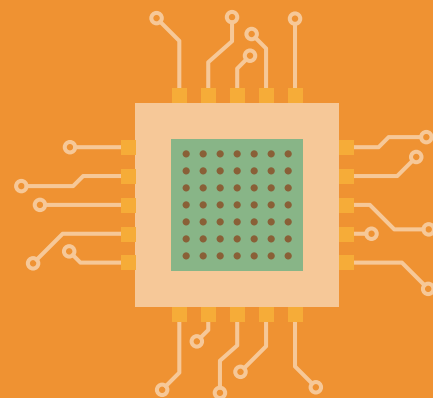
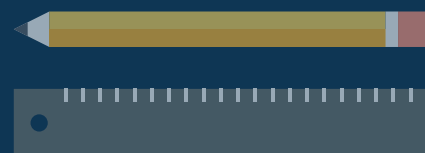
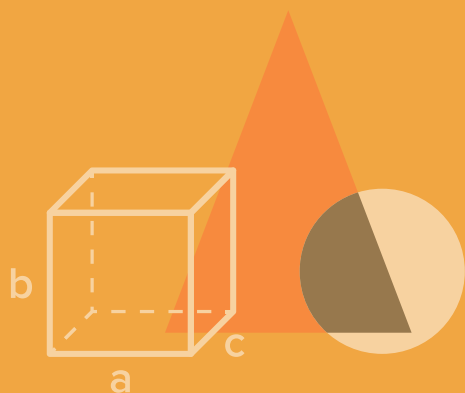




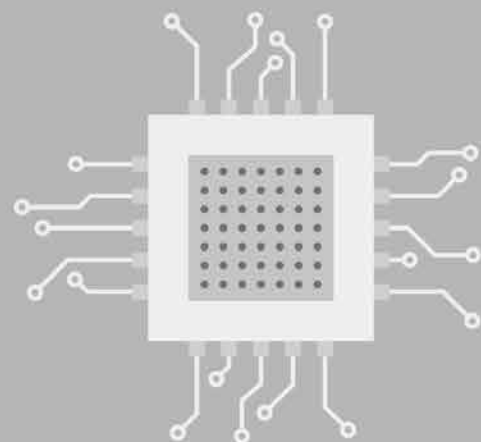
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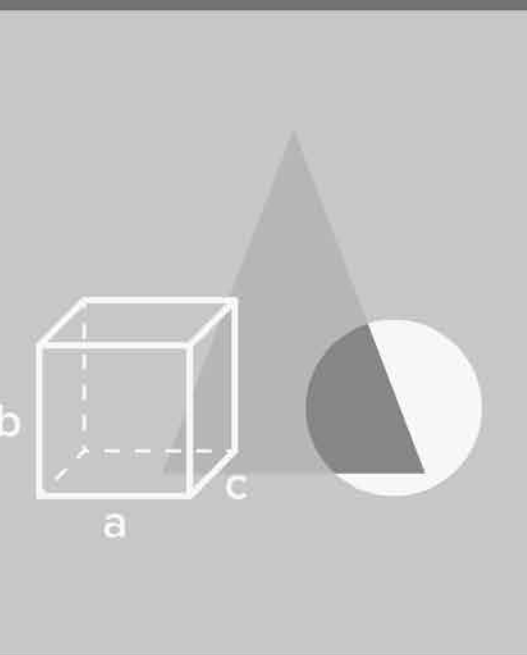
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Creating a STEM Culture

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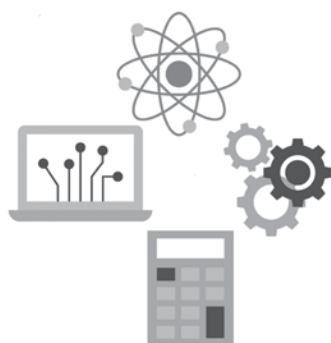
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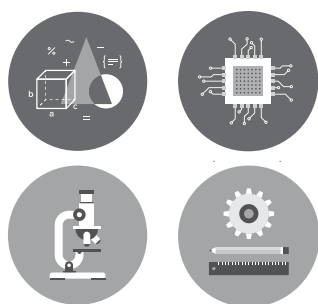
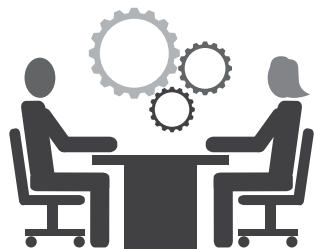
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About This Book

*C*reating a STEM Culture for Teaching and Learning is small part historical treatise and most part contemporary profile. Its content reaches back 30 years when SMET and STS were the operative abbreviations for a transformative, nascent vision for education. And it stretches forward decades, painting the horizon that awaits this generation of learners. Between those outward points on the time line of the most exciting era in science and mathematics education, the story of STEM unfolds as a *how-to, can do, who's who, you too* manual and memoir based on the experiences of leaders who walk the talk. Each chapter is sprinkled with light-hearted illustrative case studies and metaphors along with real-time exemplary vignettes to complement the topic at hand. What this book is *not* is a compendium of all known programs across the country, although it highlights a significant few. It is also *not* a research tome that reads like a doctoral dissertation, although a number of studies and references are cited in support of claims.

