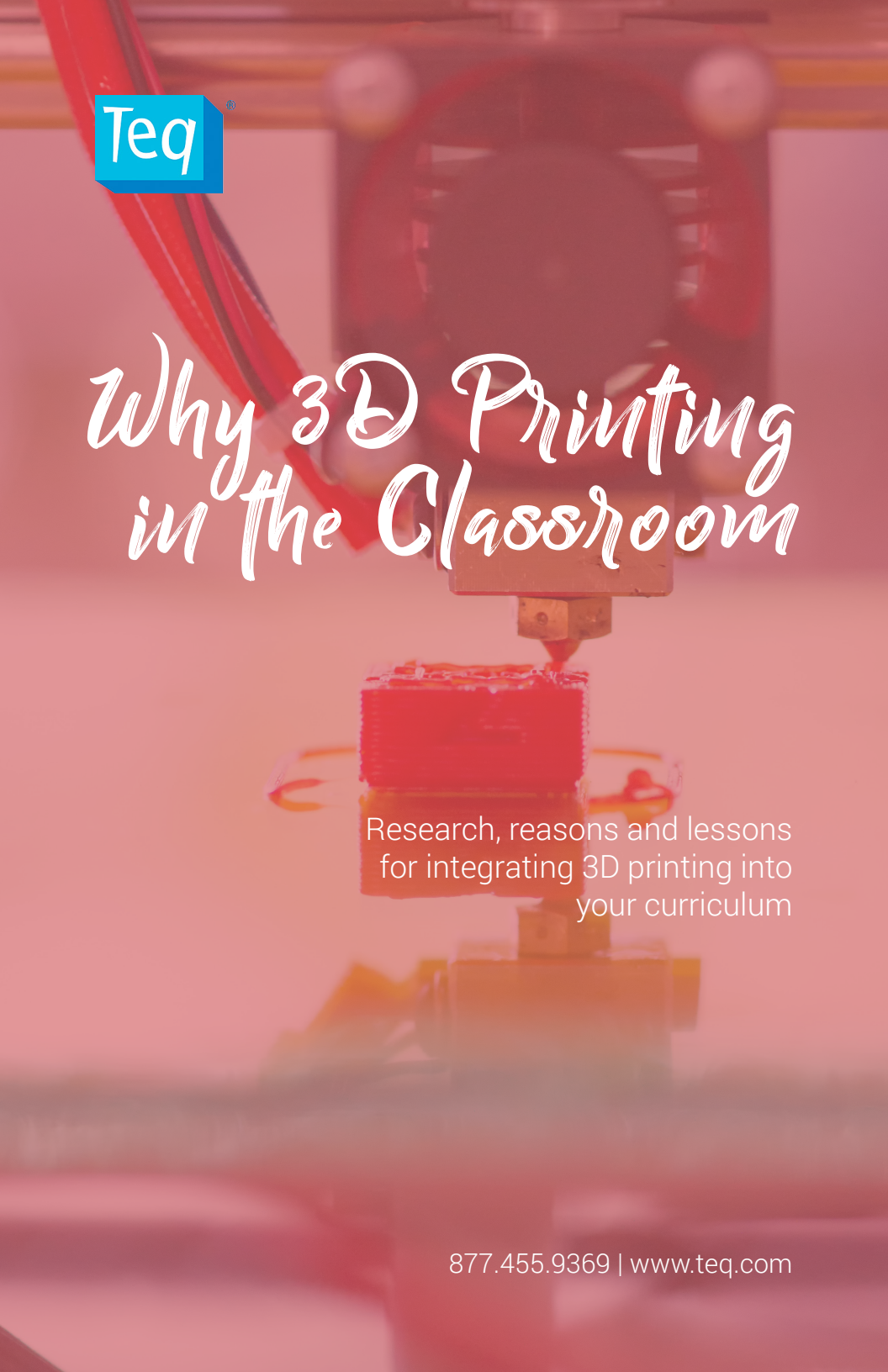

Why 3D Printing in the Classroom

Research, reasons and lessons for integrating 3D printing into your curriculum

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Why 3D Printing in the Classroom

E-BOOK

With this eBook, we hope to answer some of these questions, and put you on a path to success with 3D printing in your classroom. We have some resources for lesson ideas and activities, will share some research, and will give you the knowledge you need to advocate for 3D printing as a valuable educational tool.

