Reimagine that:

MAKING THE MOST OF 3D PRINTING IN THE CLASSROOM

Maker's Red Box

CONTENTS

BRING LEARNING ALIVE WITH 3D PRINTING

When the first wave of the coronavirus pandemic hit, 3D printing proved a lifesaver in shortening production chains and providing much-needed medical supplies, like nasopharyngeal swabs and protective face shields, which had quickly become in short supply. Whether or not this momentum carries over post-pandemic is uncertain. The technology has the potential to revolutionize several areas of production where customization is key, from prosthetics to running shoes. Just how to make this transformation a reality, however, is a question organizations of all sizes and industries still grapple with.

Schools are no exception. 3D printers have been popping up in classrooms across the globe for years, but teachers often have a hard time figuring out what to do with them – let alone how to use the technology to prepare children for future jobs and teach indispensable skills. In fact, a global survey into the adoption of 3D printing in educational settings has found that

a whopping 87% of educators limit student access to 3D printers.

More than a third said that they find it challenging to understand how 3D printing can be used in their curriculum, Education Technology reports.

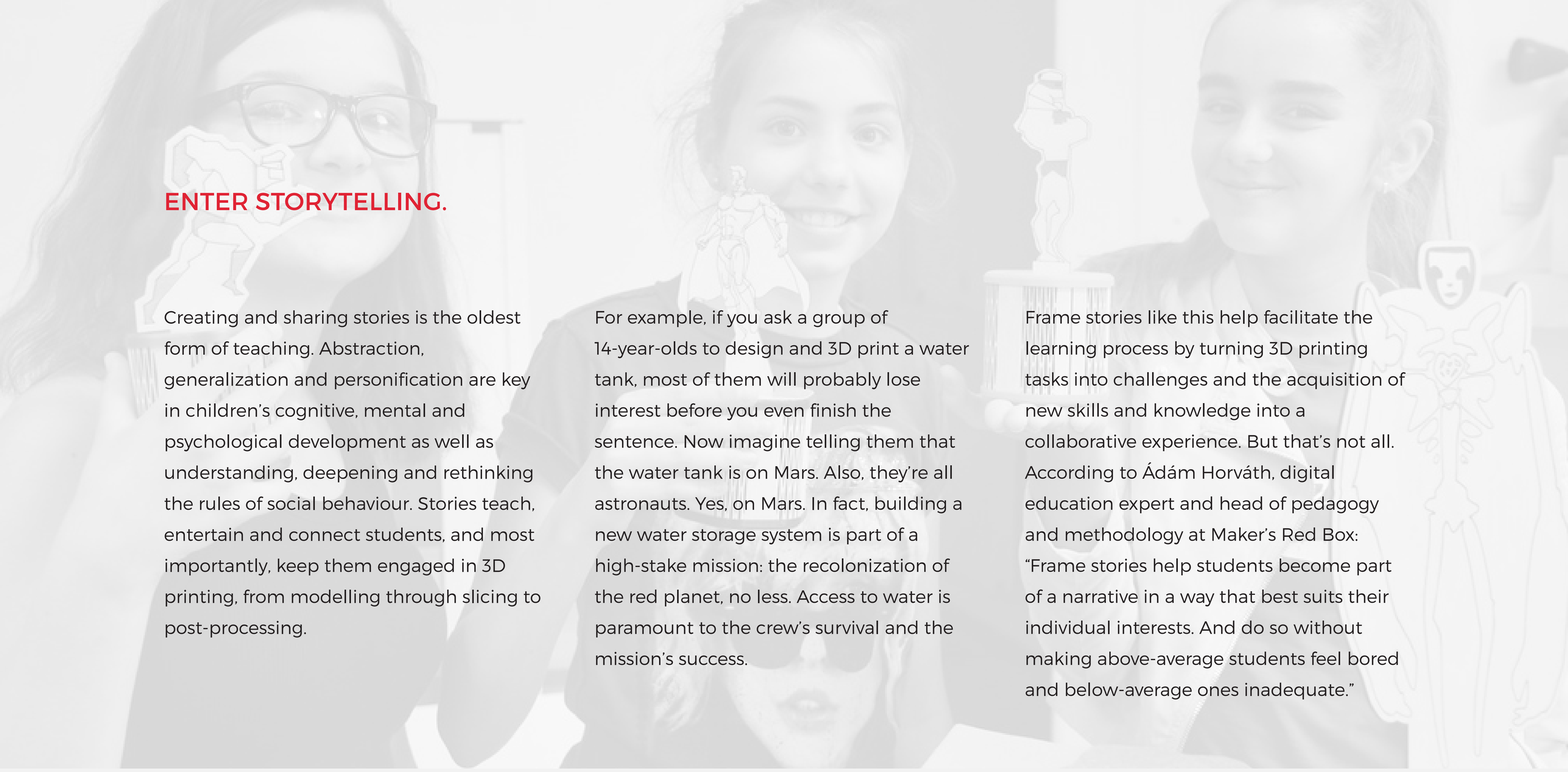
The educational possibilities that come with the ability to bring any idea to life in the classroom are endless. During 3D modelling, objects often need to be resized using simple formulas, which helps improve mathematical and engineering skills. Students' creativity is put to the test when they design solutions to real-world challenges, and so are their problem-solving and critical thinking skills when things go wrong. Empathy, collaboration and communication are essential both for completing 3D design tasks in class and functioning effectively in today's workplace and society at large.