At its essence the book channels the wisdom and practice of hundreds of professionals in education, business, nonprofit, and state and local government who together have built nationally recognized models for STEM from the level of theory and policy to street-level credibility of the classroom. It is for teachers, administrators, business partners, community members, parents, scholars, and policy makers who seek to be up-to-speed on the many elements of STEM about which this book was compiled. Inspired and prepared students will be the measure of its success.

Acknowledgments

A decade of personal encounters, life experiences, research studies, and probing observations amalgamate in *Creating a STEM Culture for Teaching and Learning*. Its existence owes to trusted mentors who said such a book is needed and that I am the one to do it. It traces back to visionary school leaders who tolerated my STS teaching forays in the pre-STEM science classroom and to university deans and department heads who later embraced the maverick-to-mainstream STEM transformation of courses and programs to which I was entrusted. It is a prominent credit to leaders in Iowa government, most notably she who has the last word in Chapter 9. Governor Kim Reynolds positioned me to direct, alongside amazing teammates, one of the most comprehensive, dynamic, and productive statewide STEM projects from which the purview between these covers draws. This book is a stew of thoughts and actions of 17 direct contributors and countless more who indirectly shaped education's STEM awakening. Should any of those mentors and thought leaders wonder to whom I refer, I look forward to dispelling their wonder.

Bravo to NSTA Press for advancing STEM education by welcoming the concept of this book and for nurturing its refinement toward public consumption.

Finally, the investment of hundreds of hours over countless nights and weekends in producing this book asked the greatest contribution of those closest to me. My sons David (who provided early, key reviews) and Andrew (with his new bride Madison) adapted gracefully to my schedule curveballs, all the while inspiring me by their devotion. But it is my life partner Mary who attended to all things not STEM to keep us happy, healthy, and connected during my single-mindedness. She also deserves credit for many of the bright ideas attributed to me over the course of Iowa's STEM journey. Her prints are all over this work.

About the Author

Jeff Weld, PhD, has directed the acclaimed Iowa Governor's STEM Advisory Council since its inception in 2011. On extended leave from a faculty position in the Department of Biology at the University of Northern Iowa where he specializes in science education, Weld is a frequent speaker, consultant, and writer on the national STEM scene. Formerly an award-winning high school science teacher in Mission, Texas; Kirkwood, Missouri; and Pella, Iowa; he draws inspiration for this book from the hundreds of colleagues and friends navigating the uncharted but promising waters of STEM education together. Many helped him account for the essential elements of STEM that follow.

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Community Buy-in for STEM



It is at the community level where STEM dreams come to life. But the community in recent history has been neglected in educational innovation, despite serving as the linchpin to “viral” expansion of the good habits, practices, and goals of STEM. Of all the great possibilities in cross-pollination from the world of business to education, messaging ranks near the top. Schools and organizations that capitalize on the power of public awareness strategies win over audiences. Revisiting the notion that citizens’ perceptions of school become their reality, successful STEM programs are at work shaping public perceptions.



CHAPTER 3

Re-entry of the Community to Educational Discourse

The marrow of any STEM network skeleton is the community, where the magic happens. Local, regional, statewide, and national networks are re-engaging communities in

the discourse as well as delivering new era educational programming. This is a recent resurgence. An historic educational upheaval equal to today's STEM disruption predates it by almost a century. As so many upheavals go, it was an innovation made possible by a new technology that held great promise but ushered an unforeseen disconnect between schools and their communities. The innovation was regional comprehensive schools, made possible by a new technology, the school bus.



The school bus was a supremely disruptive technological innovation for 20th-century education.

School and Community Decoupled

Blue Bird, the brand burned into the psyche of every transported school child, turned out its first steel bus in 1927. Built on the chassis of a Model T, it could carry a dozen youth at speeds up to 40 miles per hour at about 20 miles per gallon. With a tank of gas costing about \$2.50, lots of kids could be moved a few miles each day for very little money. And that helped spell the demise of the one-room school.

An American education was once a quite personal, umbilical connection of learners to their communities. At their peak in the late 19th century, Iowa had more than 12,000 one-room schools, within walking distance for nearly anyone seeking to learn. The schools were built by the local citizenry who recruited the teacher, collectively contributed to salary, and rotated responsibility for the teacher's room and board. The curriculum asked basic skills development in reading, writing, and arithmetic—essential know-how to function and contribute as farmers and merchants. The era of an agrarian economy linked schools



F. D. Richards, Wikimedia Commons, CC By-SA 2.0.



and their communities locally and viscerally. Yet, pressures were looming—forecast by electrification, telephones and radio, cars, trucks, highways, banking, and manufacturing—on schools. Functionality in the rural community was inadequate for what Peter Drucker (1992) coined the term *Knowledge Economy* around the turn of the 20th century.

