HOW TO CREATE
A MAKER SPACE
IN YOUR SCHOOL

A step-by-step guide to
unleashing students' creativity

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RESOURCE SERIES

Introduction

The "maker movement" is catching on in education, and it's easy to see why.

Looking to inspire the next generation of tinkerers and innovators, a growing number of schools are creating spaces to unleash students' creativity.

These spaces, which are equipped with everything from popsicle sticks and glue guns to electronics kits and 3D printers, can go by many different names. In some schools, they're called "dream labs." In others, they might be referred to as "innovation spaces." To keep it simple, we will refer to them as "maker spaces" throughout this guide.

When educators encourage students to learn by creating, they inspire students to take ownership of their learning. Students become highly engaged and invested in their education.

In the process, students can learn not only key STEM concepts (like how an electronic circuit works or what the engineering design process entails), but also 21st-century skills such as problem-solving, teamwork, critical thinking, creativity and perseverance.

The maker movement isn't really a new concept. "Montessori said that when you work with your head, your heart and your hands, it all works together," says Sylvia Martinez, co-author of the book Invent to Learn: Making, Tinkering and Engineering in the Classroom. Learning by creating "is good pedagogy," she says, explaining that the idea can be traced from Rousseau to John Dewey, Piaget and others throughout history.

But one thing that's different today is the sophistication of the tools that are available to students.

As recently as 10 years ago, K-12 students would not have been able to design a machine and then fabricate parts for that machine. Now, with the help of widely accessible design programs and 3D printers, "any sixth grader can do that in a single class period," says Trevor Shaw, director of technology for the Dwight-Englewood School in New Jersey and a leader in the maker movement for education. "It's such an empowering experience," he observes.

Creating a maker space for your schools might seem like a daunting task. With this guide, we hope to make the process easier.

Within these pages, you'll find questions and strategies to consider as you define your vision and goals, design and equip your maker space and help teachers shift their mindset to take full advantage of the space with their students.

Chapter 1
CRAFTING YOUR VISION

As is true when developing any plan, it's important to start with your vision for the space and outline the goals you hope to accomplish. Your vision and goals will help you answer other critical questions, such as what the space should look like, how it will be equipped and so on.

Here are four key questions to guide your initial planning efforts.

Eight Essential Elements of a Good Maker Space Project

Are you looking for a template to follow when designing high-quality maker space experiences? In their book Invent to Learn, authors Sylvia Martinez and Gary Stager describe these eight characteristics of a good maker space project:

- **Purpose and relevance.** Is the project personally meaningful to students, so they feel invested in it?

- **Time.** Have you given students enough time to plan, carry out, test and revise their work?

1. Who will use the space?

- Which grade levels or age ranges is your maker space intended for? Grades K-2, 3-5, 6-8, 9-12, adults or some combination of these?

- Which classes and academic disciplines will use the space? Is it meant only for certain subject areas or for all academic subjects?

- Will you open your maker space to members of the public, such as adults for night classes or students from other schools?

- **Complexity.** Does the problem require knowledge from multiple subject areas to solve?

- **Intensity.** Does the project provide an outlet for students to deeply engage with the material?

- **Connection.** Are students collaborating with each other or connecting with powerful ideas and/or experts from around the world to solve a problem?

- **Access.** Do students have sufficient access to materials and information to complete their project?

- **Shareability.** Does the project provide an opportunity for students to share their work with an authentic audience outside of school?

- **Novelty.** Does the project represent a fresh idea? (If you're assigning the same tasks to students every year, they can simply draw upon prior students' experiences rather than reaching their own discoveries.)

2. How, and when, will students use the space?

- Will the space be used for formal, structured learning activities led by a teacher? Informal, student-directed learning and exploration? Or both?

- Will students use the space during school hours? Before or after school? Or both?

3. What are your instructional goals?

- What are you hoping students will learn by using the maker space—core academic skills, 21st century skills, or both?

- If core academic learning is your target, how do your intended learning activities align with state instructional standards, Next Generation Science Standards, or other curriculum goals?

- If 21st skills are your desired outcome, which specific skills are you hoping students will acquire? How will the activities completed in the space lead to the development of these skills?

