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Fun Ideas for #ActiveLearning

IN A STEAM ENVIRONMENT WITH 3D PRINTING

The best learning isn't a "spectator sport." It engages students in activities that push them to write and talk and, most of all, create. Here are the top ideas for helping your students engage in their learning through 3D design and printing.

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STEAM-powered education is definitely on the move. Science, technology, engineering, art and math form a powerful concoction of opportunities for students to become actively engaged in learning inside and after school. This potion of STEAM and active learning morphs learners into better problem solvers, innovators, inventors and logical and independent thinkers, preparing them for a life of learning and earning in the 21st century.

It's not news to any educator that STEM has become embedded into the curriculum. A 2014 occupational forecast by the U.S. Bureau of Labor Statistics projected that occupations in these fields would grow faster than the average for all occupations; and median salaries were more than twice the earnings reported for all workers—$76,000 compared to $35,080.

And people undertaking careers in STEM find the work highly rewarding and stimulating. As a BLS report noted, these individuals "enjoy collaborating with people who share their enthusiasm and working with cutting-edge technology." STEM offers a "cooperative, innovative, and exciting work environment that is unparalleled," one expert stated.

But why the addition of art to all that math and science? What role does that play? As Mae Jemison, a scientist, engineer, physician, futurist and the first African-American woman in space, explained in a TED talk, "The difference between science and the arts is not that they are different sides of the same coin... or even different parts of the same continuum, but rather, they're manifestations of the same thing... The arts and sciences are avatars of human creativity."

The Thing About Active Learning

Active learning is hardly a new concept. After all, great teachers have been involving students in activities to help them learn since Socrates asked his pupils questions. In an oft-cited report, Charles Bonwell and James Eison described active learning as "anything that involves students in doing things and thinking about the things they are doing."

What it isn't is a traditional lecture, though it could involve a lecture followed by a group discussion that is then turned into a student presentation or video recording and thereafter assessed by other students. Students must be doing something, whether it's discovery, processing or applying information.

"Learning is not a spectator sport. Students do not learn much just by sitting in class listening to teachers, memorizing prepackaged assignments, and spitting out answers," as two researchers, Arthur Chickering and Zelda Gamson, pointed out in a 1987 article in the American Association for Higher Education and Accreditation Bulletin. "They must talk about what they are learning, write about it, relate it to past experiences, apply it to their daily lives. They must make what they learn part of themselves."

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According to a research project, the "elite" scientists—those who have won a Nobel Prize—are 2.8 times more likely to have a hobby in photography, music, the visual arts, creative writing or maker crafts. As one analysis explained, "It appears that artistic development and scientific productivity are closely related—experience in the arts enriches one's skills in the sciences," noting that there exists "functional connections between scientific talent and arts, crafts and communications talents." Developing one can foster the other.

The remainder of this report includes six active learning activities you can introduce into your lessons to help you foster enthusiasm for STEAM inside the hearts and minds of your students to expand curiosity and comprehension.

FOR LOWER GRADES

See Inside a Cell

The typical cell structure lesson involves students drawing pictures and labeling the important points. Allowing them to design and print 3D versions of cells, both plant and animal, gives older students practice in designing ever-more complex 3D models and helps imprint the parts of the cell on their brains. It also gives them the chance to create "manipulatives," objects to be handled and scrutinized and that help learners visualize complex structures and equations. In fact, students can build up their skills by offering 3D design and printing services to teachers in lower grades. Many of those educators have adopted the use of manipulatives to help their young learners make the connection between the basic math and science concepts they see on paper and what they can hold in their hands. The older students can work with those teachers and younger students to design and produce objects that might otherwise not be available due to budgetary restrictions.

To add the arts dimension, before getting into the 3D design work, consider having your students create shapes and parts of cells with different materials in collage format.

Resources:

"Plant and Animal Cells" includes a ZIP file containing four STL design files as well as a paper-based assessment of cell parts and a vocabulary lesson. http://www.thingiverse.com/thing:1716812

"Get Inside a Cell," a lesson from The Kennedy Center ArtsEdge website, provides lessons that help students understand the components of an animal cell. The lesson includes suggestions for teachers, such as sharing scientific drawings of Beatrix Potter's science pictures and the pictures for her Peter Rabbit books to help students understand the differences between the two types of illustrations. https://artsedge.kennedy-center.org/educators/lessons/grade-6-8/What_Is-Inside_a_Cell

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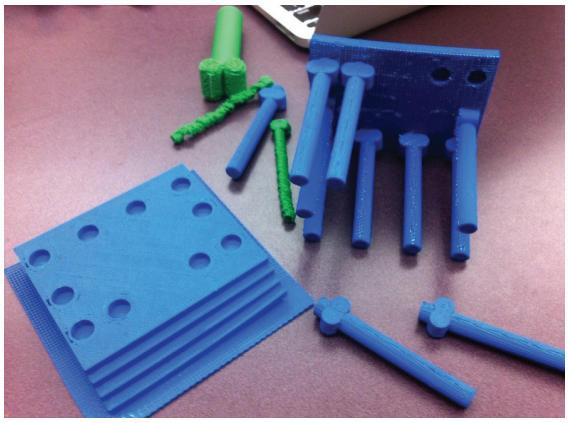
Create a Sustainable Roof

This lesson helps kids understand the design functions that repurpose runoff rainwater in cities. Along the way they learn about the water treatment process before it's released back into the ocean and get the chance to measure liquids using a graduated cylinder, which will be used for runoff.