A new set of basic facts and skills provided the graduate a visa to a career in industry (and increasingly, access to higher education). To set the table for a more modern curriculum, the National Education Association's "Committee of Ten" in 1892 rolled out expectations that persist to this day—classes in abstract mathematics, the suite of sciences including biology, chemistry, and physics, as well as history and foreign language. It is in that confluence of higher expectations, specialized learning, and school buses that community connections to schooling frayed and popped loose. Youth were trucked off to regional schools, divided into grade levels, and taught the universal curriculum of success-for-the-times by imported subject matter experts. Everyone graduated with at least a command of long division, stoichiometry, and Hamlet. The product of K–12 was factory job-ready or queued up for college.

Divergent Evolution of Schools and Communities

Drucker's Knowledge Economy gave way to the Information Age with the rise of computers and the internet in the late 20th century. The need for subject matter experts to pour information into the heads of learners evaporated. "Today knowledge is free. It's like air, it's like water," said Tony Wagner of Harvard University's Innovation Lab, at the 2015 Second Annual Symposium on Global STEM Education at Harvard Graduate School of Education. He continued, "There's no competitive advantage to knowing more than the person next to you. The world doesn't care what you know. What the world cares about is what you can do with what you know."

Meanwhile it has been said that a time traveler up from the 19th century would find nearly everything about our era bewildering except maybe the instructional mode of some of our schools and colleges. By contrast, a tour through a John Deere tractor factory—with its computer-numeric-controlled robotic assemblers, precision axle milling to the micron, triangulated satellite guided autopilot control systems—would render our time tourist catatonic. The bewildering pace of advancement in the modern workplace coupled with our lost competitive advantage for knowing lots of things are the factors driving a reconnection of schools and their communities. Schools cannot create the modern product—collaborative, adaptive, real-world problem solvers—without help from the community. And Eric Engelman knows why.

Engelmann is the president of a software company, Geonetric, in Cedar Rapids, Iowa. They specialize in web-based health-care tools. He revealed at the 2014 Association of Business and Industry's Taking Care of Business conference what it is that keeps him up at night, "My 70 employees who are more like family depend on me and this business to stay fresh and front-edge because right now somewhere in Paris or Tokyo or Tucson somebody



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is building a competitive product. We've got to be constantly striving, improving, and innovating." Geonetric, like all global businesses (except maybe a rare few who occupy such a specialized niche that they have no competitors ... yet) dwell in a piranha pit of accelerated Darwinian evolution. New technologies and strategies that build efficiency and profit are the traits of fitness for survival. The advent of Kaizen-like practices toward lean and continuous improvement are examples of strategies that spread through the pit enhancing the fitness/profitability of early adopters. Cybersecurity of proprietary information is an essential technological adaptation acquired by survivors in the competitive piranha pit of global business. Corporations must constantly evolve, sometimes dramatically rapidly, as did McDonald's with an all-day breakfast, and Microsoft with the acquisition of LinkedIn to access a vast professional network, or perish like Pets.com, RadioShack, Blockbuster, Borders Books, Circuit City, Atari, Polaroid, and so on.

Public schools, by contrast, rarely dwell in such competitive environments (though the charter movement, vouchers, and online schools are dialing up the heat in some regions)—more of a bucolic pond of meandering koi and catfish than a pit of piranhas. Schools evolve, too, of course, but at a comparatively leisurely pace. New technologies are adopted—smart boards, 1:1 digital devices, learning diagnostics—but their impact on learning can be incremental more than revolutionary. Teachers take part in professional development to differentiate instruction, flip the classroom, and bring gaming to learning, with each innovation moving the needle, not breaking the gauge. Over time, varied survival pressures result in almost unrecognizable relatives—schools and the communities that depend on them.