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Students love it and learn from it, and educators keep asking for 3D printers in their schools. But even with this demand, some school administrators struggle to justify the purchase of 3D printers.

Questions remain:

Why bring 3D printing into the classroom?

How can 3D printing help students learn problem-solving skills and develop their critical thinking?

How is 3D printing technology being integrated into instruction so it engages students and aligns to curriculum?

How can 3D printing get students interested in careers in STEM

3D printing in the Classroom

5

reasons why

1 Put the A in STEAM

The arts are vital for student success

It's no surprise that more of an emphasis is being placed on introducing the arts into STEM programs. According to a study by Kent State University, **students who study the arts are four times more likely to be recognized for academic achievement**. As a result, educators are looking for innovative ways to reestablish the arts in their curriculum.

3D printers have emerged as a powerful tool to reintroduce the arts by allowing students to use their imagination and creativity. Students experience the full design process from start to finish. Using computer-aided design (CAD) software, students can design a 3D object, and then create that object using the printer.

By designing 3D objects using CAD software, students can better understand how 3D shapes fit and work together to create 3D models based on their imagination. **Being able to understand how 3D shapes work and fit together can also result in improvements in a student's spatial intelligence**. Spatial intelligence is the ability to mentally and visually grasp 3D images and shapes. According to a recent study conducted by David Lubinski and his colleagues at Vanderbilt University, spatial intelligence is an overlooked indicator of future student success, and is a vital part of learning development.

Kent State URL: https://musicedmasters.kent.edu/stem-to-steam/
Vanderbilt University URL: https://my.vanderbilt.edu/smpy/files/2013/01/DoingPsychScience2006.pdf

Lesson Idea

Tessellation Escher Project

Encourage students to see patterns in the world around them! In this activity students create tessellation patterns and then 3D print them as puzzle pieces. This project helps students build spatial intelligence by manipulating physical objects through kinesthetic learning.

Find it here: **https://www.thingiverse.com/thing:1318696**

Recommended # of printers: 1-3

Research

Case Study:

Why Spatial Intelligence is Important and How to Help Develop it with 3D Printing

Created by Australian primary school teachers Graham Gordon and Ruth Cowen, this study concluded that students demonstrated a significant improvement in their ability to mentally rotate and manipulate shapes (spatial intelligence) after using 3D design and printing in the classroom.

Research URL: https://www.makersempire.com/spatial-intelligence-important-help-students-develop-3d-printing/

2 Engage Different Learning Styles

Students are unique – and so are their learning styles

3D printing can facilitate successful learning experiences that accommodate the different ways students learn. It has the power to bring a lesson to life for kinesthetic and visual learners, and to **build an immersive and dynamic learning environment for everyone**.

For example, 3D printing can bring a history lesson on ancient Egypt to life when students design and print replicas of structures and artifacts from this time period. Kinesthetic (tactile) learners will benefit because it allows them to physically create, touch, and analyze objects that may not have been possible before.

3D printing can also provide personalized learning experiences for visual learners. By designing and printing different 3D objects, complex concepts become tangible. For example, a lesson on engineering design could have students modify and print robot parts and then assemble them. As they work with the parts, students will be able to visualize how the different pieces fit together, thus giving them a better understanding of the engineering concepts behind them.

Lesson Idea

The T-Rex Skull

What's the difference between scientific facts and theories? With this 3D printable model of a T-Rex skull, students will learn from fossils and explore the characteristics of the most-studied dinosaur.

Find it here: **https://www.thingiverse.com/thing:308335**

Recommended # of printers: 1-3

Research

Case Study:

Introduction of 3D Printing Technology in the Classroom for Visually Impaired Students

This study concludes that one advantage of 3D printing technology is its ability to create customized materials for visually-impaired students who have different learning aptitudes and cognitive abilities.

