
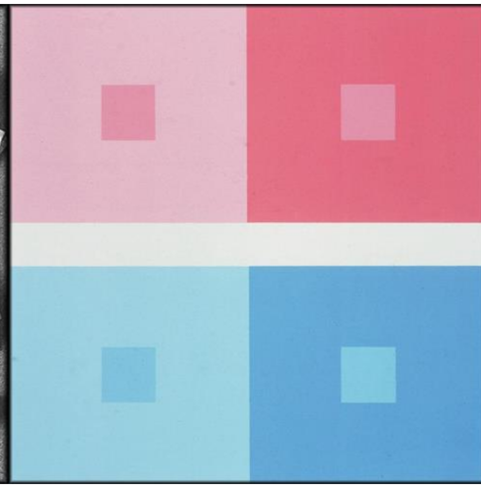
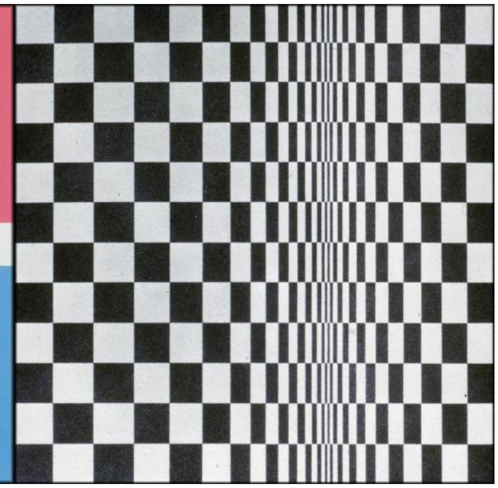

Subject: Art **Grade Level:** Fifth Grade **Estimated Time:** 20 instructional hours

UNIT TITLE: Mathartmagic

Enduring Idea or Theme: Precision, Illusion, and Perception

Unit Description:

In this unit, students will investigate relationships between math, art, and optical illusion. They will explore the work of illusionary artists in search of patterns and proportions which fool the eye. They will identify various geometric devices and describe how artists have applied them. They will participate in cooperative projects which incorporate their shared knowledge. They will choose from a selection of multi-media processes in order to achieve an individual work of art that demonstrates understanding of unit concepts.

National Core Art Standards or State Standards:

NCASS: VA Cr1.1.5a: Combine ideas to generate an innovative idea for artmaking
NCASS: VA Cr1.2.5a: Identify and demonstrate diverse methods of artistic investigation to choose an approach for beginning a work of art.
NCASS: VA Cr 2.2.5a: Demonstrate quality craftsmanship through care for and use of materials, tools, and equipment.
NCASS: VA Cr3.1.5a: Create artist statements using art vocabulary to describe personal choices in art-making.
NCASS: VA Cn10.1.5a: Apply formal and conceptual vocabularies of art and design to view surroundings in new ways through art-making.
NCASS: VA Re7.1.5a: Compare one's own interpretation of a work of art with the interpretation of others.
NCASS: VA Pr5.1.6a: Individually or collaboratively, develop a visual plan for displaying works of art, analyzing exhibit space, the needs of the viewer, and the layout of the exhibit.

1. What broad, overarching understandings are desired of students?

- Artists can manipulate our perception by producing optical illusions.
- Many artistic techniques have connections to mathematics.
- Color, line, and shape can be manipulated to produce illusionary effects.
- Artists use measurement and precision to enhance their artwork.
- Art makes us think about mathematics in new ways.

2. What are the overarching "essential" questions that support this unit?

- In what ways, do art and math connect? Which artists make such connections?
- What is perception? Why does it vary from person to person?
- How is it possible to fool the eye?

3. As a result of this unit, students will be expected to demonstrate an understanding of:

- How different artists have incorporated mathematics into their artwork.
- How artistic techniques can be used to generate optical illusion.
- How color is never independent and is always subject to its surroundings.

4. What "essential" and unit questions will focus the discussions and activities of this unit?

- Why might an artist organize her/his artwork using mathematic principles?
- Which illusions are most successful and how are they created?
- How did artists use geometric devices in the artwork we have seen?
- How are sight and sensation related?

5. Key Vocabulary or Concepts: Op Art, Illusion, Perception, Perspective, Rhythm, Repetition, Vibration, Geometry, Symmetry, Tessellation, Reflection, Rotation, Translation, Angle, Hexagon, Pattern, Center Point, Surface, Precision, Color Relationships, Primary, Secondary, Tertiary, Compliment, Split Compliment, Monochromatic, Achromatic, Value, Shadow, Interaction

6. Major Learning Activities:

Project One: Pieces of the Puzzle

Big Ideas or Essential Questions:

- Art can fool the eye through reactions between line, shape, and color.
- Perception can fluctuate rapidly and is responsive to multiple variables.

