

**A Geometry Treasure Hunt:
Uncovering Geometry in Art, Architecture, and the World Around Us**

Karen “Bert” Bertomaschi
Askew Elementary School

Education is the point at which we decide whether we love the world enough to assume responsibility for it and by the same token save it from that ruin which, except for renewal, except for the coming of the new and young, would be inevitable.

-Hannah Arendt (1968)

INTRODUCTION

Throughout my fourteen odd years of teaching, I have had the good fortune to teach an array of subjects. Each change in my assignment, I have taken as a new challenge. And challenge it was that day I accepted the position of art teacher for kindergarten through fourth grades.

I have always maintained a passion for the arts. However, with limited formal training, I have found the road to success and the feeling of confidence as an art teacher frankly woeful. Since the visual arts require both the knowledge of a particular medium (i.e. drawing, printmaking, painting, sculpting, and so on) and the ability to successfully demonstrate such, this new assignment was daunting. Because my school has a kiln, I was expected to teach ceramics. I have never taken a class in ceramics, so my approach to the medium would be difficult, something to put off.

Initially I wanted all of my students to embrace art and every project that I presented and hoped they would. Sadly, simply creating a project that a kindergarten child could produce within a forty-five minute period, and not see the product of the lesson in the wastebasket, became my only goal. I have an art textbook to follow, but I found teaching five different kinds of lessons a day unrealistic, beyond my budget of one dollar per student, and the children did not appear challenged by the work suggested in the text. As an art instructor to elementary school children, one learns that classroom management of materials as well as managing the students’ use of these materials is essential to all concerned.

Fortunately, I did not have to reinvent the wheel to become a good art teacher. As Nicolaidis states about drawing, “In the beginning the rules and their application will remain a mystery no matter what one does about it” (xiv). Perhaps the two rules that aided me the most were: 1) adapting the works and medium of artists I was familiar with, and 2) the simple method of trial and error. Are these really rules? Perhaps not, but they helped me uncover the mystery of how I could begin to be a better art teacher.

The current opportunity to learn why art and geometry relate is not only providing me with new, interesting ideas, it is also giving me a chance to create a lesson unit that has continuity. Perhaps due to the structure of the elementary school schedule, and the unreal expectation from the parents that each class period the student will create and take home a new project, I usually find ongoing lesson units impossible. However, at the onset of the unit on geometry and art, I plan on giving the parents and administrators a course outline. Since I see my students only once every seven teaching days, the unit will cover approximately one grading period (nine weeks of school or seven class periods). Pending administrative approval, a field trip to the Museum of Fine Arts will be an added lesson.

It is my hope that the lessons developed will be substantial enough to sustain the interest of my students, make a deep impact on their learning of art, and provide a nice introduction to geometry.

UNIT BACKGROUND

The title of my unit, “A Geometry Treasure Hunt: Uncovering Geometry in Art, Architecture, and the Natural World Around Us,” is a metaphor that will give the lessons a “play-like” format. Because I believe today’s students need more learning opportunities that are fun, I imagine the concept of a treasure hunt to be helpful in reeling in the interest of each student. My original teaching goals are being revised after I received a memorandum from the Title One Coordinator concerning teacher expectations for the upcoming third and fourth grade TAKS test. Lines of symmetry, the identification of geometric shapes (2-dimensional and 3-dimensional), lines, vertices, and congruent shapes will be included in the unit, as per her memorandum (personal communication). Additionally, I will include geometric concepts such as tiling, grids, patterns, some art history, relevant artists, and projects involving several art mediums. Since teachers are encouraged to teach all subjects, regardless of one’s specialty, I expect to integrate into the unit: history, language arts, and geography.

As Lasky and Mukerji state, “. . . learning and development occur naturally in young children, they will not occur automatically without conscious contributions from adults” (Danko-Mcgee and Slutsky 12). My initial idea for presenting this unit to my students is to pilot it to my fourth-grade Sights class – a class for the gifted and talented. Since the students from my Sights class are brighter, more motivated, and quite honestly come to class lacking the behavior problems of my traditional classes, I anticipate a lively experience for both my students and myself.

My present school serves students from kindergarten through 4th grade. There are gifted and talented classes, a behavioral adaptation class, an autistic class, traditional, bilingual, and ESL classes on each grade level. The approach of first piloting this unit to a Sights class will give me an opportunity to practice and fine-tune the unit lessons so that I may later reduce and modify them for my younger students, special needs students, and lower achieving classes.