Chicago Offers a Successful Maker Space Model

With support from an Investing in Innovation grant from the U.S. Department of Education, two public schools in Chicago have created maker spaces (called "digital ateliers") that provide both formal and informal learning opportunities for students—and the addition of these spaces has made a big impact on student achievement.

The project, called Convergence Academies, is expanding traditional ideas about education while giving urban students a greater sense of purpose. The Center for Community Arts Partnerships at Columbia College Chicago joined with the Chicago Public Schools on the program, which is making learning more active

and engaging by integrating digital media into the curriculum of Morrill Math and Science School, which serves grades K-8, and Tilden Career Community Academy, which serves grades 9-12.

During the school day, teachers take their students into the digital atelier to complete hands-on projects using technologies such as graphic design software, video editing tools, electronics kits and 3D printers. During lunch and after school, the ateliers provide a safe and comfortable place for students to gather and explore 21st century skills under the guidance of artists and other professionals, called "digital media mentors."

This blending of formal and informal learning is one of many aspects that make the program unique.

Chicago Offers a Successful
Maker Space Model *(continued)*

"Students learn in multiple ways," says Mindy Faber, co-director of the Convergence Academies project. Besides learning in the classroom, "they learn through their peer culture, and their interests motivate their learning." But many schools have been slow to cultivate the learning that happens when the school day ends, Faber says—and the Convergence Academies model could be one way to change that.

There is evidence to suggest the program is having a big impact on student success. Morrill has moved from a Level 3 to a Level 1 school and off the district's probation list since the program began in 2013. At Tilden, the average attendance rate has increased from 74 percent to 82 percent, and the graduation rate has improved from 37 percent to 54 percent.

# 4. How will you measure success?

- What methods will you use to evaluate the success of your maker space initiative? Formal measurements of the skills students gain, informal observation and reflection, or both?

- If you're measuring the skills that students gain, what types of assessments will you use? How will you put these together?

- If you're using informal observation and reflection, how will you collect this information? Teacher observation forms, post-program surveys of students or some other method?

Tilden's average **attendance increased** since the program began in 2013.

74%
2013

82%
2017

Tilden's **Graduation Increase**

54%
2017

37%
2013
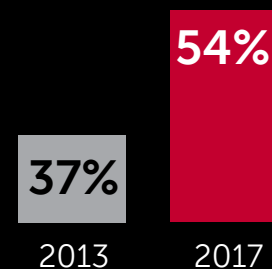
More importantly, students are being exposed to possibilities they never would have known about before—and they're learning important technology skills that can put them on a successful career path.

"When you come into a maker space, the process begins with inquiry: What problem do I want to solve?" Faber says. "It's a safe space for experimentation and discovery, not a high-stakes, right-or-wrong type of environment—and everyone has something to contribute."

Chapter 2
DESIGNING THE SPACE

Once you have a plan for how your maker space will be used, you can design the actual space itself.

Issues you'll want to consider include location, configuration, tools and materials, storage and utility and safety. Here's a closer look at each of these aspects.

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Location

How you plan to use your maker space will influence what kind of space you choose to host it. For instance, if you want the space to be used by students or members of the public after school hours, you'll want a location that is easily accessible from outside without having to traverse the school hallways.

Here are some ideas for current school spaces that can be converted into a maker space fairly easily. Note that you shouldn't confine your thinking just to these suggestions; your only real limit is your imagination.

- **A classroom.**

- **A science lab.** Most middle and high school science labs already have sinks, which can be useful for cleaning up after projects, as well as cabinets for storing materials.

- **The library.** School libraries are centrally accessible to students across all grade levels, and they are often open for extended hours already. Many schools have converted part of their library into a maker space as they replace their reference collections with digital versions.

- **A computer lab.** Instead of replacing old computers with newer desktop versions, some enterprising schools have replaced their outdated machines with laptops, tablets, 3D printers, electronics kits and other fabrication tools.

- **A home economics or industrial arts shop.** These subjects have fallen out of favor in recent years, and a maker space would be a great new use of these outdated spaces.

