

The Cleveland Museum of Art Distance Learning Program
Angles and Answers: Origami and Math

Grades 4-5

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How to Prepare Your Class for the Distance Learning Presentation

Teacher Information will be sent or made available to you prior to the program.

Please familiarize yourself with the materials and discuss them with your class.

Have the Teacher Information Packet (T.I.P.) materials on hand in the classroom, ready for the program. These materials may be used during the videoconference.

Be prepared to facilitate by calling on students yourself during the lesson. Students are sometimes initially shy about responding to questions during a distance learning lesson.

Explain to students that this is an interactive medium and encourage them to ask questions.

Reinforce topics discussed in the program by asking students to complete some of the suggested pre- and post-conference activities in the Teacher Information Packet.

We ask teachers, after the program, to please fill out the Evaluation Form and return it to:

Dale Hilton/Distance Learning
The Cleveland Museum of Art
11150 East Boulevard
Cleveland, OH 44106

Thank You!

Angles and Answers: Origami and Math

Teacher Information Guide

- **Prerequisites**

FOR THE VIDEO CONFERENCE YOU WILL NEED:

1. 2 pieces of **Origami paper** per student – or square sheets no smaller than 6x6 inches.
2. Copies of the **Ladybug Folding instructions**.
3. Copies of the **Origami Box instructions**.
4. Copies of the **Vocabulary** are recommended for the students.
5. **Markers** (optional).

- **Program Objectives**

Educational/Program Objectives:

1. Name and identify geometric vocabulary.
2. Use technology to communicate and process information.
3. Apply concepts of geometry to create art.
4. Identify a variety of shapes and angles.

- **Program Description**

Students reinforce their knowledge of the vocabulary of geometry and recognize attributes of two- and three-dimensional shapes through an examination of selected geometric themed works from the museum. Concepts are applied as students create original origami figures in the shape of a ladybug and a box during the videoconference.

- **National Education Standards**

For Mathematics – Geometry (grades 3-5):

- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems.
- Apply transformations and use symmetry to analyze mathematical situations.
- Use visualization, spatial reasoning, and geometric modeling to solve problems.

For Fine Arts - Visual Arts (grades K-4, 5-8):

- Understanding and applying media, techniques, and processes.
- Using knowledge of structures and functions.
- Understanding the visual arts in relation to history and cultures.
- Making connections between visual arts and other disciplines.

For Language Arts - English (grades K-12):

- Evaluation Strategies
- Communication Skills
- Applying Knowledge
- Evaluating Data
- Developing Research Skills

- **Common Core Standards**

English Language Art & Literacy in History/Social Studies, Science, and Technical Subjects-

4th Grade:

CCSS.ELA-Literacy.W.4.4

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCSS.ELA-Literacy.W.4.7

Conduct short research projects that build knowledge through investigation of different aspects of a topic.

CCSS.ELA-Literacy.L.4.1

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

5th Grade:

CCSS.ELA-Literacy.W.5.4

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCSS.ELA-Literacy.W.5.7

Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

CCSS.ELA-Literacy.L.5.1

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on *grade 5 topics and texts*, building on others' ideas and expressing their own clearly.

Math-

4th Grade:

CCSS.Math.4.G.3

Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.

Angles and Answers: Origami and Math

Videoconference Pre-Activities/Information

- **History / Background Information: Origami**

- “*The History of Origami in Japan*” – This site discusses the history and development of origami from the early seventh century to the present. Click on the hyperlink below:

[The History of Origami in Japan](#)

- “*Origami History*” – This site defines origami and provides historical background written by several authors. Click on the hyperlink below:

[History of Origami](#)

- *Greenfuse Films* – This site links to a 13-minute film which presents origami in the 21st century. The work of six artists is featured. Click on the hyperlink below:

[Origami Video](#)

From the home page, click on the **New: 6 Artists: On Origami**.
(For best results, select the Windows Media (Low-Res) option.)



