

Lesson Plan

3D Geometric Art

Summary

1. Topics: 3D Modeling, Visual Programming, Coding, Geometry, and Creative Art/ Design
2. Grade/Level: 8th Grade
3. Time Allotment: 40min Instruction > 10min Break > 40min Activity
4. Project Assignment Due Date: 1 week after
5. Objectives:

The goal of this lesson is to teach the students about advanced geometry by revealing the interesting mathematical relationships, intriguing visual qualities, and various design applications. While geometry is often taught as a math topic conventionally, its application to visual art and engineering are apparent. Not only will students learn to model different 2D and 3D geometric shapes digitally, they will also get to explore the mathematical formula and how the form will be affected when they adjust the variables in the formula through visual programming platform as a coding exercise.

Standards - CCSS and National Art Core Standards

Common Core State Standards (CCSS)

Based on CCSS, Standards for Mathematical Practice, Grade 8 Geometry, the lesson will help students to understand congruence and similarity using physical models, transparencies, and geometry software (Rhino and Grasshopper) to cover the following topics:

CCSS.MATH.CONTENT.8.G.A.1

Verify experimentally the properties of rotations, reflections, and translations:

CCSS.MATH.CONTENT.8.G.A.1.A

Lines are taken to lines, and line segments to line segments of the same length.

CCSS.MATH.CONTENT.8.G.A.1.B

Angles are taken to angles of the same measure.

CCSS.MATH.CONTENT.8.G.A.1.C

Parallel lines are taken to parallel lines.

CCSS.MATH.CONTENT.8.G.A.2

Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.

CCSS.MATH.CONTENT.8.G.A.3

Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.

CCSS.MATH.CONTENT.8.G.A.4

Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.

CCSS.MATH.CONTENT.8.G.A.5

Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.

Understand and apply the Pythagorean Theorem.

CCSS.MATH.CONTENT.8.G.B.6

Explain a proof of the Pythagorean Theorem and its converse.

CCSS.MATH.CONTENT.8.G.B.7

Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

CCSS.MATH.CONTENT.8.G.B.8

Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.

CCSS.MATH.CONTENT.8.G.C.9

Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

National Art Core Standards

Based on National Art Core Standards, Visual Arts Discipline, the lesson will help students to utilize what they have learned from the Geometry Math session to create visual arts with the following guidelines:

VISUAL ARTS - Creating

Investigate - Plan - Make

VA:CR1.1.8A

Document early stages of the creative process visually and/or verbally in traditional or new media.

VA:CR1.2.8A

Collaboratively shape an artistic investigation of an aspect of the present day life using a contemporary practice of art and design.

Investigate

VA:CR2.1.8A

Demonstrate willingness to experiment, innovate, and take risks to pursue ideas, forms, and meanings that emerge in the process of artmaking or designing.

VA:CR2.2.8A

Demonstrate awareness of practices, issues, and ethics of appropriation, fair use, copyright, open

source, and creative commons as they apply to creating works of art and design.

VA:CR2.3.8A

Select, organize, and design images and words to make visually clear and compelling presentations.

Reflect - Refine - Continue

VA:CR3.1.8A

Apply relevant criteria to examine, reflect on, and plan revisions for a work of art or design in progress.

VISUAL ARTS - Presenting

Select

VA:PR4.1.8A

Develop and apply criteria for evaluating a collection of artwork for presentation.

Analyze

VA:PR5.1.8A

Collaboratively prepare and present selected theme-based artwork for display, and formulate exhibition narratives for the viewer.

Share

VA:PR6.1.8A

Analyze why and how an exhibition or collection may influence ideas, beliefs, and experiences.

Lesson Procedure

40min Instruction: 20min Intro > 15min Live Demo > 5min Assignment

20min Introduction

The lesson will start with an introduction to go over mathematical concept and visual art reference in parallel motions to inspire students for their final project. The following resources will be used for geometry math and visual art on the corresponding topics:

CYLINDER volume and surface area:

8min Math | Geometry | Khan Academy

<https://www.youtube.com/watch?v=gL3HxBQyeg0>

1min Art | WORKac | P.F.1

<https://work.ac/work/pf1/>



Volume of a **CONE**:

5min Math | Perimeter, area, and volume | Geometry | Khan Academy

<https://www.youtube.com/watch?v=hC6zx9WAiC4>

3min Art | Traffic Cone Art | Exhibitions, Artists & installations

<https://labyrinth-bcn.com/blog/traffic-cone-art-exhibitions-artists-installations>