Fabrication Lab
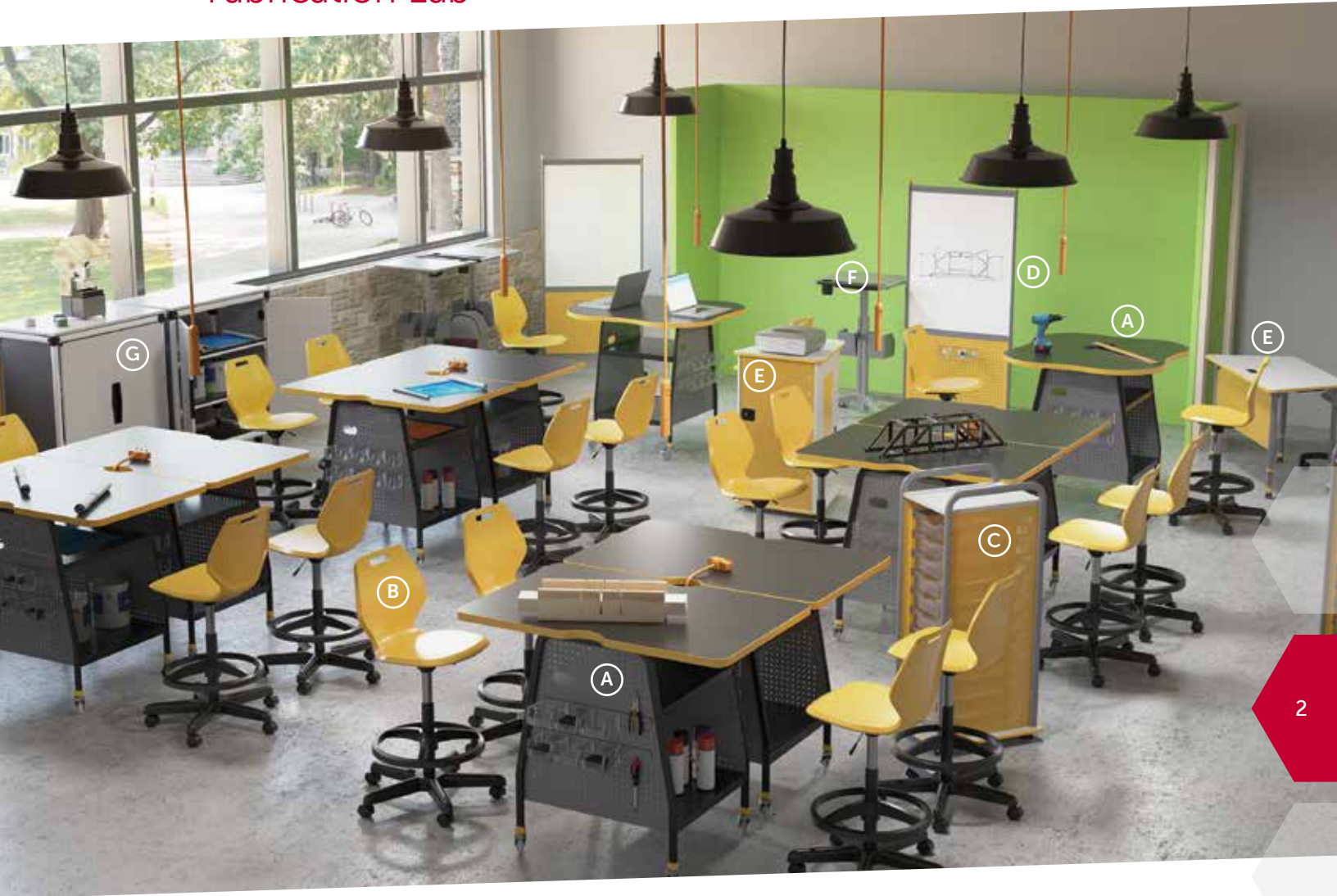
A. MAKER™ INVENT™ Table

Available in rectangle or clover-shaped work surfaces and in youth and adult heights

B. READY™ Lab Stool

Height-adjustable stool available in 16 plastic shell colors and five frame colors

