MAKERSPACES
Bring STEM Lessons to Life

Improve Engagement and Understanding Through Experiential Learning

By Jo Anne Vasquez, Michael Comer, and Joel Villegas

Fifth-grader Jennifer walks in her front door and excitedly tells her mother that her team at school is designing and developing a new and creative game, which is similar to a pinball machine. They are going to be working with wires, batteries, and Legos, and they could even use a 3-D printer if they need it! All of this is thanks to the school's makerspace. These types of integrated science, technology, engineering, and math (STEM) experiences motivate students, engage them intellectually, develop their creativity and collaboration skills, and provide an authentic way for students to build their understanding.

In STEM-oriented makerspaces (inside and outside schools), people can create, plan, fail, learn, revise, and revamp solutions to problems they are investigating. Individuals can share equipment and materials, knowledge and expertise, to design, prototype, or manufacture products that individually they could not manage or afford. In schools, makerspaces can be areas of self-directed learning, a kind of DIY area for experimenting, creating, and exploring. In makerspaces, students take control of their own learning; they create their own learning goals, and they design alongside other interested students. Jennifer and her team are going

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to apply all the skills and knowledge they are learning to design and build their new pinball machine.

Makerspaces like this one are just one example of how integrated STEM experiences are shifting the focus away from emphasizing one discipline at a time, or "siloed" education. Students have a world of information at their fingertips, so it becomes our role as educators to help them understand and recognize how they can use new knowledge to develop solutions.

In another example, third-grade teachers in one school were teaching force and motion in science, graphing in math, and reading informational text in literacy. Instead of addressing the subjects separately, they designed an integrated STEM unit. Using their science content as the "driver" for their unit, students built and tested Mars Rovers with different applied forces that moved the Rover over different surfaces simulating the landscape of Mars. The students kept track of the distance traveled within a certain time and created a graph, which they shared as they explained their design. Along the way, they learned and applied their science and math content and skills in a new and meaningful way and were able to use the skills of critical and creative thinking, collaboration, and communication.

These integrated experiences can extend beyond the four STEM fields—and beyond the classroom walls. A fourth-grade teacher in Pinal County, Arizona, realized that her students were having difficulty solving multistep word problems involving area and perimeter. The teacher planned a project in which students developed a floor plan for the design of a new library that was being built in a neighboring town and submitted the proposal to local city officials. Not only was the project a rigorous and relevant way for students to learn the math content they had previously struggled with, it incorporated key social studies content as well. Students collaborated with the deputy town manager and an architect from a design company. They learned about area and perimeter; they also learned about local government structure, taxes, voting, and procurement procedures through this project. And they engaged in authentic research on town demographics, building codes, and historic district regulations.

The students collaborated and presented their proposals to a panel consisting of the mayor, town council members, and deputy town manager. Their communication skills were evaluated as well as their proposals. When the new library was completed, the students took a special VIP tour of the facility. Although their proposals were not actually used, the students recognized and commented on different aspects of the library's design that they had also proposed. They were left with a clear understanding of how this type of facility comes to life and the many different roles and careers of the individuals who worked hard to complete it. They felt pride and ownership as they followed the process from start to finish. What a wonderful learning experience.

Integrated STEM experiences and classroom makerspaces are best when they tap into students' natural curiosity and give them the chance to develop questions, collect data, and have some reason to analyze what they collect. This type of learning ensures retention of knowledge and skills as well as transference to other real-world situations. If the learning is presented within a context that is connected to the students' world, be it their own life, a local issue, a global concern, or a social need, students are more apt to take notice and show interest in finding solutions.

The Mars Rover and library architect STEM units both were results of teachers having access to ongoing professional learning, collaboration with their peers, and mentoring. It takes time, other teachers' STEM units to use as models, and practice to integrate STEM learning, but the result—students who are engaged not only with the content we want them to learn, but with real-world problems to which they can make real contributions—are more than worth it.

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Jo Anne Vasquez, Michael Comer, Joel Villegas are coauthors of the popular new *STEM Lesson Guideposts: Creating STEM Lessons for Your Curriculum*.

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