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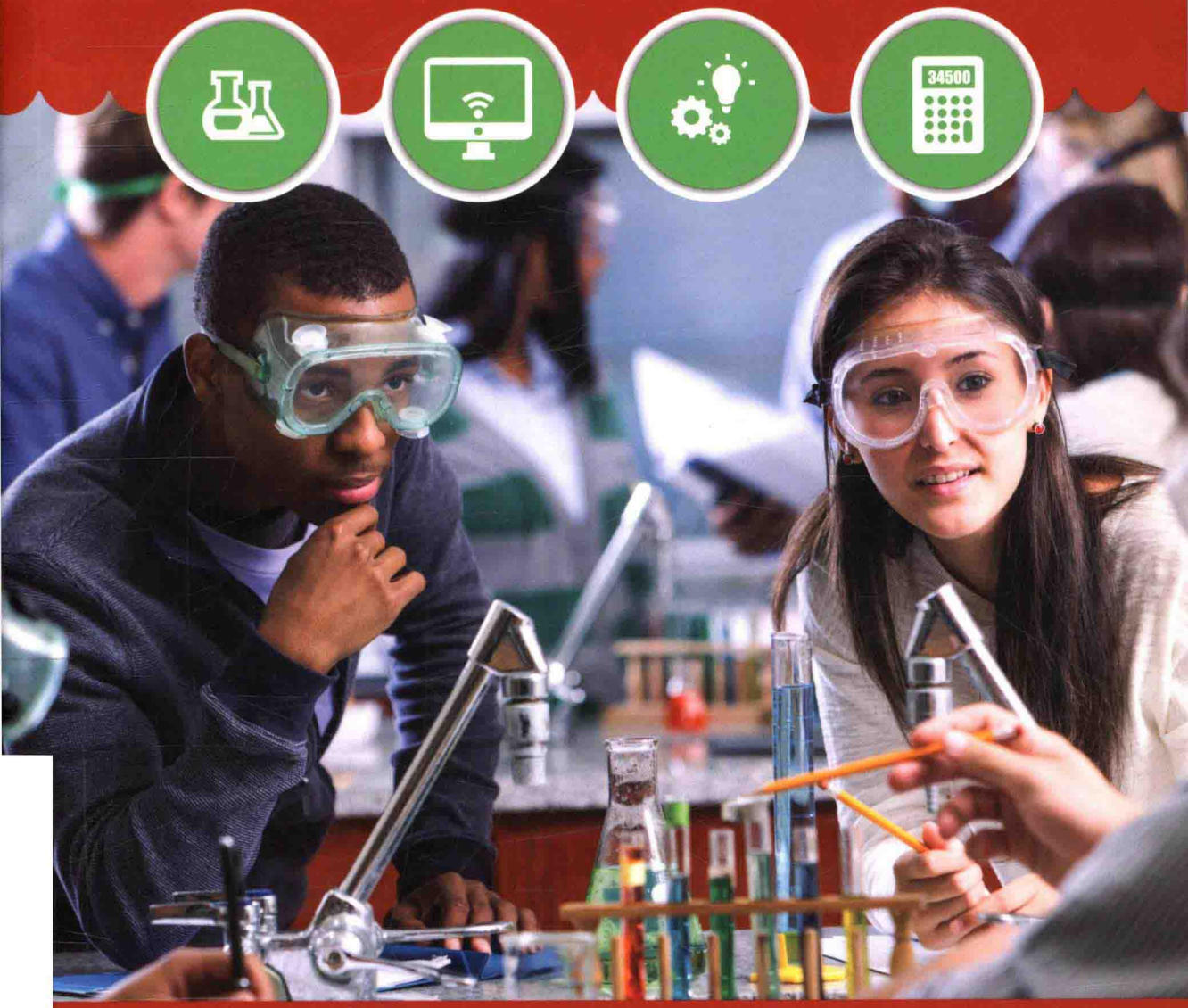
The STEM Shift

A Guide for School Leaders



Ann Myers Jill Berkowicz

"Finally! A great book that clearly explains what STEM education is, why we need it, and how to do it well. A must-read for all educators, parents, and policymakers."

