Making a Makerspace

Planning and Building a Successful Makerspace

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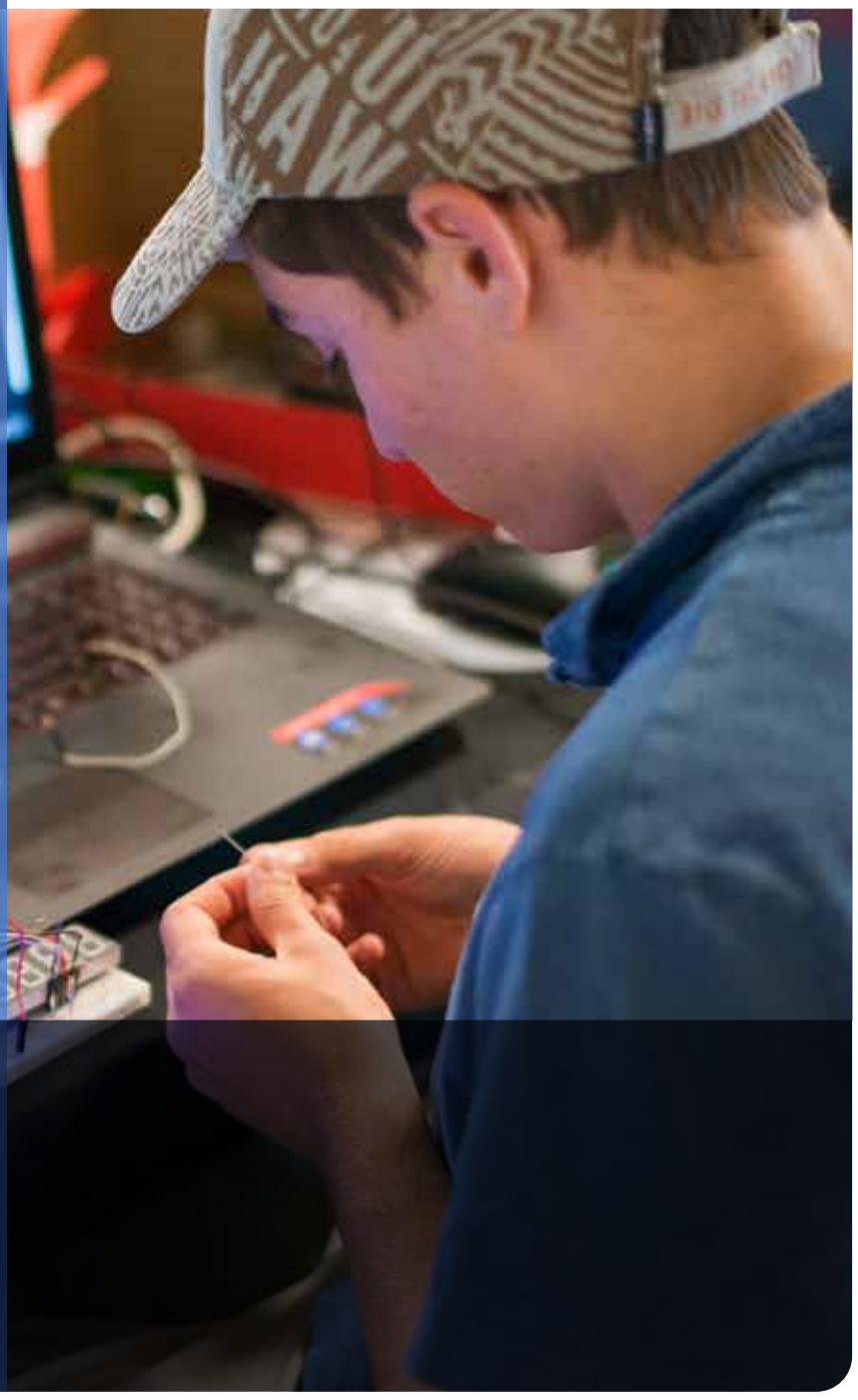

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Makerspaces are modern workshops where students can create projects they are passionate about in an environment that fosters and encourages learning through experimentation. Through the kinds of hands-on learning offered by makerspaces, students are able to deepen their understanding of higher-level concepts, allowing lessons to leave more of an impact. When used correctly, makerspaces can inspire cross-disciplinary projects that are tied to standards and deeply engage students in learning. However, in order to achieve these goals, makerspaces need to be planned and constructed with a purpose in mind. This paper discusses the value of makerspaces, ways to integrate them into schools, and the keys to preparing and planning for their successful implementation for the benefit of both educators and students.

