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Encouraging the Hand-Mind Connection in the Classroom

By Margaret Honey & Eric Siegel

Imagine math and science from the perspective of a middle or high school student. That student's first image is more than likely that of a textbook—dense, daunting, and dry—accompanied by his or her sigh, "Please, anything but this!" Only the rare student, who already is passionate about the topic, would consider navigating the textbook alone or for pleasure. Truthfully, a theoretical book of formulas and facts has never been the way people have learned science, technology, engineering, and math—what we now refer to as the STEM disciplines. Long before the rules were codified in textbooks, people engaged with these disciplines to exercise one of the defining characteristics of our species: Our ability to construct the things we need to understand and function in our lives. How did we manage to get so far off course, to take something that is so quintessentially human and make it so alien?

Fortunately, there is a quiet revolution—called the Maker Movement—that is deeply rooted in these natural instincts and is unfolding in communities across the country. With the potential to transform STEM learning, the movement has been spurred largely by the success of *Make magazine* and its creation, Maker Faires.

Who are these makers? In the words of **Dale Dougherty**, the general manager of *Make's* parent company, O'Reilly Media, and the founder of the Maker Faire festivals, they are the people who "look at things a little differently and who just might spark the next generation of scientists, engineers, and makers." Makers share in the common delight of tinkering, hacking, creating, and reusing materials and technology. They organize themselves into thriving communities to create objects that they are passionate about and to engage others. Maker-spaces are springing up in cities and communities across the country. People can drop in and learn from friends, mentors, and peers. They learn about using 21st-century tools such as computer-controlled table saws, laser cutters, and 3-D printers to create prototypes and fabricate physical objects.

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According to Thomas Kalil, the deputy director for policy for the White House Office of Science and Technology Policy, the Maker Movement “begins with the makers themselves—who find making, tinkering, inventing, problem-solving, discovering, and sharing intrinsically rewarding.”

Make magazine started **Maker Faire** five years ago in San Mateo, Calif. By 2010, the Bay Area Maker Faire—the first of its kind—attracted more than 80,000 people and featured 1,000 makers. The same year, two new venues were added to the roster in New York City and Detroit. World Maker Faire at the **New York Hall of Science**, or NYSCI, in Queens, drew more than 25,000 visitors and 500 makers, and Maker Faire Detroit at the **Henry Ford Museum** attracted a crowd of 20,000 visitors.

Innovation, particularly in the STEM fields, has emerged as a rallying cry of the Obama administration. In his April 2009 address to the National Academy of Sciences, the president urged, “I want all of us to think about new and creative ways to engage young people in science and engineering, whether it’s science festivals, robotics competitions, fairs that encourage young people to create and build and invent—to be makers of things, not just consumers of things.” A recently released **report**, “Designing a Digital Future: Federally Funded Research and Development Networking and Information Technology,” from the President’s Council of Advisers on Science and Technology, or PCAST, states that “the problem is not just a lack of proficiency among American students; there is also a lack of interest in STEM fields among many students.” PCAST acknowledges that education is most successful when students and teachers develop personal connections with the ideas and excitement of STEM fields. The maker movement is able to stir this kind of passion and personal motivation that is often lacking in traditional education.

This past fall, in conjunction with World Maker Faire at NYSCI, the National Science Foundation funded a workshop to consider how the maker movement could inform and improve STEM education. Working in collaboration with Tom Kalil and Dale Dougherty, NYSCI convened leaders from foundations and federal agencies; educators; innovators from schools of engineering, architecture, computer science, and multimedia design; entrepreneurs; research scientists; and directors of leading science centers, museums, and arts institutions. This seasoned group reached an important conclusion: The maker movement is not a shiny new toy to be appropriated by education reformers as the next disruptive wave. Rather, it is defined by the characteristics of the maker sensibility: deep engagement with content, experimentation, exploration, problem-solving, collaboration, and learning to learn—the ingredients of effective learning communities. From John Dewey to Theodore R.Sizer, progressive educators have championed these very conditions, urging schools to value depth over breadth, exploration over efficiency, and patience and persistence over acceleration. By creating spaces where individuals can dig deeply into their passions and take time to explore, tinker, and invent with like-minded others, the maker movement affirms the kind of deep learning that matters.

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Classroom Support

Providence, R.I.-based **Big Picture Learning** supports a network of 140 schools that focus on students who have been alienated by traditional schooling—the “dropouts” or the “leavers.” Big Picture uses a methodology known as pops—people, objects, places, and situations—to encourage students to find their

interests with a process of "*thinking*" to help engage their hands and minds. Boasting a 92 percent graduation rate, Big Picture schools have been recognized by the Obama administration as a successful school model that reduces the dropout rate and prepares students for 21st-century careers.

If we want to teach students how to become makers, we need to consider how to engage teachers. Because there is little in the K-12 culture that fosters the connection between "making" and formal education—from the design of undergraduate teacher-preparation programs to how schools are structured—encouraging a maker mentality presents a major challenge.

Resource Area for Teaching, or RAFT, founded in 1994 and based in San Jose, Calif., is a thriving nonprofit organization whose mission is to help educators transform the learning experience through hands-on education, collaborative activities, and an emphasis on 21st-century learning skills. RAFT currently works with more than 10,000 teachers in classrooms, home-school environments, and after-school or community-based programs. These teachers create compelling classroom approaches through relevant, practical, and concrete investigations.

Community Access

In the months leading up to the 2010 World Maker Faire, NYSCI staged a series of Maker Days. These weekend family programs were collaborations between NYSCI, which helped facilitate the effort, and local maker organizations (including Vision and RePlayground), which provided activities. Together we guided visitors through open-ended tabletop challenges, such as building robotic vehicles, designing buildings, and creating miniature boats. Makers inspired visitors of all ages to innovate, create, and solve problems together. Watching the intergenerational play, family collaboration, and positive feedback from visitors, we were encouraged by the potential of making activities to keep visitors deeply engaged.

Marrying the passion, creativity, and engagement of the maker movement to educational opportunities that exist in formal and informal settings is the injection that stem learning needs. It is working effectively in many places throughout the country. And each one reminds us of the fundamental connection between hand and mind, and doing and reflecting. It is our natural inclination to create as we learn and to learn as we create that is at the heart of this movement.

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