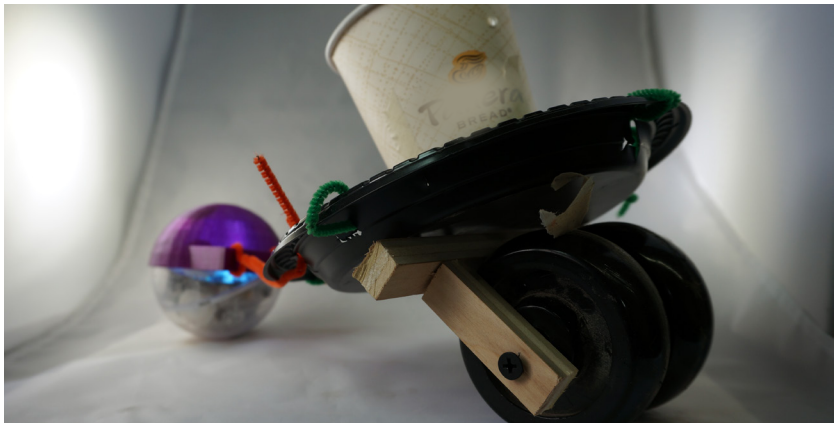
Research URL: https://files.eric.ed.gov/fulltext/EJ1114998.pdf

3 Make STEM Fun and Engaging

Curriculum can come to life with the integration of 3D printing

While educators recognize the importance of teaching STEM, many find it difficult to keep the content engaging for their students. Schools can drive student engagement around STEM by providing access to new technologies that **create a "wow" factor around the content being delivered**. 3D printers are the perfect tools to do this.

3D printers offer a new approach for educators to engage students in critical thinking and problem solving – and to bring lesson plans to life. For example, an elementary school math lesson on perimeter, volume, or probability could feature students designing and printing their own 3D objects. Getting to design a 3D object– and then see it come to life as a 3D model – is exciting, keeps students motivated, and helps them gain a better understanding of new concepts they are learning.



Lesson Idea

H2 Make It Go

Robots, STEM, and some serious creativity! This activity asks students to measure volume and explore the design elements needed to create a "vehicle" for their Sphero robot. Students also learn how the weight, materials, and drag alter the speed of the robot.

Find it here: **https://www.thingiverse.com/thing:1622569**

Recommended # of printers: 5+

Research

Case Study:

Turning Students into Engineers with 3D Printing

This article concludes that learning to design and create objects through the 3D printing process is not only helpful to students' learning development, but prepares them with skills they will need in the future.

Research URL: http://stevemurrayink.com/wp-content/uploads/turning_students_into_engineers.pdf

4 Inspire an Interest in STEM Careers

Giving students dynamic experiences can plant seeds for the future

The 3D printing process can not only make subject matter more engaging, but can **ignite students' curiosity and interest in STEM fields** – an approach that is particularly valuable when applied at an early age. And with the demand for STEM professionals expected to add over 1 million new STEM jobs within the US by 2020, it is more important than ever to engage students in STEM and STEM-related career fields.

One of the biggest benefits of 3D printing is its ability to facilitate real-world problem solving in the classroom. Hod Lipson, a Cornell University professor, has experienced this benefit first-hand with his product design students. While design projects are normally limiting because they don't connect the designer to the final product, 3D printing is changing that. "What 3-D printing allows us to do," says Lipson, "is to accelerate the innovation process so that students can experience the entire product design and marketing from A-Z in one semester, within a period of maybe three months or less."

Schools have modified this example to not only exercise real world problem solving, but to **allow students to experience what a STEM career would entail**.

STEM jobs URL: https://www.kukakore.com/robotics-stem-education-infographic/
Cornell University URL: http://bigthink.com/in-their-own-words/two-ways-3d-printing-is-revolutionizing-the-classroom

Lesson Idea

Prosthetic Hand Mission

Apply 3D printing to the real world! This activity has students applying real-world engineering design to create and 3D print their own prosthetic hands.

