

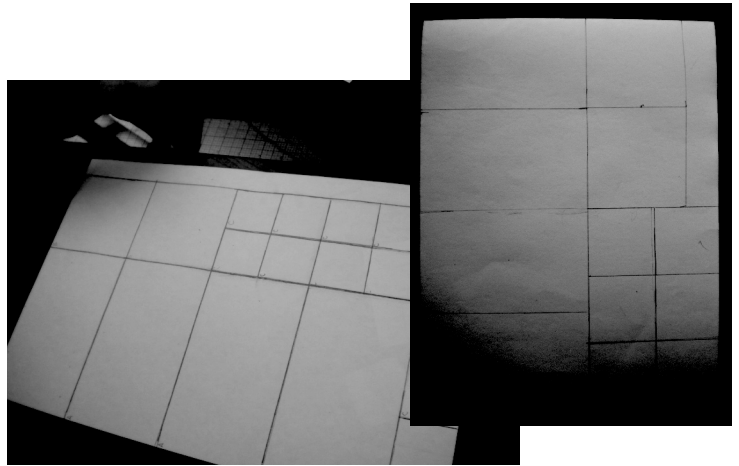
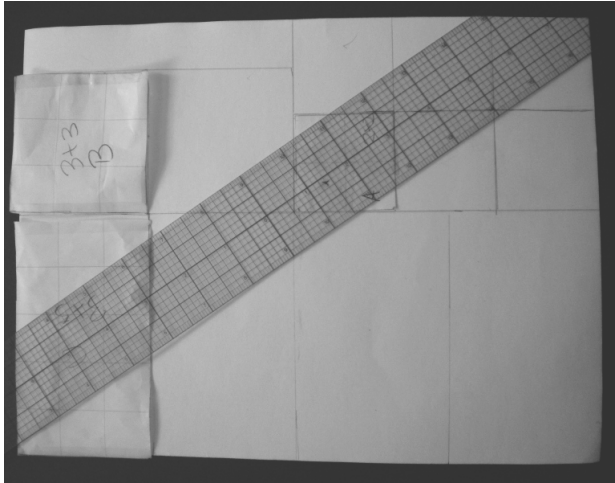
# **ARTS IMPACT—ARTS-INFUSED INSTITUTE LESSON PLAN (YR2-MAP)**

## **SIXTH GRADE—LESSON TWO: Anibots: Polyhedra Patterns and Parts**

**Artist-Mentor** – Shannon Eakins & Meredith Essex

Grade Level: 6

Examples:



### **Enduring Understanding**

Using formulas for calculating surface area and volume can create estimates for the minimum amount of materials required to create a product.

### **Math**

**Target:** Makes list of required pattern pieces.

**Criteria:** Identifies quantities of singular and repeated faces of the polyhedra in nets to construct geometric solids.

### **Art and Math**

**Target:** Uses craftsmanship in pattern making.

**Criteria:** Measures and counts for accuracy, draws lines with straightedge.

### **Math**

**Target:** Determines surface area of polyhedra.

**Criteria:** Uses math operations to calculate sum of all faces.

### **Math**

**Target:** Calculates volume of polyhedra.

**Criteria:** Uses height, width, depth measurement and/or operations to total polyhedra volume.

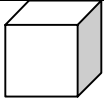
## Session I

### Materials

1-inch grid paper 14 x 16 (2 sheets per student), white drawing paper 12 x 18 (1 sheet per student), small and large rulers, pencils, erasers, Anibot Production Manual (APM)

### Learning Targets

- Makes list of required pattern pieces.
- Determines surface area of polyhedra.

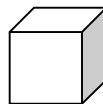
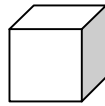


### Do Now

Congruency review and practice: Analyze nets for rectangular prisms. Identify congruent faces in net diagrams. APM 5-11

### Activities/Prompts

- Working with materials requires efficiency + accuracy to reduce waste of time and money. Our completed APM becomes a manufacturing guide.
- Identifying congruent shapes in Anibot polyhedra will help us manufacture our Anibots. Draw nets on 1-inch grid paper (a second time) for the two Anibot Polyhedra used in your design.
- Find the distinct shapes and also their congruent matches in both Anibot nets. Label all matching congruent shapes in both nets with a letter and dimensions.
- "A" and 2x2 is written on each square shape that is 2x2 inches on my Anibot nets. Then the unique pattern A shape name (square), dimensions (2x2) and number of shapes are entered in the table on APM page 11. Find all unique shapes, label and add to table.
- Surface Area = the "skin" of your Anibot. Calculate the total surface area.
- Show your thinking process using counting, drawings, formulas, and equations. APM 5-12
- Estimate amount of vinyl needed to construct Anibot polyhedra. APM 5-13