C. A&D® Crossfit Single Storage

Available in 32" and 46" high configurations with open fronts or with doors and include all totes, all shelves or a combination of both

D. MAKER™ Idea Board

Features double-sided dry erase finish that is both a writing surface and magnetic

E. A&D® Crossfit Teacher Desk & Podium

Features storage with adjustable shelf and a locking door, optional magnetic connecting side table

F. A&D® Crossfit Motion

Available in rectangle and KOI-shaped work surfaces, adjust height from sitting to standing

G. INFORMATION COMMONS™ Series Mobile Cart

Available in two heights with or without doors, end or back panels

Innovation Lab

A. MAKER™ INVENT™ Table
Available in rectangle or clover-shaped work surfaces and in youth and adult heights

B. READY™ 4-Leg Stool with Glides
Available in counter and café heights (25-inch and 30-inch) with three glide options and 16 shell finishes

C. A&D® Crossfit Single Storage
Available in 32" and 46" high configurations with open fronts or with doors and include all totes, all shelves or a combination of both

D. Science Table with Wood Leg
Available in laminate, chemsurf or epoxy resin work surfaces with solid wood legs

E. MAKER™ Idea Board
Features double-sided dry erase finish that is both a writing surface and magnetic

F. INFORMATIONCOMMONS™ Series Mobile Cart
Available in two heights with or without doors, end or back panels

Hackerspace

A. MAKER™ INVENT™ Table

B. MAKER™ Idea Board
Features double-sided dry erase finish that is both a writing surface and magnetic

C. READY™ 4-Leg Chair with Casters
Available in child, youth and adult heights (14-inch, 16-inch and 18-inch) in 16 shell finishes, stacks 6 high

D. A&D® Activity Table
Adjustable height table available in half-round, trapezoid or rectangle-shaped work surfaces

E. A&D® Crossfit Teacher Desk & Podium
Features storage with adjustable shelf and a locking door, optional magnetic connecting side table

A. MAKER™ INVENT™ Table
Available in rectangle or clover-shaped work surfaces and in youth and adult heights

F. A&D® Activity Pod
Each pod comes equipped with a 1- or 2- gangable table system in bullet, rectangle or trapezoid-shaped work surfaces, height adjustable

G. READY™ Task Chair
Adjustable-height, mobile task chair available in 16 shell finishes

H. A&D® Crossfit Double Storage
Available in 32", 46" and 64" high configurations with open fronts or with doors and include all totes, all shelves or a combination of both

I. A&D® Crossfit Single Storage
Available in 32" and 46" high configurations with open fronts or with doors and include all totes, all shelves or a combination of both

J. A&D® Crossfit Flip-Top Student Desk
Mobile flip-top desk nests and is available in four work surface shapes from 27"- 60" wide, and three heights

K. File-IT Mobile Pedestal
Features box/box/file design and is available in 17 different paint colors

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Tips for Equipping a Maker Space on a Budget

Some of the equipment common to maker spaces can be expensive, but that shouldn't deter you from moving forward with your initiative. You can always start small and then add new materials as you can.

"You can have really powerful experiences with kids and not spend a lot of money," Shaw says. "You can get started with some very simple materials. By far, the most valuable tool in our maker space is the hot glue gun, because it's so simple and easy to use."

Configuration

When you are designing a maker space, you'll want to make sure the space promotes creativity and collaboration. You can encourage both of those traits through the design of the space itself. Here are some ideas to guide you.

- Ask students what they want. Giving students a voice in the design of the space can inspire their ingenuity.

- Build flexibility into the design of the space. Use furniture that can be arranged easily in many different configurations to promote different kinds of student groupings and activities.

- Take inspiration from the "stations" approach to classroom design that is common in elementary schools. Consider creating separate areas for different kinds of activities, and equip each area as appropriate.

- Include open, informal spaces for students to gather together, brainstorm and bounce ideas off one other. Soft seating options can make the space comfortable and inviting for students to congregate.

As you look to accumulate additional equipment, here's some advice that can help.

- **Buy used.** Watch for deals on used equipment from sites like eBay and Craigslist.