3D design and printing of small buildings with receptacles allow the students to compare runoff between a "control" building without a green roof and the runoff generated with an experimental roof with soil and grass.

The idea originated with a teacher in Brooklyn, and the small buildings resemble Brooklyn brownstones (albeit in green, blue and red). After experimenting with the existing model, consider having your younger students come up with their own building planter designs—at least on paper—and work with older students to create new versions of the model.



Try this!

It's easy to worry about the fate of the elephant or whale or panda. But it's the mass extinction of insects that could have the biggest impact on the fate of the biological world. Help your students appreciate the amazing variety of endangered insects by encouraging them to draw, design and 3D print larger-than-life models of bugs. Here's how one fourth grade teacher approached the project. This lesson plan focuses on students learning insect anatomy.

Resources:

"Using 3D Printing and Modeling to Enhance a Green Roof Lesson" explains the sequence of lessons, offers an informal way to assess the student's understanding and proposes the math and science standards covered. http://spolearninglab.com/curriculum/lessonPlans/science/green_roofs.html The 3D design file for a "green roof planter." http://www.thingiverse.com/thing:25403

FOR MIDDLE GRADES

Outsource Temple Construction

Two grade 5 classes studying ancient Greece learned about the challenges of project management and contract labor. The two classes exchanged specifications for building Greek temples and then held virtual meetings to discuss the project and work out the details.

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The project was not just a lesson in the Greek "artist/patron" relationship, but it was also a way to learn about outsourcing, requests for proposals and the problems inherent in human communication.

The RFP process forced students to better understand basic measurements of Greek temples (height, width and length) and details such as column styles that were common (Corinthian, Doric and Ionic), the numbers of steps and columns required for their designs, and the types of adornments that would be carved into the upper part (in this case, a few letters of text).

***Resources*:**
Technology director Karen Blumberg shares several photography tips and her excitement about the project in this blog post. https://karenblumberg.wordpress.com/2012/05/24/3d-greek-temples/

Thingiverse features numerous designs for Greek temples that students can use to kick start their design thinking. http://www.thingiverse.com/search/page:1?q=greek+temple

LEARN TO FLY WITH WHIRLIGIGS

Whirligigs are a simple mechanism to help your students explore the concepts of flight, particularly lift, drag, shape, torque and angle. While a propeller's movement creates a force to lift it upward, the weight of the attached stem pulls it downward, as does the air rushing through its spinning blades. This set of lessons can go in multiple directions, by asking questions such as, "How does size or weight affect the ability to fly?" and "How does the angle of the propeller affect its properties of lift?"

Propel active learning into the arts by having students take photos or make videos of objects in nature that display propeller-like features or objects in the mechanical world that use the momentum of propellers.

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Try this!

Scientific models can be expensive and hard to come by, especially models for meeting specific learning goals. Online libraries, such as Thingiverse and GrabCAD make it easy for science students and educators to download free design files and 3D print their own scientific models. Explore this blog post providing scientific models for 3D printing, including human anatomy, molecular structures, microorganisms, tissue structures, custom labware and more. See, hold and manipulate 3D printed scientific models to help students "visualize" detailed structures.
http://blog.stratasys.com/2016/12/08/3d-printed-science-models/

Or expand the lesson into the upper grades by building wind turbines to examine the optimal means for converting kinetic energy into electrical energy.

Resources:

The overall lesson for both whirligigs and wind turbines is shared here.
http://spolearninglab.com/curriculum/lessonPlans/science/whirligig.html

A more extensive lesson, including learning standards and assessments, is available here.
https://www.nms.org/Portals/0/Docs/FreeLessons/MG_Whirligig%20Lollapalooza_web.pdf

Additional explanatory content targeted at grades 3 and 4 is available on the STEMEdhub here.
https://stemedhub.org/resources/1763

Here, you'll find the 3D design file for a basic "puddle jumper" whirligig that's launched by hand.
http://www.thingiverse.com/thing:22454

For a wind turbine starter plan, try this.
http://www.thingiverse.com/thing:1767153

FOR UPPER GRADES

Extreme Redesign Challenge

Each year, Stratasys fuels innovation by sponsoring a design challenge encouraging students to remodel existing products or create new ones in 3D CAD. Students worldwide reimagine the future of products to improve a process or meet an unfulfilled need. The contest encompasses three unique categories: Art, Jewelry and Architecture (one category, any grade level), Engineering (post-secondary) and Engineering (secondary education). After preparing their best STL file for 3D printing, students include their reasoning as to why the world needs their new or reinvented product.

The winner and runner-up in each category will receive up to a $2500 scholarship, and category finalists (30 total) will receive a 3D printed model of their design from a Stratasys 3D Printer. Teachers of winning students receive a 3D printer for their classroom and all students receive a T-shirt for participating.

Custom Chess Set

The purpose of this lesson is to help high school-level students practice drawing and designing in CAD as well as learn 3D printing design specifications. Students design a chess set that includes six unique game pieces: pawn, rook, knight, bishop, queen and king. They will need to incorporate a consistent theme in each of the six pieces and each chess piece must be clearly identifiable. By the end of the project, students will be able to identify and apply steps they would use in a real product design scenario. They will know how to apply information and gather requirements pertinent to design planning.

Try this!

Encourage your students to learn how to build their own custom labware. The U.S. National Institutes of Health "3D Print Exchange" includes a category just for that with downloadable STL files for everything from a bacteria coupon holder and ball valve to a soil sieve and soldering assistant.

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