What is a Makerspace?

Makerspaces are defined more by what they enable than what they actually look like. A makerspace can take many forms, from a mobile cart loaded with crafting supplies to a room full of computers, tools, and tables. Makerspaces are a combination of a traditional lab, art room, shop and conference room, where hands-on learning takes place and people are encouraged to collaborate to turn ideas into reality. Makerspaces are all about getting hands-on and creating real-world projects using the tools and expertise on hand.

Why are Makerspaces Important?

The need for makerspaces comes down to two things (1) an urgent need for employees in STEM fields in the future and (2) the impact they have on student learning, including the development of problem-solving and critical-thinking skills.

STEM Workforce

The urgency behind building technological literacy and digital scientists has never been greater. According to the United States Department of Commerce (2014), while jobs overall are expected to grow by just under 10 percent by 2018, STEM jobs are predicted to grow by 17 percent—fueling concern that the United States will have a serious and damaging shortage of skilled workers to fill open positions. Furthermore, according to a 2015 Gallup study, in collaboration with Google, opportunities for students to learn computer science in schools are lacking—three in four principals surveyed report that their school does not offer computer science classes with programming/coding.

Makerspaces can fill in the gaps, working across all content areas to expose more students to the options available within STEM. More than half of teens report they would be more interested in STEM sly by having teachers who enjoy the subjects they teach (STEM Career, n.d.). By adding

makerspaces to schools, all teachers are able to show enthusiasm for STEM and encourage students to pursue careers in STEM. Additionally, makerspaces "have the potential to demystify science, math, technology, and engineering; and encourage women and underrepresented minorities to seek careers in those fields" (Britton, 2012).

As Kylie Peppler, the head of the Make to Learn Initiative, puts it, "Ninety percent of the time you talk to an engineer, the experience of making a boat in eighth grade was what sparked their interest in engineering" (Costanza, 2013).

Student Achievement

Studies have shown that students experience deeper learning when they learn by doing (Barron & Darling-Hammond, 2008). Makerspaces turn every student into a creator, allowing them to make connections between science, language, math, music, and art. Although often taught as separate functions, each subject builds off knowledge from the others to create a full picture.

Furthermore, making encourages student development within a number of standards, including abstract and quantitative reasoning; applying math to everyday life, society, and the workplace; numeracy; measurement and data (including data visualization); and core cross-cutting concepts and skills. In literacy, Maker Education often involves presenting projects and concepts; providing detailed written explanations, describing procedures, or discussing an experiment; and integrating technical information and visuals into written work. With this connection to core content, Maker Education is effective at demonstrating mastery, can be used as a formative or summative assessment, and can impact student engagement.

Through making, students learn how important even the smallest detail can be, a lesson which can translate into paying more attention to their work and higher levels of achievement in all of their classes.

Ways to Makerspace

There is no "correct way" to makerspace. In fact, makerspaces can be as versatile as those who use them. From an instructional perspective, three ways to incorporate makerspaces in schools are (1) supplemental, (2) dedicated makerspaces, and (3) curriculum.

Supplemental

The first method involves infusing any classroom with maker projects and activities in order to teach curriculum concepts and standards. This method uses makerspaces on an on-demand basis, when projects would align with standards and help meet specific learning objectives in a class. The tools for making may be minimal, and projects typically consist of those that can be completed without a lot of specialized equipment or materials. See the 5 Activities to Get Started sidebar for ideas on activities to add to the classroom.

Dedicated Makerspace

This is the method most commonly thought of when talking about “makerspaces.” Dedicated makerspaces can take many forms, including mobile carts, an area of a classroom or library, or a more typical lab space. The primary point of differentiation for dedicated makerspaces is that they provide a consistent space where teachers and students can access hands-on learning materials.

Mobile Carts

Mobile carts bring makerspaces to any area of campus, allowing teachers in any subject to access maker equipment and materials. These carts can be rolled from room to room and are self-contained makerspaces, often including equipment and materials for robotics, electronics, sewing, and design and fabrication. They are a great starter option for schools looking to make Maker Education accessible in all subjects. Potential materials to stock the cart with include crafting items such as popsicle sticks, cardboard, and fabric; electronics such as LEDs, Raspberry Pi, and motors; and tools such as scissors, hot glue guns, and rulers. To get started, check out SparkFun’s Makerspace in a Box wishlist.