- **Put out a call for donations.** Parents, local businesses, and others might have equipment they no longer need that they would be willing to donate to your maker space.

- **Try crowdfunding.** Sites like DonorsChoose.org help you publicize your request for funding and collect donations toward your project.

- **Borrow where you can.** Consider partnering with other schools or maker spaces to share the use of expensive equipment.

Tools and materials

The tools and materials you choose for the space will depend on your goals for its use, as well as your budget. Here are some of the types of materials you might consider.

- Equipment and machinery such as computers, laptops, tablets, video monitors, 3D printers, laser cutters and vinyl cutters.

- Electronics kits and components for building simple circuits, machines, computer motherboards and robotics. Commercial kits include littleBits, Makey Makey, Raspberry Pi and Arduinos.

- Digital media production tools such as cameras, tripods, green screens, video editing software, keyboards, turntables, music composition software and graphic design software.

- Materials to create with, such as paints, paper, cardboard, plastics, wood, fabrics and metals.

- Tools for cutting, joining, and splicing, such as scissors, wire cutters, glue guns, soldering irons, hand tools and power tools.

Storage and utility

Your maker space must be functional. It should be large enough for students to work without getting in each others' way. It also should include plenty of shelf or cabinet space to store equipment safely. Here are some key questions to think about.

- Does the space have adequate power supplies and internet access?

- Do desks and tables include large surfaces for working?

- Are materials easy to find? Consider using clear or mesh containers for storing materials so they are easily visible, or at least clearly label their containers.

- Are cleaning supplies easily accessible for cleaning up the space when you're done using it?

- Have you set aside space to showcase student projects? Students love to see their works displayed, and past projects can serve as inspiration for a new wave of creations.

How Space Design Influences Learning

The design of a learning space can have a profound impact on the learning that takes place there, as the Convergence Academies program demonstrates.

In the digital ateliers, or studios, constructed at Chicago's Morrill Math and Science School and Tilden Career Community Academy, the use of modular furniture has led to flexible, creative and inviting spaces that enable a new kind of "connected learning" to take place, in which students learn while collaborating with mentors or even just hanging out with their friends.

Researcher Nathan Phillips from the University of Illinois-Chicago has been observing the activity in the digital ateliers for more than 30 hours, and he says the flexibility of these spaces "makes learning possible in ways that would be difficult or impossible in most traditional classrooms."

The modular furniture makes it easy for students to form quick collaborative groups or break off individually to do their own thing. And the power supplies that are embedded in the tables and soft seating allow them to sit anywhere and still plug in a laptop or other digital device for working. What's more, the use of comfortable seating creates a warm, inviting environment that draws students into the space and inspires their creativity.

The combination of the technology and the layout of the space is calming for students and lets them focus on whatever they need to focus on, says Luke Sequeira, a digital media mentor at Tilden.

"Real learning happens in these casual spaces," he said in a video interview. "You kind of come in and learn at your own pace, and you're self-directed. And I think self-directed learning is extremely powerful, because no one can inspire you to learn the things that you want to learn more than yourself."

Safety

Keeping students safe as they work in the maker space is vital. Students must learn the proper use of, and respect for, tools and equipment. Students also should understand the rules for the space, and these rules should be clearly posted. Here are some other safety considerations:

- Make sure you provide enough space for tools to be used safely, as well as safety equipment such as goggles and earplugs.

- Keep all pathways to tools, exits, and safety equipment clear.

- Make sure the space is well lit and ventilated. Make sure it's equipped with a first aid kit and a fire extinguisher.