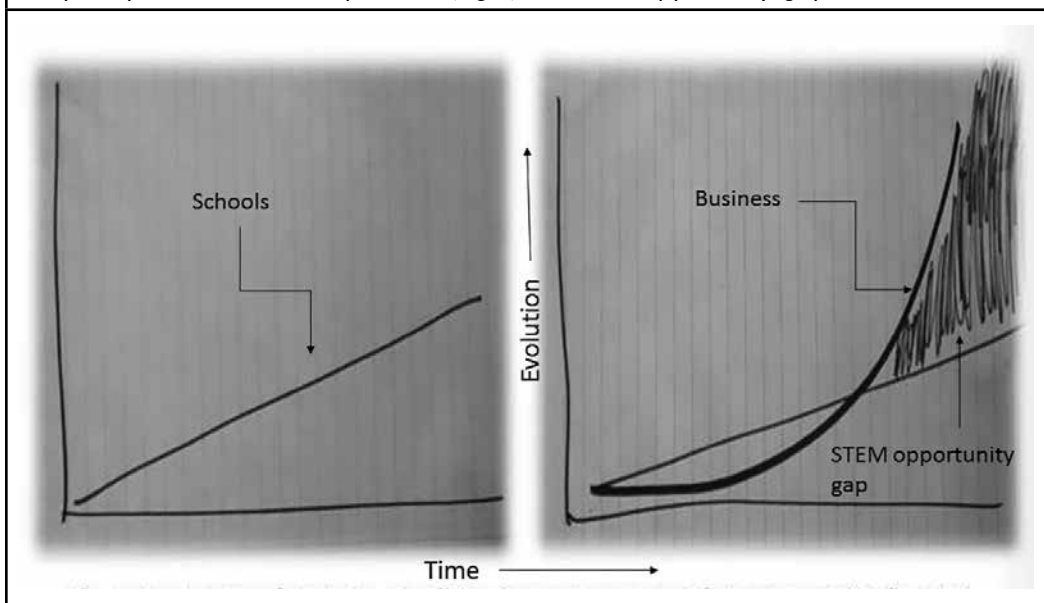
A natural analogue to the school–community disconnect is dolphin–hippo divergence. They branched off the same family lineage about 50 million years ago, during one of Earth's warm eras where seas were expansive and land was swampier thanks to melted polar ice caps. One side of the family tree opted for the carnivorous life and hit the water in pursuit of small fish, the other chose swamp life and vegetarianism. A 2009 research study points out similarities in their ears, skin, bones, and teeth not to mention genes, which solidly link the lineages of hippos and dolphins. But time and environment can really do a number on appearances. Bulky legs and deep-set ear parts were more costly than helpful underwater. And a trachea venting the lungs out of forward-positioned nostrils simply would not do. A watery world favored ear drums right up on the skin, and fins where legs were. A blowhole atop the head that can exchange air in a fifth of a second was the answer to nostrils under-sea. Millennia and survival adaptations separated two close relatives (Spaulding, O'Leary, and Gatesy 2009).

Time and environment have also separated the world of education from its community of employers and workplaces that await graduates. Environmental factors including busing, teaching for a knowledge economy, and the onset of the information age (now on to the Innovation Age, according to Tarak Modi's insightful 2011 book *Living in the Innovation Age*), compounded by time, has resulted in a gap—the two sides hardly recognize one another. That gap is an opportunity space where STEM enters in (Figure 3.1).



Figure 3.1. The STEM Opportunity Gap

The arithmetic pace of change in schools: Steady improvements to infrastructure and professional development means a better experience each year (left). The logarithmic pace of change in business: Rapid improvement through research and development, adaptive processes, and acquisitions (right) create an opportunity gap for STEM.



School and Community Coupled Again

STEM connects the bucolic educational pond of koi and catfish to the piranha pit of the broader community, making both better. Consider STEM a channel introducing cutting-edge business practices to education while awakening the work world to its talent pipeline—wonders, warts, and all. As a hybrid reform movement, STEM has been called an *edu-nomic* development initiative, a term that generates over a million Google search hits (through some sort of algorithmic miracle, Iowa STEM usage shows up in position 7—or positions 1, 6, and 8 with *development* attached—as of the time of this writing). A quick aside is in order, an homage to career and technical education (CTE): school–business partnerships are the heartbeat of CTE and have been since the birth of the nation (remember Johnny Tremain?). STEM brings such partnerships mainstream in terms of both lateral connections across core disciplines, and horizontally kindergarten through grade 12, as will be explored in more detail in the next chapter. How schools are re-engaging communities in the name of STEM may take many forms, with three key ways dominating the landscape: school–business collaborations, messaging, and bringing STEM to the community.



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School–Business Collaborations

The breadth of this topic and its explosive growth as both a priority and practice in schools across the country merits a chapter solely devoted to exploring a thorough profile. For now, the imperative that has brought business to the table to lend a hand in talent production was succinctly stated by Andreas Schleicher, director of education and skills at the Organization for Economic Cooperation and Development, who said at the Governor’s 2016 Future Ready Iowa Summit, “Your school system today is your economy of tomorrow.” The community has come to grips with that reality and in some places, brings the cavalry to help at school. More to come in Chapter 4, devoted to school–business partnerships.