Find it here: **https://www.thingiverse.com/thing:1954875**

Recommended # of printers: 5+

Research

Case Study:
Expanding Applied Learning

This study concludes that 3D printing is a powerful tool that teaches the problem-solving skills and collaboration skills needed to make them valuable assets in the job market.

Research URL: http://global72.stratasys.com/~/media/en/Corporate/Newsroom/F123/Case-Study_FDM_Dunwoody_0117a-Web.ashx

5 Teach Students to Learn from Failure

Opportunities to try, try, and try again build important skills for students

Student success is traditionally measured by students taking tests and receiving a passing or failing grade. The problem with this approach is that it encourages students to gain only the knowledge required to pass the test, builds anxiety around test taking, and above all, ignores the lessons that can be learned from failure. The lessons we learn from failure are just as important as the lessons we learn from success. **Failure develops resiliency**, and being able to learn from our mistakes is a vital skill to develop in students – as a character trait, and as a skill set for the future.

3D printers are a great tool for facilitating learning through failure. Students will have to analyze, modify, and test their design multiple times before they are successful. During the preparation phase, students will have to select the optimal settings to make their print successful. If the print ends up failing, students can go back to analyze and modify the settings until they are successful. By doing this, students will become better designers – and learn how to face failure and overcome it. As Yoda said during Star Wars: *The Last Jedi,* "The greatest teacher, failure is."

Lesson Idea

Archimedes Screw Project

Reinvent the wheel! In this activity, students will create and modify an Archimedes Screw and are tasked with moving different materials up an incline. Students observe the original design, and then create a more efficient screw design that fits into the case.