- Enforce a strict cleanup policy to keep the space free from clutter.
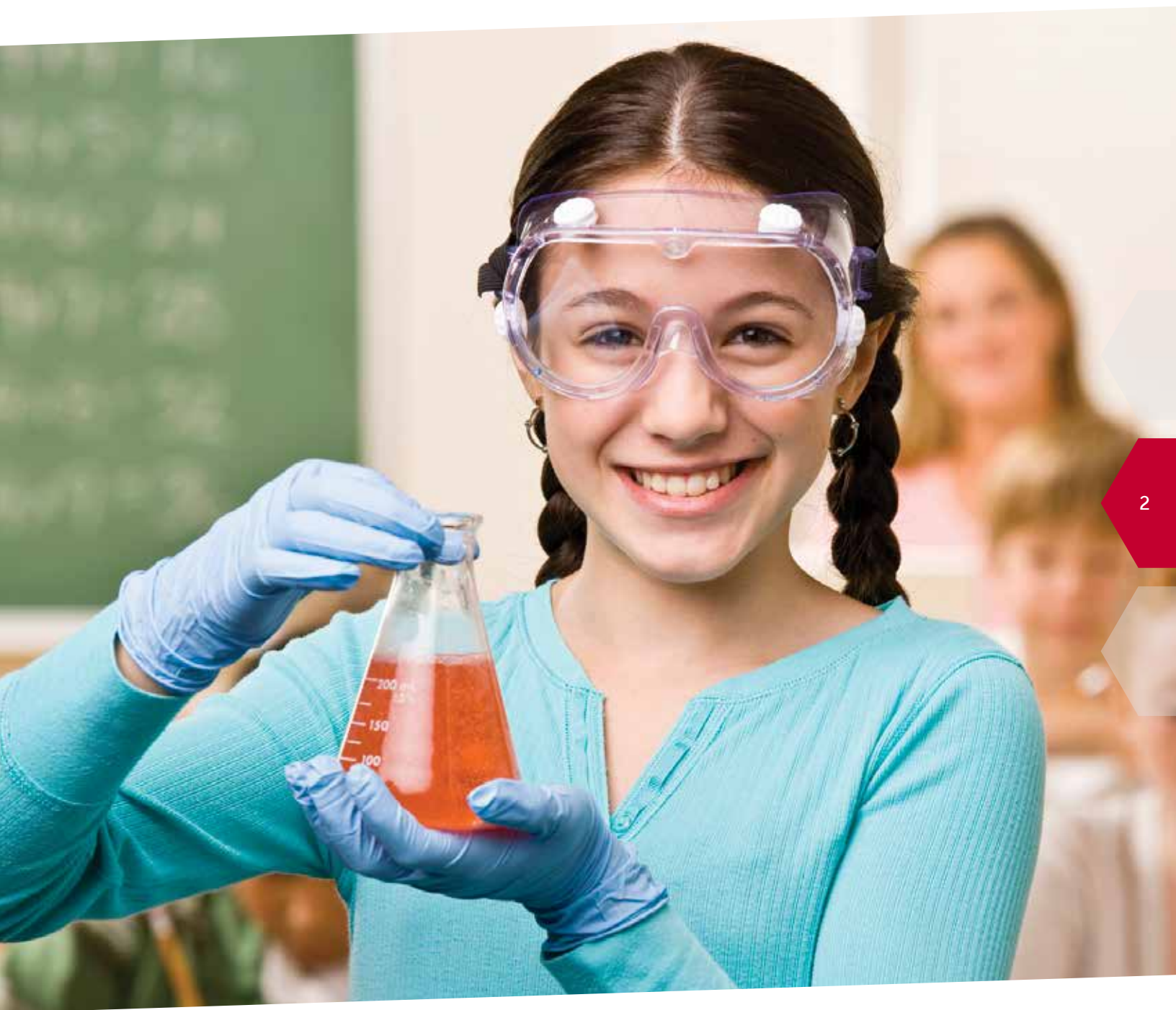
Chapter 3
TRANSFORMING THE TEACHER'S ROLE

Launching a successful maker space program requires training teachers to use the space effectively with their students.

Teachers must learn not only how to design high-quality projects, but also how to transition into a new role they might not feel comfortable with.

3

Instead of passing along knowledge to students as the "sage on the stage," teachers must step aside and let students work through challenges and make discoveries for themselves.

Teachers need to shift their role away from being providers of content and toward becoming "designers of learning experiences," says Mindy Faber, co-director of the Convergence Academies project in Chicago. "Learning how to set up structures, design environments, use space effectively and curate technologies and resources strategically—that is the future role of the teacher."

This shift in mindset from leading a teacher-centric to a student-centric learning environment can be difficult. It's a fundamentally different way of approaching instruction, Faber says—and many teachers don't know how to teach this way. "It's not part of their pre-service education," she notes.

