

Student-Centered 3D Printing



Pathfinder of 3D printing resources

Lesson Ideas

Lesson Plans

Monica Schaffler

Media Specialist
Lafayette High School

Monica.Schaffler@wjccschools.org

Amy Wallisch

Media Specialist
Lafayette High School

Amy.Wallisch@wjccschools.org

3D PRINTING REVOLUTIONISING

the

CLASSROOM

Biology students can study cross-sections of hearts or other organs.



3D Printers have actually been around for about 25 years. Barriers like costs are breaking down, so they are now very affordable and easy to use.

3D Printing has caught the attention of educators who are looking into ways to incorporate it into the classroom.



Design and Engineering students can make prototypes of their creations.

Chemistry students can print out complex molecules to study.



Using 3D Printers in the classroom could mean:



Engineering students can print modified car or robot parts.



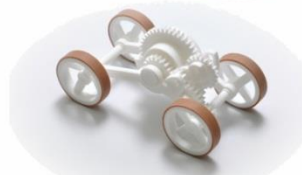
Architectural students can print new or existing designs.



History classes can print artifacts for closer examination



Geography students can print out topography, population or demographics of an area.



Graphic design students can create prototypes of product designs



Food Technology students can design molds and cookie cutter templates

3D Printing Resources Pathfinder

Use Google Chrome

Thingiverse

<http://www.thingiverse.com/>

Find premade objects to print in Thingiverse! Make sure you read the notes and comments sections for extra printing tips. No username/passwords needed. Use Google Chrome!!!!

Tinkercad

<https://www.tinkercad.com/>

Use 3D shapes to create objects that you can then print! You must make a free account before using the site. However, the teacher can make one account and the whole class can log into that account at the same time.

Tutorial for Tinkercad- http://spolearninglab.com/curriculum/software/3d_modeling/tinkercad_intro.html

Lessons for Tinkercad- <https://www.tinkercad.com/quests/>

Gallery of premade, customizable objects- <https://www.tinkercad.com/things/>

Online converter

www.online-convert.com/

Use this website to convert image files to .svg files. This lets you upload the .svg image to TinkerCad to make it a 3D design.

- Students can make something in Word, use the “Snipping Tool” to take a picture of it, use Online Converter to turn it into a .svg file, and upload to Tinkercad to turn it into a 3D design.
- Students can also draw something on paper, take a picture of it, use Online Converter to turn it into a .svg file, and upload to Tinkercad to turn it into a 3D design.

Kathy Schrock’s Guide to 3D Printing in the Classroom

<http://www.schrockguide.net/3d-printing.html>

Kathy Schrock is an educational technologist who has created an in-depth page of links for 3D printing articles, lesson plans, tutorials, and more.

Documentary: 3D in the MC

<https://www.youtube.com/watch?v=MRXUf69KC-I>

By Monica Schaffler and Amy Wallisch
Lafayette High School Media Center

3D Lesson Ideas

Social Studies

-Research and print artifacts or monuments- ancient, modern, or even future

-You can find artifacts available for download at Thingiverse.com or <https://www.tinkercad.com/things/>.

Students can also create their own artifacts at www.Tinkercad.com

-Curate a museum exhibit using printed artifacts.

-Example lesson plan for a Greek Temple can be found at -

http://spolearninglab.com/curriculum/lessonPlans/social_sciences/greek_temples.html

-Geography: Print topographical maps

-Step-by-step directions- https://dl.dropboxusercontent.com/u/11089897/3drucken/maps_to_3D.pdf

-Create a map of the United States to compare data by state.

-Students can create a map of the United States where the height of each state represents a specific topic. Examples could include population, taxes, number of electoral votes, immigration, etc.

-Customizable map of the continuous US can be found here <http://www.thingiverse.com/thing:209005> (Alaska and Hawaii could be created separately)

Create a Coat of Arms to represent themselves or a historical figure

-Lesson plan found here- http://spolearninglab.com/curriculum/lessonPlans/lang_arts/coat_of_arms.html

Create a historical marker or plaque in Tinkercad- <http://www.thingiverse.com/thing:81412/#comments>

-This does not give a lesson plan, but provides pictures and ideas to get started

Study 3D scans at Smithsonian X 3D- <http://3d.si.edu/>

-The Smithsonian has created 3D scans of artifacts and places. Scans can be used for student exploration and some can be downloaded and printed, but they are mostly for exploring in 3D. Articles accompany each scan in order to provide more information.