A School Treasure Hunt

For the first lesson, I plan on presenting the students with a series of treasure hunt challenges. This approach will give the students a real-life connection to such abstract ideas as angle, corner, vertices, edge, and symmetry. Contemporary Mathematics educator Marilyn Burns emphatically states: “Real world contexts can give students access to otherwise abstract mathematical ideas” (17). The real-life treasure hunt will begin on the school grounds. For this initial activity, the students will be grouped. Grouping students provides time for communicating with each other and thus an opportunity to hear other points of view (Burns 15). After an introduction to the geometry vocabulary appropriate to this unit, each group will receive a list of geometric entities to hunt for. As an example, I will have the students go outside their classroom to view and touch the corner of a staircase. One group will visit the office and request an ice cube so that they can observe the vertices. As the students learn, they also begin to utilize their five senses. This is an added incentive to learning. The author Kimon Nicolaidis instructs teachers of art that, “The first function of an art student is to observe, to study nature” (5). Furthermore, he believes students need opportunities to observe in a way that uses as many of the five senses as one can possibly use at a given time.

Since much of a child’s school day is spent indoors, within the confines of a classroom, going outdoors presents a unique situation: discovery, learning outside the box of the classroom, seeing, touching, smelling, and listening to nature. This lesson will borrow and sharpen the skills that are utilized within the science curriculum. The students will observe and pick up their “treasures,” and these objects will become a type of manipulative. Furthermore, Burns encourages her teachers to not just reserve the use of manipulatives for early learners; older students should also use them (18). Since the students will work in groups, they will have the opportunity to discuss the purpose of their task, their process, and the logic behind their work. The interaction that the group provides versus having the student work silently and alone provides feedback for thinking and a way to clarify their ideas (Burns 18). This approach—the binding of the lesson to an actual situation—uncovers abstract concepts of geometry and one hopes, creates a rich and interesting learning opportunity. David Hawkins invites teachers to uncover their subjects’ contents in a deep and meaningful way (Burns 18). All too often, the pressures placed on teachers require us to “cover” volumes of material in a relatively short time frame. However, when one takes the time to present topics that interest children and present opportunities for learning, to travel in different directions, the student, not the teacher, pushes the curriculum.

Uncovering Geometry at Home

The next lesson will involve a treasure hunt in the students’ own homes. In this homework assignment, the student will be equipped with a 35mm camera to record evidence of geometric figurations within their home environment (tiles, decorative rugs, patterns, windows, car wheels, geometric shapes, etc.). At this point symmetry will be

reviewed and the students will be encouraged to take portraits of family members for use in a grid portrait lesson. Using the medium of photography, the lesson will comply with the Texas Essential Knowledge and Skills objective that requires fourth -grade students to “explore photographic imagery” (TEKS).

As the unit continues to unfold, the students will be introduced to: nonobjective art, the artists Piet Mondrian and Chuck Close, architecture, art from the Middle East, drawing through perspective, and a project that involves designing tiles for a walkway for our school’s Spark Park.

WHY GEOMETRY THROUGH ART

For numerous students, drawing, as well as math, can be frustrating. In providing students with terminology that relates to both subjects, perhaps the objectives are more likely to be comprehended and the insecurities that children tend to hold, reduced. Because art in elementary school is not a choice, invigorating student interest is a large challenge of each lesson taught. The art of the Dutch painter Piet Mondrian exemplifies the use of plane geometry in an exciting and simple manner. His paintings contain squares and rectangles, bold horizontal and vertical lines, and color, specifically, primary colors, all within a two-dimensional plane. Are these complex ideas for fourth-grade students to grasp? Possibly. However, when presenting art projects, I believe the success of the lesson depends on how the student himself can recreate the stated idea. Mondrian’s work is easy to copy. By selecting his style, my hope is to instill individual pride, respect, and a sense of accomplishment in the students’ products. Success in one’s work just might give the student an impetus to enjoy art class and look forward to new challenges. (There will be a lesson plan on Mondrian.)