In this ebook, you'll learn how to make the most of 3D printing technology as an educational tool, including essential tips on fostering creativity and enthusiasm as well as inspiring lesson plans to teach real-world skills for a high-tech future.

1 TELL A STORY

TO GET (AND KEEP) THE KIDS EXCITED

Using 3D printing for educational purposes requires much more than a printer, some PLA and a group of enthusiastic teachers. After the excitement of printing a couple of downloadable templates wears off, the head-scratching usually begins. Not to mention that printing a Baby Yoda figurine to wow students might sound like a good idea, but it takes an excruciatingly long time, costs a lot and holds little to no educational value.



ENTER STORYTELLING.

Creating and sharing stories is the oldest form of teaching. Abstraction, generalization and personification are key in children's cognitive, mental and psychological development as well as understanding, deepening and rethinking the rules of social behaviour. Stories teach, entertain and connect students, and most importantly, keep them engaged in 3D printing, from modelling through slicing to post-processing.

For example, if you ask a group of 14-year-olds to design and 3D print a water tank, most of them will probably lose interest before you even finish the sentence. Now imagine telling them that the water tank is on Mars. Also, they're all astronauts. Yes, on Mars. In fact, building a new water storage system is part of a high-stake mission: the recolonization of the red planet, no less. Access to water is paramount to the crew's survival and the mission's success.

Frame stories like this help facilitate the learning process by turning 3D printing tasks into challenges and the acquisition of new skills and knowledge into a collaborative experience. But that's not all. According to Ádám Horváth, digital education expert and head of pedagogy and methodology at Maker's Red Box: "Frame stories help students become part of a narrative in a way that best suits their individual interests. And do so without making above-average students feel bored and below-average ones inadequate."

2 REWARD

WITH MILESTONES, FEEDBACK AND EXPERIENCES

“Motivation has three pillars: autonomy, competence and connection,” explained self-described risk-taker and Teacher Prize top 50 finalist Jukka Sinnemäki in a 2019 interview. To feel a sense of accomplishment, children must be given the opportunity to experience being in charge of their own learning and to show what they’re good at. These positive experiences, combined with strong community support, can be powerful drivers for learning. “For example, the kids in my class designed the furnishings and purpose of their classroom. They’ve all played a part in creating a strong school culture.”

