Tapping the Potential of Fab Labs

Teachers discover that "keeping it simple" can lead to big breakthroughs

Kenneth Welty

One cannot help but marvel at all the technological innovations that have become part of our everyday lives. We have cell phones that can sense we are driving and automatically reply to incoming text messages, automobiles that detect potential hazards and engage the brakes accordingly, and small appliances that play music, make phone calls, and answer questions with simple voice commands. Each of these amazing things can be traced back to the imaginations of people that harnessed science, technology, engineering, and mathematics in synergistic ways to create new systems that impact how we live, work and play.

Advancements such as these have shined light on the importance of science, technology, engineering, and mathematics in our everyday lives. Furthermore, it is becoming increasingly clear that placing more emphasis on science and math in isolation of the roles they play in engineering endeavors will not adequately prepare students for life and

Teachers from around the state gathered at the University of Wisconsin-Stout for a Fab Lab retreat.

work in our technologically sophisticated society. Empowering students to make sense of the human-made world and participate in its development requires illuminating the connections between science, technology, engineering, and mathematics in ways that reflect how these disciplines come together beyond the walls of school.

A New Learning Environment

The rapid pace of technology development has inspired educators across Wisconsin to establish "Fab Labs" in their school buildings. These novel learning environments typically feature digital fabrication tools like laser engravers, 3D printers, and vinyl cutters. Many include computer numerically controlled (CNC) routers, milling machines, lathes, and plasma cutters. Together, these tools can be used to transform ideas into tangible products under the auspices of workforce development, vocational training, STEM education, service learning, makerspaces, and more. They can be utilized for informal as well as formal education and include provisions for public access to support local entrepreneurs.

However, many of the Fab Labs found in public school settings were created without a clear mission or strategic plan for their use. Their installation was born out of a desire to have the capability found in other schools. The idea of creating a modern-day version of Thomas Edison's laboratory has intrinsic appeal and clear potential for student learning. However, many of these facilities have been characterized as "a solution in search of a problem." This observation is supported by the frequent inquiries directed toward university faculty that echo, "Now that we have a Fab Lab, what should we be doing with it?"

Questions like this inspired the Discovery Center at the University of Wisconsin-Stout to study Fab Labs throughout the state. They looked at nine schools with established labs and conducted focus groups with 14 others in order to describe the current state of affairs and uncover promising practices. The data gathered suggested the installation and utilization of Fab Lab technologies are as diverse as the schools participating in this prominent movement. In some cases, Fab Labs are used in elective classes where students learn how to operate the equipment to make objects from files that came with the equipment or were found on the internet. In other cases, they are collections of resources that are tapped when students, teachers, or community members identify a need to fabricate something.

Establishing a Plan

The current trend in Fab Lab installation has created rich opportunities for evaluation research, professional development, and leadership endeavors. With support from the Wisconsin Economic Development Corporation, UW-Stout's Discovery Center and School of Education have launched programs of work to inform the use of digital tools in the teaching and learning process in public schools.

The first step was to adopt language from the Fab Foundation to define the nature of a Fab Lab. Their concept of a Fab Lab is, "an authentic, engaging, personal context, one in which students go through a cycle of imagination, design, prototyping, reflection, and iteration as they find solutions to challenges or bring their ideas to life."

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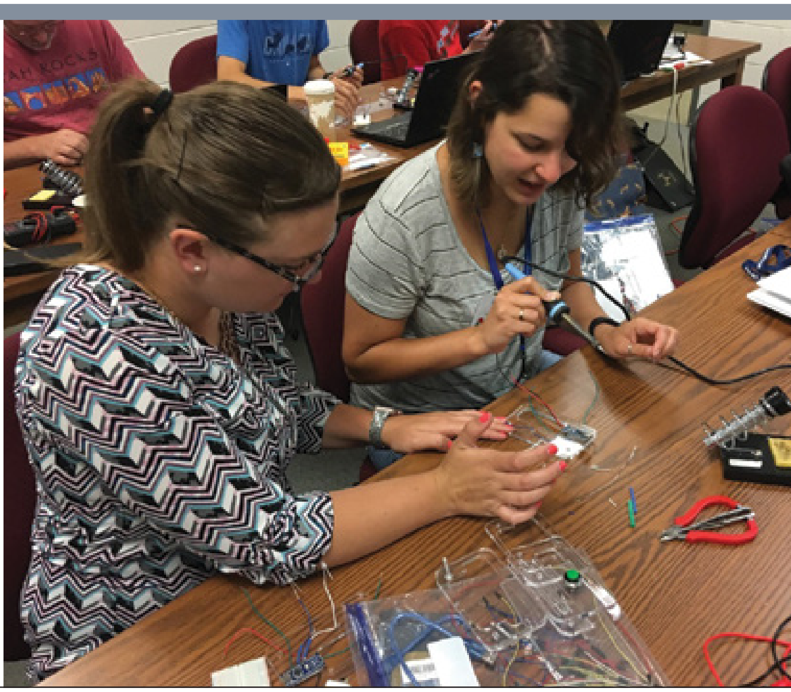


This definition provided a framework for a series of professional development experiences for teachers in the context of an introductory course serving the needs of high school freshmen under the auspices of STEM education (i.e., science, technology, engineering, mathematics). The learning activities were based on the premise that designing very simple devices enables students to harness prior knowledge and engage in first-hand experiences that apply science, math and technology to the development of a viable solution to a problem under the burden of evidence.