Science

-Create your own insect, animal, etc.- include necessary parts and describe the habitat

-Lesson plan -https://docs.google.com/document/d/1Oe-ftUz5c3eRBjt_e1OWN7r0JAM0IIncXN9JGCMbt5U/edit

-This lesson uses a free app called 123D Creature that could be added to school iPads, or students could use Tinkercad or any other design software.

-Find the volume and density of an object

-Create a shape in TinkerCad and use the measurements to calculate the volume. Take printed models back to the classroom to find the mass and the density of the object

-Erosion- design and print a building or a house. Once models are printed, set them on a model river bank and watch what happens as the river erodes the soil.

-View the detailed lesson plan here <http://spolearninglab.com/curriculum/lessonPlans/science/erosion.html>

-Physics- design and print a bridge- uses force, Newton's laws of motion, vector diagrams and resolution, & equilibrium

-Lesson plan- <https://www.printyourmind3d.ca/pages/lesson-plans-bridge-design>. This lesson uses Autodesk 123D to create bridge joints. However, a premade bridge joint .stl file comes with the lesson, which can be imported into Tinkercad and adjusted there.

- Focal length of a concave mirror- design and print curved mirror templates, and apply reflective/foil tape to inner side of these templates to make a set of concave mirrors. By shining parallel light rays on these mirrors, the relationship between the focal length and radius of curvature will be experimentally determined.
 - Full lesson plan and description can be found here <https://www.printyourmind3d.ca/pages/lesson-plans-mirrors>
 - The lesson gives step-by-step directions for Autodesk 123D Design, but Tinkercad or any other design software would work too
 - A premade .stl file of a mirror is included in the lesson plan. You can also import this into Tinkercad and modify it instead of making one from scratch.
- Optics- create custom lenses to study radius of curvature and focal length
 - Lesson plan- <http://www.bcssa.org/wp-content/uploads/2014/08/SD41-3Dv2.pdf>
- Study 3D scans at Smithsonian X 3D- <http://3d.si.edu/>
 - The Smithsonian has created 3D scans of artifacts and places. Scans can be used for student exploration and some can be downloaded and printed, but they are mostly for exploring in 3D. Articles accompany each scan in order to provide more information.

Math

- Measure Length, Width, Height, and Radius of a Curve- measure a mobile phone and create a 3D phone case in Tinkercad
- Volume and Surface area lesson with 3D printed "race cars" – <https://institute.uteach.utexas.edu/sites/institute.uteach.utexas.edu/files/suarez-racecar-lesson.pdf>
 - Gives step-by-step directions to create race cars in Tinkercad
- Differentiation, Integration, and Volume (Calculus)- create a container that will have a change of height of -0.5 cm /sec.
 - Lesson plan- <http://airwolf3d.com/2015/01/23/draining-tank-problem/> (uses Google Sketch Up but Tinkercad or other design software will work too)
- Use Slope and Pythagorean Theorem to design and produce scaled model of a handicap ramp to accommodate a specific request
 - Lesson plan- <http://airwolf3d.com/wp-content/uploads/2014/07/3.-PythagoreanTheorem.pdf> (uses Google Sketch Up but Tinkercad or other design software will work too)
- Volume- Give students a specific volume (ex: 30 cm cubed) and have them create a prism that matches. Students can measure printed designs to see if the measurements match.
- Geometry Lessons- <http://spolearninglab.com/curriculum/lessonPlans/math/geometry.html>
 - Scroll to the bottom of the page for several lesson plans dealing with geometry
- Design a mathematical rollercoaster- <http://www.thingiverse.com/thing:1581716>
 - Scroll all the way down for tips and lesson plan. This lesson plan used 123D Design, but Tinkercad or other design software should work too.

English

Any 3D printing lesson can be incorporated into Language Arts class. Students can write the steps for creating their printed object, they can write a story involving their object, they can describe how it works, they can research their object, etc.

-Create a coat of arms for a character

-Lesson plan found here- http://spolearninglab.com/curriculum/lessonPlans/lang_arts/coat_of_arms.html

-Create a badge (similar to a girl scouts badge) that represents a character using Tinkercad

-Create a model of an important scene using Tinkercad

-Create a prop for a character using Tinkercad

-Create a cookie cutter that goes with a story. Write an explanation of how it relates to the book.