General Vocabulary

Origami	The traditional Japanese art of folding paper to form flowers, animals, etc.
Polygon	A figure formed by three or more segments connecting only at their end points. Polygons can be <i>regular</i> – when sides and angles are equal; and also <i>non-regular</i> (<i>irregular</i>) – when sides and angles are not equal.
Equilateral	A figure in which all sides are of equal length
Scalene	Triangle that has unequal sides and angles
Isosceles	A triangle with two equal sides
Right-Angled Triangle	Triangle with one interior angle equal to 90 degrees
Triangle	A polygon with three sides: can be equilateral, scalene, isosceles, right-angled, etc.
Tetragon	A polygon with four sides, also called quadrilateral: square, rectangle, parallelogram, trapezoid, rhombus, etc.
Pentagon	A polygon with <i>five</i> sides and interior angles equaling 540°
Hexagon	A polygon with <i>six</i> sides and interior angles equaling 720°
Heptagon	A polygon with <i>seven</i> sides and interior angles equaling 900°
Octagon	A polygon with <i>eight</i> sides and interior angles equaling 1080°
Nonagon	A polygon with <i>nine</i> sides and interior angles equaling 1260°
Decagon	A polygon with <i>ten</i> sides and interior angles equaling 1440°



Melencolia I

Albrecht Dürer (German, Northern Renaissance, 1471 - 1528)

1514

1926.211

IDEA!

Have students try sketching each type of triangle:



- **Additional Geometry Vocabulary**

- The suggested vocabulary/concepts for the video-conference are listed below. Definitions and illustrations are provided through the hyperlink:

[Geometric Vocabulary / Concepts](#)

- **Vertex** - The vertex of an angle is the point where the two rays that form the angle intersect. Also, the vertices of a polygon are the points where its sides intersect.
- **Acute triangle** - A triangle having three acute angles (an angle measuring between 0 and 90 degrees).
- **Obtuse triangle** - A triangle having an obtuse angle (an angle measuring between 90 and 180 degrees).
- **Quadrilateral** - A four-sided polygon. The sum of the angles of a quadrilateral is 360 degrees. It is also called: tetragon, square, rectangle, parallelogram, trapezoid, rhombus, etc.
- **Rectangle** - A four-sided polygon having all right angles. The sum of the angles of a rectangle is 360 degrees.
- **Square** - A four-sided polygon having equal-length sides meeting at right angles. The sum of the angles of a square is 360 degrees.
- **Parallelogram** - A four-sided polygon with two pairs of parallel sides. The sum of the angles of a parallelogram is 360 degrees.
- **Rhombus** - A four-sided polygon having all four sides of equal length. The sum of the angles of a rhombus is 360 degrees.
- **Trapezoid** - A four-sided polygon having exactly one pair of parallel sides. The two sides that are parallel are called the bases of the trapezoid. The sum of the angles of a trapezoid is 360 degrees.
- **Parallel lines** - Two lines in the same plane which never intersect are called parallel lines.
- **Perpendicular lines** - Two lines that meet at a right angle are perpendicular.
- **Intersecting lines** - The term intersect is used when lines, rays, line segments or figures meet, that is, they share a common point. The point they share is called the point of intersection.


- **Angles** - Two rays that share the same endpoint form an angle. The point where the rays intersect is called the vertex of the angle. The two rays are called the sides of the angle.
- **Line segment** - A line segment is a straight line that has two distinct endpoints.
- **Symmetry** - A figure that can be folded flat along a line so that the two halves match perfectly is a symmetric figure; such a line is called a line of symmetry.
- **Congruence** - Two figures are congruent if they have the same shape and size.
- **Similar** - Figures that have the same shape are called similar figures. They may be different sizes or turned somewhat.



Origami Specific Vocabulary

- This site provides illustrations and descriptions of a variety of folds. Click on the hyperlink below:

[Origami Vocabulary](#)

- **Accurate** – careful, exact, precise (your folds should be accurate)
- **Create** – a line or ridge in the paper formed by folding 

- **Square** 

- **Vertical** 

- **Horizontal** 

- **Diagonal** 

- **Fold** 

- **Valley fold** 

- **Mountain fold** 

THOUGHT!

Visual aids help connect words with concepts. These sheets make good hand-outs for students.



