

## **The focus points in this guide:**

- **To educate administrators and staff in the knowledge and operations of 3D printing and 3D printing applications.**
- **To empower users with the skills to understand and apply STREAM concepts (Science, Technology, Robotics, Engineering, Art, and Mathematics) and other subjects (ELA, History, Economics) through 3D printing technology.**
- **To instruct on how to implement cross curricular learning.**
- **To demonstrate how 3D printing can be incorporated into every educational environment.**
- **To create an environment where learning is practical, interactive, and engaging.**

## 3D Printing and Education

3D printing relates to education by encompassing all aspects of **STREAM** (Science, Technology, Robotics, Engineering, Art, and Mathematics) and other subject matters such as ELA, economics, and history. Lesson plans are created based on project-based, cross-curricular learning, and incorporate [Common Core](#) and [NGSS](#) standards. The lesson plans are ready-to-go which require no extra work for educators. They are designed to be incorporated at any grade level from K-12 and college level. The lessons are created to be implemented so that students get exposure to subjects and topics whether or not they had previous experience with these concepts. Using our online learning management system combined with 3D printing technology gives educators the ability to revolutionize education.

- Students get the opportunity to explore and try new ideas and concepts that they can touch and explore.
- Hands-on learning promotes values such as creativity, problem-solving, collaboration, and self-expression.
- Many colleges and some careers use 3D printing technology. Having these tools at earlier levels of education will expose and prepare students for future career paths.
- 3D printing teaches students to accept and work through failure. The prototyping and experimenting process can be challenging. With the understanding of failure in engineering, particularly 3D printing, students will develop the skills to think critically and continue to push forward.
- Teachers can work together to implement cross-curricular, project based lesson plans.

