



Engagement in Practice: The SMU Maker Education Project

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Katie Krummeck is an educational designer and a national thought leader in leveraging the power of design to drive change in the K-12 system. She is also an expert in using the design process and maker-based instruction to create student-centered learning experiences that develop students' creative confidence, optimism, and problem-solving skills. Katie has led design teams to tackle diverse projects such as reimagining a PreK-12 school schedule, redesigning the substitute teacher program for a district and helping a theater company diversify their patronage. Katie has coached school leaders, educators, non-profit leaders and corporate executives to develop their design mindsets and the capacity to leverage design to drive innovation.

Katie began her career as a secondary teacher and co-founder of a small, experimental independent school, where students collaborated across age groups to engage in project-based, interdisciplinary learning. She has since helped scale a national education non-profit start-up, helped develop the K12 Lab at the Hasso Plattner Institute for Design at Stanford University ("the d.school"), and directed a collegiate makerspace. Katie also founded the Maker Education Project at Southern Methodist University, an initiative dedicated to catalyzing transformational maker-based learning experiences for students in K-12 schools. She is currently working as an independent consultant based in Portland, Oregon.

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DiMitre Higginbotham is an Educational Innovator and Design Thinker currently working as a faculty member at Good Shepherd Episcopal School (GSES) in Dallas, Texas. He manages the SPARQ (Solving Problems Asking Real-World Questions) Makerspace for the school and helps to incorporate maker education and design thinking into the school curricula.

Previously DiMitre was the Senior Teaching Lab Manager and Program Manager for the Caruth Institute for Engineering Education at Southern Methodist University where he managed the mobile makerspace MakerTruck and helped develop curriculum for the Lyle School Summer Engineering Camps.

DiMitre has a Bachelor's in Music Education from the University of North Texas and a Master's of Arts in Design and Innovation from Southern Methodist University. At SMU DiMitre focused on using design thinking to research Makerspaces in the Dallas-Fort Worth Area.

DiMitre and his wonderful wife Hollie currently live in Rowlett, Texas with their son Mason and daughter Amelia. DiMitre loves spending time at the lake with his family, playing percussion, reading, listening to music and podcasts, and watching documentaries.

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Introduction

For nearly two decades, collections of like-minded individuals have united to create makerspaces in their communities. Community makerspaces serve as places where people can congregate, access high-tech tools and materials, share design knowledge, and make unique and personally-relevant items [1]. This phenomenon, known as the maker movement, has spread to institutions such as universities, libraries, and museums [2], [3]. A number of these institutions have created makerspaces and launched maker programming with the goal of fostering the skills and mindsets commonly exhibited by the people participating in the maker movement [4].

More recently, K-12 educators have come to value makerspaces as venues for innovative teaching and learning [5]. As a result, more and more K-12 schools have opened makerspaces on their campuses in the past several years. Like others, K-12 educators generally aim to create makerspaces that engage students in activities that foster opportunities for collaboration, inventiveness, and creativity. Additionally, some K-12 schools use makerspaces to support students developing 21st century skills such as communication and critical thinking while also learning content related to science, technology, engineering, and math (STEM) [5].

In our experience working with several schools and districts on maker education initiatives, we have observed that K-12 educators tasked with using a school makerspace often have a difficult time integrating the makerspace into their day-to-day instruction in a sensible and impactful way. In addition, we have observed that when K-12 educators who use school makerspaces have questions about best practices, or when they need guidance developing their own maker-based activities, they have relatively few helpful resources to consult. These issues appear to be due, in part, to the fact that there is no universally-agreed-upon canon of makerspace best practices and limited high-quality makerspace standards-aligned curricula.

In an effort to support K-12 educators integrating makerspaces and maker-based activities into their instruction, we created The SMU Maker Education Project. The SMU Maker Education Project is a unique interdisciplinary collaboration whose mission is to partner with local schools, districts, and educational organizations. Through these partnerships, the SMU Maker Education Project shares knowledge, skills, equipment, and curriculum to support K-12 educators gaining skills and confidence implementing maker-based activities in their own schools.