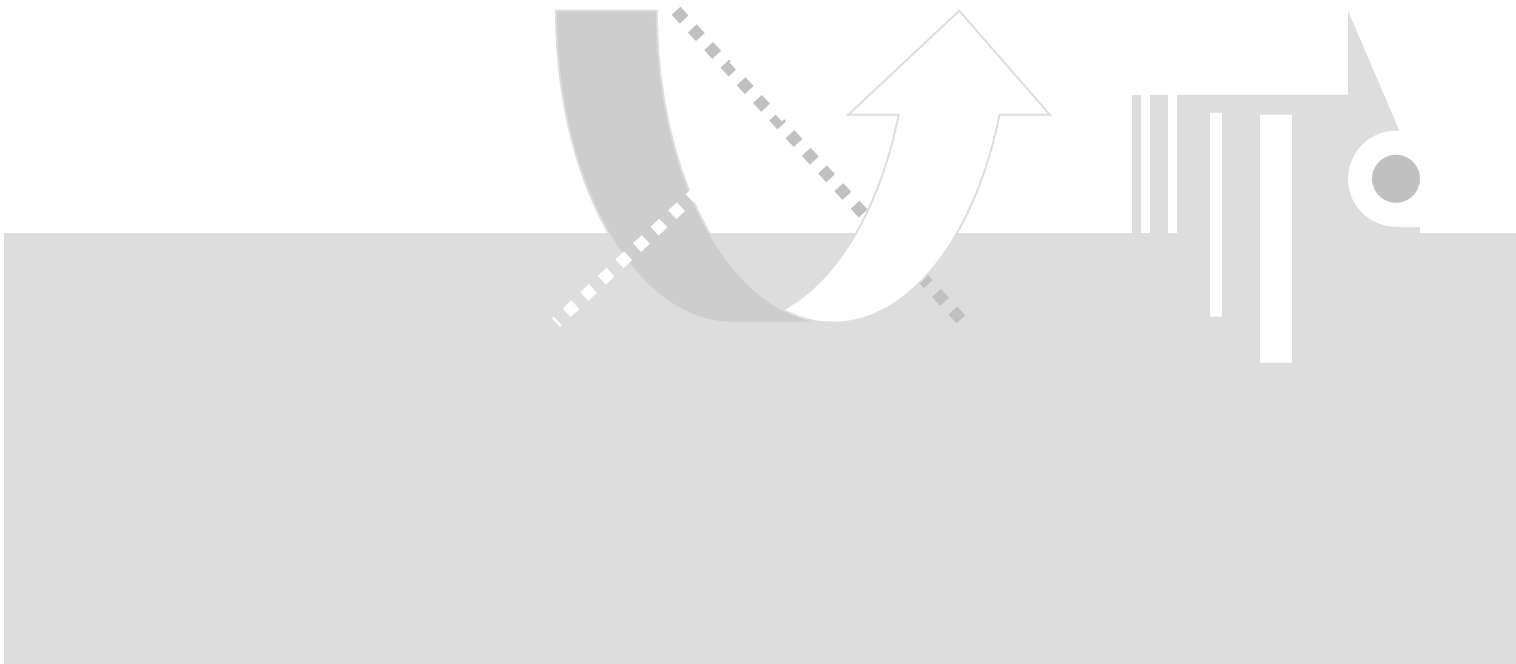
- **Paper Folding Practice**

- This site provides diagrams of basic folds. Click the hyperlink below:

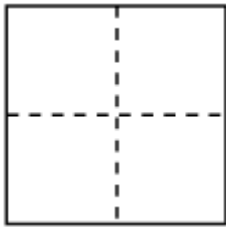
[Folding](#)

Materials needed: Square origami paper, a minimum of 6" x 6"

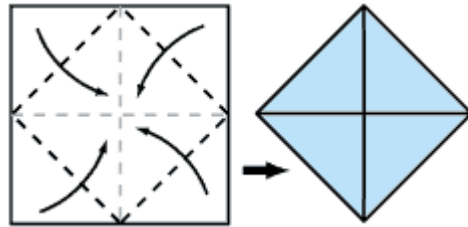
- Fold in half vertically
- Fold in half horizontally
- Fold diagonally
- Folding an edge to a line of symmetry and repeating on the other side
- Practice folding and unfolding paper
- Emphasis on accurately lining up edges (discussion about not being afraid to undo and do again! Practice makes perfect)



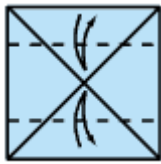
Origami Box Folding Instructions:



1. Start with a square piece of paper. Fold the paper in half horizontally and then vertically, so the creases look like this.