Messaging

The field of education in general, and STEM education particularly for our purposes, could take a lesson from the engineering profession. In 2008, the National Academy of Engineering produced a report *Changing the Conversation: Messages for Improving Public Understanding of Engineering*. The report had two overarching goals: to elevate the importance of the profession in the minds of the public, and to draw more youth into the profession. The mechanisms developed include tactical messages and strategies for getting the word out. Taglines that emerged from the study included “Engineers make a world of difference,” and “Engineers help shape the future.” Professional societies, academic institutions, and corporate partners were charged with carrying the message forward (National Academy of Engineering Committee on Public Understanding of Engineering Messages 2008). Today, engineering is one of the fastest growing undergraduate majors, on a steady incline since 2007 including a 7.5% enrollment spike in 2014–2015 according to the American Society for Engineering Education working paper “Engineering by the Numbers” (Yoder 2015). Engineering colleges across the country are experiencing enrollments boosts, including Michigan State, Olin College, the University of Oklahoma, Belmont, Youngstown State, MIT, and Iowa State, to name but a few.

STEM education could be the best thing for U.S. education since Horace Mann, but if the community does not get the memo, all of the evidence and expertise is stunted. Yet messaging is often an afterthought, or at least undervalued. When Iowa launched a state-wide STEM initiative in 2011, a public awareness campaign was proposed by members of the Governor’s STEM Advisory Council. The rationale centered on citizen buy-in, which would steel legislators’ resolve. But a counterargument prevailed, that precious taxpayer resources ought to be maximally committed to programming directly benefiting youth rather than to a seemingly nebulous ad campaign aimed at manipulating lawmakers and the public. It was a principled stance that tested well with constituents. And it was wrong.

Among the two-dozen metrics annually gauged by evaluators of the state’s STEM program is public awareness and support of STEM. A random survey of a sufficient number of Iowans to permit generalization to all the citizens of the state shows a doubling (from 26%



to more than 50%) who recognize the acronym STEM since 2012 (Heiden et al. 2016). And respondents affirm the STEM imperative at a 90% clip once familiarized. Public service announcements on television and radio, billboards along the interstates, social media posts, tweets, pins and chats, bumper stickers, lapel pins, newspaper columns, branded trinkets, event exhibits, and more tactics carry Iowa's STEM message to the masses today as a result of a grand compromise that vaulted public awareness from ill-advised to indispensable. Leaders agreed to a communications budget line of about 3% of the legislature's STEM appropriation so long as vendor bids included a dollar-for-dollar match. The brand "Greatness STEMs From Iowans" debuted in 2013 and has never looked back (Figure 3.2). The campaign proved to be a cyclic feedback loop of awareness-begetting support that figured prominently in achieving a tipping point of engagement across agencies and organizations joining the STEM awakening.

The Design of a State's STEM-Messaging Campaign

In 2013, the advertising agency Strategic America (SA) of West Des Moines, Iowa, was selected from a competitive pool of applicants to develop the state's STEM brand and message. SA works with such brands as Lennox, Wendy's, Pella Windows and Doors, Toro, and other national as well as local clients. Matching the state dollar-for-dollar, SA focuses on media relations, events, and a messaging toolkit to drive the Greatness STEMs From Iowans campaign.

Branding is the primary tool that SA wields to drive excitement and inspire action around any product or service. A bright, invigorating logo of fun colors is high up on the early to-do list. The team at SA came up with the Greatness STEMs From Iowans logo and look (Figure 3.2) to "Convey the idea that greatness can come from the young people of Iowa." Courtney Shaw, STEM account manager for SA, revealed the inner workings of creative minds as "A play on words, visual appeal and contemporary block type intentionally tilted [to] indicate that this is not your ordinary teaching platform, but something fun and exciting."

Once branded, the message was shaped in collaboration with leaders of the state STEM initiative. A goal was forged from a molten stew of factors ranging from academic skills to economics, from public enthusiasm to career connections. SA arrived at a mission to "create a public awareness campaign that increases interest in and awareness of STEM education in Iowa, and develop a creative platform that will incite ingenuity, deliver key messages and build on the existing efforts and activities of the STEM

Figure 3.2. Iowa STEM Logo

Brand can contribute significantly to public support for STEM. The advertising agency Strategic America produced this logo for Iowa STEM.





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initiative.” Target audience came next, which were “key supporters in accepting and promoting the STEM initiative” according to Shaw and included primarily leadership and members of the Governor’s STEM Advisory Council, followed by K–12, youth agencies and nonprofits, higher education, employers, parents, legislators, and media outlets themselves.

The strategies and tactics employed by SA to execute Iowa’s STEM integrated communications campaign focused on four main areas: public and media relations, events, billboards and public service announcements, and a messaging toolkit. When it came to media relations Shaw detailed, “Our team created and maintained a statewide media list to pitch unique story ideas to outlets across the state. We also hosted media training sessions, coordinated the launch of the Iowa STEM PSA, created talking points, wrote opinion guest editorials, coordinated speaking engagements, created media packets, and conducted various pitches resulting in media coverage.”

SA also helped the STEM Council with major events, including STEM Day at the Iowa State Fair, the Lt. Governor’s STEM Town Hall Tour, and others. STEM billboards dotted the state, and a television commercial featuring Pinterest CEO and Iowa native Ben Silbermann was broadcast statewide. Finally, a toolkit that included a message map, PowerPoint presentations, lapel pins, letterheads, business cards, banners, bookmarks, brochures, flyers, Greatness STEMs From Iowans video, and other items was delivered to the Council and various STEM supporters.