Background and Context

The SMU Maker Education Project operates out of Southern Methodist University's Caruth Institute for Engineering Education and is a partnership between the Lyle School of Engineering and the Simmons School of Education. At the time of its inception, the project lead on the school of engineering side was the director of SMU's makerspace. This individual brought expertise in maker education and design thinking to the project. The project lead on the school of education side was a clinical assistant professor. This individual brought expertise in K-12 teaching and learning to the project. Over time, as the project continued to grow, these two individuals

assumed the roles of director and assistant director, respectively. In addition, the director hired a graduate student worker, who eventually joined the team as the full-time senior lab manager.

With the support of the deans of the engineering and education schools, a team of people composed of representatives from each school jointly created a proposal outlining the project goals and describing the nature of the project work. Next, the team presented this proposal to a pair of donors who had expressed interest in funding a similar project in the past. The donors were excited and agreed to fund the project for three years with a gift of \$1.2 million.

After securing funding for the project, we began developing a set of maker education design principles. These design principles served to frame the work of the project and relay our intent to potential partners. While developing and refining our design principles, we also began strategizing about how to effectively partner with schools in the community. Because we were a lean team with a narrow bandwidth, we decided to build a website and pursue partnerships via the website and word of mouth. We also decided that for independent schools who wanted to partner with us, we would charge a fee for our services—and for public schools who wanted to partner with us—we would provide our services for free. Our rationale was that this partnership model might potentially turn into a viable funding model after we spent the initial gift.

We were fortunate to make two strong partnerships early in the life of the project. The first was with a newly-opened public K-2 all-girls elementary school and the second was with an established independent preK-4 elementary school. Participating in these partnerships helped us refine our design principles, generate a library of materials and activities to use in subsequent partnerships, and establish our credibility in the community as an organization capable of doing interesting, innovative, and transformative work in the area of maker education.



Figure 1. The SMU Maker Education Project's mobile makerspace, the MakerTruck.

During the second year of the project, we launched a mobile makerspace, the MakerTruck. The MakerTruck is a former delivery truck retrofit by SMU engineering students to include a suite of high-tech and low-tech tools and materials helpful for creating personalized artifacts. Some of the items on the MakerTruck include: a laser cutter, a vinyl cutter, a 3D printer, hand tools, and

crafting materials. Once operational, we began deploying the MakerTruck in the community to deliver unique maker-based experiences to educators and students at K-12 schools. (See Figure 1 for images of the outside (left side) and inside (right side) of the MakerTruck.)

Partnering with Educators and Schools

The SMU Maker Education Project has partnered with a large number of educators across a variety of public and independent schools in the Dallas-Fort Worth Metroplex. When we enter into a partnership, we attempt to tailor our support based on the particular needs of the school and its educators. While this means that each partnership is unique, they generally fall into three categories: (1) brief encounters, (2) continued encounters, and (3) sustained encounters. Below, we report on the nature of each of these types of encounters. After describing the type of encounter, we follow with an example, and end by reporting the lessons we have learned.

Brief Encounters

Brief encounters are partnerships in which we introduce educators and students at a school to making and the maker movement. Brief encounters spark people's interest in making by allowing them to use—often for the first time—the tools and technologies available to makers. Whether working with educators or students, one universal component of a brief encounter is that participants create tangible artifacts they can take away from the experience.

Example: Smith Elementary School STEM Night

Brief encounters include all manner of short-lived interactions with educators and students. However, the most common type of brief encounter is “STEM night.” STEM nights are popular events that K-12 schools stage to expose their students to STEM content and careers. When we participate in a STEM night, we deploy the MakerTruck and implement a hands-on activity with attendees. These activities range from creating LED jewelry to designing unique vinyl stickers.

