

Preface

My son was born a builder. From the time he developed the least amount of motor control, he built towers, castles, and bridges out of everything from blocks to the little plastic creamer cups for the coffee at IHOP. He learns by exploring. He grows by creating, testing, and improving his design. He is a natural engineer.

If you have children, this may sound familiar. This approach to learning is nearly universal among babies and toddlers. Babies put everything in their mouths because they are experimenting and exploring. They learn from the effects of every move they make. They build up a mental library of experiences and information through every action. And if you are an elementary teacher, you also know that this is not the exclusive practice of babies. Children continue to learn through trial and error (for as long as we let them).

This is what STEM-infusion is all about. It's about capitalizing on a child's natural curiosity, the need to understand, the desire to try something and see what the outcome will be. As seems appropriate, in our school, STEM-infusion is a model of teaching that was developed by accident. Just like we ask our students to do in a STEM-infused classroom, my colleagues and I have developed, tweaked, and improved this method of teaching through trial and error. In order to understand exactly what this method is, it's important to hear the backstory of how we came to use it in our school.

OUR ROAD TO STEM-INFUSION

I live in a fairly small city school district. We have one high school, one junior high, two intermediate schools, and three elementary schools. Our district consistently ranks among the top performing districts in the state of Tennessee. But several years ago, as part of our strategic plan, we decided to enhance our math and science programs in order to graduate students who were better prepared for 21st century colleges and the workforce. In an effort to do so, the district decided to introduce STEM classes at the intermediate, middle, and high school levels and purchase

Project Lead the Way curriculum for those programs. However, after considering the justification for STEM education (found in Chapter 2 of this book), our administrators decided that STEM should be taught at all grade levels, starting in kindergarten.

At the time I was a fourth-grade math and science teacher in one of our elementary schools and when the position was posted for elementary STEM, I decided to apply. Although I had only recently heard of STEM, the concept of integrating subjects through creative design resonated with me. To me, it made sense to teach that way. After I was hired to teach my kindergarten through third grade STEM class, I was given the charge of researching what STEM would look like at the elementary level and the freedom to design the course according to that research. Little did I know what a challenge that would be. At the time, there was very little content to be found about STEM in elementary school. That summer, however, I attended the National Science Teachers Association (NSTA) STEM forum, which really helped me envision how an elementary STEM class might look.

When our first year of STEM began, the class was built around the engineering design process (ask, imagine, plan, create, and improve). I primarily attempted to connect the engineering projects to the science standards for each grade level. For example, when the students learned about habitats, each group designed a habitat for a hermit crab (see Figure P.1). The students researched what food, water source, shelter, etc. a hermit crab would live in and built a habitat in a plastic box. We connected those habitats using plastic tubes and placed four hermit crabs in the center box. Each day, the students would graph where the hermit crabs were living and make adjustments to their habitat in an attempt to better attract the crabs. Although this plan to connect science and the engineering design process served us well that first year, it was only the first step in our journey. Deep connections to math and technology were lacking that year as the program was being developed.

The following summer, however, my whole philosophy of STEM changed. I attended the Tennessee STEM Teachers Academy, which was organized by the Tennessee STEM Network and the Oak Ridge Associated Universities. That summer, my colleague, Dee Dulin, and I heard Dr. Tony Donen, principal of STEM School Chattanooga, talk about his high school that totally integrated their entire curriculum through design projects. He described how all of their departments (language, math, science, social studies, arts, physical education, humanities, etc.) worked together to come up with semester-long projects in which the students would use all of the skills and coursework to build a solution to an engineering challenge. After hearing about their success, we felt that we had short-changed STEM's potential by simply teaching it one hour a week in isolation from the rest of the curriculum. Instead, we began to build the idea of STEM-infusing elementary classrooms. Dee, who is a first-grade teacher, and I prepared model lessons to show our faculty. Instead of long-term projects, we felt that a week-long project integrating the content covered that week would be ideal. Dee demonstrated

Figure P.1 Third graders designed hermit crab habitats, tracked the movement of live hermit crabs, and improved their habitats using the engineering design process.



SOURCE: Photo by Linda Talley.

what we would eventually come to call the thematic approach to STEM-infusion (Chapter 6) with a first-grade lesson, and I showed the standards alignment approach (Chapter 5) with a third-grade lesson.

Buy-in for this new concept began with a small minority—just a couple of teachers on each team. However, the STEM-infusion movement began to take root as those energetic pioneers shared their ideas and resources with their teams. By the third year of STEM in our school, over half of our faculty was using STEM-infusion regularly, while many others were beginning to understand the relevance of this teaching model in preparing kids to live in the 21st century.