Measuring the effect of SA’s awareness campaign is important to STEM leaders, especially in answer to the early (and lingering) skeptics. Findings from the aforementioned public survey are critical feedback that equip SA “to create measureable goals that align with the direction of Iowa’s STEM initiative” according to Shaw. In addition to data from STEM’s annual survey, the SA team also conducts quarterly media coverage reports detailing the number of media placements, impressions, locations, key messages, and open rates for all STEM stories published across the state over time. All the while, she keeps focused on understanding the wants, needs, and desires of the target audience, resulting in a substantial increase in the interest and awareness of STEM in Iowa. And a value-add unanticipated by the STEM Council but figuring prominently in the partnership’s success is that the agency really cares. “Our devotion to this initiative shines through every single project we have done, and will do,” Shaw affirmed, “because we are passionate about STEM.”

Bringing STEM to the Community

This chapter rounds out with a third and most powerful mechanism by which schools are re-engaging communities in the name of STEM: bringing STEM to the community. Citizen access to the community school is often limited to sporting events, band concerts, parent-teacher conferences, and, for a limited few, school board seats. Otherwise it can be something of a black-box mystery what takes place between 8 a.m. and 3 p.m. behind those walls, save for the school day revelations that may spill forth over the family dinner table.



“The traditional isolated way that many schools have functioned,” argued Mavis G. Sanders, “is anachronistic in a time of changing family demographics, an increasingly demanding workplace, and growing student diversity” (Sanders 2005). More and more STEM educators are de-isolating schools for these changing times.

Festivals, events, showcases, family night, science fair, robotics competitions, and other means of dismantling the walls between schools and communities generate buy-in. One of the biggest and best family STEM events is Minnesota’s STEM Day at the State Fair (<http://stemdaymn.org>). Annually since 2009, dozens of exhibitors and stage performances enrapt many thousands of families from across the North Star State, supported by select corporate sponsors. Their neighbors to the south found the concept so appealing that since 2012 the Iowa Governor’s STEM Advisory Council has sponsored STEM at the State Fair as a means to access the broadest and most diverse an audience gathered in any one place throughout the state (www.iowastem.gov/STEM-Day-Fair). Exhibitors from industry, higher education, K–12, trade organizations, and more provide scintillating learning experiences to children and their families. Popular exhibits include the Pella Window company’s baseball-proof glass door, Rockwell Collins’ flight simulator, and the University of Iowa



Photos courtesy of the author.

STEM at the Iowa State Fair, a premiere community engagement event, draws thousands of visitors each year for hands-on activities and awareness.



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Medical College's Laparoscopic Surgical Trainer. By sunset on the fair, some 10,000 children and adults take part in one or more exhibits. Surveyed adults rate STEM at the State Fair an average 8.9 out of 10 for excellence. Children exit "more interested" in STEM at about an 80% frequency, with over 90% rating STEM at the State Fair "a lot" of fun.

What works at the statewide level scores even bigger locally. Community STEM events abound, driven by schools as well as employers, economic developers, libraries, universities, zoos, museums, churches, and combinations thereof. iExploreSTEM (<http://iexplorestem.org>) was a festival concept hatched in 2011 that has spawned replicas throughout Iowa and across the Northwest United States. Evidence of effect is similar to the impact of STEM at State Fair: Adults rate the value of iExploreSTEM at 8.7 on a 10-point scale, and 82% of children rate it "a lot" of fun with 79% expressing more interest in STEM as a result.

Designers of iExploreSTEM developed a detailed manual for community STEM festivals that includes a timeline, essential partners, funding sources, form templates, evaluative considerations, and more at <http://bit.ly/2oENyaV>. Plenty of other resources exist for anyone contemplating a bridge event that connects schools with communities in the name of STEM. For example the American Association of University Women (AAUW) coaches local chapters on how to host a STEM event (see www.aauw.org/resource/workshop-hosting-a-stem-event). North Carolina's STEM Community Collaborative released a 2012 Guide to STEM Community Engagement that features a systematic "community visioning and design process" (www.ncpublicschools.org/docs/stem/resources/diy-guide.pdf). Finally, the Science Festival Alliance is a membership organization of planners and executors of community science festivals. Among its resources is a Neighborhood Science Toolkit full of examples, templates, activity ideas, and even signage samples, which can be found at <http://sciencefestivals.org>.