When we attended Smith Elementary School's STEM night, we developed an activity in which students created personalized laser-cut pendants. Students began this activity by using Sharpie markers to write their names on a single sheet of white paper. When students finished writing their names, we took pictures of each name, uploaded the picture files to a Google drive, opened the files in Adobe Illustrator, cleaned up the images, exported the images to the laser cutter, and cut the files on a pendant template we created. Throughout the activity, we invited students onto the MakerTruck to participate in the process. After receiving their laser-cut pendants, students attached string to them to create wearable pieces of jewelry.

Lessons Learned: Brief Encounters

Based on our experiences with brief encounters, we have several recommendations for groups interested in delivering similar educational experiences to students at K-12 schools. First, consider planning activities in which student create simple tangible artifacts. We have observed that when students know they will walk away with even a simple product, they are often highly engaged. Second, invite students to use tools and technologies that they may never have used—

or that they use infrequently at school. We have found that students typically show great interest in learning how to use new tools and technologies in pursuit of creating a personalized product. Third, conduct authentic activities. In our case, authentic activities were activities that closely resembled the types of activities that makers might pursue in a community makerspace. Although brief encounters engage students and get them interested in making and the maker movement, they provide few opportunities for extended teaching and learning. Thus, we also recommend using brief encounters as a springboard into doing more sustained work.

Continued Encounters

Continued encounters are partnerships with schools that move beyond one-time visits. Many continued encounters stem from educators participating in a brief encounter first, and then seeking us out to schedule additional activities. Examples of continued encounters include workshops for teachers and extended maker projects for students. Importantly, both parties participating in the partnership seek to align activities with the specific needs of the school.

Example: River Elementary School Makerspace

After learning about the SMU Maker Education Project from a colleague, the STEM coordinator at River Elementary School invited us to visit and work with teachers to prepare them to use the school's new makerspace, which was under construction. When we arrived, we orchestrated a series of grade-level workshops, interacting with all of the school's teachers across the day. During the workshops, we introduced teachers to the mindsets important to the maker movement and asked them to brainstorm answers to two prompts: (1) Describe the ethos you would like in your makerspace. And, (2) Describe important goals to connect to in your makerspace. Teachers generated statements such as, "Every student should feel like they have a voice," to answer the first prompt and statements such as, "Students should be able to learn from their mistakes," to answer the second prompt. Afterward, we sorted the statements the teachers generated and collapsed them into themes. Next, we wrote a makerspace mission statement based on the themes: "River Elementary School's makerspace is a safe place where students are empowered through relationships to express themselves and make change in the world around them."

The next semester, after the makerspace had been completed, the STEM (and now also the makerspace) coordinator invited us to return and complete a whole-day maker education training with all of the teachers at River Elementary School. During this follow-up visit, teachers participated in an activity in which they used a free web-based graphic design program to design personalized icons. After designing their icons, teachers used the tools on the MakerTruck (i.e., the vinyl cutter and the t-shirt press) to cut and press the icons onto miniature flags.

Lessons Learned: Continued Encounters

Based on our experiences with continued encounters, we have several recommendations for groups looking to partner with educators on projects that extend across multiple meetings and site visits. First, because continued encounters require both parties to commit a significant amount of time and resources to the partnership, it is important to build rapport early with potential partners. We did this by getting to know the educators we anticipated working with by

visiting them at their school as well as by inviting them to visit our university's makerspace. In addition, we also scheduled a meeting with the school's principal to show how we could support teachers and students and make it clear that we had the school's best interest in mind. As a result of this meeting, the principal provided funds for substitutes to cover classes for all of the teachers who participated in the activity described above. The principal volunteered to do this because she believed in the educators leading the effort at the school, but also because we sat down with her and explained our plan. Second, continue making tangible products and exposing students and teachers to new and interesting tools and technologies. Once again, for us this work was related to the tools and technologies central to community makerspaces and the maker movement. One drawback to continued encounters is that although there are opportunities for extended teaching and learning, there is no guarantee that teachers will incorporate what they have learned into their instruction. Therefore, it is important to engage in even more sustained work.