Volume of a **SPHERE**:

2min Math | Perimeter, area, and volume | Geometry | Khan Academy

<https://www.youtube.com/watch?v=leIS2vg7JO8>

1min Art | Yayoi Kusama | Narcissus Garden

<https://www.dailyartmagazine.com/kusamas-narcissus-garden/>

<https://www.moma.org/calendar/exhibitions/4995>

<https://www.dezeen.com/2016/05/04/yayoi-kusama-narcissus-garden-installation-philip-johnson-glass-house-connecticut-floating-steel-balls/>



15min Live Demonstration

After the 20min Introduction period, there will be 20min of live demonstration on the use of Rhino and Grasshopper going over topics that are covered as below:

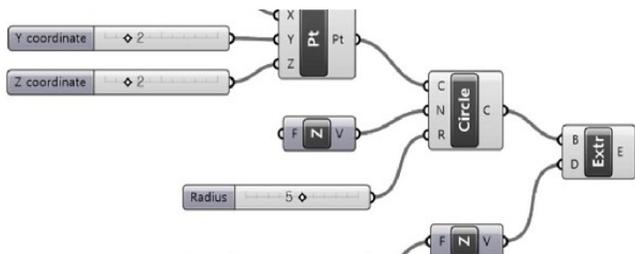
3min Rhino Interface | Rhino Tutorial 1 Interface

<https://www.youtube.com/watch?v=mblmaXI8EAQ>

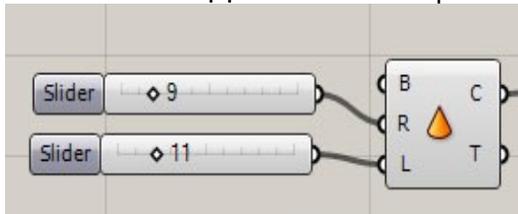
3min Grasshopper Interface | Grasshopper Tutorial: Basic Interfaces

<https://www.youtube.com/watch?v=vfpwABFNgr0>

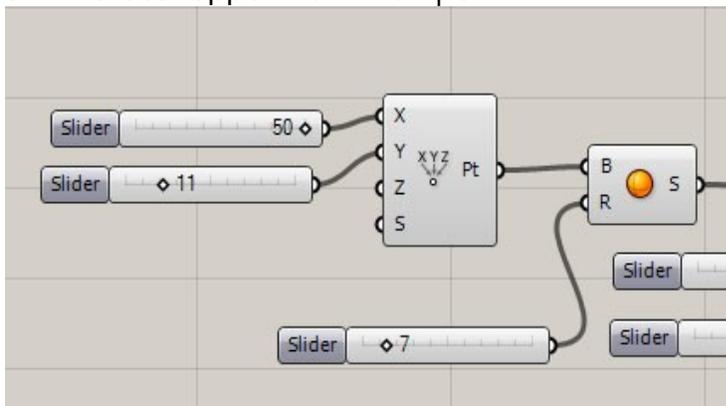
4min Grasshopper Definition | **CYLINDER**



2min Grasshopper Definition | **CONE**



3min Grasshopper Definition | **SPHERE**



5min Project Assignment

The last 5min of the 45min instruction period will be used to go over the project assignment and address how the students should utilize the following 45min activity period after 10min break to get themselves familiar with the software and brainstorm for their project assignment.

Project assignment consists of the 3 areas of research, creation, and presentation.

1. Research

Following the format of the introduction session, students will pick at least one geometry topic that they would like to explore and research on the formal application on any specific artwork.

2. Creation

Construct the chosen geometric shape in Grasshopper by applying the formula as part of the definition to drive at least 1 parameter that affects the shape of the chosen geometry. Arrange the shape either manually or parametrically to construct 3D visual graphics inspired by the chosen artwork from Part 1.

3. Presentation

The selected geometry topic, an image of corresponding inspiration artwork, a screenshot of grasshopper definition, and final image of creation should be composed into 4 slides to be presented 1 week after. Rubric will be given out as guidelines for the presentation work.