A Community STEM Event Par Excellence

The first USA Science and Engineering Festival took place in Washington, D.C., in April 2010, and Dr. Gina Schatteman, on leave from her faculty post in Physiology at the University of Iowa for a Fellowship at the American Association for the Advancement of Science, helped plan it. "We regularly celebrate sports and the arts in this country, but rarely STEM," Schatteman explained, "It seemed overdue that STEM be included in our cultural landscape."¹ The USA STEM festival had planted a seed in Schatteman's mind about scaling such an event to the local level. Upon return to her home state, Schatteman discovered a convergence of interest along the same line of thinking from the State Hygienic Laboratory and an inter-university Iowa Math and Science Education Partnership (IMSEP). The three parties brainstormed a homegrown, scalable version of the national festival and iExploreSTEM was born.

The first iExploreSTEM festival was held on the lawn of the State Hygienic Laboratory in Coralville, Iowa, in September 2011. It featured 37 tent-based activities, three mobile

¹ Quotes in this section are from the author's personal communications with Schatteman on June 2016.



labs, an “elevator pitch” competition, two interactive stage presentations, and a tour of the State Hygienic Laboratory. Exhibitors included representatives from universities, corporations, nonprofit organizations, schools, museums, and the media. Up to 1,000 visitors were expected, though Schatteman admits, “I was terrified that no one would come.” In fact nearly 2,000 visitors showed up despite inclement weather, giving the team its first inkling of the thirst for such events in communities across the state and beyond.

The design and intent of iExploreSTEM was and continues to be about exposing children and their families to the STEM educational pathways in their midst, and to the careers right in their own backyards that await. Thus it is a very personal, locally relevant bridge-building experience both for planners as well as participants. Instrumental to the event’s success is community ownership—planning from afar by detached organizers is a recipe for failure. And so is poor logistical planning. “The experience of neither the exhibitors nor attendees should be tainted by poor organization,” cautions Schatteman. Much like a restaurant whose reputation is on the line with each dinner served, subsequent STEM events will depend on healthy relationships born of respect and organization in the early going. And, planners, exhibitors, and support crew all must commit to a free event in order to draw the most diverse and deserving of audiences.

Planners do well to incorporate an assessment plan into developments right from the start. Not only do exhibitors and sponsors rely on evidence to provide return on investment, but future events evolve under the bright light of measurement and feedback. The first iExploreSTEM was assessed by a university team from the IMSEP, and since then Schatteman has engaged a National Science Foundation consortium of science festival evaluators, EvalFest (www.evalfest.org), for protocols and instruments to gauge effect. She continues to value three primary metrics: enjoyment and learning on the part of children and families, exhibitor satisfaction, and achievement of event goals, including sheer numbers of attendees as well as their breakdown by gender, ethnicity, race, demography, and geography. One more measure that Schatteman considers is sustainability, stating that “If I am not around next year, will the community organize the festival again?”

There were 44 community STEM festivals enlightening over 13,000 citizens across Iowa in 2016, all built on the iExploreSTEM model. Schatteman has expanded iExploreSTEM throughout the Northwest United States. Her advice for others contemplating a STEM festival? “Start early,” and “Involve as many partners as you can. Many hands make light work and you maximize community buy-in.” Naturally her coaching tips include taking advantage of the planning guides available through iExploreSTEM or the Science Festival Alliance (<http://sciencefestivals.org>) and elsewhere. Importantly, events need to feel local and fresh, by ensuring that exhibitors reflect the demographics of the community and understand the nature and mission of the day (hands-on fun versus static displays, for example). And don’t overlook the significance of site and date. “Avoid holding your festival in a school building if at all possible” because in Schatteman’s experience, “No one wants to go back to school on Saturday.” Nor “will anyone come if it’s the day of the Iowa vs. Iowa State football game.”



CHAPTER 3



Reprinted with permission from Aziza Chaouni Projects.

An eco-lodge design for Marrakesh, Morocco, by Aziza Chaouni is shown. As do architects of STEM partnerships, Chaouni brings a diverse voice to the table.

Architects of STEM

The inspiring architect Aziza Chaouni devotes her life's work to reconnecting human environments to the landscape—relinquishing a bit of control back to nature. She pulls together eclectic teams of local communities, experts in geology, hydrology, botany, structural engineering, and landscaping, to build restorative, harmonious habitats. Aziza's work parallels the modern STEM builder committed to reconnecting schools and their communities after a knowledge economy-driven fissure abetted by school buses. STEM's counterparts to Aziza dwell in that opportunity gap between the arithmetic rate of change in schools and the logarithmic pace of business. They, too, enlist diverse arrays of experts in unifying the worlds of education and industry as architects of partnerships, messaging, and community events. They do for schools what all-day breakfast did for McDonalds—strengthen the brand by adapting to an ever-evolving environment. STEM, all day.