Find it here: **https://www.thingiverse.com/thing:1769714**

Recommended # of printers: 2

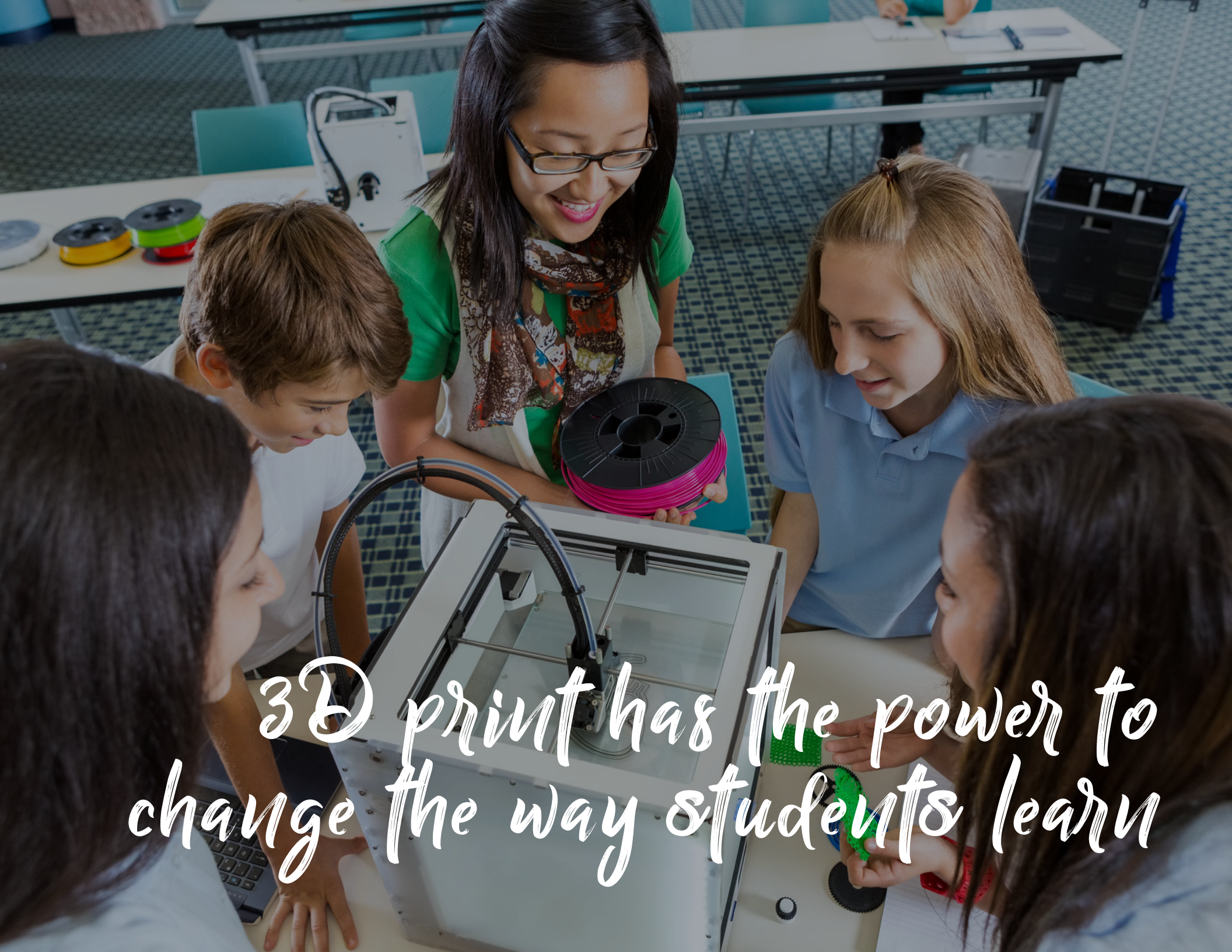
Research

Case Study:

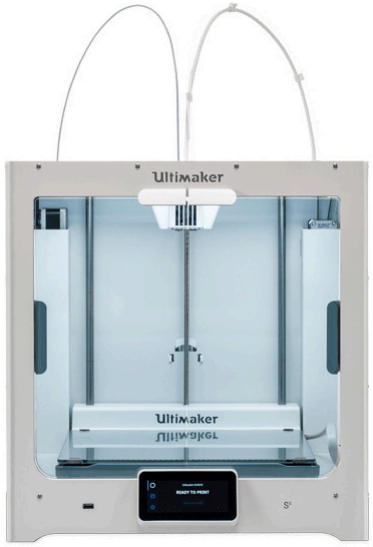
3D Printing for Learning

This article looks at how the 3D printing process gives students hands-on practice in problem solving, as they work through the prototyping process, reiterating failed designs and prints until they are successful.

Research URL: https://www.techlearning.com/tl-advisor-blog/3d-printing-for-learning


3D print has the power to
change the way students learn

Printers we love



Ultimaker s5
Ultimaker's most advanced 3D printer yet, the Ultimaker S5* builds on the capabilities of the Ultimaker 3, then adds enhanced performance with a larger build volume, effortless operation, and unparalleled reliability.

http://www.teq.com/stem/ultimaker-3d-printer/.

MakerBot Replicator +
Engineered for Reliable, Faster 3D Printing. The MakerBot Replicator+ combines unparalleled performance with superior results and lasting reliability.

http://www.teq.com/stem/makerbot-3d-printer/.

About Teq

Learning is at the heart of everything we do at Teq. With our unique blend of innovative edtech products and dynamic professional development, we are committed to supporting and enriching the classroom environment.

The Teq story began over 40 years ago, in a small barn, where we sold vocational training equipment. Our family business evolved as educational technology evolved, and we're proud to have grown from our humble beginnings into the world-class edtech organization we are today.

The power of educational technology is that it can be harnessed and personalized for each learner and learning environment. We offer a broad portfolio of the best and most innovative products the edtech industry has to offer, so you can choose the tools that work best for you.

But leveraging educational technology isn't as simple as merely having the latest and greatest technology in the classroom – it's about effectively integrating that technology into curriculum in a way that engages, supports, and inspires all learners. That's why we provide relevant, flexible, and standards-based professional development to empower educators, improve technology integration, and raise student achievement. From customized onsite coaching and mentoring, to a library of online professional development courses and certifications, we are committed to fostering passion and creativity in the 21st century learning environment.

It's all about learning.

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