Here's some advice for helping teachers make this shift.

- **Lead with the "why."** School leaders should explain not just how teaching should be different in a maker space, but why. When students take ownership of the creative process, learning becomes much more rich and meaningful to them—and when teachers understand these benefits, they are more likely to embrace this change.

- **Create a culture of innovation.** School leaders must create a culture that encourages risk-taking among staff. This involves making sure that teachers know it's OK to make mistakes, and rewarding teachers for trying something new or different.

- **Observe other maker spaces in action.** Have teachers visit other schools, watch exemplary maker space teaching, ask questions and learn from others' successes.

- **Pair teachers with maker space mentors.** Have teachers co-teach in the maker space with other teachers who have more experience in this kind of environment, so they can learn from a mentor until they are ready to try it for themselves.

- **Let teachers become the students.** Hold training workshops in which teachers have an opportunity to explore and create in the maker space for themselves. As teachers discover the possibilities that exist in the space, they can begin to think about how to apply these possibilities to student projects.

Four New Roles of a Maker Space Teacher

In making the shift from instructor to facilitator and designer of high-quality learning experiences, talking is no longer the primary goal of teachers, Martinez and Stager write; instead, it's learning about their students. Here are four new roles they have identified for teachers in a maker space classroom.

- **Ethnographer:** Find out what students already know.

- **Documentarian:** Collect evidence of learning that makes students' thinking visible.

- **Studio manager:** Make appropriate tools and resources available to students so they can bring their ideas to life.

- **Wise leader:** Guide students' inquiry toward big ideas without coercion.

Teachers Learn to Lead Self-Directed Learning

To support teachers in making the shift to self-directed, student-centered learning, the Convergence Academies program hosted a training session in which teachers learned to design and evaluate digital media projects while giving their students the space to create and explore.

During the workshop, teachers assumed the role of students as they completed challenges using tools such as robotics kits, photo and video editing software and graphic design software.

"Our goal was to help teachers make the connection between play, tinkering and discovery and how these lead to deeper learning experiences for students," Faber says.

Organizers set up the digital atelier with six different stations that teachers could explore during the first part of the day. At each station, teachers could assume one of four roles, depending on their comfort level with technology: observer, dabbler, tinkerer or innovator. Each teacher received a challenge card with a task to complete at that station, based on the role they chose.

The tasks—which helped introduce teachers to each digital media tool—became more complex as the roles progressed from observer to innovator. At each station, a digital media mentor was available to help teachers use the tools.

In the afternoon, participants formed small groups. Each group developed an idea for a project they could assign to students, using the tools they had explored that morning.

After the groups have designed their projects, organizers discussed how to put together a rubric to assess student projects. They provided examples that valued the process students followed more than the final product, with dimensions that measured how well students could explain what they wanted to make and why, how well they worked together and how well they gave feedback to their peers.