Classroom Space

Many activities can be easily and safely done at students’ desks, making classroom spaces another great way to get started with making. These can take the form of dedicated spaces in a classroom or library, where students and teachers are able to access the tools and materials available in the same space at all times. Classroom makerspaces can be started by individual teachers looking to incorporate Maker Education into their classroom or by media specialists striving to provide students with diverse learning opportunities. The materials needed for these spaces will depend on the projects the individual educator wants to encourage within the space.

Physical Lab

Physical makerspace labs provide the most versatility in terms of projects that can be completed within the space as well as the types of tools and materials that can be added to the space. Physical labs are ideal if the school is looking to purchase larger equipment, such as a 3D printer, or tools that may require greater caution or safety equipment. These can easily lead to dedicated maker classes or can be reserved by any teacher for use with specific projects.Physical labs take the most effort to get started, consider seeking professional consultation from companies such as SparkFun to make the process of adding a physical makerspace lab to your school as easy as possible.

The curriculum method of making involves creating an entire class around the idea of students making and learning throughout the semester. This method is usually used in middle school through college and commonly includes classes such as electronics, computer science, engineering, or robotics. Class content includes lessons that involve workshops and hands-on activities, typically culminating in a larger, capstone-type project. To see an example of a curriculum based approach to makerspaces, see SparkFun’s engineering curriculum focused on programming hardware.

Successful Integration

The potential of a makerspace has less to do with the physical space than with the people and activity within; however, it is important to think about space requirements, tools and materials, the mindset required, and training options before adding makerspaces to your school.

Space Requirements

Many maker activities can be accomplished at a typical student desk, making it possible to create a makerspace anywhere, even with very little or no space to dedicate. Start small; a box of materials or an unused storage closet can go a long way toward adding Maker Education to a school. When looking for space, think creatively, as makerspaces can be in multiple smaller places throughout a school rather than one large place.

Storage is one thing that is critical for makerspaces. Unused closets can be the ideal place for project storage or to store a mobile cart when not in use. Shelves and bins are a great way to provide both storage and organization. Even in the smallest spaces, all shelves, bins, and drawers should be clearly labeled to ensure that all users know where everything goes.

Workspace is also important for makerspaces. Depending on the project, workspace can take the form of desks, tables, counters, or even the floor. Having room to think and try things will help students create better projects and put the makerspace to better use.

Tools and Materials

There is no set list of tools and materials required for a successful makerspace. Instead, these should be tailored to the needs and objectives of those who will be using the space. It is possible to achieve a lot with very little, and equipment can grow over time based on what users show interest in. To get started, incorporate "trash" (recyclables and scraps) from around the school into the space—plastic bottles, empty toilet paper rolls, fabric, boxes, anything destined for recycling can be a great maker tool.

When it comes time to purchase tools and materials, select tools that will be functional for the user's size, strength, and skill levels as well as for the space available. Kits designed for student use, such as the SparkFun Inventor's Kit, can be a great way to quickly stock a makerspace without much effort.

For schools looking for a full list of equipment and tools needed for various levels of makerspaces, wish lists—such as those created by SparkFun at https://www.sparkfun.com/wish_lists/131259 —can be found online. For any specialty equipment that is purchased, be sure someone at the school is comfortable using it and showing students how to do so. Filling a space with expensive equipment that nobody is comfortable running or maintaining is a quick way to have a makerspace fail.

Mindset

The key to a successful makerspace lies just as much in the mindset needed as in the tools themselves. Adding makerspaces is a chance for both educators and students to embrace what psychologist Carol Dweck calls a "growth mindset," or the opportunity to develop skills and embrace the effort of learning (2014). As we discuss below, makerspaces allow for projects that push students beyond their current abilities and require those using them to be open to the possibility of growth in a number of ways. Noise, collaborative learning, and iteration/design thinking are all equally important in a makerspace and require a growth mindset be embraced.

Noise

Makerspaces are not quiet places of reflection; they can get noisy as students try new things and work out the kinks in a project. A certain level of noise is to be expected and should be embraced in all makerspaces.

Collaborative Learning

Students should be encouraged to collaborate on projects and ideas inside a makerspace.

Makerspaces are places where students come together to try out ideas and to learn by doing. Everything, and everyone, inside a makerspace provides an opportunity to advance student learning, and, as such, collaborative learning should be encouraged. Sometimes the solution to a problem can only be found by talking with others and getting fresh eyes to see it from a different angle.