On a personal level, my own successes as an adult art student have been the projects that not only were praised by my teachers, but also the ones that gave me the most satisfaction. Being a creative individual involves a certain amount of ego building and ego stroking. As I’m fond of saying to my students, “There are no mistakes in art, all art is good.” By definition, I’m saying, at this early stage in one’s art development, one has to practice and in the process of practice, we all make mistakes. However, “mistakes” are not really mistakes at this point. It is the process that counts and the product is “good” to the point that the budding ego needs to take away the praise and idea that one’s work is indeed good. I was encouraged to find that, in a letter to a friend, Mondrian stated what I had already thought, that, “all art is good” (Bois, et al. 29). Perhaps he was not referring to the art of a ten-year-old, but then how could we question his statement in today’s so thoroughly permissive art world?

In Praise of Mondrian

Mondrian’s work is easily duplicated. This lesson provides the student with a process in which the learning of simple terminology (horizontal, vertical, square, rectangle, parallel)

takes on a visual meaning in a piece of art. By using drawing across the curriculum, one increases the student's capacity for learning and sustains his or her motivation (Brooks 230). Here again we see the value of student motivation. After looking at Modrian, the students are required to stand in rows or grids, the introduction to the terms horizontal, vertical, and parallel are acted out with arms and hands. The concept of grid also becomes three-dimensional. The students' prior knowledge of these terms was limited to black and white renderings (as seen on paper), and perhaps a drawing or sketch on the blackboard. And on a third-or fourth-grade level, prior knowledge was assumed. During a lesson that uses the term horizontal, and in my art classes the term crops up frequently, I hint at the meaning by making an association with horizon. Oftentimes, this makes an association to prior learning. Recently, when I questioned my class on the term horizon, a student eagerly replied, "That's a phone." -Verizon Wireless. Sort of mixed-up learning!

Mondrian's work contains straight lines and angles. The students will be exposed to measuring, and the use of rulers and protractors: further evidence of how this unit strives to use prior learning and intertwine new learning though numerous subjects.

In addition to discovering a new way of seeing these terms, the Mondrian lesson also involves the use of primary colors. As teachers, we tend to reserve the use of primary colors for our kindergarten students, after which we put them back into the coloring box and move on to blends, compliments, and value. Because Mondrian's use of this primary color composition came with his later works, he reverted back to his prior knowledge, and with this act more or less gave us permission to take the colors out of the box and use them again.

The process of the Mondrian lesson may sound simplistic; however, I believe teaching requires the instructor to routinely review. For example, the terms horizontal and parallel are most likely taught either in a basic mathematics class or from a list of sight words. I tend to introduce and review these terms at the beginning of the school year. For example, I routinely ask the students to place their paper vertically when drawing a self-portrait. In my experience, the majority of students, regardless of level, do not comprehend that prompt. Despite the fact that we've gone over these terms, it appears that their comprehension of these words relies on constant review. Granted, the present schedule has the students coming to art only once every seven teaching days. Lack of interest, short attention spans, among other things, somehow seem to get in the way of the transfer of pure knowledge. When teaching terminology, I generally revert to another subject by which the word may have been learned. I then proceed to teach the word in the context of the art lesson. At the conclusion of each lesson, we review what the lesson was about, and how the new or reviewed vocabulary related to the lesson.

From the beginning stages of a child's development, his exposure to color and shape (two-dimensional and three-dimensional) is primarily through play toys. By the time the child is ten years old and with participation in a proper school art program, his bank of

knowledge in the arts should be rich and extensive. We see geometry in art, architecture, interior design, and craft arts (carpets). These arts appear to be a natural way to enhance prior learning and expand learning into new areas. A study of Mondrian will be the foundation from which to build other concepts of the unit “A Geometry Treasure Hunt: Uncovering Geometry in Art, Architecture, and the World Around Us,” and how it involves a close awareness of geometry.

HOW TO TEACH GEOMETRY TO AN ARTIST

The contemporary artist Chuck Close gives new meaning to portraits by executing them on a grid. His work is considered “Superrealism.” He begins by projecting images, portraits, onto a grid-patterned canvas. The paint is airbrushed in, one square at a time. Oftentimes, these paintings require months of work.