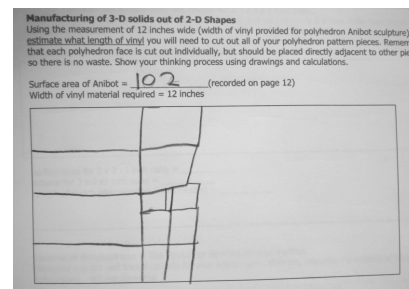
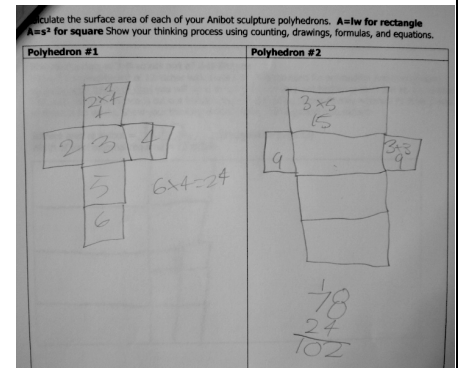


### Big Math and Art Ideas

Polyhedra: Rectangular prisms/cubes  
2-D nets represent 3-D forms, sides, faces, vertices, congruent, sculpture, surface area, volume

Number of Shapes in Anibot 3-D Forms: This your Anibot Production/Manufacturing "cut list".

Unique Pattern Piece	Shape Name	Dimensions (length x width)	Quantity
A	square	2x2	6
B	square	3x3	2
C	rectangle	3x5	4
D			
E			



### Self Assessment/Reflection

Students have teacher or partner check calculations for accuracy.

### Closure

Students put APM and nets (and any other tools as directed by teacher) in zipper bag with name on it. Store.

### Assessment Criteria

- Identifies quantities of singular and repeated faces of the polyhedra in nets to construct geometric solids.
- Uses math operations to calculate sum of all faces.

**Next Steps/Follow up Needs** Gather materials for following day.

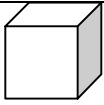
## Session II

### Materials

white drawing paper 12 x 18, large rulers, pencils, erasers, scissors, APM

### Learning Targets

- Calculates volume of polyhedra.
- Uses craftsmanship in pattern making.



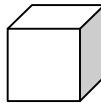
### Do Now

Calculate the surface area and volume for a 3 x 3 x 3 inch cube.

If you were constructing that cube out of wood and your board was 6 inches wide, how many inches would your board need to be in length to be able to construct the cube? APM 5-14

### Activities/Prompts

- We will be stuffing our polyhedrons so we will need to calculate the volume of each form. Volume is the amount of space inside the polyhedrons: the "guts" of our Anibot.
- What are some math operations we can use to calculate this? Show your thinking process using counting, drawings, formulas, and equations. Then add up volume of both polyhedrons for total volume. APM 5-14
- Use accuracy in measurement, congruency and precise parallel and perpendicular lines.
- Cut apart Anibot nets if needed. Transfer pattern for cutting guide by tracing around shapes the number of times needed (see table on APM 5-11). Label each shape with the designated letter from that table. APM 5-15
- Using the traced net pattern shapes as a preliminary guide for placement of lines, then use a ruler to accurately measure and draw all of the faces for the two polyhedra. APM 5-15
- Fit pieces together to conserve material. Compare your estimate of vinyl material needed to the actual amount of vinyl needed as shown on you paper layout. APM 5-15



### Big Math and Art Ideas

Polyhedra: Rectangular prisms/cubes  
2-D nets represent 3-D forms, sides, faces, vertices, congruent, sculpture, surface area, volume, parallel, perpendicular, pattern

Two polyhedrons in the "guts" or inside of your Anibot. Flatten and folded up nets for your Anibot as a reference, calculate the volume of your two polyhedra. Volume formulas:

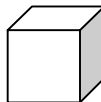
	Polyhedron #1	Polyhedron #2
Width	2 in	3 in
Depth (Length)	2 in	3 in
Volume (show your work)	$8 \text{ sq in}$	$45 \text{ sq in}$

Total Volume of my two Anibot polyhedrons:  $53$   
Show a teacher or a peer check your answer, then enter this total on Anibot Specifications sheet APM page 9



### Self Assessment/Reflection

Students complete self-checklist and reflect: *Why is it important to know the surface area and volume of something that will be constructed and stuffed?* APM 5-15



### Closure

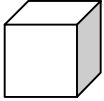
Students put APM, drawings, patterns, and nets (and any other tools as directed by teacher) in zipper bag with name on it and store.

### Assessment Criteria

- Uses height, width, depth measurement and operations to total polyhedra volume.
- Measures and counts for accuracy; draws lines with straightedge.