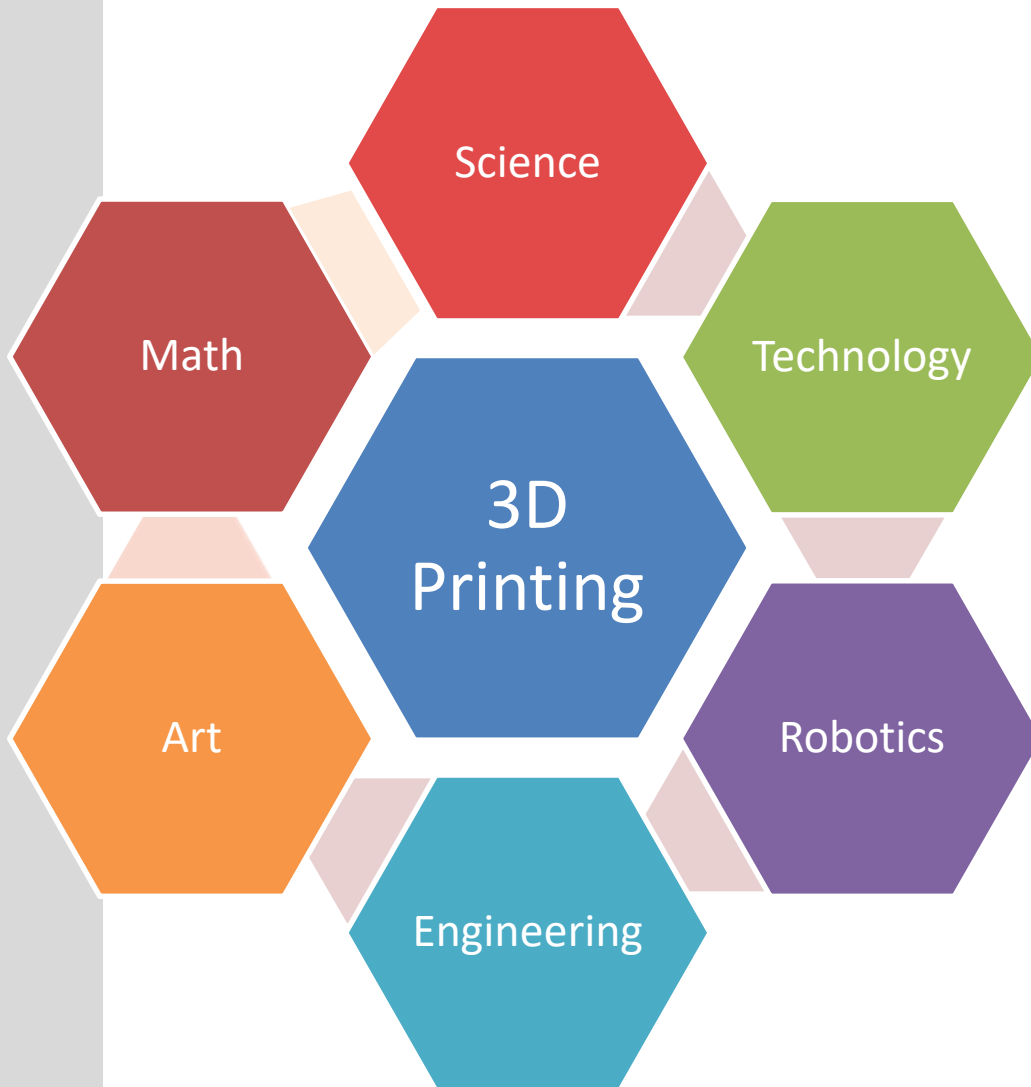
The website to the learning system is

[www.3dxstream-university.com](http://www.3dxstream-university.com)

“It is time embrace the coherence and learning that can be achieved by making meaningful connections between and among direct experience with science and engineering practices along with reading, writing, speaking, and listening.”  
(NRC, 2012) The National Research Council.

# 3D Printing and Education

Introducing 3D printing into education makes learning practical, interactive, and engaging.



## 3D Modeling

In order to have an object 3D printed it must first be created as a digital 3D model. 3D modeling skills are widely used in many career areas such as, architecture, engineering, graphic design, machine shops, video game creating, animation videos, art, etc. With our unique style of combining 3D printing and 3D modeling into a learning environment users will obtain specific skills for practical jobs in various industries.

# Crosscutting Concepts

Crosscutting concepts provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas.

Crosscutting concepts:

- Help students better understand core ideas in STREAM concepts.
- Grow in complexity and sophistication across grades levels.
- Provide a common vocabulary for STREAM subjects.
- Should not be assessed separately from practices or core ideas.

## Assessments Processes When Applying STREAM concepts

The assessment process guides students with formative feedback for implementing critical thinking. Our lesson plans are based upon these criteria:

### **Stage 1: Understand**

Understand the problem. Ask questions!

### **Stage 2: Research**

Brainstorm and explore different concepts to work toward one or more solutions.

### **Stage 3: Solution**

Sketch, design, and develop the best solution concept.

### **Stage 4: Review**

Review and revise the solution.

### **Stage 5: Presentation**

Share your concept!

# Lesson Plans

To begin teaching 3D printing and STREAM concepts use these lessons from our learning website:

## Lesson 1: 3D Printing – Lesson 1 - Introduction to 3D Printing

- Understanding the concept of 3D printing and its applications
- How 3D printers work
- Software used in 3D printing
- General terminology used in the 3D printing industry
- History of 3D printing

| NGSS  | Common Core  | Art   |
|---|--|---|
| K-PS2-1 & K-PS2-2<br>2-PS1-4<br>3-PS2-1<br>4-PS3-1<br>4-PS3-2F<br>4-PS3-3<br>6-MS-PS2-3<br>6-MS-PS2-1<br>6-MS-PS2-2<br>6-MS-PS3-1<br>6-MS-PS4-1<br>6-MS-PS4-2<br>7-MS-PS3-4<br>8-MS-PS3-3<br>8-MS-PS3-5<br>MS-PS1-2 | Math: Geometry K.G-8.G,<br>Basic Functions, Counting,<br>Measurement & Data, The<br>number system<br><br>ELA: Anchor Standards for<br>Reading, Writing, Speaking and<br>Listening; Reading:<br>Informational Text K-12;<br>Writing K-12; Speaking &<br>listening K-12; Language K-12<br><br>RI 1-10; RF1 & 2; SL1-6; L1-<br>L6; W1-W10 | Art: Creative expression<br>VA-CE-E1 through E7<br>VA-CE-M1 through M7<br>VA-CE-H1 through H7<br>VA-AP-E1 through E6<br>VA-AP-M1 through H6 |

Assessments include:

