

Preface

STEM has an undeniable presence on the educational landscape. STEM-identified classes, programs, and events are appearing everywhere. States have funded initiatives to develop a generation of STEM teachers. An extraordinary coalition among business leaders, government leaders, philanthropists, parents, and communities at large is generating a crescendo of support for STEM in schools.

STEM seedlings emerged in charter schools, in magnet schools, or as specialized high schools. Supported by government and private dollars, they began to attract attention. Forward-thinking school leaders and their teams traveled to visit them and considered how to replicate them. STEM programs are being created daily across the nation, but few districts are exploring the full depth and breadth of possibility that this book presents.

● DEFINING THE STEM SHIFT

There is a four-word definition for STEM. It involves the four subject areas identified in the acronym . . . science, technology, engineering, and math. The name and the initiative emanate from the National Science Foundation over fifteen years ago, but the seeds for the STEM shift were planted in the 1950s after *Sputnik*. Since then, STEM has grown slowly and organically without sensationalism or the power of legislation and regulation. Now, it is sprouting everywhere.

Our definition of STEM is inspired by the teachers and leaders of the Metro Nashville School District. We see **STEM as a shift in the philosophical framework for teaching and learning**. The shift leaves behind a subject-based, rigidly scheduled, unintegrated system to become one that is **defined by subject integration, project-based learning, relevancy for the lives of children, and structural flexibility**.

STEM-based subject integration challenges the current nature of our “siloes” educational systems and encourages teachers to work together in inter- and trans-disciplinary ways. New interactions emerge causing

changes in relationships among subject areas, teachers, students, and communities. From the interests and the interaction of teachers and students, problems and projects are created. Project-based learning involves students in teams actively working toward solving complex, real-world problems. Relevancy relates content and projects to the lives of our students. Classroom doors open to the community, drawing in STEM professionals as guests, coteachers, and assessment designers and participants. Our vision of STEM brings students into the community (and beyond) through technology to gain experiences and expertise heretofore unavailable. This new system is characterized by organizational and structural flexibility. Schedules no longer constrain the thinking of educators and learners as we become designers of new environments where real-world problems are the focus of student learning

This book investigates STEM as a systemic shift, beginning with revisiting how learning happens and culminating in new learning environments, new structures, and new relationships. The shift relies on access to technology at all levels. It offers the opportunity to reignite the creativity of school leaders and teachers. The interplay of these dynamics, with planning, leadership and resources, becomes a systemwide STEM shift.

As we traveled and listened to the stories of the STEM pioneers, we heard a theme of emergence from within each system. The STEM shift may have been externally set in motion but it was being defined internally. We developed the following chart (see Figure P.1) to describe the emergence of a STEM shift on three levels. We call them Stages I, II, and III. The column on the left identifies who is involved with the interactions shifting at each stage. Moving from top to bottom, more of the school and community are involved. The column on the right describes the characteristics emerging in that stage. The characteristics column is cumulative from top to bottom; therefore, a Stage II shift includes the characteristics of Stage I. Within a school or district in a Stage III shift, all characteristics in the right column will be evident.

You will note that the chart allows **entry at any of the three stages**. Stage I describes an individually led program that affects a class of students. Stage II is defined by the inclusion of several classrooms, multiple teachers, and STEM field professionals. The schoolwide system STEM shift is Stage III. Remember a district can choose the system level entry stage. Three of the districts described in this book did that. One of the differences between a STEM shift and other “reform efforts” is that each teacher, school, and district described in this book decided how fully they wanted to enter the shifting process. Many are following a plan to move from one to another.

