the year 2020, knowledge or information will double every 73 days. (Appleberry, 2000)

Can you imagine? In just a few years, the amount of knowledge that exists in the whole wide world will double almost two-and-a-half times during our school year! How in the world can we prepare kids with a knowledge base to live, succeed, and contribute in a world like that? Well, teaching them a list of standards written

several years ago certainly will not be enough. If we want our kids ready for these increasingly complex work environments, we have to teach them to think critically and creatively.

In 2001, Bloom's Taxonomy (Figure 2.1) was updated in an effort to better reflect the importance of creative thinking in the 21st century. Whereas originally, evaluation was seen as the highest level of thinking, Lorin Anderson's team of experts in psychology, instruction, curriculum, and assessment found that creating was the ultimate assimilation of knowledge (Forehand, 2005). In this body of research, creating is defined as "putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing" (Anderson & Krathwohl, 2001).

Dr. Willard Daggett and the International Center for Leadership took this concept a step further with their Rigor/Relevance Framework® (Figure 2.2). They asserted that effective teaching not only challenges students to work in the highest levels of the Knowledge Taxonomy (resulting in **rigor**) but also in the deepest level of the Application Model (resulting in **relevance**). The application continuum begins with knowledge of one discipline and stretches to application in one discipline, application across disciplines, application to predictable real-world situations, and finally application to unpredictable real-world situations (Daggett, 2014). In other

Figure 2.1 Bloom's Revised Taxonomy

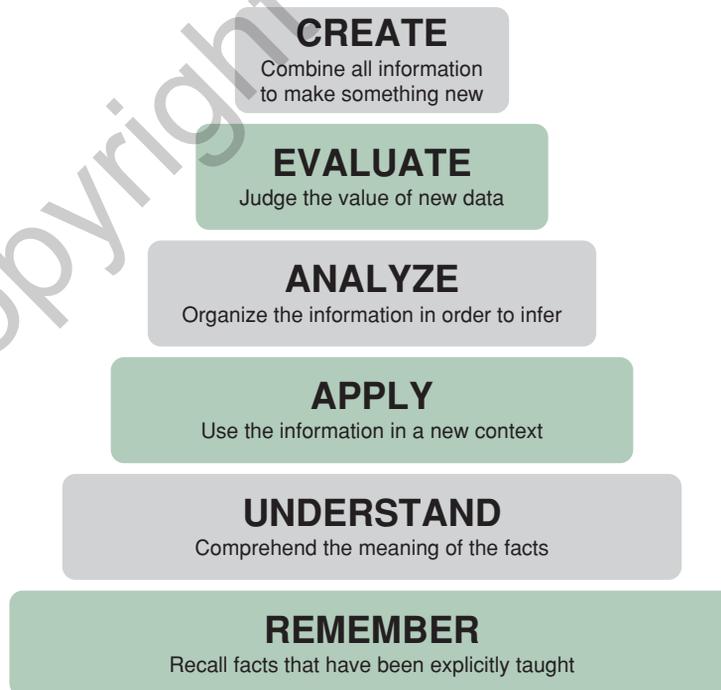
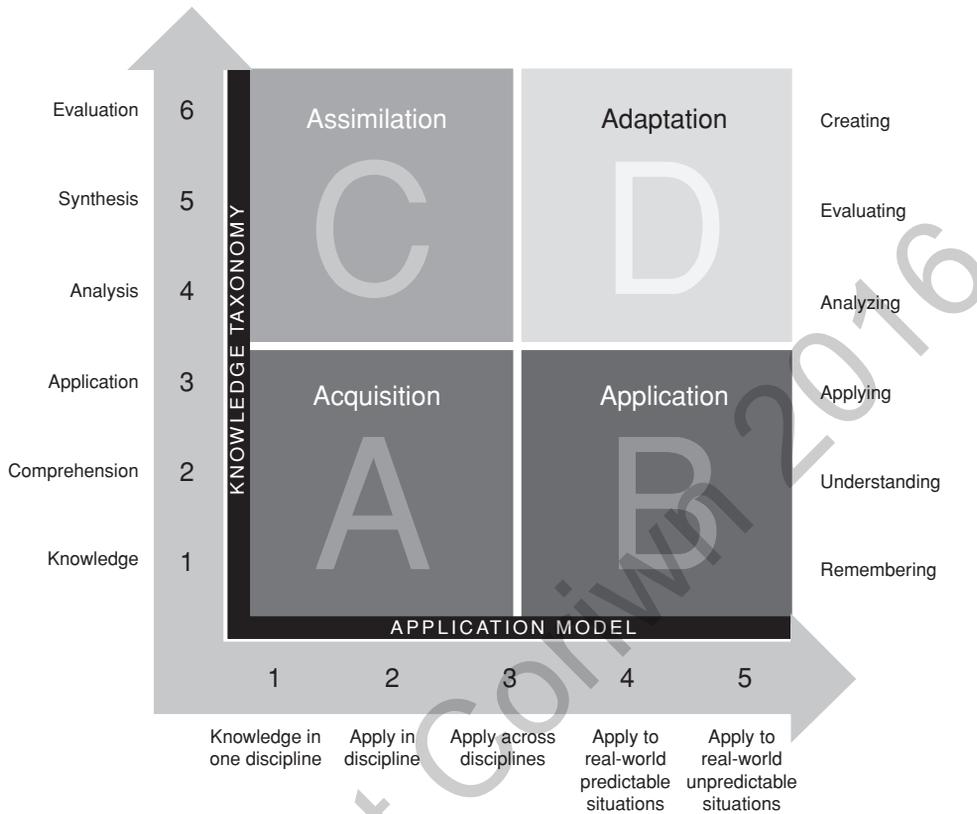