Iterations and Design Thinking

Trying is risky, and risk can lead to failure but also iteration and innovation. Makerspaces are a great place to teach students about the opportunities that can be found from failure within a safe space. Not all projects work perfectly the first time, allowing students the chance to rethink their approach and learn from what didn't work. Within makerspaces, iterations allow for the chance to try again until you get it right, an important skill from which many students can benefit. Many great inventions are the result of making mistakes. The effort put into a project and the act of trying should be rewarded and praised.

Celebrate Success

One of the best part of any project is sharing it with others. Motivate students by planning showcase events where parents and the community are invited to see what students have created on a regular basis. In-class showcases can be planned once a week to encourage students to show one another what they have been working on. Alternatively, challenge students to share pictures or videos of their progress on a class website or with the larger maker community on InventorSpace (http://invent.sparkfun.com). Seeing the success of one student may inspire creativity in another.

Training

To be successful, makerspaces need a champion on the staff promoting their use and teaching others how to effectively use the space to incorporate standards-based projects into their classrooms. Ideally, any educator who wants to use the space should be trained on how to help students find the resources they need in order to complete a project. Teachers do not need to be a master of every tool, but, at a minimum, should be trained on safe operation of every tool.

Schools and districts looking to add makerspaces should offer training to those educators, parents, students and volunteers who are interested in either using the space or helping get it started. Topics can range from the basics of different electronics components to how to build circuits or use machinery. Once a few champions/mentors have been trained, training for the makerspace can be ongoing and led by those who are currently using the space.

Allowing time for educators to publicly share what they have learned or how they use a specific material or tool to inspire student creativity may lead to increased interest in using the space from other staff members.

Key Considerations

When designing a makerspace, it is important to think about the appropriate ages, activities, safety measures, and training for those who will be using it.

Age Range

Think about the abilities of the students who will be using the space. Tools and materials appropriate for high school students may not be the same as those for learners in elementary school. Spaces can be designed to be functional across a range of ages or for a single age group, based on your needs and objectives. The important thing is to keep the users in mind as the space is being designed.

The best way to find out what students want is to ask them. Let the future users of the space tell you what they want by surveying them about their interests, prior experiences, and goals. Involving students in this way helps them feel a sense of ownership that will go a long way toward ensuring the success of your makerspace.

Activities

Before building a makerspace, it is important to think about what types of activities and projects the space will be used for. Ask yourself what you would like to see accomplished in the space and make sure you have a reason for purchasing everything that goes into it. The classic example of a makerspace failure is when schools purchase a 3D printer with no idea how they plan to use it. Avoid this trap by clearly defining standards-aligned learning objectives for the space before making any purchases.

Safety

As with any lab environment, it is important to consider safety measures when designing a makerspace. Some tools are inherently more dangerous than others and should be treated as such. Rules for using the space and individual tools should be clearly displayed and communicated to students from the start. For more advanced tools, training should be offered to ensure both students and educators know how to properly use the equipment without hurting themselves or others. Standard safety equipment—such as eye protection, first aid supplies, and a fire extinguisher—should be readily available within the space. Be sure to adhere to any district or school level safety rules and regulations regarding the tools within the makerspace.

How to Use a Makerspace

The key to any makerspace is fun projects that move students toward standards proficiency. The number and variety of potential projects are endless. To help get you started, we've compiled a list of initial activities that students can easily complete and that can be used to spark interest in making among students of all skill levels. For details on any of these projects, visit learn.sparkfun.com, where tutorials, material requirements, and templates can be found.

As with anything, there is such a thing as overthinking and over planning a makerspace. Once you have a basic idea of the appropriate approach for your school, just start making.

Makerspaces are intended to be in a constant state of change. They grow with the needs and curiosities of their users, meaning they are never fully finished. You'll never know everything you need until you get started and try it out. Once the foundation and safety measures are in place, don't wait to be fully

5 Activities to Get Started

Building bridges with toothpicks or popsicle sticks. This activity is already a classroom staple as a way to introduce geometry and weight support concepts to students. This can be a simple way to ease teachers into using the makerspace through an activity they already use.

Paper Circuit Pins

These are a great way to get students excited about electricity and science. Paper circuits easily introduce students to the concept of building circuits and lighting up LEDs without a lot of expense and are often used during prototyping of larger projects.

E-Textile Mask

Sewable electronics are a fun way to introduce programming and electronics to students who might otherwise not be interested, including girls who are underrepresented in these content areas. This project teaches the basics of electricity and circuits in an approachable manner.