- Vocabulary quiz
- Technical writing

## Lesson 2: How to use a 3D printer

- 3D printing concepts
- How to use a 3D printer
- How to make objects with a 3D printer

| NGSS  | Common Core  | Art   |
|---|--|---|
| K-PS2-1 & K-PS2-2<br>2-PS1-4<br>3-PS2-1<br>4-PS3-1; 4-PS3-2F; 4-PS3-3;<br>6-MS-PS2-3; 6-MS-PS2-1; 6-MS-PS2-2; 6-MS-PS3-1; 6-MS-PS4-1;<br>6-MS-PS4-2<br>7-MS-PS3-4<br>8-MS-PS3-3; 8-MS-PS3-5<br>MS-PS1-2 | Math: Geometry K.G-8.G,<br>Basic Functions, Counting,<br>Measurement & Data, The<br>number system<br><br>ELA: Anchor Standards for<br>Reading, Writing, Speaking and<br>Listening; Reading:<br>Informational Text K-12;<br>Writing K-12; Speaking &<br>listening K-12; Language K-12<br><br>RI 1-10; RF1 & 2; SL1-6; L1-<br>L6; W1-W10 | Art: Creative expression<br>VA-CE-E1 through E7<br>VA-CE-M1 through M7<br>VA-CE-H1 through H7<br>VA-AP-E1 through E6<br>VA-AP-M1 through H6 |

## Lesson 3: Introduction to 3D modeling - TinkerCAD

- 3D modeling concepts
- Using a mouse in 3D modeling
- Understanding and visualizing 3D space
- Identifying the correct buttons in TinkerCAD

## Lesson 4: 3D modeling - Exploring Geometric Shapes

- Team building or individual learning
- Understanding geometric shapes
- How to use 3D modeling software
- Software involved in 3D printing
- Concepts in Drafting and Design

| NGSS  | Common Core  | Art  |
|---|--|--|
| 2-PS1<br>4-PS<br>6-MS-PS2-2<br>6-MS-PS3-2<br>6-MS-PS4-2 | Math: Geometry K.G-8.G;<br>Basic Functions; Counting;<br>Measurement & Data; The<br>number system<br><br>ELA: Anchor Standards for<br>Reading, Writing, Speaking and<br>Listening; Reading:<br>Informational Text K-12;<br>Writing K-12; Speaking &<br>listening K-12; Language K-12 | Creative expression<br>VA-CE-E1 through E7;<br>VA-CE-M1 through M7;<br>VA-CE-H1 through H7;<br>VA-AP-E1 through E6;<br>VA-AP-M1 through H6 |

Assessments include:

- Vocabulary quiz
- Technical writing

## Lesson 5: 3D model and make an object – Make a name plate

- 3D modeling concepts
- Geometric shapes
- Understanding and visualizing 3D space
- Concepts in drafting and design
- Process to make 3D printable objects in TinkerCAD

## Lesson 6: Make a crab robot

- Ability to read step by step instructions
- Team building or individual learning
- Assembly of parts to fit
- Simple electronics
- Simple power and battery use
- Simple mechanics

| NGSS  | Common Core   | Art   |
|---|---|---|
| K-LS-1<br>1-LS1-1<br>2-PS1<br>3-LS-1<br>4-PS3<br>5-PS1<br>MS-PS<br>HS-PS1<br>HS-LS1<br>HS-LS4-2 | Math: MP 2, MP 4, MP 5<br><br>ELA: W2.1, W.2.7, W.2.8,<br>W.5.7, W.5.8, W.5.9<br><br>RI.2.1, RI.2.3, RI.2.8, RI.5.7 | Creative expression<br>VA-CE-M1<br>VA-CE-M6<br>VA-AP-M4 |

Assessments include:

- Vocabulary quiz
- Technical writing



## Lesson 7: Build the Louisiana State Capitol Building

- The LA State Capitol Building is 450 feet tall and has 34 stories making it the tallest building in Baton Rouge.
- Construction started on December 16, 1930 and took a little over a year to complete.
- The project costed \$5 million.
- It is the seventh tallest building in Louisiana and house the chambers for the State Legislature and office of the Governor.
- Architecture involves creativity, structural engineering, and understanding of existing building codes.