Figure 2.2 Rigor/ Relevance Framework®



SOURCE: Courtesy of Willard Daggett, EdD. <http://www.leadered.com>.

words, the most effective type of education is one in which students are pulling together and reorganizing information from all content areas in order to find a solution to an unpredictable real-world problem.

## MOTIVATING CHANGE

As you read on through this book, I hope you will see the previous information in this chapter as a foundation for all of the other information. This research has come to me in pieces in the form of professional development activities, conference keynotes, Professional Learning Communities (PLC) discussions, articles, and degree coursework over the past few years. They have assimilated in my brain as elementary STEM-infusion. This information about the mystical future world our kids will grow up in has motivated me to change how I teach and stretch my own imagination and comfort to allow kids the freedom to create. Most likely, if you are still reading, you believe this change is needed too. So how do we do it? We STEM-infuse.

The President’s Council of Advisors on Science and Technology lifted up the need for more STEM education in its 2010 report to the president titled “Prepare and Inspire: K–12 Education in Science, Technology, Engineering, and Math [STEM] for America’s Future” (President’s Council, 2010). The recommendations of this report included the following:

- Showing national support for the state-led movement toward shared standards
- Recruiting and training 100,000 STEM teachers in the next decade
- Creating the STEM Masters Teaching Corps to recognize the best STEM teachers
- Creating a support system for educational technology innovation
- Creating opportunities for students outside the classroom
- Creating 1,000 STEM-focused schools over the next decade
- Ensuring national leadership for STEM education

With STEM being lifted up as a matter of national importance, it is essential that we prioritize it within our classrooms, even our elementary classrooms.

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## Discussion Starters

- What information in this chapter was most surprising to you? Why?
- What challenges might our students face in their future jobs that have not been an issue in the past?
- In what ways do you feel your current standards prepare students for their futures? In what ways do they fall short?
- In what ways are you preparing your students to help build the unknown future talked about in this chapter?
- What is a lesson that you recently taught in which you required a standard outcome? How could you change the lesson so that the student outcome was unpredictable?

### YOUR NEXT STEP

Analyze a lesson plan that you recently taught. Highlight parts in which you are preparing students for an unknown future with skills such as communication, collaboration, creativity, and critical thinking. Circle parts that require tasks based on the assumption that our future economy will look like the present or even the past.