**Next Steps/Follow up Needs** Vinyl is cut to precise shapes: 12 x 12, 12 x 16, 12 x 20, 12 x 24

## Session I Teaching and Learning Strategies



### DO NOW WARM-UP

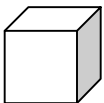
Congruency review and practice: Analyze nets for rectangular prisms.  
Identify congruent faces in net diagrams. APM 5-11

**1. Initiates discussion about the “functionality of math” for working with materials with emphasis on efficiency, accuracy and reducing waste of time and money. Introduces idea that a completed APM becomes a manufacturing guide that someone else could use to make an identical Anibot “clone”.** *Prompts:* Think of a scenario (real or imagined) where accurate calculation of amounts of materials needed is important. What comes to mind? How can Math serve us every day to be more efficient with our money? Our Anibot Production Manual is our guide for manufacturing our own personal Anibot. It will have enough information in it that it actually could be handed off to someone else and they could manufacture an Anibot clone just like our own.

Student: Talks about life experience where math measurement and planning saves money and how math specifications become transferable knowledge essential to manufacturing.

**2. Discusses importance and efficiency of identifying congruent shapes in polyhedra. Guides process of drawing nets (a second time) for the two Anibot polyhedra used in design. Identifies which pattern piece shapes are needed to construct Anibot polyhedra out of vinyl.**

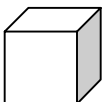
*Prompts:* Understanding the **relationship of congruent shapes in polyhedrons** can simplify the process of constructing any 3-dimensional geometric solid. It can also save an artist, a carpenter or mason time and money. In the case of our sculptures, many shapes that we will put together in our 3-dimensional Anibot are congruent: same size, same shape. We are going to draw the nets again for the two polyhedra we have chosen for our Anibots (see APM 5-8 to review dimensions). Now we are going to label all matching congruent shapes in both nets with a letter and dimensions. For instance, A and 2x2 is written on each shape that is 2x2 inches on the nets. Then the pattern A shape name (square), dimensions (2x2) and number are entered in the table on APM page 11. Find all unique shapes and record on table.



Student: Draws two flat net patterns for Anibot polyhedra; completes shape table on APM page 11; checks accuracy of list with a partner.

Embedded Assessment: Criteria-based peer check

**3. Guides students in calculating surface area of Anibot polyhedra.** *Prompts:* Any time an artist, carpenter or a carpet installer gets ready to do a job they need to estimate the amount of material they will need. Mistakes in math calculations can result in buying too much or not enough of an expensive material. It can also result in wasting materials because of poor planning. Calculate the **surface area** of each polyhedron you are creating for your sculpture by looking at your nets. What are some math operations we can use to calculate this?  **$A=lw$  for rectangle  $A=s^2$  for square.** Show your thinking

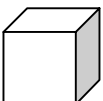


process using counting, drawings, formulas, and equations.

Student: Makes calculations for total surface area of Anibot polyhedra. APM 5-12

Embedded Assessment: Criteria-based teacher checklist

**4. Guides students in estimated amount of vinyl needed to cut out all needed polyhedron pieces.** *Prompts:* On page 12 of APM, add up the surface area of each polyhedron you are using in your soft sculpture. Think about all of the different faces of the three-dimensional forms and how they might fit together on a flat rectangle. You can cut apart your nets used to help calculate surface area: practice plotting the shapes on APM page 13 to show your work. The vinyl pieces are 12 inches wide. What length of 12 inch wide vinyl will you need to cut out all of your pieces with the least waste? Circle the size of vinyl that you estimate you will need APM page 14: Vinyl comes in: 12 x 12, 12 x 16, 12 x 20 and 12 x 24 inch sizes.

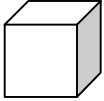


Student: Lays out/sketches Anibot polyhedra shapes. Estimates vinyl needed, APM 5-13 – 5-14

Arts Impact/TPS AEMDD Grant 2008-12 – ARTISTIC MATH PATHWAYS  
Sixth Grade Lesson Two – Anibots: Polyhedron Patterns and Parts 10.16.2010

## Session II

### Teaching and Learning Strategies

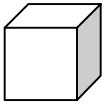


#### DO NOW WARM-UP

Calculate the surface area and volume for a 3 x 3 x 3 inch cube.

If you were constructing that cube out of wood and your board was 6 inches wide, how many inches would your board need to be in length to be able to construct the cube? APM 5-14

**1. Guides students in calculating the volume of polyhedrons.** *Prompts:* We will be stuffing our polyhedrons so we will need to calculate the volume of each form. Volume is the amount of space inside the polyhedrons—it is the "guts", or insides, of our Anibot. We already calculated the surface area; that is how we know how much vinyl we need. The volume calculations will reflect the amount of stuffing we will need. Calculate the **volume** of each polyhedron you are creating for your sculpture by looking at your taped up and flat nets. What are some math operations we can use to calculate this? Show your thinking process using counting, drawings, formulas, and equations. Then add up volume of both polyhedrons for total volume.