Figure P.1 The Emergence of a STEM Shift

Stages	Characteristics Emerging
<p>I Stand-Alone</p> <ul style="list-style-type: none"> • Individually led • Leader supported • Small number of students involved 	<p>Science, technology, engineering, math (and art) centric</p> <p>21st century skills</p> <p>Project-based learning</p> <p>Student-directed discovery</p> <p>Teamwork among students</p> <p>Unit-specific community partners</p> <p>Events highlight student work</p>
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<p>II Collaborative and Cross Disciplinary</p> <ul style="list-style-type: none"> • Multiple teachers participate in planning and delivery • Students from multiple classes or classrooms involved 	<p>Interdisciplinary or transdisciplinary content</p> <p>STEM professionals as partners in classrooms, labs, events</p> <p>Students and worldwide community engaged digitally</p> <p>STEM experts participate with teaching and learning</p> <p>Student presentation of culminating work</p>
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<p>III Systemwide</p> <ul style="list-style-type: none"> • Planned buildingwide or districtwide STEM shift • All teachers • All students 	<p>Culture of innovation, risk taking, and reflection</p> <p>Complex, real-world problem solving</p> <p>Crosses grade levels vertically and horizontally</p> <p>Authentic assessments aligned with STEM</p> <p>Collaborative faculty learning, lesson design, and teaching</p> <p>Ongoing, purposeful professional development</p> <p>Structural flexibility supports opportunity generation</p> <p>Community-, business-, collegiate-embedded partnerships</p> <p>Wholehearted leaders who see the STEM shift as opening possibilities for all children and for the future. They ignite followership, develop capacities, and create energy to sustain the shifting process.</p>

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● THE AUDIENCE FOR THIS BOOK

This book is written for those who want to make informed choices about STEM. Leaders who want to consider making a schoolwide or districtwide STEM shift will find stories from those who have successfully achieved this. Teachers and teacher leaders are offered experiences of colleagues at elementary, middle school, and high school levels who have been pioneers of the STEM shift. Policymakers and school board members will be able to explore implications for fiscal, physical, and human resource issues as the shift begins and disrupts existing policies and procedures. Parents who chose to become STEM advocates will find support and resources. All will become better prepared as ambassadors for STEM-centric learning environments.

● HOW THIS BOOK IS STRUCTURED

The book is structured for a diverse audience. **Part I, Why STEM?** contextualizes the need for STEM in the larger world and within the world of education. It addresses the limiting mental models that may be encountered by those wanting to lead a STEM initiative. Part I introduces STEM as both responsive and future defining, as high rigor, high relevance, and inclusive, as a national imperative, and as locally created and controlled.

Part II, Shifting, invites the reader into the process with practical steps, processes, and stories from those who are already shifting. This part begins with a chapter on leadership. It is purposefully placed centrally within the book. Each story we heard wove a tale of leadership. In some cases, it was an entrepreneurial teacher, in others, it was a visionary district leader but, in all, leaders were essential. We discovered edge walkers, those who have ventured out of the familiar terrain to discover potential in unexplored territory. Choices are locally made, assessment is inherent in the design, and students and communities are the beneficiaries.

The stories come from across the country . . . from Nashville, Tennessee; Salt Lake City, Utah; East Syracuse, New York; Goochland County, Virginia, and elsewhere; from elementary, middle, and high schools, and from public schools in a variety of forms: community schools, magnet schools, and vocational schools. As you read them, you will hear how STEM characteristics within a single classroom vary greatly from those of a whole school or district. **Referencing the chart above will help you determine where the storyteller is located . . . and maybe where you are or want to be . . . in the shift process.** Some are high school programs that

focus on the careers in STEM fields. Others have comprehensively shifted systems, beginning in kindergarten and going through high school.

As career educators, our own entry to the STEM world has been exciting. We have been inspired by those who are the pioneers, and we have become increasingly optimistic about education's capacity to reinvent itself, one school at a time. STEM shifts can reenergize professional educators, can engage children as problem solvers, prepare them to be college and career ready, tap the community as resources, and discover corporations as partners. All the potential for a STEM shift is in your hands.

● HIGHLIGHTS

This book contextualizes and defines the current educational landscape, takes a look at the horizon, delineates how to lead a STEM shift, and shares rich stories from those around the nation who have entered, planned, and implemented a STEM shift. Readers will discover

- The converging forces that cause STEM to be at forefront of the educational conversation, with support rather than deep controversy
- An understanding of what STEM means and how it can shift the learning environments into the 21st century for all students
- The importance of a STEM shift in closing the achievement gap
- The essential elements of leadership and leaders
- Their own readiness and their local questions
- Themselves actively engaged in the reconsideration of how they teach and how children learn
- References and Resources at end of each chapter
- QR codes for some resources that can be found within the text
- Live links and URLs mentioned throughout the book that can be also be accessed by visiting <http://bit.ly/TheSTEMShift> (please note that this URL is case sensitive).