Sustained Encounters

Sustained encounters are school partnerships that occur over an extended period of time and involve multiple points of contact. Sustained encounters result in teachers taking actionable steps to incorporate maker-based activities into their existing curriculum. These types of encounters are also subject to evaluation and reevaluation. Thus, sustained encounters are fluid partnerships in which both parties can react to problems, successes, and in-the-moment needs of a school.

Example: Lunar Preparatory School's Makerspace Curriculum

Almost immediately after we launched the SMU Maker Education Project, Lunar Preparatory School (Lunar Prep), a newly-opened public all-girls K-2 school, contacted us to discuss pursuing a partnership. As a part of their innovative instructional model, every student at Lunar Prep spent 30 minutes per day in the school's makerspace. However, administrators and teachers at Lunar Prep reported to us that they were concerned the school was not using the makerspace to its full potential. Furthermore, the teachers responsible for running the makerspace explained that they were uncertain how to structure the time or activities in the makerspace because of a lack of expertise and training. As a result, when students entered the makerspace, they were directionless—and although students often enjoyed spending time in the makerspace—teachers were unsure if they were learning anything from spending time there. In addition, teachers also reported that the products students created in the makerspace were simple and ephemeral. That is, the products were either deconstructed at the end of the class or at the end of the day, effectively erasing the record of the work that happened in the makerspace each day.

Following our initial conversations, administrators at Lunar Prep invited us to the school to see the makerspace and to examine how the teachers and students were currently using the makerspace. At the end of our visit, we agreed to partner with Lunar Prep to work towards improving their makerspace curriculum. After our initial visit, our team scheduled a recurring meeting and met with the makerspace teachers every other week for the remainder of the school year. Meetings generally consisted of debriefing recent events in the makerspace, discussing proposed work and deliverables, and planning upcoming makerspace lessons. As these meetings continued throughout the year, we jointly developed a lesson plan model for how students could predictably and productively spend their time in the makerspace. We called our model the

“maker sprint” model. Each maker sprint consisted of three distinct parts: an “engage,” a “skill build,” and a “challenge.” In addition to co-developing the maker sprint lesson plan model, we also conducted two whole-staff professional development (PD) sessions. The first PD focused on maker education, and the second PD focused on design thinking. At the end of the year, as a culminating activity for students, we parked the MakerTruck on the lawn in front of the school and orchestrated a project in which 65 second graders digitally designed, laser cut, and assembled keepsake boxes to fulfill the final challenge of the last maker sprint of the semester.

Lessons Learned: Sustained Encounters

Based on our experiences with sustained encounters, we have several recommendations for groups looking to partner with educators on projects involving many activities over a long period of time. First, it is important to partner with schools whose administrators support their teachers making significant changes to existing curriculum. The teachers at Lunar Prep had this support and were comfortable and confident restructuring the time and activities in their makerspace. As a result, students’ makerspace products transformed from simple and ephemeral items into items that were much more complex and suitable for showcasing to classmates, teachers, and parents. Second, it is important to elicit educator feedback and make changes based on that feedback. Through cycles of design, reflection, and feedback, we co-designed and vetted a sizable collection of unique curricular materials which we hope will serve as a resource for teachers at Lunar Prep for years to come. The chief drawback of engaging in this sustained encounter was the huge time commitment required of both parties. Collaborative activities included visits, biweekly meetings, curriculum development, and professional development. Investing less time in these activities would have undoubtedly decreased the success of the partnership.

Conclusion and Next Steps

In the future, we plan to grow both the number of partnerships and the quality of partnerships we enter into. Our goal is to develop more sustained encounters. We also plan to focus on measuring the effectiveness of the partnerships we enter into by collecting feedback from the educators and students who we work with and by assessing how educators’ attitudes, beliefs, and knowledge change in response to partnership. Our goal is to improve our methods for supporting educators and to share our results with a wider audience. Finally, we plan to create opportunities for undergraduate engineering students to join the project. Our goal is to form a dedicated group of student workers and volunteers to design maker activities and operate the MakerTruck.

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