Participants were given a packet with 15 pages of sample activities and rubrics they could take back to their classroom. In a post-event survey, 94 percent of teachers said the session was "highly effective" in helping them learn new strategies for leading and assessing self-directed, interest-driven learning—and many said they'd use what they learned in their classrooms right away.
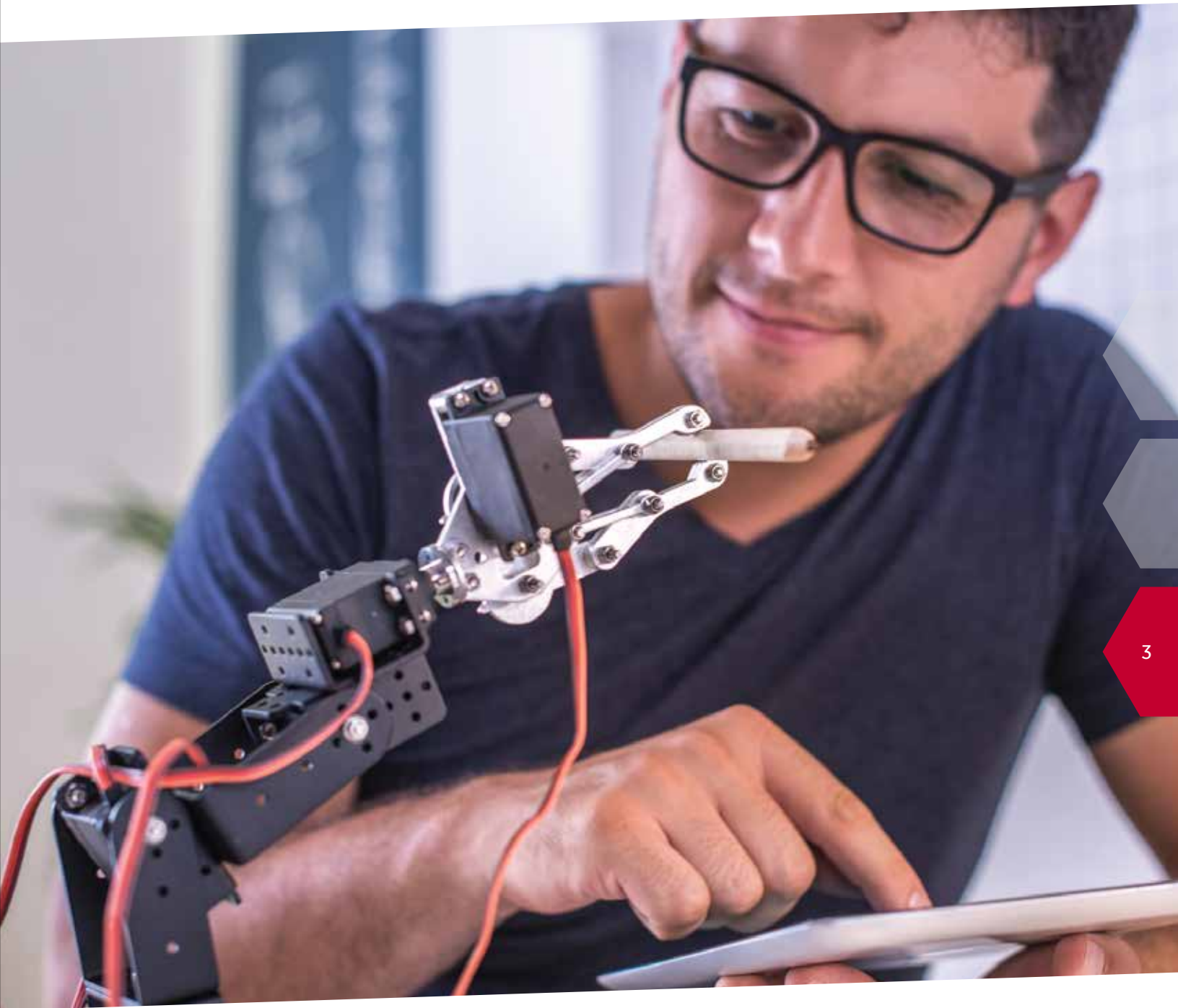
Conclusion

When students are given the chance to create, anything is possible. Students become excited and engaged, and real learning occurs.

We hope this guide helps you through the steps needed to create a maker space in your school, so you can unleash the creativity that exists in every child. Good luck in your journey—and let us know how the process goes. We'd love to share your story with your colleagues in other schools.

Additional Resources

This guide would not have been possible without the wisdom gained from the following sources. After you've digested the advice in this guide, you might want to check out these additional resources for further information.

- Autodesk. Maker Program Starter Kit: A step-by-step guide to launching your first maker program, 2016. Retrieved from http://www.makingstartshere.com/teach.

- Convergence Design Lab, http://convergenceacademies.org.

- Genesis Learning, https://www.genlrn.com.

- Maker Media. Makerspace Playbook, School Edition, 2013. Retrieved from http://makered.org/wp-content/uploads/2014/09/Makerspace-Playbook-Feb-2013.pdf.

- Martinez, Sylvia, and Stager, Gary. Invent to Learn: Making, Tinkering, and Engineering in the Classroom. Torrance, Calif.: Constructing Modern Knowledge Press, 2013.

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