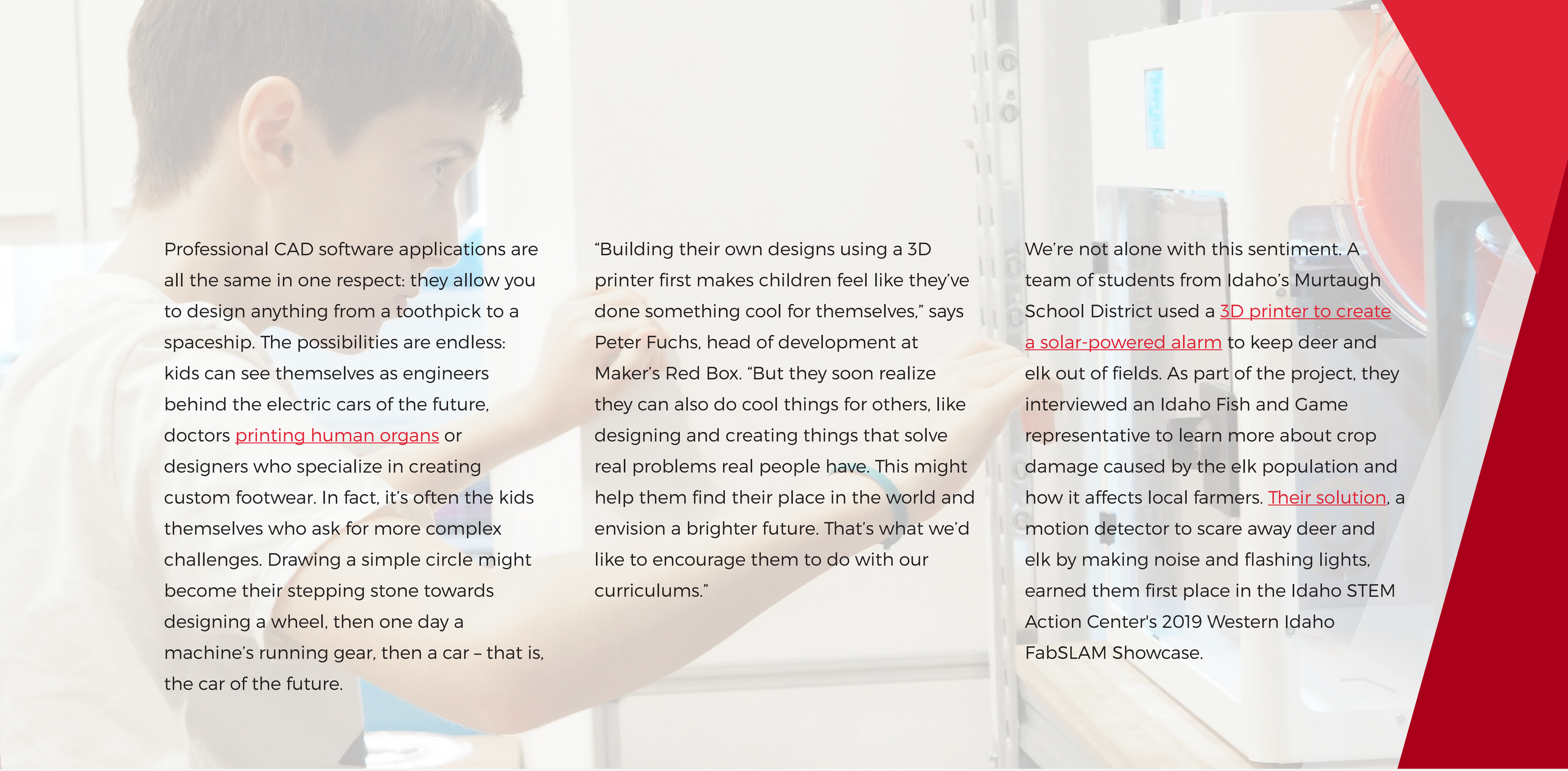
Keeping kids on track can be a challenge even if you've come up with the most elaborate frame story for 3D printing activities. The reason? The so-called "attentional shift", researchers have found. It usually works like this: when we first embark on something, be it a new diet or a school assignment, it's easy to see how much progress we've made relative to the start, so our motivation soars. The same happens as we get closer to achieving our goal. More often than not, the problem comes in the middle, when both the start and the end of our journey seem distant. To combat attentional fatigue, make sure to gradually increase the difficulty of tasks and give kids a chance to reach small milestones as they move forward in the curriculum.

Don't delay hands-on activities too long by providing lengthy explanations. Otherwise you'll risk students losing focus and missing out on the confidence that comes from learning through trial and error. Divide the 3D printing curriculum into projects, tasks and subtasks to give kids a sense of accomplishment at each step of the learning process. This will also reinforce the idea that their learning efforts have positive, practical payoffs. When they've finished a project, ask students to tell the class about their printouts: these mini-demos can not only improve communication and presentation skills but also provide inspiration and feedback on their work.

In our City of the Future curriculum, for example, the kids' task is to design a city they would like to live in 80-100 years from now. While working on their individual projects, they first get exposed to 3D printing when creating lamp covers for the city's micro:bit-controlled streetlights. The templates are pre-designed and the tiny objects take only 15 minutes to print, plus they're inexpensive. Not to mention that kids can use them right away and get instantly rewarded for their efforts: the lamps automatically turn on when the light in the room goes off.

3 CHALLENGE THE KIDS' TECH SAVVY AND IMAGINATION

After their first successful attempts at 3D printing, kids are ready to print their own designs. Tinkercad is a great tool for teaching them the basics: the easy-to-use 3D CAD design tool was developed for the very purpose of making 3D design more accessible. It only takes a couple of minutes for kids to understand how it works and start designing. That said, teaching them how to design with professional CAD software like Fusion360 straight away might be an even better idea. They can use it for much more than school assignments, which makes the learning process all the more motivating.