Discussion Questions:

- Which of the six illusions is the most successful? Why do you think it is so?
- How have artists used pattern, proportions, and other mathematic devices in their work?

Beneficial Knowledge Base:

Visual Thinking Strategies
Basic Color Theory

Practical Skills Required:

Visual Discrimination
Spatial Orientation
Fine Motor Manipulation
Language Arts Skills

Activity:

Six different large scale images will be used as sources for puzzles. A number of the puzzle pieces from each image will be withheld. Four pieces of each image will be available to students. Students will choose a puzzle piece when they come into the class room. These pieces will eventually be used to divide the class into cooperative learning groups.

Students examine their piece carefully and complete one side of a notecard according to three VTS prompts; I see, I think, I wonder. Students will then use their puzzle piece in an attempt to reconstruct the original image. They will compare and contrast the piece they hold with those of other students. Each cooperative learning group is composed of the four students who each have one piece belonging to a single image. When everyone believes they have identified all four pieces of their image puzzle, the group will attempt to put it together.

Groups will notice fairly quickly that they do not have all the pieces for their puzzle. The remaining pieces are laid out on the floor. Each student chooses one piece that they believe belongs to their group image. The groups return to their puzzle and attempt to incorporate the pieces. Pieces that fit are put in place, pieces that do not fit are returned to the floor. The process continues until all six images are once again complete. Students are asked to examine the image as a whole and to complete the other side of their notecard according to the same VTS prompts.

Through group discussion they are asked to share their notecards. They will compare their personal response to the individual piece and to the image as a whole. They will also compare their response to others' in the group. The group will construct a unified statement; we see, we think, we wonder. In addition, the group will briefly describe the image and hypothesize as to the mechanisms which make the illusion successful. When all groups have completed the process, the class gathers to share the results. Images are projected for everyone to see and a group representative shares their unified statement.

(3 instructional hours)

Works Shown and Discussed: Bridget Riley, *Movement in Squares*, 1961; M.C. Escher, *Waterfall*, 1961; M.C. Escher, *Reptiles*, 1943; Gilbert Hsiao, *Event Horizon*, 2012; Josef Albers, *Oper/Opera*, 1933; Josef Albers, *Monte Alban*, 1942

Assessment: What levels of completion and complexity did students achieve through the Visual Thinking strategies? To what degree did the student's observations lead to quality inquiries? How successful were students in identifying individual components (pieces) of their image? How successful was the cooperative learning group in completing their image, its description, and a hypothesis? Is there evidence of critical thinking or problem solving within the group? What levels of completion and complexity did the group achieve through the VTS?

References:

Gilbert Hsiao, *Event Horizon*, (2012). Retrieved October 2, 2016, from Gilbert Hsiao: http://gilberthsiao.com

Optical Illusions, (n.d.). Retrieved October 1, 2016, from Optical Illusions: http://www.illusions.org/

Albers, J. (1971). *Interaction of color*. New Haven: Yale University Press.

Hauptman, L. (1997). *The maximal sixties: Pop, Op, figuration from the drawing collection*. Retrieved October 3, 2016, from The Museum of Modern Art: https://goo.gl/eQCJ88

Josef & Anni Albers art. (2016). Retrieved October 4, 2016, from The Josef & Anni Albers Foundation: http://www.albersfoundation.org/art/selected-works/

M.C. Escher gallery. (n.d.). Retrieved October 1, 2016, from M.C. Escher: http://www.mcescher.com/gallery/

The maximal sixties: Pop, Op, and Figuration. (1997). Retrieved October 3, 2016, from The Museum of Modern Art: http://origin-www.moma.org/calendar/exhibitions/231?locale=en

Project Two: The Responsive Eye

Big Ideas or Essential Questions:

- Artists use many techniques to generate optical illusions.
- Sight and sensation have significant connections. What we see effects the way we feel.

Discussion Questions:

- Which artists or pieces of art do you recognize from our previous class?
- What kind of connections can we make between Op Art and mathematics?

Beneficial Knowledge Base:

- **Basic Color Theory**

Practical Skills Required:

- **Visual Discrimination**
- **Inspection and Inquiry**
- **Language Arts Skills**

Activity:
Students will watch the three part video of the 1965 MoMA exhibition titled *The Responsive Eye*.

[**The Responsive Eye – Part One**]

[**The Responsive Eye – Part Two**]

[**The Responsive Eye – Part Three**]

Upon completion of the video series, students will write a personal reflection. In addition to noting familiar artists or artwork, they will respond to one of the following prompts:

1. Some of the people in the videos state that the artwork in the exhibit is disturbing. Why do you think they felt this way? Do you find the images disturbing? Why do you feel this way?

2. Some of the people in the videos state that the images are not ART. On what evidence do they base their opinions? Do you think the images are art? On what evidence do you base your opinion?

