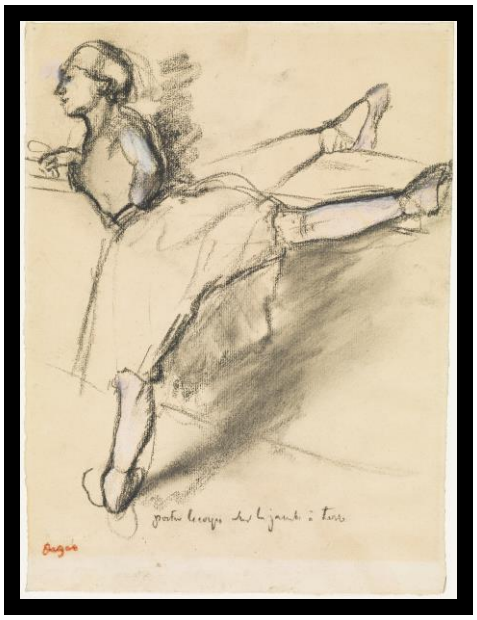
CLASS EXPERIENCE

Choreography: Transformations on a Coordinate Plane

Art, Dance, and Mathematics

GRADES: 5-9

BASED ON



Edgar Degas (1834-1917), France
Dancer at the Bar
Circa 1885
Black chalk and pastel on paper
12 5/16 x 9 5/16 in. (31.3 x 23.7 cm)
Annual Membership Fund, 1920.40

OBJECTIVES

- Students will use ratio, proportion, and visual-spatial relationships to create a replica of Edgar Degas's *Dancer at the Bar,* Circa 1885 (Launch)
- Students will view videos and describe how geometry is used in choreography/dance (Launch)
- Students will describe and "dance" on a coordinate plane dance floor (represented on the classroom floor) given transformations directions – translation, reflection, rotation, and glide rotation – and points and lines on the plane (Explore)
- Students will "dance" on the coordinate plane (created on the classroom floor) given directions for transformations

CONCEPT

Dance is the mathematics of the Soul
A body in movement is its philosophy.
Nellie Mazloum

CLASS EXPERIENCE

The purpose of this lesson is to help students develop an appreciation for the connections between choreography/dance and mathematics. Integrating mathematics and choreography/dance in this lesson will allow students to enactively (physically) experience abstract mathematical concepts.

Five works of art by Edgar Degas which depict ballet dancers will be used to "Launch" the lesson. Students will use ratio and proportion to create a replica of the *Dancer at the Bar* (Degas, 1885). For the "Explore", students will perform choreography/dance moves on a floor-sized coordinate plane. They will use transformations – translation (slide), reflection (flip), rotation (turn), and glide reflection (slide and flip) – to dance from a starting position (x,y) to an ending position (x',y'). Finally, during the "Summarize" students will apply what they learned in the "Explore" to answer discussion questions.

MATERIALS

- Photocopy of *Dancer at the Bar* (Degas, 1885) – cut into 16 rectangles and numbered
- Colored pencils or markers (BLACK)
- Chart paper sectioned into a grid with 16 rectangles
- Masking tape or duct tape and markers for the coordinate plane stage

VOCABULARY

Ratio – a way of representing how two numbers compare
Proportion – two ratios that are equal
Transformation – movement of a shape so that it is in a different position but it retains the same size and shape
Translation – "sliding" a shape so that it is in a different position but it retains the same size and shape
Reflection – "flipping" a shape so that it is in a different position but it retains the same size and shape
Rotation – "turning" a shape so that it is in a different position but it retains the same size and shape
Glide reflection – "sliding" and "flipping" a shape so that it is in a different position but it retains the same size and shape

PROCEDURE

Launch

1. Tell students background information about the *Degas, Renoir, and Poetic Pastels* exhibition at the CAM and show photos of Degas's work (do not show *The Dancer at the Bar*). Ask them to talk about connections between choreography/dance and mathematics. When/how do choreographers use mathematics?
2. Show one or more of these video(s) and ask students to describe the mathematics that they see: http://www.huffingtonpost.com/2013/07/15/gymnastics-ballet-video_n_3598542.html (Video - Gymnastics Ballet Video will Leave You Speechless); http://www.youtube.com/watch?v=m3ZgD58kiTI (Video - 3D Geometric Shapes Dance Ballet); http://video.about.com/dance/The-Five-Ballet-Positions.htm (Video - Five Classical Ballet Positions).
3. Replica Activity: Give each student a blank rectangle (numbered) and a segment of the small image (numbered) [see below]. The task is to draw the small image onto the blank rectangle

and preserve the proportion. After students draw their images ask them to post the drawings on the numbered chart paper [see Figure 2 below]. All 16 images posted will create a replica of Degas's black chalk and pastel, *The Dancer at the Bar*, from the CAM collection.

4. Ask: How did you draw the image and preserve the proportion? What mathematics did you use? Are the images similar? Why or why not? What was difficult or easy about drawing the image? Where (middle, corner, edge – specify – of the rectangle) did you start and why? If students tell you the "number" they had you can point to it in the replica and allow them to talk about their specific rectangle.

Dancer at the Bar partitioned and cut into 16 equal-sized rectangles

Explore

Before class, create a large coordinate grid on the floor of the classroom. This is the stage! (You can do this by making the x-and y-axes with wide masking tape or duct tape. Label the axes with integers -10 to +10. Place the numbers at least 1 foot apart if possible.)
Students will "choreograph" dance moves using mathematical directions.