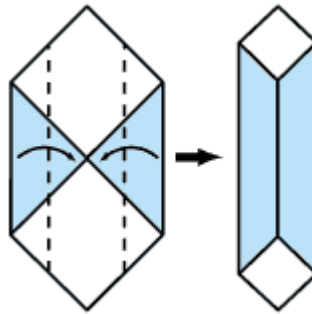
2. Fold the four corners of the paper toward the center point



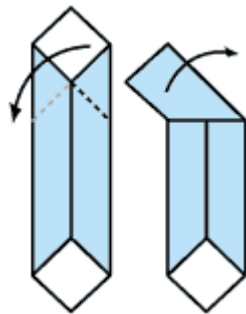
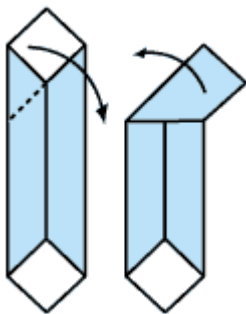
3. Fold the top and bottom of this square into the center and open out again to create these creases.



4. Open out the top and bottom triangular flaps.



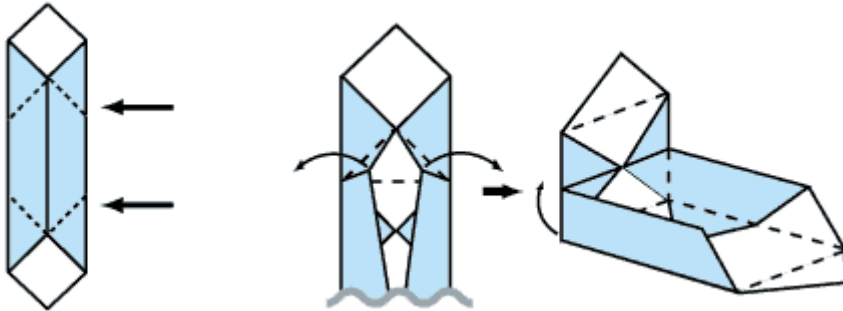
5. Fold the sides of the model into the center, creasing well.



6. Fold down top corner of model and then open out again.

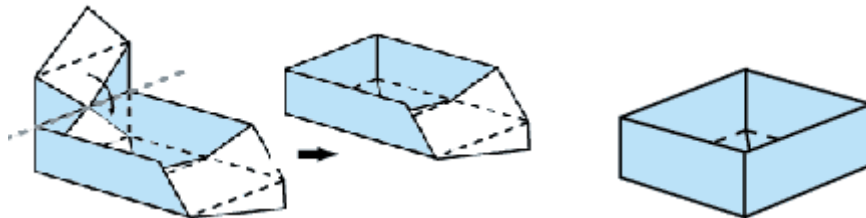
7. Fold down model in the other direction

You should now have 2 new diagonal creases like this.



8. Repeat steps 6 & 7 at the other end of the model, so you have the new creases at both ends.

9. At one end of the model, open out model along the creases you just made. This will raise the top portion of the model vertically.



10. Fold top of model over into the box. It's taking shape!

11. Repeat steps 9 and 10 at the other end of the box... and it's finished!

Ladybug Folding Instructions:

Materials:

- A square of plain origami paper, 6" square preferred,
- Black marker (optional)

Step 1



If paper is colored on one side only, begin with white side up. Fold corner to corner.

Step 2



Fold the outside corners down, but leave a gap in between. Notice the tips of the paper don't meet at the bottom; the ladybug shows through.

Step 3



Form the head by folding the top down and then back again, in a pleat.

Step 4



Round the body by folding back the two outside corners and the corner under the wings. You'll have small triangles at the sides and the tail on the underside of the bug. If you like, you can tuck them in between the main layers of paper. This gives a neater look preferred by paper folders. It's called reverse folding.

Step 5



Make the ladybug three-dimensional. Fold the body in half. Then open it again until it is not quite flat.

Step 6



Add spots to it with a marker if you wish. The ladybug is finished!

ladybug lineup



1. What is the name of the first shape we folded when we began the ladybug?

2. Does the ladybug have a line of symmetry? Where is it?

3. What type of triangle forms the wings, head, and tail?

4. How many sides does each wing have? What is this figure called?

5. Name another type of polygon that is not found in the ladybug.

6. Can you name another polygon in the environment around you?



Composition with Red, Yellow, and Blue
Piet Mondrian (Dutch, 1872 – 1944)
1927
1967.215

