

Fractions in Art and Mathematics

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Abstract

Art and mathematics are two subjects in the K-12 curriculum that can be readily linked in a synergistic way: Art deals with composition –visual relationships of the parts to the whole; mathematics deals with numeric and geometric relationships. This paper presents a unit of study on the 6th – 7th grade level, which could be taught in either a mathematics or an art course, focusing on fractions as explored through visual design. It integrates understanding of fractions, skills in measuring, and creating an artwork incorporating fractions of geometric shapes and designs of numbers achieved through a stenciling process.

Background on the Interdisciplinary Experience

The unit of study, entitled “Fractions in Art and Mathematics”, was developed by two art education students, Cary Fentzloff and Matt Voelker in an art education interdisciplinary field experience course at Towson University. The purpose of this course is to provide opportunities for art education students to design and implement units of study in art that use content/processes in other subjects (such as mathematics, science, and social studies) to motivate learning in each subject area. The steps taken in the design and implementation of the unit were as follows:

1. The two students selected mathematics as their preferred academic subject to integrate with art.
2. They met with a 7th grade mathematics instructor at the field site school to determine what was being presented in the mathematics curriculum and to brainstorm possible interdisciplinary links.
3. The students, using a framework that included instruction in art making, art criticism, art history, and aesthetics, brainstormed ideas for the integration of mathematics skills/concepts with art.
4. *Fractions* was selected as a theme to connect “visual composition” with “mathematical composition”.
5. Robert Indiana, Jasper Johns, and Piet Mondrian were selected as artists exemplifying the use of mathematics content/processes in their work.
6. Visuals, a unit plan, and lesson plans were created to lead the 7th grade students through mathematics and art making processes.
7. The plans were implemented over six 45-minute sessions.
8. A notebook documenting the experience was created as an example of art/ mathematics interdisciplinary education.

The unit plan that follows outlines the goals, concepts, skills, and teaching procedure that Ms. Fentzloff and Mr. Voelker developed to integrate art education with mathematics education.

The Unit Plan: *Fractions in Art and Math*

1. Theme and General Description

- a) Fractions serve as the theme to explore mathematics-art connections. The unit integrates understanding of fractions, skills in measuring, and the creation of artwork incorporating the use of numbers and wholes/fractions of geometric shapes.
- b) Grade level: middle school
- c) Time: six 45-minute sessions

2. Goals

- a) To develop knowledge and appreciation of mathematics concepts, skills, and use in the creation of art (historical/aesthetic domains)
- b) To develop knowledge and appreciation of artists Piet Mondrian, Robert Indiana, and Jasper Johns, who use mathematical processes and content in the creation of their works (historical/aesthetic domains)
- c) To demonstrate skills in measuring and partitioning of shapes to create fractions (productive domain)
- d) To demonstrate an understanding of formal qualities in art, focusing on composition achieved through warm and cool color schemes, positive and negative shapes, repetition, and contrast. (critical/productive domains)
- e) To demonstrate skills in the use of media and processes, including cut paper collage and stenciling with oil pastels (productive domain)
- f) To demonstrate problem-solving skills in the design of an original composition integrating art and mathematics (productive domain)
- g) To develop critical skills through oral and written discussions of cultural exemplars and final products (critical domain)

3. Concepts/Skills

Art Concepts

- a) Artists Robert Indiana and Jasper Johns used numbers as subject matter in their artwork.
- b) Artists Robert Indiana and Piet Mondrian used geometric shapes to divide space.
- c) Cut paper collage is the process of cutting and gluing shapes to create 2D designs..
- d) Stenciling is a printing process used to create repeated positive and negative shapes.
- e) Two color schemes are warm (red, orange, yellow) and cool (green, blue, violet).
- f) Repetition and contrast can be created in a composition through choices of color and shape.
- g) Composition reflects the choices an artist makes in the process of designing artwork.

Math Concepts

- a) Numbers are used in mathematics to solve arithmetic problems.
- b) A fraction can be used to represent the congruent parts of a whole.
- c) Rulers are tools used in mathematics for measurement purposes.
- d) Geometric shapes can be constructed through the connection of accurately measured lines and line segments.