-Lesson plan found here <http://www.local-guru.net/blog/pages/cookiecutter-editor>

-Shakespeare Lessons

Hamlet- Ophelia's Flowers http://spolearninglab.com/curriculum/lessonPlans/lang_arts/ophelia.html

Hamlet- Elsinore Castle- http://spolearninglab.com/curriculum/lessonPlans/lang_arts/hamlet.html

Romeo and Juliet- http://spolearninglab.com/curriculum/lessonPlans/lang_arts/chess.html

Art

-Lithopanes- View a detailed lesson plan here

<http://spolearninglab.com/curriculum/lessonPlans/science/engineering/light/lithopanes.html>

-Step 3 is a link that takes you to Makerbot's Customizer site. You will need to create a free account in order to use it

-You can skip step 2 and stop after step 11

-After step 11, students should open the downloads folder and copy their .stl file, then paste it in their teacher's folder in Stu-Share.

-Create wearable art-design jewelry, hair pieces, clothes, buttons, etc.

-Could create pieces from scratch in Tinkercad or draw designs on paper and import a picture into Tinkercad to extrude the design.

Create a stencil- <http://www.thingiverse.com/thing:32772>

-No lesson plan given but there are pictures and instructions for making the stencils.

World Languages

-Create a name plate in Tinkercad- Students can choose a new name for themselves in the language they are learning and create a name tag to display on their desk.

-Create and print a monument from the culture of study. Students can then write or talk about the monument in the language they are learning.

- Create a lithopane of a famous painting from the culture of study.
 - Lesson plan-<http://spolearninglab.com/curriculum/lessonPlans/science/engineering/light/lithopanes.html>
 - Step 3 is a link that takes you to Makerbot's Customizer site. You will need to create a free account in order to use it
 - You can skip step 2 and stop after step 11
 - After step 11, students should open the downloads folder and copy their .stl file, then paste it in their teacher's folder in Stu-Share.
- Create signs in the specific language they are studying
 - Lesson plan can be found here- http://spolearninglab.com/curriculum/lessonPlans/art/text_labels.html

Health and P.E.

- Print organs, bones, or other body systems. Many of these systems are already created in Thingiverse and can be downloaded to print.
- Design a new "food pyramid"- Students will research the recommended guidelines for each of the 5 food groups, and use Tinkercad to create a new model to visually represent the information.
- Compare health data by state
 - Students can create a map of the United States where the height of each state represents a specific topic. Examples could include obesity rate, \$ spent on health care, birth rate, etc.
 - A customizable map of the continuous US can be found here <http://www.thingiverse.com/thing:209005> (Alaska and Hawaii could be created separately)
- Create and design a tool or object to promote healthy living- use Tinkercad to design your object.

Lafayette Library Media Lesson (March 1st, 2016)

Lesson Title: Finding the volume of a solid with a known cross section

Subject Area: Library Media; Calculus

Objectives:

Students will be able to determine the volume of a solid with a known cross section.

Students will be able to navigate the Tinker Cad software to produce a 3D version of their shape based on their given measurement.

Intended Grade Level: 12th

Standards of Learning (SOL):

AASL Standards for 21st Century Learners

1.1.8 Demonstrate mastery of technology tools for accessing information and pursuing inquiry.

2.1.3 Use technology and other information tools to analyze and organize information.

3.1.4 Use technology and other information tools to organize and display knowledge and understanding in ways that others can view, use, and assess.

3.3.4 Create products that apply to authentic, real-world contexts.

Resources:

Computer and mouse for each group of students

Tinker Cad Website

Tinker Cad direction sheets

Polar 3D Printers and filament

Procedures:

-Welcome students to the library and show students live feed of the 3D printers in action

-Math teacher will review mathematical equations for finding the volume of a solid using a known cross section

-After students are given their assigned “x” axis value, they will use their formulas to determine the size of the square or triangle they will be making in Tinkercad

-Pass out Tinker Cad direction sheets

-Demonstrate to students how Tinker Cad works

-How to add shapes

-How to size shapes and rotate the screen

-How to delete the circle base

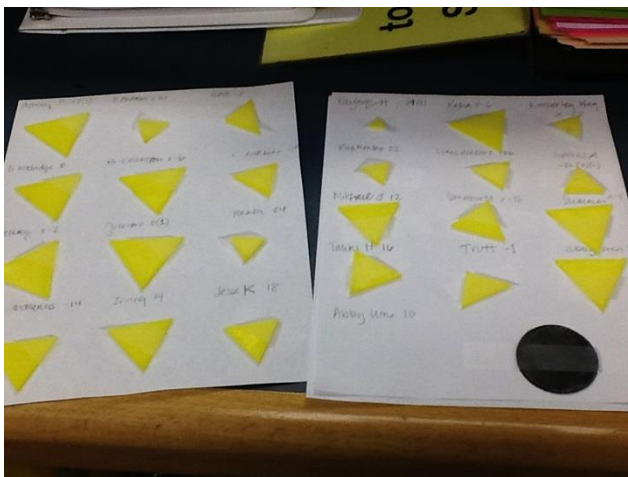
-Show students how to save their work in Tinker Cad as a .stl file

Assessment:

Teacher will monitor student created shapes which will be placed together on the given circle base.