Other Resources:

Geometry

<https://www.youtube.com/channel/UC4a-Gbdw7vOaccHmFo40b9g>

<http://www.corestandards.org/Math/Content/8/G/>

Computational Design:

<https://www.grasshopper3d.com/>

40min Activity: 20min Usage > 15min Brainstorm > 5min Game Plan

20min Usage

Students will launch rhino and grasshopper to construction one of the three demonstrated definitions. Instructor will provide guidance and support during the process.

15min Brainstorm

Students will start to form teams and brainstorm on project assignment according to the given guidelines and rubric. Instructor will provide guidance and support during the process.

5min Game Plan

Teams will take turn to quickly go over their game plans for the project assignments in terms of chosen geometry topic, source of research for corresponding inspiration artwork, initial methods to construct grasshopper definition, and strategy on final image production.

5E Lesson Plan		Media/Platform
<p><u>Engage</u> The purpose for the ENGAGE stage is to pique student interest and get them personally involved in the lesson, while pre-assessing prior understanding.</p>	<p>Geometry: Watch educational TV of Khan Academy on 3D geometry to engage students on sharing their understanding on the topic</p> <p>Visual Arts Reference: https://www.moma.org/calendar/exhibitions/4995 https://work.ac/work/pf1/ https://labyrinth-bcn.com/blog/traffic-cone-art-exhibitions-artists-installations</p>	<p><u>Educational TV</u> Khan Academy</p>
<p><u>Explore</u> The purpose for the EXPLORE stage is to get students involved in the topic; providing them with a chance to build their own understanding.</p>	<p>Introduce students to Rhino and Grasshopper to begin the modeling of 3d shapes like Cone, Cylinder, and Sphere</p>	<p><u>3D Modeling:</u> Rhino <u>Visual Programming:</u> Grasshopper</p>
<p><u>Explain</u> The purpose for the EXPLAIN stage is to provide students with an opportunity to communicate what they have learned so far and figure out what it means.</p>	<p>Demonstrate the use of Rhino and Grasshopper for students to learn about basic commands of the software, the formula that drives the size and dimension of the 3D shapes.</p>	<p><u>Presentation:</u> Power Point Live Demonstration</p>
<p><u>Elaborate/Extend</u> The purpose for the EXTEND stage is to allow students to use their new knowledge and continue to explore its implications.</p>	<p>Students are asked to pick one 3D shape to do their in depth research on and construct it in Rhino with the help of Grasshopper. Rubric will be given to students as guidelines and instructions for the work.</p>	<p><u>3D Modeling:</u> Rhino <u>Visual Programming:</u> Grasshopper</p>
<p><u>Evaluate</u> The purpose for the EVALUATION stage is for both students and teachers to determine how much learning and understanding has taken place.</p>	<p>Students will present their research and learning progress and be graded according to the previously assigned rubric</p>	<p><u>Online Survey:</u> Google Forms</p>

Rubric

	3 Distinguished	2 Proficient	1 Apprentice	Score
Presentati on	<ul style="list-style-type: none"> ● Explains inspiration image <i>and</i> final creation ● Makes it clear why some changes were made for aesthetic purposes & clarifies success of changes ● Presentation is well organized with clear and intriguing graphics 	<ul style="list-style-type: none"> ● Explains <i>only</i> final creation ● Makes it clear why some changes were made for aesthetic purposes, but does not clarify if changes were successful ● Presentation is organized with clear graphics 	<ul style="list-style-type: none"> ● Clearly explains the aesthetic preference behind the creation ● Makes some reference to changes ● Presentation is less organized with some graphics 	___/3
Design Progress	A screenshot of grasshopper definition that drives the creation, the progress image, and a picture of the final creation are shown	A screenshot of grasshopper definition that drives the creation and a picture of the final creation are shown	Only one version of the creation is shown	___/3
Formula + Parameter s	Creation allows all 4 of the following: Change of height Charge of width Automatic Replication Parametric Distribution	Creation allows 2-3 of the following: Change of height Charge of width Automatic Replication Parametric Distribution	Creation allows 1 of the following: Change of height Charge of width Automatic Replication Parametric Distribution	___/3
Visual Graphics	Final image of the creation is presented with 4 of the following: Colors Materials Lighting/Shadow Background Setting	Final image of the creation is presented with 2-3 of the following: Colors Materials Lighting/Shadow Background Setting	Final image of the creation is presented with 1 of the following: Colors Materials Lighting/Shadow Background Setting	___/3
Comments: (Bonus points for Creativity and Effort)				Total: ___/12