Art Skills

- a) Cutting, gluing, arranging shapes into a composition
- b) Experimenting with warm and cool colors
- c) Stenciling
- d) Creating compositions that include division of space (use of fractions), repetition of shapes and imagery, and color contrast

Math Skills

- a) Process of measurement (linear)
- b) Using a ruler to construct shapes
- c) Recognizing /demonstrating understanding of fractions
- d) Creating fractions of a whole through partition of geometric shapes

4. Cultural Exemplars (artworks exemplifying concepts and processes) by the following artists:

- a) Piet Mondrian
- b) Robert Indiana
- c) Jasper Johns

5. Scope And Sequence

Day 1: Introduction to Interdisciplinary Art-Mathematic Connection

- a) Teacher introduces unit by presenting the art of Piet Mondrian, Robert Indiana, and Jasper Johns. Teacher facilitates a discussion on the use of fractions to partition space in a composition and on the use of numbers as subject matter in art as exemplified by these artists. (See Figures 4, 5, and 6.)
- b) Teacher presents the concept of fractions as partitions of space using manipulative visuals (posters showing colored squares partitioned into smaller squares, rectangles and triangles, representing $1/2$, $1/3$, $1/4$, $1/5$, $1/8$, etc. of the original square.)
- c) Students review artworks exemplifying use of mathematics, use of fractions to partition space, and warm and cool colors.

Day 2: Creation of Collage Background Based on Fractions

- a) Teacher reviews the use of fractions to partition space using the manipulative visuals. Teacher reviews concepts related to warm and cool colors.
- b) Teacher demonstrates how to use a ruler to accurately measure and create squares, rectangles, and triangles that are fractions of a larger sheet of paper. Teacher provides a short cutting and gluing demonstration.
- c) Students work on studio assignment: to create a cut paper design in which warm or cool colored squares are partitioned into fractions of the whole ($1/2$, $1/4$, $1/8$, etc.) and glued down (collaged) to create a background. (See Figures 1(a) and 1(b).) Criteria for background is as follows:
 - 1. Choose a warm or cool color scheme.
 - 2. Use a ruler to construct accurately measured fractions of squares, making smaller squares, rectangles, and/or triangles.
 - 3. Create at least 3 definable fractions (such as $1/2$, $1/3$, $1/4$, $1/5$, $1/8$, etc.) of shapes from cut paper.
 - 4. Glue shapes onto 14x14 white paper background using good craftsmanship.

Day 3: The Stenciling Process

- a) Student complete collage backgrounds.
- b) Teacher demonstrates how to create a positive shape stencil and a negative shape stencil of a number. (See Figures 2(a) and 2(b).)
- c) Students create stencil. Criteria for stencil is as follows:
 1. Measure 1/2 inch from top and bottom of 6x6 tag board square and make guide marks.
 2. Draw and cut number as a thick shape (about 1/2 inch thick).
 3. Tape necessary parts of the stencil back together.
 4. Keep all shapes (both positive and negative images).

Day 4: Exploring Composition

- a) Teacher reviews information on positive and negative shape presented on day 3.
- b) Students experiment with the stencil printing process, creating positive and negative images in oil pastels. They use oil pastel colors that are of the opposite color scheme of their backgrounds.
- c) The concept of composition is introduced as an artist's choice and arrangement of colors and shapes. Teacher's examples of the final assignment are shown (see Figures 3(a) and 3(b) and criteria are established, as follows:
 1. You must use the stencil printing process to repeat the number on your cut paper background.
 - If you have a warm colored background, you must choose cool colored oil pastels for stenciling.
 - If you have a cool colored background, you must choose warm colored oil pastel for stenciling.
 - You have the option of using black and white oil pastels for accents.
 2. You may choose to collage the stencil itself onto your composition.

Day 5: Work Day

- a) The criteria for the final composition are reviewed.
- b) Students work on final products.

Day 6: Final Day for Critique and Reflection

- a) Students complete final products.
- b) Teacher and students share and discuss artwork during class critique.
- c) Teacher leads a review of how students used mathematics to create artworks.
- d) Students complete a closing written reflection sheet (see figure 7) to demonstrate learning.