Professional CAD software applications are all the same in one respect: they allow you to design anything from a toothpick to a spaceship. The possibilities are endless: kids can see themselves as engineers behind the electric cars of the future, doctors printing human organs or designers who specialize in creating custom footwear. In fact, it's often the kids themselves who ask for more complex challenges. Drawing a simple circle might become their stepping stone towards designing a wheel, then one day a machine's running gear, then a car – that is, the car of the future.

"Building their own designs using a 3D printer first makes children feel like they've done something cool for themselves," says Peter Fuchs, head of development at Maker's Red Box. "But they soon realize they can also do cool things for others, like designing and creating things that solve real problems real people have. This might help them find their place in the world and envision a brighter future. That's what we'd like to encourage them to do with our curriculums."

We're not alone with this sentiment. A team of students from Idaho's Murtaugh School District used a 3D printer to create a solar-powered alarm to keep deer and elk out of fields. As part of the project, they interviewed an Idaho Fish and Game representative to learn more about crop damage caused by the elk population and how it affects local farmers. Their solution, a motion detector to scare away deer and elk by making noise and flashing lights, earned them first place in the Idaho STEM Action Center's 2019 Western Idaho FabSLAM Showcase.

4 COMBINE 3D PRINTING WITH OTHER TOOLS AND TECHNOLOGIES

Creating and assembling moving mechanical parts can be pretty exciting for kids. Seeing how enthusiastic they get making Mars rovers with gears as part of our Green Engineers curriculum is something right out of a Seymour Papert book. The late mathematician and ed-tech pioneer was himself fascinated by gears as a child, which later helped him redefine and revolutionize learning as an active process of making. He developed his learning theory, constructionism, in direct opposition to passive, teacher-directed setups, to describe the way in which students can build knowledge instead of absorbing it by working with concrete materials rather than abstract propositions.

3D printers can help educators a great deal in making Papert's vision a reality. What we've learned after years of experimenting is that they work best when used in combination with other technologies like hand tools, microcontrollers, soldering stations and laser cutters. In our City of the Future curriculum, for example, by the time students get to printing lamp covers, they've successfully programmed microcontrollers, soldered circuits and created whole streets using a laser cutter. Mixing these technologies, there'll always be a milestone to celebrate. Plus, kids will have a bigger and better toolset for turning their ideas into functioning objects.

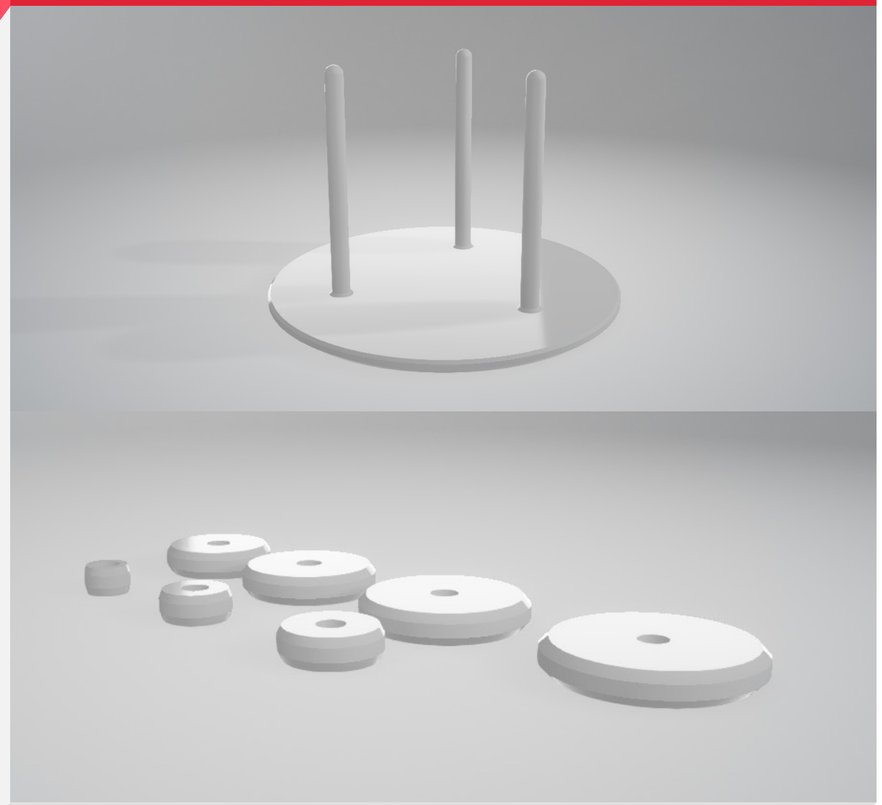
Makerspace workshops enhance the kids' digital toolkit by adding manual tools needed for making with one's own two hands. "A makerspace is not solely a science lab, woodshop, computer lab or art room, but it may contain elements found in all of these familiar spaces," maker ed expert Jennifer Cooper writes on Edutopia. "Diversity and cross-pollination of activities are critical to the design, making and exploration process."