Tony Wagner, author of *The Global Achievement Gap* and *Creating Innovators*

"Reading Jill and Ann's column in Education Week *has been a critical part of my weekly reading since they began writing it. I've learned a lot from those short snippets, and now it's exciting to see their expanded thoughts in* The STEM Shift. *You can't go wrong by reading anything they write!"*

Larry Ferlazzo, high school teacher and *Education Week* columnist

All you need to make the shift to STEM a reality!

Now more than ever, educational leaders are encouraged to implement STEM as the foundation for preparing students with the 21st century skills required for college and career readiness. This resource puts the process of shifting to a comprehensive, integrated STEM school or district within reach!

Invaluable case studies featuring current STEM pioneers from across the country model how successful STEM-centered learning takes place. You'll find process-specific best practices and strategies to help you

- Understand, create, and lead the STEM change process
- Transform existing school programs
- Prepare the school community for STEM and plan for STEM integration
- Integrate 21st century skills, the arts, and humanities
- Create essential partnerships with business and higher education

Use this groundbreaking resource to systematically implement coherent and integrated STEM instruction that transforms learning and prepares students for the global economy!

Access links to video and web content at http://bit.ly/TheSTEMShift

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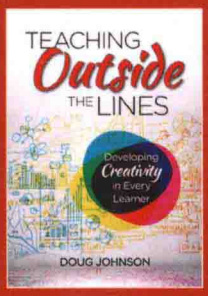

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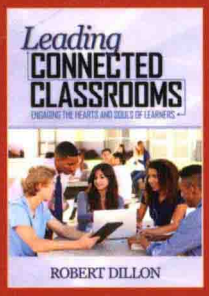

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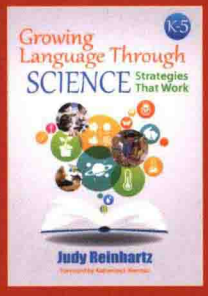

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The STEM Shift

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A Guide for School Leaders

Ann Myers
Jill Berkowicz

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PRAISE FOR *THE STEM SHIFT* BY ANN MYERS AND JILL BERKOWICZ

"*The STEM Shift* provides an excellent overview for a school or district contemplating a move to a STEM learning approach. The authors make a strong case for engaging in a STEM shift and then step through the planning and change processes called for, with special attention to building collaboration and trust. A real strength of the book is the inclusion of real cases and voices from the field where this shift is happening. The inclusion of successful programs and perspectives gives the reader confidence that engaging in a STEM shift is a real possibility for their organization."

—**Peter Brouwer,** Dean, School of Education & Professional Studies and Graduate Studies

"Myers and Berkowicz expose the power of STEM and how it heightens the trajectory for student success. *The STEM Shift* is the definitive go-to guide for educators."

—**Leigh Byron,** Founder and Head of School of STEM-to-Civics Charter School

"*The STEM Shift* frames the current STEM movement as a powerful lever for the learning of all students (and their teachers) and issues a call to leadership to make it so. The book offers both a useful primer on what STEM means and an expansive vision as to what it can be. Both will serve teachers, principals, superintendents, board members and others who will drive this change."

—**Terry Chadsey,** Executive Director of the Center for Courage & Renewal

"Want to know the four most important words for 21st century learning? Authors Myers and Berkowicz reveal that *science, technology, engineering* and *math* are the four words that will unlock your students' learning opportunities and open up a world of possibilities. This book is filled with examples that will help schools and districts become 'STEM-centric' learning environments focused on identifying and solving problems. *The STEM Shift* will help you build bridges to the 21st century . . . and beyond!"

—**Spike C. Cook,** Author of *Connected Leadership: It's a Click Away*

"*The STEM Shift* is a much needed book for K–20 educational institutions looking to move from good to great. It highlights the importance of why we need intentional learning environments that drive innovation and collaboration."

—**Brad Currie,** Lead Learner, Co-Founder of #Satchat, ASCD Emerging Leader, Author of *All Hands on Deck: Tools for Connecting Educators, Parents, and Communities*

"This insightful book casts light on the important issue of teaching STEM in a coherent and integrated way. The strategies presented go beyond curricula in each discipline to focus on four design principles: subject integration, project-based learning, relevancy, and structural flexibility. This is an important, useful resource for anyone interested in STEM."