6. Evaluation Questions

- a) Reflection on planning and teaching
 1. How effectively were art and mathematics concepts integrated to support the unit theme?
 2. How effective was the sequencing of activities to support unit content and learning in each subject area?
 3. Was time sufficient to explore processes and concepts in both subject areas?
 4. How effective were visuals, demonstrations and teaching strategies to teach concepts and skills in both subject areas?
- b) Observation of student behaviors
 1. Were students motivated by unit activities relating art and mathematics?
 2. How well did students demonstrate understanding of art and mathematics concepts and processes through critical discussion, studio production, reflection sheets, and critiques?
- c) Assessment of studio products
 1. How well did products fulfill criteria?
 2. How well did products reflect an understanding of unit concepts in both art and mathematics?
 3. How successful was the work in demonstrating fulfillment of unit goals?

7. Assessment of Learning

- a) Review the artwork produced by each student and compare it to answers given on question #1 on the Unit Reflection Sheet (to ascertain each students level of understanding of fractions).
- b) Evaluate level of skill in using a ruler to accurately measure and produce geometric shapes that illustrate partitioning of larger areas.
- c) Evaluate artworks on use of negative-positive space, warm and cool colors, repetition and contrast in visual design.
- d) Evaluate answers to questions 2 – 6 on the Unit Reflection Sheet to assess understanding of art concepts.
- e) Assess comments made by students about their artwork, the experience, and use of mathematics during the final critique session.

Figures Illustrating Processes in Creating Artwork

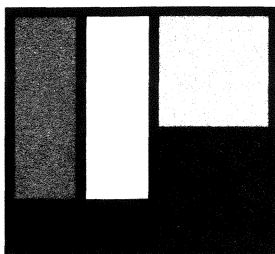


Figure 1(a): Example 1 illustrating use of fractions in a cut paper collage background.

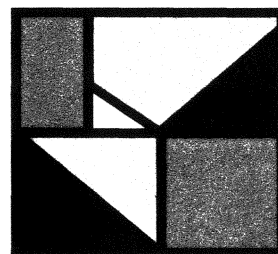


Figure 1(b): Example 2 illustrating use of fractions in a cut paper collage background.

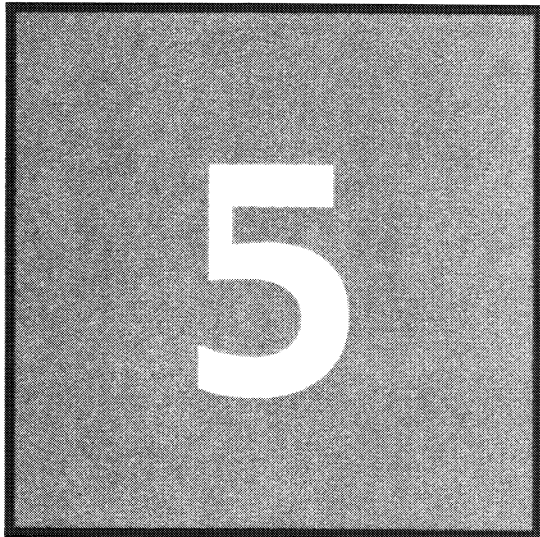


Figure 2(a): Example of a number created from a negative shape, which can be used as a stencil by filling in the space.



Figure 2(b): Example of a number created from a positive shape, which can be used as a stencil by drawing around it.

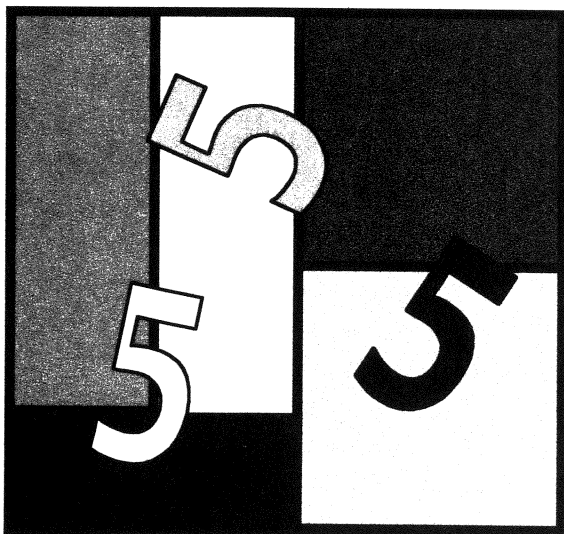


Figure 3(a): Example 1 of the finished design incorporating stenciled numbers on top of the collaged background.