When creating and using physical objects, applying fine motor skills helps develop more advanced cognitive functions and synapses in the brain. This does not only make cognition easier but also serves as the foundation of creativity. Plus, it enables children to remember and apply what they've learned and adapt it to new problems.

5 GET INSPIRED
LESSON PLANS

Ready to super-charge creativity in your classroom? Here are two sample 3D printing lesson plans that will help get you started.

LOGIC AND MATHS GAMES



Download printable file.

THE TOWER OF HANOI

Requirements

Familiarity with the definition of exponentiation.

Activity

1. Design and build a model of the Tower of Hanoi.
2. Slice and print the model, preferably in a variety of colours. In the meantime, introduce the rules of the game.
3. Colour the discs with felt-tip pens or acrylic paint.
4. Kids compete in pairs to see who can move the discs from one rod to another following the rules. (One student should make sure the rules are observed and keep track of time, while the other one moves the discs.)

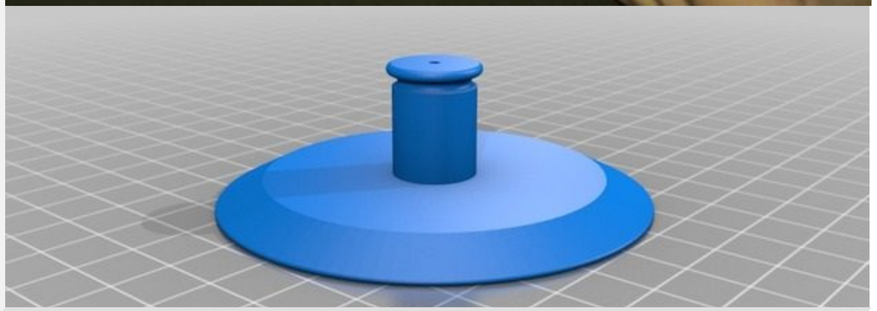
Discussion

The kids should work out how many moves it takes to solve the puzzle and why. Ask them to research and model similar games.

Outcome

The students figure out that the number of moves needed is connected to the power of 2, because there are two choices involved in each move. The activity is ideal for improving strategic thinking and planning skills.

VEHICLES WITHOUT FRICTION



Download printable file.

HOVERING DISC

Requirements

Familiarity with the force of friction as well as the difference between helpful and harmful friction, plus one balloon per student.

Activity

1. Give a refresher on what friction is and ask the kids how harmful friction can be reduced.
2. Design an air-cushion vehicle. Using a ready-made sample, the students should prepare a similar hollow disc with a cylindrical balloon holder attached to it.
3. Focus on finishing the models quickly, so you can label and decorate them.
4. Print the models one after the other.
5. Attach an inflated balloon to the printed models and hold a hovercraft race.

Discussion

Ask the kids if they know what air-cushion cars and hovercrafts are used for and what “multimodal” means. Then move on to designing other types of multimodal vehicles.

Outcome

The kids deepen their knowledge of friction and practise sizing objects, using Vernier calipers, working in teams and collaborating with others.

ABOUT MAKER'S RED BOX

LOOKING FOR A WELL-ROUNDED CURRICULUM DEVELOPED BY MAKERS FOR MAKERS?

Using the power of storytelling, Maker's Red Boxes help you turn kids into avid makers and your workshop into an inspiring learning space. Each box includes an exciting, STEAM-focused curriculum as well as a starter kit with a comprehensive teacher's guide and supporting digital content, such as presentations and lines of code. The curriculums have been tested in various environments during a several-year-long development process, from five-day summer camps to weekly workshops.

The boxes focus on strengthening hard and soft skills like 3D design and printing, laser cutting, soldering, electronics, robotics, teamwork, emotional intelligence and critical thinking. They encourage story-driven teaching and follow a different storyline to cater to all interests and skill levels, strengths and weaknesses. Stories both define the creative process and help makers gain transferable knowledge through hidden learning. And turn assignments into playful challenges instead of dreaded tasks.

CONTACT US

Interested in Maker's Red Boxes?
Get in touch.

Eva Naszaly
Product Ambassador
E-mail: eva.naszaly@makersredbox.com
Phone: +36 70 709 3729
Web: makersredbox.com

Maker's Red Box