Curved Plane/ Figure VII (Study)
Robert Mangold (American, 1937 -present)
1994
1995.171.a



ladybug lineup - ANSWER KEY

1. What is the name of the first shape we folded when we began the ladybug?

Right Isosceles Triangle

2. Does the ladybug have a line of symmetry? Where is it?

Yes. It is a vertical line straight down the center of the body

3. What type of triangle forms the wings, head, and tail?

Isosceles triangle - 2 sides are equal

4. How many sides does each wing have? What is this figure called?

5 - Pentagon

5. Name another type of polygon that is not found in the ladybug.

6 - Hexagon

6. Can you name another polygon in the environment around you?

Answers will vary

Angles and Answers: Origami and Math

Post-Videoconference Lessons and Activities

Opening Activity

1. Each student will unfold their origami shape so they can see all the folds that they have produced.
2. The teacher will instruct the students to outline each fold with a pen, pencil, or marker so they can better see the folds.
3. Now that all the folds are outlined, the students should then identify and define the shapes that they see.
4. After identifying all the shapes, the students should label the different shapes they see on the origami figure.
5. After labeling the figure, the students should look at the figure to find lines of symmetry. The students should end up finding two different lines of symmetry using the two diagonals.
6. Using this activity, the teacher can teach shapes, their names, and the number of sides. The teacher can explain that there are many different figures with four sides and not all of them are called a rectangle or a square. With each new figure the teacher can ask the students about symmetry and help them identify it in each shape.
7. The teacher can also explore with students the area of rectangles, squares, and triangles.

Websites to help for reference:

<http://www.aaamath.com/geo.html>

<http://www.321know.com/geo318x4.htm>

- With an interactive practice quiz

• Lesson #1

The Haiku

Objective: The students will be able to . . .

1. Write a haiku
2. Explore other Japanese art forms

Content: Teaching material includes . . .

1. History and Background:

The haiku is a form of Japanese poetry. The traditional haiku usually has three lines, of 5, 7, and 5 syllables.

Here are two examples of a haiku in translation:

A

“ The red blossom bends
And drips its dew to the ground
Like a tear it falls. ”

B

“ Curving up, then down
Meeting blue sky and green earth
Melding sun and rain. ”

2. Haiku Activity:

Using haiku examples students will create a haiku of their own.

Some ideas for haikus:

- ✓ Write about the origami figure they created
- ✓ Write about connections with math
- ✓ Write about connections with the natural world
- ✓ Write about a specific work of art at the Cleveland Museum of Art.

References: For further information on haikus, visit the following sites . . .

<https://www.poets.org/poetsorg/text/haiku-poetic-form>
<http://www.ahapoetry.com/haiku.htm>

• Lesson #2

Symmetry in Art

Objective: Students of origami will learn to make a connection between the creative and mathematical skills learned through this video-conference and the works of art found in the Cleveland Museum of Art collection.

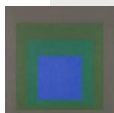
Assignment: Suggested learning activity . . .

1. Select one work of art from the CMA's collection of sculpture, paintings, or three-dimensional objects: Refer to <http://www.clevelandart.org/art/collections>
2. Research online the artist, the artwork, the medium, and the style of art.
3. Write a one-page essay that describes the work of art based on your research.
4. Observe and describe the connection between the CMA work of art and the geometric patterns learned in our origami video conference lesson.

Examples: Three works of art from the CMA collection with website references.



1. "White Mozart" by Dorothea Rockburne. American. 1932. #1988.26
 - a. website: <http://www.dorothea-rockburne.com/>
 - b. website: <http://www.nmwa.org/explore/artist-profiles/dorothea-rockburne>



2. "Homage to the Square" by Josef Albers. American. (1939). #1965.1
 - a. website: http://en.wikipedia.org/wiki/Josef_Albers
 - b. website: <http://www.albersfoundation.org/>



3. "Tondo, No. 12" by Fritz Glarner. American (1949). #1967.4
 - a. website: http://www.artcyclopedia.com/artists/glarner_fritz.html
 - b. website: http://en.wikipedia.org/wiki/Fritz_Glarner

Assessment:

1. Written essays should demonstrate students' understanding of geometry as illustrated during the origami video-conference.
2. Written essays should reflect students' understanding of art history, including biographies of the artist and his or her intention in creating the work of art.
3. Written essays should reflect the appropriate grade level expository writing skills expected of the students.

• Lesson #3

Symmetry in Nature

Objective: Students will be able to make a connection between the natural world around them and the elements of symmetry we have observed in our lesson of origami.