Students will present their finished print to the class.

Student created triangles



Final project



Lafayette Library Media Lesson (March 10th, 2016)

Lesson Title: Creating stamps for coil pots

Subject Area: Library Media; Ceramics

Objectives:

Student will be able to convert a 2D drawing, into a 3D file for printing.

Student will import a 3D file into the Tinker Cad software and successfully navigate the system to produce their finished 3D stamp.

Intended Grade Level: 9th-12th

Standards of Learning (SOL):

AI.2: The student will identify and use steps of the design process, including brainstorming, preliminary sketching, planning, reflecting, refining, elaborating, and researching, in creative problem solving.

AI.6: The student will use a variety of traditional and contemporary media (e.g., two-dimensional, three-dimensional, multidimensional) to create works of art.

AII.5: The student will use contemporary media, tools, and processes to create works of art.

AASL Standards for 21st Century Learners

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3.1.4 Use technology and other information tools to organize and display knowledge and understanding in ways that others can view, use, and assess.

3.3.4 Create products that apply to authentic, real-world contexts.

Resources:

Student drawn designs

iPods and USB cables

Computer and mouse for each group of students

Tinker Cad Website and Online-Convert Website

Polar 3D Printers and filament

Microsoft Word

Tinker Cad Direction Sheet

Procedures:

-Welcome students to the library and show students live feed of the 3D printers in action

-Prior to coming to the library, students will have drawn the design of their stamp on a piece of paper

-Media Specialist will demonstrate for students how they will take their 2D drawing and turn it in to a 3D stamp

-Students will use markers to darken their drawings and make any edits

-Using the iPods, students will take a picture of their drawing and upload to a computer.

-Insert the picture into Word and use the "Snipping Tool" to crop the picture as much as possible.

-Save the Word document as a .jpeg

-Use the website <http://www.online-convert.com/> to take the image file (.jpeg) and convert it to a .svg file

-Demonstrate to students how Tinker Cad works

-Pass out Tinker Cad Direction Sheet

-Show students how to upload their .svg file

- Show students how to size their image (between 25mm-30mm)

- Show students how to add a 3mm base if needed and lift image on the "z" axis (bases are needed if all the lines of the drawing do not connect)

- Show students how to increase the height of their file (around 15mm)

-Show students how to save their work in Tinker Cad as a .stl file

-Show students how to copy the .stl file out of the downloads file, and paste it into their teacher's folder in the Stu Share

-Once all shapes are printed, students will take their stamps back to the art room to be used on their coil pots.

Assessment:

Teacher will monitor student created shapes to make sure they are appropriate for this project.

Students will present their finished prints to the class.

Finished Stamps



Stamp in Action



Lafayette Library Media Lesson (May 6th, 2016)

Lesson Title: 3D Molecules

Subject Area: Library Media; Chemistry

Objectives:

Students will be able to determine the number of unshared electrons present in their molecule.

Students will be able to navigate the Tinker Cad software to produce a 3D version of their given molecule.



Intended Grade Level: 11th

Standards of Learning (SOL):

Chemistry 3: The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations.

Essential understandings:

- predict, draw, and name molecular shapes (bent, linear, trigonal planar, tetrahedral, and trigonal pyramidal).
- draw Lewis dot diagrams to represent valence electrons in elements and draw Lewis dot structures to show covalent bonding.
- use valence shell electron pair repulsion (VSEPR) model to draw and name molecular shapes (bent, linear, trigonal planar, tetrahedral, and trigonal pyramidal).
- recognize polar molecules and non-polar molecules.

Chemistry 5: to investigate the forces of attraction between molecules

Essential understandings:

- Forces of attraction (intermolecular forces) between molecules determine their state of matter at a given temperature. Forces of attraction include hydrogen bonding, dipole-dipole attraction, and London dispersion (van der Waals) forces.

AASL Standards for 21st Century Learners

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2.1.3 Use technology and other information tools to analyze and organize information.

3.1.4 Use technology and other information tools to organize and display knowledge and understanding in ways that others can view, use, and assess.