Student: Makes calculations for total volume of Anibot polyhedra. APM 5-14

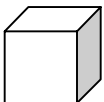
Embedded Assessment: Criteria-based teacher checklist

**2. Demonstrates drawing pattern onto paper for cutting guide for vinyl Anibot shapes. Emphasizes accuracy in measurement, congruency and precise parallel and perpendicular lines.** *Prompts:* Cut apart Anibot nets, if needed. Transfer pattern pieces to paper (12 inches: the width of the vinyl) by tracing around the number of times needed using the table on APM page 11 as a guide. Label each shape with the designated letter from that table. Using the traced net pattern shapes as a preliminary guide for placement of lines, then use a ruler to accurately measure and draw all of the faces for the two polyhedra. Remember to fit pieces together to conserve material. Compare your estimate of vinyl material needed to the actual amount of vinyl needed as shown on you paper layout.

Student: Creates precise paper pattern for cutting out vinyl pieces.

Embedded Assessment: Criteria-based teacher checklist

**3. Guides student self-assessment and reflection.** *Why is it important to know the surface area and volume of something that will be constructed and stuffed?*



Student: Self Assesses. APM 5-15

Embedded Assessment: Criteria-based student self checklist

Vocabulary	Materials and Community Resources	WA Essential Learnings & Frameworks
<p><u>Arts Infused:</u>            2-D            3-D            Geometric shape            Grid            Parallel            Pattern            Perpendicular            Rectangle            Square</p> <p><u>Math:</u>            Area            Congruent            Cube            Edge            Face            Geometric solid            Net            Polygon            Polyhedron            Ratio            Rectangular prism            Surface area            Volume</p> <p><u>Arts:</u>            Craftsmanship            Form            Sculpture            Soft sculpture</p>	<p><b>Museum Artwork</b></p> <p><b>Art Materials:</b>            1-inch grid paper 14 x 16 (2 sheets per student)            white drawing paper 12 x 18            Pencils            Erasers            Small and large rulers            Scissors            APM            2-gallon zipper bags for storage</p>	<p><b>Arts State Grade Level Expectations</b></p> <p>AEL 1.1 concepts  <i>2-dimensional to 3-dimensional Geometric shape and form</i></p> <p>AEL 1.2 skills and techniques  <i>Measuring            Drawing</i></p> <p>AEL 4.2 connections between the arts and other content areas  <i>Explains relationships between the arts and other content areas</i></p> <p>AEL 4.5 knowledge of arts skills in the world of work  <i>Identifies Math and Art in three-dimensional product construction</i></p> <p><b>Math State Grade Level Expectations</b></p> <p>6.4.B two- and three-dimensional figures  <i>Determines the perimeter and area of a composite figure that can be divided into triangles, rectangles, and parts of circles</i></p> <p>6.4.D two- and three-dimensional figures  <i>Recognizes and draws two-dimensional representations of three-dimensional figures</i></p> <p>6.4.E two- and three-dimensional figures  <i>Determines the surface area and volume of rectangular prisms using appropriate formulas and explains why the formulas work</i></p> <p>6.6.E reasoning, problem solving, and communication  <i>Communicates the answer to the question in a problem using appropriate representations</i></p>

**ARTS IMPACT—ARTS-INFUSED INSTITUTE LESSON PLAN (YR2-MAP)**  
**SIXTH GRADE—LESSON TWO: Anibots: Polyhedra Patterns and Parts**  
**ASSESSMENT WORKSHEET**

Disciplines	MATH	ART AND MATH	MATH		Total 4 Points
Concept	Pattern Pieces #s of Shapes in 3-D Forms	Craftsmanship in Pattern Making	Surface Area of Polyhedra	Calculates volume	
Students	Identifies <b>quantities of singular and repeated faces</b> of polyhedra in net study	<b>Measures and counts</b> for accuracy, <b>draws lines with straightedge</b>	Uses math operations to calculate <b>sum of all faces</b>	<b>Uses height, width, depth measurement</b> and/or operations to total polyhedra volume	
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
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17.					
18.					
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20.					
21.					
22.					
23.					
24.					
25.					
26.					
Total					
Percentage					

**Criteria-based Reflection Questions:** (Note examples of student reflections on back.)  
*Why is it important to know the surface area and volume of something that will be constructed and stuffed?*

**Thoughts about Learning:**  
*Which prompts best communicated concepts? Which lesson dynamics helped or hindered learning?*

**Lesson Logistics:**  
*Which classroom management techniques supported learning?*

Teacher: \_\_\_\_\_ Date: \_\_\_\_\_