Assignment: Introduce topic to students showing pictures of leaves, bugs, the human body, etc. Describe to students that the same symmetrical elements we have created in our origami can be found everywhere in nature. If you divide a leaf in half, you will often find that the one half has the same shape as the other half.

- Have students go outside and find leaves or any other natural element that are symmetrical in nature.
- Choose a few students to show their objects to the rest of the class and explain how their objects are symmetrical.
- Students will create their own butterflies duplicating the same patterns on both sides.
- Materials: paper, scissors, and markers.
- Students will fold paper piece of paper in half to create line of symmetry, draw their butterflies, color, and cut out their designs.

References: Other resources and useful websites . . .

http://jwilson.coe.uga.edu/EMT668/EMAT6680.2002.Fall/Nazarewicz/7210_final_2/7210_Project/index.html

[http://en.wikipedia.org/wiki/Symmetry_\(biology\)](http://en.wikipedia.org/wiki/Symmetry_(biology))

• Lesson #4

Symmetry Around Us

Objective: Students will be able to see the elements of symmetry and shapes around them.

Assignment: Students will be asked to find ten different shapes that surround them in their every-day lives. Students will then draw and label each of these shapes and find the different lines of symmetry.

References: Other resources and useful websites . . .

<http://www.origami-usa.org>

<http://artfulorigami.com/>

http://www.shodor.org/interactivate/activities/tessellate/?version=1.5.0_11&browser=MSIE&vendor=Sun_Microsystems_Inc

<http://www.janm.org/exhibits/foldingpaper/artists/>

<https://www.scholastic.com/teachers/blog-posts/alycia-zimmerman/teaching-math-modular-origami/>

CREDITS

- Lesson based on an idea by Louisa Matthias, 6th Grade Teacher, Shaker Heights, OH.
- Script and Teacher Information Packet developed by Dale Hilton, The Cleveland Museum of Art, Karli Wheeler, Yorktown, NY, and graduate students in Education at Mercy College, Yorktown, NY.
- Graphic Design by Tami Liss.

Selected Images:



Melencolia I, 1514
Albrecht Dürer (German, 1471-1528)
engraving
1926.211



White Mozart, 1986
Dorothea Rockburne (American, b. 1932)
prismacolor on folded paper
1988.26

The Cleveland Museum of Art Distance Learning Evaluation Form

Your Name _____

Your School _____

School Address (with zip code) _____

E-mail Address _____

Grade/Class of students (e.g. 10th grade French) _____

Program Title _____

Program Date _____

Thank you so much for your participation in our distance learning program. We would appreciate your response to these questions by circling the appropriate answer and returning the survey. Please Mail or Fax to Dale Hilton at 216-707-6679

**5= Strongly Agree 4= Agree 3= Neither Agree nor Disagree
2= Disagree 1= Strongly Disagree**

1. The teacher information packet was helpful for preparing my class and me for the distance learning lesson.

5 4 3 2 1

2. The teaching style of the on-camera instructor was interesting, engaging and fostered interaction.

5 4 3 2 1

3. The Teacher Information Packet was helpful in providing interdisciplinary extension activities that I did use or plan to use.

5 4 3 2 1

4. The distance learning lesson successfully taught its objectives.

5 4 3 2 1

5. The distance learning lesson was not interrupted by technical difficulties.

5 4 3 2 1

6. The pre-requisites the distance learning lesson and extensions are aligned with The National Education standards.

5 4 3 2 1

7. I plan to register for another distance learning lesson.

(circle one)

Yes

No

If no, why? _____

8. I would like more information about The Cleveland Museum of Art's Teacher Resource Center.

(circle one)

Yes

No

9. Why did you choose The Cleveland Museum of Art Distance Learning?

(circle one)

- a.) Price Point
- b.) Quality of lessons
- c.) Selection of lessons
- d.) Ease of working with CMA
- e.) Other

10. How did you hear about The Cleveland Museum of Art Distance Learning program?

(circle all that apply)

- a.) CMA inservice
- b.) CILC
- c.) TWICE
- d.) Conference
- e.) Brochure
- f.) The Cleveland Museum of Art website
- g.) The Teacher Resource Center
- h.) Other

11. Do you have any additional comments about the distance learning lesson?

Please return the completed teacher evaluation form to:

**Dale Hilton/Distance Learning
The Cleveland Museum of Art
11150 East Boulevard
Cleveland, OH 44106**

Or fax to Dale Hilton at 216-707-6679