3.2.3 Demonstrate teamwork by working productively with others.

3.3.4 Create products that apply to authentic, real-world contexts.

Resources:

Computer and mouse for each group of students
Tinker Cad Website
Tinker Cad direction sheets
Polar 3D Printers and filament

Procedures:

- Welcome students to the library and show students live feed of the 3D printers in action
- Give groups time to discuss their molecule and figure out its properties (number of bonds, electrons, etc.)
- Pass out Tinker Cad direction sheets
- Demonstrate to students how Tinker Cad works
 - Provide measurements for the different elements of their electrons
 - How to add shapes
 - How to size shapes and rotate the screen
 - How to add bonds (cylinders)
 - How to add electrons
- Show students how to save their work in Tinker Cad as a .stl file

Assessment:

Teacher will monitor student created molecule models in Tinker Cad and completed 3D prints of molecules. Students will present their finished print to the class.

Lafayette Library Media Lesson (March 17th, 2016)

Lesson Title: Creating shapes that fit a given perimeter

Subject Area: Library Media; Geometry

Objectives:

Student will be able define the term congruent.

Student will be able to recognize the concepts of rotation, reflection, and translation.

Student will work with a partner to navigate the Tinker Cad software to produce congruent 3D shapes.

Intended Grade Level: 9th and 10th

Standards of Learning (SOL):

Geometry 3: The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include

d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.

Geometry 6: The student, given information in the form of a figure or statement, will prove two triangles are congruent, using algebraic and coordinate methods as well as deductive proofs.

Geometry 14: The student will use similar geometric objects in two- or three-dimensions to

a) compare ratios between side lengths, perimeters, areas, and volumes;

d) solve real-world problems about similar geometric objects.

AASL Standards for 21st Century Learners

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3.1.4 Use technology and other information tools to organize and display knowledge and understanding in ways that others can view, use, and assess.

3.2.3 Demonstrate teamwork by working productively with others.

3.3.4 Create products that apply to authentic, real-world contexts.

Resources:

Computer and mouse for each group of students

Tinker Cad Website

Tinker Cad direction sheets

Polar 3D Printers and filament

Procedures:

-Welcome students to the library and show students live feed of the 3D printers in action

-Math teacher will review the term congruent with students

-Explain to students that they will be working with a partner to produce 2 congruent 3D objects. They can create any shape that they want, but they have to be congruent

-Pass out Tinker Cad direction sheets

-Demonstrate to students how Tinker Cad works

-How to add shapes

-How to size shapes and rotate the screen

-Show students how to save their work in Tinker Cad as a .stl file

-Once all shapes are printed, students will work with their partners and their objects to review the ideas of reflection, rotation, and translation

Assessment:

Teacher will monitor student created shapes to make sure they are congruent.

Students will use their congruent shapes to review the ideas of rotation, reflection, and translation.

Students will present their finished prints to the class.

Lafayette Library Media Lesson

Lesson Title: 3D United States map of Electoral Votes

Subject Area: Library Media: Government

Objectives:

Students will be able to determine the number of electoral votes each state has.

Students will be able to navigate the Tinker Cad software to produce a 3D version of their given state.

Intended Grade Level: 12th

Standards of Learning (SOL):

GOVT.6 The student will demonstrate knowledge of local, state, and national elections by
b) describing the nomination and election process

AASL Standards for 21st Century Learners

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3.1.4 Use technology and other information tools to organize and display knowledge and understanding in ways that others can view, use, and assess.

3.3.4 Create products that apply to authentic, real-world contexts.

Resources:

Computer and mouse for each group of students

Tinker Cad Website

Tinker Cad direction sheets

Polar 3D Printers and filament

Have the following Thingiverse file downloaded to a place that all students can access

<http://www.thingiverse.com/thing:1608125/#comments> (A separate file for each state can be found inside this file)

Procedures:

- 1) Assign students 1-3 states and have them research the number of electoral votes each state has
- 2) Pass out Tinker Cad direction sheets
- 3) Demonstrate to students how Tinker Cad works
 - a. Show students how to import a file into Tinkercad. (Students should navigate to their specific state. These files are small, so in Tinkercad, set the percentage to 1334%.)
 - b. Once the state is uploaded, show students how to adjust the height of their state based on the number of electoral votes it has
 - c. Show students how to add numbers to the top of their state. The number should reflect the amount of electoral votes that state has)
 - d. Show students how to name their file and download it as an .stl for printing
- 4) Once all states are printed, students will combine their finished products to create a map of the United States for display

Assessment

- 1) Teacher will monitor student state models in Tinker Cad and completed 3D prints of molecules.
- 2) Students will present their finished print to the class and combine products to create an United States map.