(2 instructional hours)

Works Shown and Discussed:

Assessment: How successful was the student in correctly stating and analyzing the opinions of others? Has the student expressed his/her opinion and arrived at logical conclusions? Does the work have proper grammar and linguistic structure?

References:
Museum of Modern Art (New York, N.Y.), & Seitz, W. C. (1965). *The responsive eye.* New York.

Hyatt, G. (Writer), & Wiemer, R. (Director) (1965). *The responsive eye* [Television series]. In G. Hyatt (Producer), New York, NY: Columbia Broadcast System.

Project Three: Mechanisms of Magic

Big Ideas or Essential Questions:

- Artists can manipulate our perceptions through the application of mathematic principles.
- Geometric devices such as symmetry and tessellation can enhance optical illusion.

Discussion Questions:

- What are the three types of symmetry and how do they differ? Which describes tessellations?
- Which of the artists we have studied shows they clearest evidence of applied mathematics?

Activity:
Students will participate as a group in a SMART Notebook Interactive Whiteboard lesson on symmetry. Through the hands-on lesson activities, students will build unit vocabulary and analytical skills.

Beneficial Knowledge Base:
Linear Measurement (mm)
Geometric Measurement (mm^2)
Angular Measurement (360 °)
Linear Perspective

Practical Skills Required:
Visual Discrimination
Fine Motor Manipulation
Layering and Overlapping
Ratio and Proportion
Pattern Recognition

Reflection and Rotation Symmetry

(2 instructional hours)

Assessment: Components of the lesson offer in process assessment and immediate feedback.

References:

CAAN Math Teacher. (2012, July 15). *1.1 Reflection and rotation symmetry*. Calgary, AB, Canada: SMART Technologies ULC.

Project Four: Interaction of Color

Big Ideas or Essential Questions:
- Color, line, and shape can be manipulated to produce illusionary effects.
- Color is never independent and is always subject to its surroundings.

Discussion Questions:
How do artists use color to successfully create illusion?
Which color relationships are the most reactive and what other elements are involved in this effect?

Beneficial Knowledge Base:
Basic Color Theory
Linear Measurement (mm)
Geometric Measurement (mm^2)
Angular Measurement (360 °)
Linear Perspective

Practical Skills Required:
Layering and Overlapping
Ratio and Proportion
Pattern Recognition
Digital Media Skills
Measurement
Design and Planning

Activity:
Students will use the iPad app *Interaction of Color* by Josef Albers generate an independent inquiry into a range of color reactions. They will read Chapter 5 of the text and then use the knowledge to complete the associated color plates. Students will then independently choose several sets of plates and manipulate them in search of combinations which will produce an illusionary effect. They will investigate the relative properties of color in order to enhance reactivity. They will use the text within the application as the primary reference as they test color relationships.

Each student will save three color studies for review. The teacher will note the owner of the student contributions, but each study will be projected anonymously during a group discussion. Class will discuss and debate which plates are most successful. They will work as a group to create a hypothesis as to the mechanisms that engender success.

Paper scraps of every kind will be hidden in "Scavenger Hunt" style in drawers and bins around the classroom. Recommended paper options include: smooth 60lb construction paper, colored cardstock, and paint sample strips. Small tokens, will be hidden around the classroom as color clues.

Students use the iPad app to sketch an Op Art design plan. They will assemble their palette, in shapes, and sizes of their choice. They will select up to three colors of paper. They may collect as many values of those three colors as they choose. The palette should evidence consideration of color theory. For example: Orange, Light Orange, Dark Orange are all one color. They may also choose an orange that has been neutralized. In addition, they may collect as many neutrals as they find. When they have collected 20 shapes, they must return to their seat. There is also a time limit.

Students will sketch a plan for an Op Art Illusion. They layout the design with paper shapes and strips. Before students begin gluing, they should have their plan approved by one teacher or three peers. Once the pieces are glued, the study should be placed on the drying rack. Students must attend to their easel and care for their materials. Once the project is complete, students will participate in a gallery walk to share their work with peers. They will write a personal reflection which identifies the type of color relationship present in their artwork.

(6 instructional hours)

Assessment: How successful was the student in correctly creating the desired optical interactions? Is there evidence of critical thinking or problem solving in his/her solution? To what extent can the student identify the cause of the interaction? Has the student correctly identified multiple color relationships? Is the illusion successful? To what extent can the student identify the color reactions at work in their design?

References:
Yale University. (n.d.). Josef Albers' interaction of color. Retrieved from https://itunes.apple.com/us/app/interaction-color-by-josef/id664296461.

7. Culminating Unit Activities

Project Five: Independent Choice

Big Ideas or Essential Questions:
- Artists use many techniques to generate optical illusions.
- Artists use measurement and precision to enhance their artwork.
- Color, line, and shape can be manipulated to produce illusionary effects.
- Geometric devices such as symmetry and tessellation can enhance optical illusion.
- Art makes us think about mathematics in new ways.