References

- Drucker, P. 1992. *The age of discontinuity*. Piscataway, NJ: Transaction Publishers.
- Heiden, E. O., M. Kemis, M. Whittaker, K. H. Park, and M. E. Losch. 2016. Iowa STEM monitoring project: 2015–2016 annual report. Cedar Falls, IA: University of Northern Iowa,



- Center for Social and Behavioral Research. Modi, T. 2011. *Living in the innovation age: Five principles for prospering in this new era*. Springfield, VA: TekNirvana.
- Modi, T. 2011. *Living in the innovation age: Five principles for prospering in this new era*. Ahmedabad, India: TekNirvana.
- National Academy of Engineering Committee on Public Understanding of Engineering Messages. 2008. *Changing the conversation: Messages for improving public understanding of engineering*. Washington, DC: National Academies Press.
- Sanders, M. G. 2005. *Building school-community partnerships: Collaboration for student success*. New York: Skyhorse Publishing.
- Spaulding, M., M. A. O'Leary, and J. Gatesy. 2009. Relationships of Cetacea (Artiodactyla) among mammals: Increased taxon sampling alters interpretations of key fossils and character evolution. *PLOS ONE* 4 (9): e7062. doi:10.1371/journal.pone.0007062.
- Yoder, B. L. 2015. Engineering by the numbers. Working Paper, American Society for Engineering Education, Washington, DC. www.asee.org/papers-and-publications/publications/college-profiles/15EngineeringbytheNumbersPart1.pdf.

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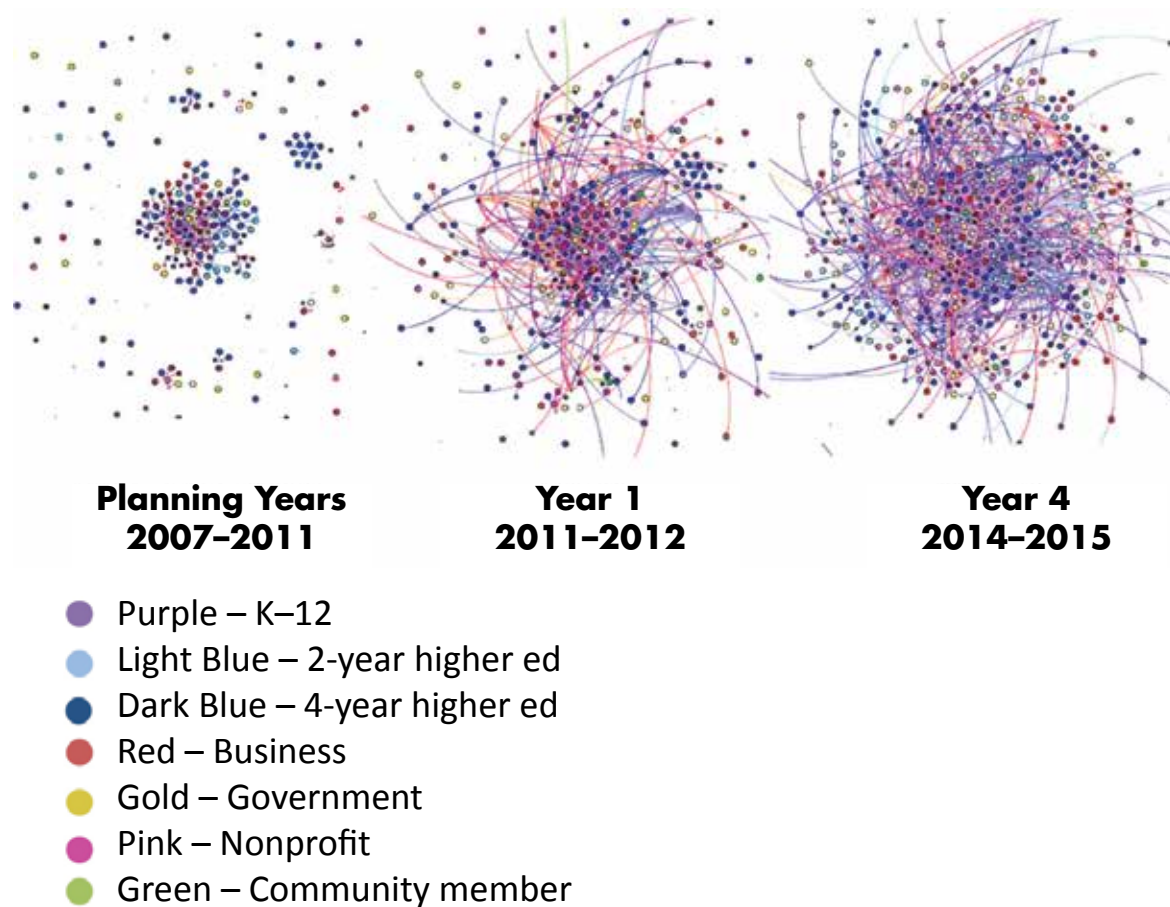
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Figure 2.1. Iowa's STEM Professional Network

Iowans (dots) and their connections (lines) grow and intertwine over time through the state's STEM network.



Source: Mari Kemis and Andres Lopez, Iowa State University. National Science Foundation grant number DRL-1238211.

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