At the same time, our district began a one-to-one device initiative, and we got iPads in the elementary schools. As our district developed a philosophy of utilizing devices to supplement effective teaching strategies and as a platform to create, research, and innovate, it became clear that our vision for STEM-infusion and the district's vision for technology integration would be mutually beneficial. In fact, many of our teachers felt like they were ahead of the game when it came to

technology integration because with the new way they were teaching, the need for technology was there. It was not just about trying to figure out how to fit technology in, it was about using technology to enhance the project-based learning and STEM-infusion that was already taking place. During that exciting first year of technology (which was our third year of STEM), I served as our school's Instructional Coach for STEM and Technology Integration. My job was essentially to help teachers plan, implement, and improve STEM and technology-integrated activities. By the end of that year, 100 percent of our teachers had used STEM-infusion to some extent, over half using it daily. Most of the lessons you will read about in this book are lessons that I co-planned or co-taught with other kindergarten through third-grade teachers.

As this book is in final drafts, I am beginning a new adventure in my STEM journey. This year, I will be a third-grade teacher. I will get to experience my own STEM-infused classroom full-time. I cannot express how excited I am about this or how fully I believe in STEM's potential to engage students, facilitate positive collaboration, deepen understanding of academic concepts, and foster the ability to innovate.

STEM-INFUSION

If you have read anything on elementary STEM before, chances are this book will be a bit different. Instead of approaching STEM as a subject or a type of activity, we will explore STEM-infusion as a teaching model to integrate all content areas in a way that provides rich meaningful experiences for students.

OVERVIEW OF THE BOOK

Chapters 1 and 2 will introduce the concept and provide a rationale for STEM-infusion. Next (Chapter 3), we will look at STEM-infusion as a solution to the need for lessons with high rigor and high relevance. After that, in Chapters 4 to 6, I will explain and model various approaches to STEM-infusion in an elementary classroom. The remainder (Chapters 7 to 10) will address the other important issues related to STEM-infusion, such as assessment, teaching grit, student and teacher collaboration, and leading educational change.

FEATURES AND BENEFITS

The book also includes the following additional resources to help you get started on your journey toward STEM-infusion.

- **Classroom Vignettes.** Each chapter will provide information from the perspective of someone who has experienced STEM-integration first-hand, in a way that is easy to read and immediately applicable to your practice as a classroom teacher, instructional coach, or administrator.
- **Glossary.** Each time you come to a bolded word while reading, you can look in the glossary for a more detailed definition.
- **Discussion Starters.** These discussion questions will help you and your teammates understand and apply the information in each chapter.
- **Your Next Step.** These teacher challenges encourage you to move forward in your STEM-infusion journey after each chapter.
- **Photographs.** Photographs in this book will help you envision the activities being described in each chapter.
- **Sample Lesson Plans.** The sample lesson plans explain the lessons described in the chapters in more detail and are found in the Resources section.
- **Lesson Plan Templates.** These resources can be used in planning your own STEM-infused lessons and are found in the Resources section.
- **Additional STEM Challenge Ideas.** These resources will get you started brainstorming your own STEM-infusion ideas and are found in the Resources section.

TESTIMONIALS

STEM-infusion has completely transformed the way I teach and the way I learn. And I am most definitely not the only one. Here are a few examples of perspectives on STEM-infusion:

It has been exciting to see the results of our STEM-infusion efforts unfold in our elementary classrooms. Teachers have collaborated across schools and grade levels to provide students with stimulating project-based experiences. Seeing students use the engineering design process to solve problems and draw conclusions from their work is evidence of a true shift in practice for us.

—Dr. Mike Winstead, Director of Schools, Maryville City Schools
(Maryville, TN)

STEM-infused instruction has totally changed the dynamics of the instruction at our school. Our teachers are facilitators and students have ownership in their learning. Through this rigorous instruction our students develop the valuable life skills of productive struggle, problem solving, and collaboration.

—Mr. Scott Blevins, Principal, Sam Houston Elementary School
(Maryville, TN)

STEM-infusion in my first-grade classroom has allowed students from all ability levels to make more connections within our curriculum, overcome challenges by using multiple problem-solving strategies, and develop relationships with peers based on considerate listening and respectful talk. Plus, most of my students would say it's their favorite part of our classroom!

—Mrs. Dee Dulin, First-Grade Teacher, Sam Houston
Elementary School (Maryville, TN)

WHAT YOU WILL GET OUT OF THIS BOOK

If you are a K–5 teacher, principal, instructional coach, or curriculum coordinator, this book is for you! It will help you do the following:

- Understand a need for STEM-infusion and help you communicate that need to your colleagues.
- Implement STEM-infusion and apply it your to your existing curriculum.
- Integrate content areas in a way that brings both rigor and relevance to your instruction.
- Foster 21st century skills of communication, collaboration, critical thinking, and creativity in both your students and faculty.

I cannot wait to share what I have learned in my classroom and the classrooms of my colleagues in the past few years. Let's get started!