Focus on Simple Problems

This summer, 29 teachers representing technology, science, art and elementary education came together during UW-Stout's second "Fab Lab Retreat." The retreat was a five-day immersion in design and digital fabrication. It engaged participants in three Fab Lab projects that called for analysis, brainstorming, modeling, coding, fabricating, testing, presenting, and more.

The participants left the workshop with working prototypes, instructional materials, teaching strategies, and new friends. They discovered that if you focus on simple problems, it is very easy to uncover and target age-appropriate science, technology, engineering and math concepts and skills. In fact, "keep it simple" was cited by most of the participants when they were asked to summarize their insights relative to pedagogical lessons learned during the retreat. Teachers saw value in contextualizing the engineering, math, and science content that is inherent in the re-design of simple things. The attention given to presenting clear images, using age-appropriate prose, dividing the engineering design into distinct and sequential pieces, and integrating grade-level math and science was endorsed by all the participants.

At the Fab Lab retreat, teachers designed Fab Lab projects and presented their ideas.

The notion "simple is complicated enough" proved to be one of the profound ideas the teachers took from their experiences. The idea, "process trumps product" became a mantra adopted by many of the participants. Others recognized the richness of the design process to facilitate student learning in a constructivist manner. In the final analysis, the participants created a professional learning community of like-minded thinkers who aspire to leverage their Fab Labs to teach STEM content via design pedagogy.

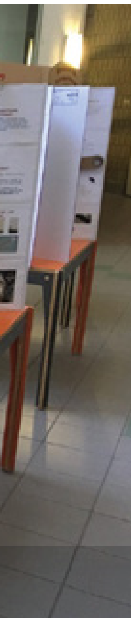
Other Ideas

One of the great things about bringing teachers together for professional development is the rich exchange of ideas, experiences, insights, and recommendations. For instance, teachers shared that the biggest fear they have relative to tapping the potential of Fab Lab tools and equipment is technology failures, especially software. Consequently, one of the recommendations from seasoned Fab Lab teachers is to

FAB LAB RECOMMENDATIONS

The Discovery Center at the University of Wisconsin-Stout assessed Wisconsin K-12 Fab Labs to identify best practices that can used to maximize their full potential. These are some of the suggestions.

- Integrate problem formulation and problem-solving processes, engineering design and/or design thinking into K-12 Fab Labs to drive more impactful outcomes.
- Develop local business advisory boards and secure local organizational sponsorships, which are necessary for both a sustainable financial Fab Lab and to contribute to competitive job growth in Wisconsin. Business advisory boards are also beneficial with networking opportunities and community support even if they don't provide direct financial support.
- Have students reflect on their Fab Lab experiences, why they may or may not have interest in continuing STEM or STEAM careers, and how they would improve their Fab Lab experience at the beginning and end of each academic semester.



work closely with the technology specialists in the building to ensure software, hardware, and network protocols are all compatible with each other.

Another recommendation that surfaced during the retreat was "think small." More specifically, one of the things that will create classroom management problems and temper student learning are big projects. Watching a 3D printer render a large object is akin to watching paint dry. The learning experience is essentially the same regardless of the size of the object being made. Having students engaged in design activities that culminate in making a small and highly developed object in 20 minutes can be more meaningful than spending hours to print a large object that required little thought. Some of the other reasons for thinking small include lower material costs, the ability to use smaller machines, and more opportunities for students to improve their designs.

Several teachers discovered that it is important to keep the role of Fab Lab tools and equipment in perspective when trying to make them an integral part of the teaching and learning process. Most of the machines in a Fab Lab are essentially printers. The teaching and learning process should start with developing a solution to an authentic problem in contrast to printing an existing design that was found on the internet. One would not ask students to find a poem online, change the font, print it off, and turn it in for a grade. The same logic can be applied to using the resources of a Fab Lab. Fabricating prototypes happens towards the end of the design process after identifying the problem, gathering information, defining design specifications, generating alternative designs, making and testing models, weighing tradeoff, and more.

Real World Engagement

Successful Fab Lab projects engage students in the engineering design process, which requires them to think deeply about the problem they are attempting to solve. Students must tap their existing knowledge to begin formulating potential solutions to the problem, and then seek answers to the questions that emerge during the engineering design process. They must use their new knowledge to develop their ideas into products that can be tested.

In short, engineering design endeavors require students to activate prior knowledge, seek and integrate new knowledge with existing knowledge, use new knowledge in conjunction with existing knowledge, and reflect upon their learning experience. This kind of learning is crucial to developing the real-world hard and soft skills students need to be successful. ■

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