Dancing Robots

This project uses recycled materials and electronics to teach engineering design and coding by creating a robot that moves around. Robots can even be programmed to dance in a specific pattern using a state standard for decimals.

Toy Car Speed Trap

Students will learn the basics of physics as they race toy cars through a speed trap that measures the velocity of the car. Test hypothesis to see if modifications to the track or vehicle speed up or slow down the car.

comfortable with the idea, or it will never happen. As the Nike slogan goes, “Just do it.” You will be glad to have gotten started and will learn a lot in the process.

Create Your Own Activities

The above options are just a few of the endless projects that can be created within a makerspace. Encouraging students to create their own projects and seeing what they come up with is a great way to use a makerspace. As an added bonus, many lessons already in use can be easily modified to incorporate making by keeping the following steps in mind:

Identify the Content to be Taught

Maker projects can and should be incorporated into the curriculum to help students achieve specific learning objectives. By ensuring that all projects align with state standards and class requirements, it becomes much easier to justify the time spent on maker projects. For every potential project idea, there are a number of content areas on which to focus. Determining the desired content concentration guides the entire project.

Identify the Skills Students Should Build Through a Project

Every course focuses on teaching content as well as building skills. Projects can be a great way to focus on skill-building without students even realizing that’s what is happening. Knowing if this project is intended to build critical-thinking, collaboration, or problem-solving skills—or a combination of these—will help determine the project parameters given to students.

Design Limitations and Restrictions

Are there certain things that need to be included in every project (a written description, a blinking LED or something red, perhaps)? Make sure the project guidelines include these so students know what is expected. Alternatively, if there are certain things that cannot be used, make that obvious as well. These restrictions will actually stimulate student creativity and push them to create a better project, so don’t be afraid to include a few.

Provide a Question or Challenge to Inspire Creativity

Once the above steps have been taken, it should be fairly easy to create a project prompt that both aligns with standards and encourages creativity. Simple prompts that allow each student to create their own version of the project provide the most satisfying and stimulating experience for all involved. Consider ways to incorporate “meaningful making” by using culturally relevant or societal challenge type prompts that add meaning to an activity and engage inquiry-driven behaviors where students seek knowledge and skills while building a solution.

Share Projects to Inspire Others

Once you've tried a few projects with students, share the best ideas with others. Online communities, such as InventorSpace [invent.sparkfun.com], allow educators and students to share project ideas with others. They also can be a great source of inspiration for new project ideas.

Conclusion

As famed educational philosopher John Dewey stated in Democracy and Education, "give the pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking... learning naturally results" (1916)

Makerspaces are a great way to incorporate projects into the classroom and motivate students to learn more deeply. The key to successful makerspaces in schools is to ensure that every project is a genuine learning experience, aligned with state standards, and that educators have been trained and empowered to successfully use the space. There is no space too small and no idea too big. Now go out and get started!

http://sparkfuneducation.com/
http://twitter.com/sparkfunedu/

Bibliography

Barron, B., & Darling-Hammond, L. (2008, October 8). *Powerful learning: Studies show deep understanding derives from collaborative methods.* Edutopia. Retrieved from http://www.edutopia.org/inquiry-project-learning-research

Britton, L. (2012, October 1). *The makings of maker spaces, part 1: Space for creation, not just consumption.* The Digital Shift. Retrieved from http://www.thedigitalshift.com/2012/10/public-services/the-makings-of-maker-spaces-part-1-space-for-creation-not-just-consumption/

Costanza, K. (2013, August 26). *The maker movement finds its way into Pittsburgh classrooms.* Remake Learning. Retrieved from http://remakelearning.org/blog/2013/08/26/the-maker-movement-finds-its-way-into-pittsburgh-classrooms/

Dewey, J. (1916). *Chapter Twelve: Thinking in Education.* In Democracy and Education.

Dweck, D. (2014, November). *Carol Dweck: The power of believing that you can improve* [Video file]. Retrieved from https://www.ted.com/talks/carol_dweck_the_power_of_believing_that_you_can_improve?language=en#t-605688

Gallup/Google. (2015). *Searching for computer science: Access and barriers in U.S. K-12 education.* Retrieved from https://services.google.com/fh/files/misc/searching-for-computer-science_report.pdf

STEM Career. (n.d.) *STEM fast facts.* Retrieved from http://stemcareer.com/stem-fast-facts/

United States Department of Commerce. (2014, July). *STEM: Good jobs now and for the future.* Retrieved from http://www.esa.doc.gov/sites/default/files/stemfinalyjuly14_1.pdf