| NGSS  | Common Core   | Art                 |
|---|---|---------------------|
| 2-PS1<br>K-2 ETS<br>1-2<br>MS-ETS1-3<br>HS-ETS1 | Math: 2.MD.A 1-A4<br><br>ELA: W.2.4, W.2.7, W.2.8,<br>W.5.7, W.5.8, W.5.9<br>RI.2.1, RI.2.3, RI.2.8, RI.5.7 –<br>SL/2.5 – RST 6-8 | Creative expression |

Assessments include:

- Vocabulary quiz
- Technical writing

## Lesson 8: Molecules

- A compound is a molecule that contains at least two different elements.
- Molecules can be solid, liquid, or gas.
- Formation of compounds.
- All compounds are molecules, but not all molecules are compounds.
- Basic understanding of atoms, elements, molecules, and compounds.
- It may be easier to understand molecules and compounds by seeing the 3D model.
- One of the goals of this lesson is to expose students to the concepts of molecular structure with 3D models.

| NGSS   | Common Core  | Art  |
|--|--|--|
| 2-PS1<br>4-PS3<br>5-PS1<br>MS-PS1<br>MS-PS<br>HS-PS1<br>HS-LS1 | Math: MP.2 P.4, MP.5<br>2.MD.D.10 MD.C.3<br><br>ELA: W.2.1, W.2.7, W.2.8,<br>W.5.7, W.5.8, W.5.9<br>RI.2.1, RI.2.3, RI.2.8, RI.5.7 | Creative expression<br>Vertical expression |

Assessments include:

- Vocabulary quiz
- Technical writing

## Lesson 9: Intro to Sketchup

- 3D modeling concepts with Sketchup program
- Using a mouse in 3D modeling
- Understanding and visualizing 3D space
- The skills to have more options in creating 3D objects

## Lesson 10: 3D Modeling – Make a chess piece

- 3D modeling concepts
- Geometric shapes
- Using specialized tools to form complex objects
- Creating a chess piece in Sketchup

## Lesson 11: Build a Dancing Robot

- Simple electronics
- Team building or individual learning
- How to assemble models
- How to read assembly instructions
- Architecture terminology
- Uploading code to electronics

| NGSS   | Common Core   | Art   |
|--|---|---|
| K-PS2-1 & K-PS2-2<br>2-PS1-3<br>3-PS2-1<br>4-PS3-1<br>4-PS3-2<br>4-PS3-3<br>6-MS-PS2-3<br>6-MS-PS2-1<br>6-MS-PS3-1<br>6-MS-PS4-1<br>6-MS-PS4-2<br>8-MS-PS3-3<br>8-MS-PS3-5 | Math: Geometry K.G-8.G,<br>Basic Functions<br>Counting<br>Measurement & Data<br>The number system<br><br>ELA: Anchor Standards for<br>Reading, Writing, Speaking and<br>Listening<br>Reading: Informational Text K-<br>12<br>Writing K-12<br>Speaking & listening K-12<br>Language K-12 | VA-CE-E1 through E7<br>VA-CE-M1 through M7<br>VA-CE-H1 through H7<br>VA-AP-E1 through E6<br>VA-AP-M1 through H6 |

Assessments include:

- Vocabulary quiz
- Technical writing

## Lesson 12: 3D Printing – Lesson 2 - 3D Printer parts

- Understanding 3D printer terminology
- Parts of 3D printers
- Extruder assembly
- Mechanical parts
- Concepts in engineering

| NGSS   | Common Core   | Art   |
|--|---|---|
| 6-MS-PS2-3<br>6-MS-PS2-1<br>6-MS-PS2-2<br>6-MS-PS3-1<br>6-MS-PS4-1<br>6-MS-PS4-2<br>8-MS-PS3-3<br>8-MS-PS3-5<br>MS-PS1-2<br>7-MS-PS3-4 | Math: Geometry, 6-12 –<br>Measurements & Data 6-12<br><br>ELA: Anchor Standards for<br>Reading, Writing, Speaking and<br>Listening; Reading:<br>Informational Text 6-12;<br>Writing 6-12; Speaking &<br>listening 6-12; Language 6-12 | Creative expression<br>VA-CE-E1 through E7<br>VA-CE-M1 through M<br>VA-CE-H1 through H7<br>VA-AP-E1 through E6<br>VA-AP-M1 through H6 |

Assessments include:

- Vocabulary quiz
- Technical writing

## Lesson 13: 3D Printing – Lesson 3 - 3D Printer calibration

- Understanding 3D printer terminology
- Parts of 3D printers
- Calibration of 3D printer hardware and software
- 3D printer configuration
- Concepts in engineering

| NGSS   | Common Core  | Art   |
|--|--|---|
| 6-MS-PS2-3<br>6-MS-PS2-1<br>6-MS-PS2-2<br>6-MS-PS3-1<br>6-MS-PS4-1<br>6-MS-PS4-2<br>8-MS-PS3-3<br>8-MS-PS3-5<br>MS-PS1-2<br>7-MS-PS3-4 | Math: Geometry, 6-12 –<br>Measurements & Data 6-12<br><br>ELA: Anchor Standards for<br>Reading, Writing, Speaking and<br>Listening; Reading:<br>Informational Text 6-12;<br>Writing 6-12; Speaking &<br>listening 6-12; Language 6-1 | VA-CE-E1 through E7<br>VA-CE-M1 through M7<br>VA-CE-H1 through H7<br>VA-AP-E1 through E6<br>VA-AP-M1 through H6 |

Assessments include:

- Vocabulary quiz
- Technical writing

## Lesson 14: Chemical Rocket

- Chemical reactions
- Newton’s 3rd law of motion
- Team building or individual learning

| NGSS                                    | Common Core  | Art   |
|---|--|---|
| MS, Chemical reactions<br>MS-PS2 Motion | ELA: W.2.1, W.2.7, W.2.8,<br>W.5.7, W.5.8, W.5.9<br>RI.2.1, RI.2.3, RI.2.8, RI.5.7 | Creative expression<br>VA-CE-M1, VA-CE-M6, VA-<br>AP-M4 |

Assessments include:

- Vocabulary quiz
- Technical writing

## Lesson 15: Catapults

- History of catapults
- Modern catapult systems
- Measuring angles

| NGSS   | Common Core   | Art  |
|--|---|--|
| K-P2S-1<br>3-PS2-2<br>MS-PS2-2<br>MS-PS3-2<br>MS-PS3-3 | Math: 5.MD.A.1 4.MD.C.5 –<br>Angles<br><br>ELA: W.2.4, W.2.7, W.2.8,<br>W.5.7, W.5.8, W.5.9<br>RI.2.1, RI.2.3, RI.2.8, RI.5.7 –<br>SL/2.5 – RST 6-8 | Creative expression<br>Vertical expression |

Assessments include:

- Vocabulary quiz
- Technical writing

# RESOURCES

## 3D Printing Websites

3D Printing Educational Resources

<https://3dprintresources.wordpress.com>

3 Tips for Stronger 3D Printed Parts

<https://www.instructables.com/id/3-Tips-for-Stronger-3D-Printed-Parts/>

<https://3dprint.com/165585/3d-printing-in-education/>

## News and update sites:

[www.3ders.org](http://www.3ders.org)

[www.3dprint.com](http://www.3dprint.com)

[www.3dprintingindustry.com](http://www.3dprintingindustry.com)

<https://wohlersassociates.com/additive-manufacturing.html>

[How to use engineering in schools](#)

[School libraries](#)

## YouTube Videos

Overview to 3D Printing - Will 3D Printing Change the World?

<https://youtu.be/GGxcjOU1vpo>

How to Design & Print 3D Moving Parts In Minutes (Tinkercad)

<https://youtu.be/v9BvoDI0thQ>

Why NGSS- <https://youtu.be/W2yEWyvWznE>

TinkerCAD Tinker Tips

[https://youtu.be/BvZkE\\_H8O4?list=PLV6cmKvnKR5Qjz0GY\\_NO4pmTwDjKhnzT](https://youtu.be/BvZkE_H8O4?list=PLV6cmKvnKR5Qjz0GY_NO4pmTwDjKhnzT)

## References

Common Core State Standards, <http://www.corestandards.org>

Next Generation Science Standards, <http://www.nextgenscience.org>

Louisiana Department of Education,

<http://www.louisianabelieves.com/resources/library/academic-standards>

Lee, O., Quinn, H., & Valdés, G. (2013). Science and language for English language learners in relation to Next Generation Science Standards and with implications for Common Core State Standards for English language arts and mathematics. *Educational Researcher*.

3D Printing Reference Website, <http://reprap.org>