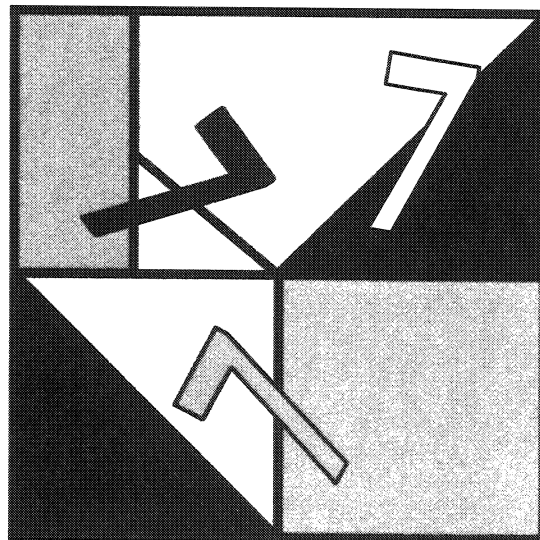


Figure 3(b): Example 2 of the finished design incorporating stenciled numbers on top of the collaged background.

Cultural/Historical Information on Artists

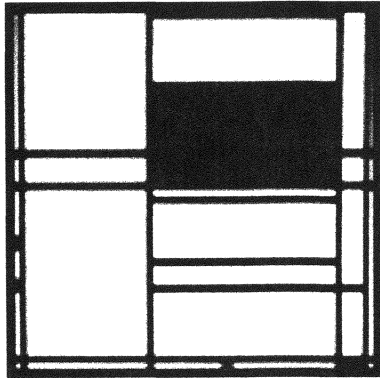


Figure 4: *No. 4*, by Piet Mondrian, illustrating partitioning of space (fractions).

Piet Mondrian

The Dutch painter Piet Mondrian devoted his career to exploring the potential of geometric shapes in his compositions. He felt that certain things are universal – the rectangle, the vertical and horizontal, black and white and primary colors. Using these elements, he hoped to cut through cultural and emotional differences and make a statement meaningful to all - a representation of “pure reality.”



Figure 5: *Decade Autoportrait*, by Robert Indiana, illustrating the use of numbers as subject matter.

Robert Indiana

The American painter Robert Indiana is widely known for his large-scale paintings of numbers and words. He lived most of his life in New York, where during the 50s, 60s, and 70s he witnessed people from around the world coming to seek the American dream. His paintings reflect views of America during specific periods of time.



Figure 6: *Figure 2*, by Jasper Johns, illustrating the use of numbers as subject matter.

Jasper Johns

The American painter Jasper Johns also painted symbols of America (such as the American flag and a map of the United States). He also created many compositions using letters and numbers as design elements.

FRACTIONS IN ART -UNIT REFLECTION SHEET

1. Identify the fractions you selected to illustrate in your collage background. Describe these fractions by color and shape. (Example: 1/4 red triangle; 1/8 orange rectangle, etc.)

2. Explain what stenciling techniques you used to create your artwork – use of positive shape, use of negative shape, etc.

3. Which color scheme did you choose for your background?

Which color scheme did you choose for you stenciling?

4. Name one of the artists we studied in this unit and discuss how he used mathematics in his art.

5. List at least two reasons why your knowledge of mathematics was important to you as an artist.
(a) _____

(b) _____

6. Describe how your artwork uses (a) repetition and (b) contrast.
(a) _____

(b) _____

7. Describe what you like best about your artwork. _____

8. Describe what you liked about this unit. _____
9. Describe what you disliked about this unit. _____

Figure 7: Sample unit reflection sheet.

References

[1] Bates, J. (2000). *Becoming an Art Teacher*. Belmont, CA Wadsworth/Thomson Learning
[2] Gilbert, R. (1992). *Living with Art* (third edition). New York: McGraw-Hill, Inc.