—**Chris Dede,** Wirth Professor in Learning Technologies

"In these days of initiative fatigue, it is easy for leaders and teachers to bypass all that is good about our changing education system. If they do, they are missing great opportunities to advance. Unfortunately, STEM is sometimes seen as the new four-letter word in initiatives and it shouldn't be. In *The STEM Shift*, Ann Myers and Jill Berkowicz offer compelling reasons why all schools need to make the shift and provide practical tools that will help schools get there."

—**Peter DeWitt,** Corwin Consultant and Author of
Flipping Leadership Doesn't Mean Reinventing the Wheel

"The authors provide examples from real leaders across the country who have transformed their school to increase STEM instruction. This book will make readers think about ways to revolutionize schools by embracing the critical importance of STEM education."

—**Lisa Dieker,** Professor and Lockheed Martin Eminent Scholar Chair

"Reading Jill and Ann's column in *Education Week* has been a critical part of my weekly reading since they began writing it. I've learned a lot from those short snippets, and now it's exciting to see their expanded thoughts in *The STEM Shift*. You can't go wrong by reading anything they write!"

—**Larry Ferlazzo,** High School Teacher,
Education Week Columnist, and Author of *Helping Students Motivate Themselves*

"Myers and Berkowicz have done a masterful job of articulating the current and future need for all to engage in conversations about STEM. They outline the importance of using inclusive, collaborative, and innovative engaged learning pedagogies and strategies for all teachers and students. Their final 'call to action' chapter is powerful. I would highly recommend this book to anyone!"

—**Susan R. Madsen,** Orin R. Woodbury Professor of Leadership & Ethics

"The world is evolving at a feverous pace, and this requires students to think and apply skills differently. Myers and Berkowicz provide a compelling narrative loaded with examples from the field to provide educators and schools with the necessary foundation to provide students with the STEM skills and knowledge they need to succeed in careers while better supporting how they learn best."

—**Eric Sheninger,** Author of *Digital Leadership* and *UnCommon Learning*

"Finally! A great book that clearly explains what STEM education is, why we need it, and how to do it well. A must-read for all educators, parents, and policymakers."

—**Tony Wagner,** Author of *The Global Achievement Gap* and *Creating Innovators*

Digital Resources

Access links and videos at http://bit.ly/TheSTEMShift (please note that this URL is case sensitive).

This content will continue to be updated, so please return for new resources and links!

Note From the Publisher

The authors have provided video and web content throughout the book that is available to you through QR codes. To read a QR code, you must have a smartphone or tablet with a camera. We recommend that you download a QR code reader app that is made specifically for your phone or tablet brand.

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PART I. WHY STEM?

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PART II. SHIFTING

Chapter 6. The Shift Begins Within a Leader

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Chapter 10. Developing Capacity: STEM-Centric Professional Development

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Chapter 12. STEM Collaborations and Trust

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Chapter 13. A Call to Action

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EdSurge (for science and technology news and updates): https://www.edsurge.com

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Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences of the United States of America, 111*, 8410–8415 (meta-analysis about effect of lecture on learning): http://iteachem.net/wp-content/uploads/2014/05/Freeman-S-Proc-Natl-Acad-Sci-USA-2014-Active-learning-increases-student-performance-in-science-engineering-and-mathematics.pdf

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STEMconnector (information about STEM): https://www.stemconnector.org

Teaching Institute Excellence in STEM (TIES): http://www.tiesteach.org

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 "siloed" 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
Enter Here *or*	**I Stand-Alone** • Individually led • Leader supported • Small number of students involved	Science, technology, engineering, math (and art) centric 21st century skills Project-based learning Student-directed discovery Teamwork among students Unit-specific community partners Events highlight student work
		+
Enter Here *or*	**II Collaborative and Cross Disciplinary** • Multiple teachers participate in planning and delivery • Students from multiple classes or classrooms involved	Interdisciplinary or transdisciplinary content STEM professionals as partners in classrooms, labs, events Students and worldwide community engaged digitally STEM experts participate with teaching and learning Student presentation of culminating work
		+
Enter Here	**III Systemwide** • Planned buildingwide or districtwide STEM shift • All teachers • All students	Culture of innovation, risk taking, and reflection Complex, real-world problem solving Crosses grade levels vertically and horizontally Authentic assessments aligned with STEM Collaborative faculty learning, lesson design, and teaching Ongoing, purposeful professional development Structural flexibility supports opportunity generation Community-, business-, collegiate-embedded partnerships 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.

● 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

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