Discussion Questions:
Which artists we have studied have impacted the way you feel about art?
How can you incorporate some of their ideas and techniques into your own artwork?
What mathematic principles will guide the creation of your artwork?

Beneficial Knowledge Base:
Accumulated experience from all activities and inquiries within the unit

Practical Skills Required:
Accumulated skills from all activities and inquiries within the unit

Applied Media Skills Required:
Pen and Ink on Paper
Transparent and Opaque Paint on Acetate
Acrylic Paint on Masonite

Activity: **(Student choice from three mediums)**
***Drawing*:** Students will create an original drawing in ink utilizing knowledge of tessellations. They will experiment as a group with various polygons to determine which will tessellate. The group will devise a list of rules which govern successful tessellations. Working independently, students will use graph paper to create their own polygonal tessellation pattern. They will apply the pattern at least four times horizontally and four times vertically to establish it as a tessellation. Students may choose to add additional repetitions to fill the picture plane. Alternatively, they may choose to transform the tessellation as it moves away from the established center. To complete the work, students should utilize color relationships which service their composition.

***Sculpting*:** Students will utilize knowledge gained about rotational symmetry to create an original acetate sculpture. They will choose the angle and order of rotation. They will use a protractor to measure the desired angle and create an isosceles wedge to use as a pattern. By cutting into the wedge, students will create an original design. An important consideration will be to leave at least two inches of the two equal sides to hold the shape intact. The two inches can be left in the center of the object. If an open center is desired, students must measure from the center along the equal sides before cutting. To remain intact, the two inch area must be equidistant from the center point along both sides. When the pattern is complete, it will be traced and repeated until the combined angles add up to 360 degrees. The paper pattern will be traced onto a sheet of acetate. Students will need to cut carefully to ensure a symmetrical design. To complete the work, students should utilize color relationships which service their composition.

The remainder of the project will follow the process of the "Classroom Chihuly" lesson from Blick Art Materials.

***Painting*:** Students will utilize knowledge gained about color interaction to create an original acrylic painting. They will choose a color relationship that has proven to produce an effective illusion – or – They will devise a new color scheme by applying proven reactive principles. Students will work on Masonite board for a smooth surface. They will treat the surface with a medium grey gesso to neutralize the natural color of the wood. All colors must be mixed using only primary colors, black and white. Using precise measurement and masking techniques, they will create an original linear or geometric design. Students may choose to use a finish sander between coats to further minimize the distraction of brushed texture.

(8 instructional hours)

Summative Assessment: Students will complete an artist statement which addresses the following questions: Which artists influenced your work? What was it about their art that appealed to you? How did you apply their influence in your work? Which mathematic principles did you use to guide your process? What was the desired outcome of your art project? What aspects of this creation challenged you? How did you address those challenges? What unexpected effects or surprises did you encounter? How might you alter or change your process to enhance your success? Describe how your understanding of art has changed since the beginning of this unit.

Unit Rubric:

Presentation and Discussion Rubric

National Standards Unit Rubric

Unit References:

Albers, J. (1971). Interaction of color. New Haven: Yale University Press.

CAAN Math Teacher. (2012, July 15). 1.1 Reflection and rotation symmetry. Calgary, AB, Canada: SMART Technologies ULC.

Dick Blick Art Materials. (2005). Classroom Chihuly. Galesburg, IL. Retrieved from http://www.dickblick.com/lesson-plans/classroom-chihuly/

Gilbert Hsiao, Event Horizon, (2012). Retrieved October 2, 2016, from Gilbert Hsiao: http://gilberthsiao.com

Hauptman, L. (1997). The maximal sixties: Pop, Op, figuration from the drawing collection. Retrieved October 3, 2016, from The Museum of Modern Art: https://goo.gl/eQCJ88

Hyatt, G. (Writer), & Wiemer, R. (Director) (1965). *The responsive eye* [Television series]. In G. Hyatt (Producer), New York, NY: Columbia Broadcast System.

Josef & Anni Albers Art. (n.d.). Retrieved October 4, 2016, from The Josef & Anni Albers Foundation: http://www.albersfoundation.org/art/selected-works/

M.C. Escher Gallery. (n.d.). Retrieved October 1, 2016, from M.C. Escher: http://www.mcescher.com/gallery/

Museum of Modern Art (New York, N.Y.), & Seitz, W. C. (1965). The responsive eye. New York.

The maximal sixties: Pop, Op, and Figuration. (1997). Retrieved October 3, 2016, from The Museum of Modern Art: http://origin-www.moma.org/calendar/exhibitions/231?locale=en

Yale University. (n.d.). Josef Albers' interaction of color. Retrieved from https://itunes.apple.com/us/app/interaction-color-by-josef/id664296461.