For example, tell students the starting position (*x*, *y*) on the coordinate grid (or stage!) and the transformation. They will decide how to move, make the move, and name the ending position. You can add some "fun" by also describing the positions of their arms, hands, legs and/or feet.

EXAMPLE: Start at the point (4,5) and translate 3 units to the left. Your arms need to be perpendicular to your body and your knees bent at about 20 degree angles. Walk on your toes ☺. Where will you end? What are the coordinates of the new position?

EXAMPLE: Start at the point (-2,-3) and reflect across the y-axis. Your elbows need to be bent at right angles pointing down. Do not bend your knees as you walk to the end position. Where will you end? What are the coordinates of the new position?

EXAMPLE: Start at the point (-2,5). Translate 3 units up and rotate your body 90 degrees. Your arms need to form lines parallel to your body. Where will you end? What are the coordinates of the new position?

EXAMPLE of an EXTENSION for high school students: Start as (5,-2) and reflect across the *x=y* axis, rotate 270 degrees from that point, and translate 2 units down vertically. Your elbows need to be bent at about 30 degree angles and your right knee bent at 145 degrees. Where will you end? What are the coordinates of the new position?

Create more examples so that other students have opportunities to perform choreography/dance moves.

Summarize

Allow time at the end of the class period to make connections between the activities. Ask students:

In what ways can the geometry of transformations be used to describe choreography/dance moves? (These transformations can be used to describe dancers' movements in relation to position, time, and space.)

On Exit Slips students answer the following question:

Describe/define what the following moves would look like on a dance floor or coordinate grid – **translation**, **reflection**, **rotation**, and **glide reflection**.

ASSESSMENT

Use students' responses to the Exit Slip question (above) in order to formatively assess their understanding of the definitions of translation, reflection, rotation, and glide reflection. The following day: Put students in groups of 3 and ask them to create the directions for choreography/dance moves on a coordinate plane. Allow time for another group to perform the moves based on the directions and focus on helping students use the academic language of transformations.

NATIONAL STANDARDS

National Standards for Arts Education

Grades 3-8:

- Content Standard #2: Understanding choreographic principles, processes, and structures.
- Content Standard # 7: Making connections between dance and other disciplines.

Common Core State Standards for Mathematics

5th Grade

- Graph points on the coordinate plane to solve real-world and mathematical problems
  1. Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., *x*-axis and *x*-coordinate, *y*-axis and *y*-coordinate).

2. Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

6th Grade

- Understand ratio concepts and use ratio reasoning to solve problems.

7th Grade

- Analyze proportional relationships and use them to solve real-world and mathematical problems.

High School Geometry

- Experiment with transformations in the plane.
    1. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
    2. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).
    3. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.
    4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
    5. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

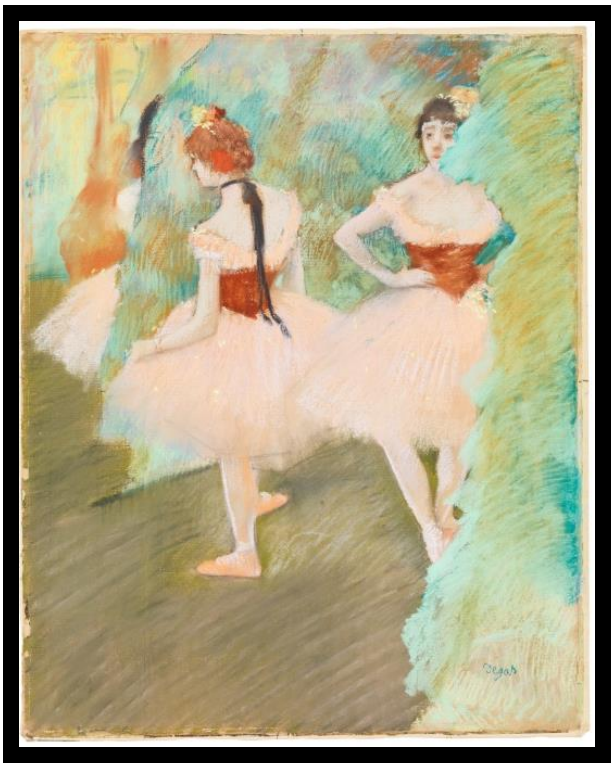
RESOURCES

http://wiki.answers.com/Q/How_do_dance_and_math_relate (Article - How do dance and math relate?)

http://www.huffingtonpost.com/2013/07/15/gymnastics-ballet-video_n_3598542.html (Video - Gymnastics Ballet Video will Leave You Speechless)

http://www.youtube.com/watch?v=m3ZgD58kiTI (Video - 3D Geometric Shapes Dance Ballet)

http://video.about.com/dance/The-Five-Ballet-Positions.htm
(Video - Five Classical Ballet Positions)



Edgar Degas (1834-1917), France
Dancers in Pink Standing in the Wings
Circa 1879
Pastel
Bequest of Mary Hanna, 1956.113

Edgar Degas (1834-1917), France
Dancer in Her Dressing Room (Danseuse dans sa loge)
Circa 1879
Pastel
Bequest of Mary Hanna, 1956.114

Edgar Degas (1834-1917), France
The Ballet
Circa 1879
Monotype, graphite, pastel and gouache on board
Bequest of Mary Hana, 1946.105

Edgar Degas (1834-1917), France
Three Dancers in Yellow Skirts
Circa 1900
Charcoal and pastel on tracing paper laid down on board
Gift of Vladimir Horowitz, 1947.542