THE GRID IN ART

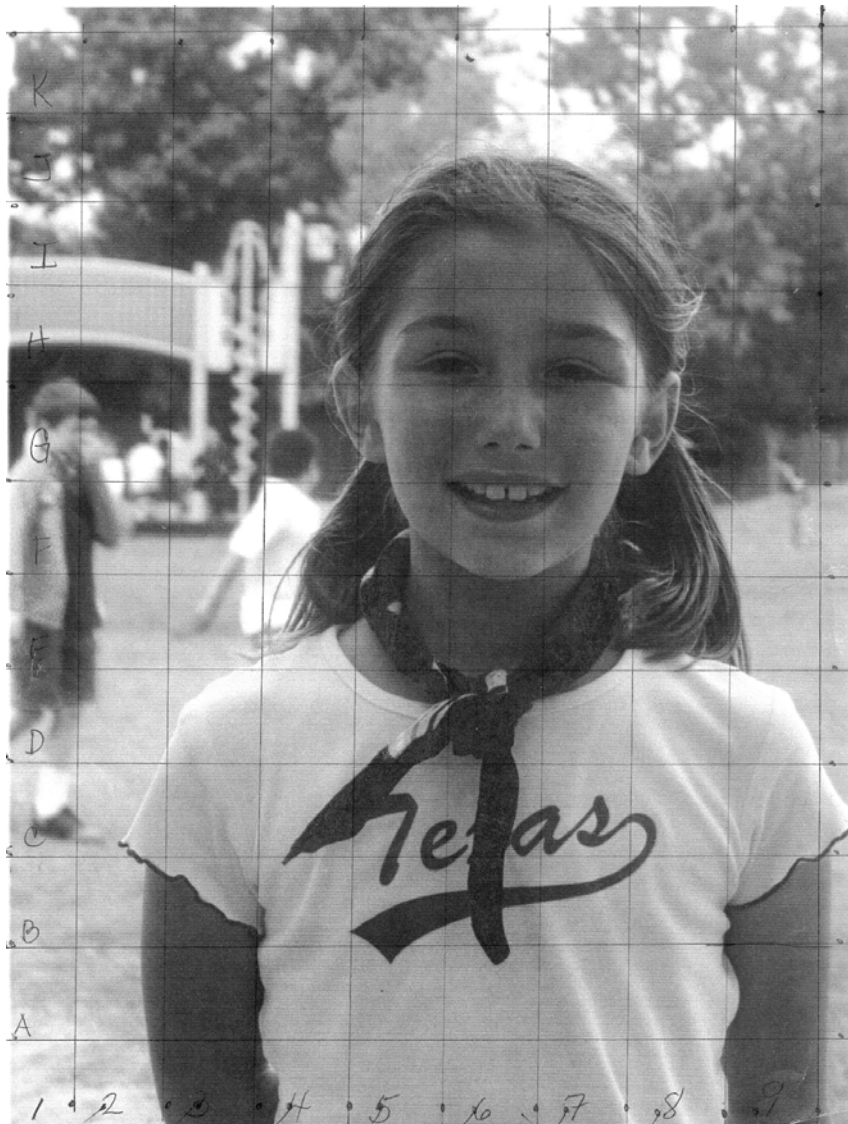
At this point, one must pose the question; why is the grid significant to math/geometry and how do we make it relate to art? A grid is nothing more than a network of horizontal and perpendicular lines. For example, a map is based on a network of lines that one utilizes to locate a destination or a point. Architecture appears to utilize the grid earlier in history than, for example, painting. A grid of windows, a building façade of bricks, interior ceiling panels: all evoke horizontal and perpendicular lines.

Within the visual arts, historic evidence of the grid is found in a technique used in mapping out large murals. Specific to the mid first century (Pompeii) and found later with more frequency in the thirteenth century and sixteenth century in Italy, the buon fresco utilizes the application of pigment to a wet surface, plaster wall. The artist composes a preliminary drawing or cartoon on paper, drawn to scale. The drawing is transferred to the wall after a grid system is drawn on both the cartoon and the wall or ceiling. In order to ensure the even transfer of the image, the horizontal and vertical lines are registered.

CLOSE TO THE GRID

At the onset of this unit, each student will be given a 35mm camera to take home. Each will learn geometric terminology and record lines of symmetry through family portraits. Specific to this lesson, bilateral or mirror symmetry is shown when an object—the portrait—can be divided into two halves, each the mirror image of the other. Prior to this lesson, (lesson plan two) the students will be instructed to take several close-up, frontal photographs of their subject’s face. The students will see the work of Chuck Close and then they will generate their own portrait of a family member using Close’s method of grids and abstract symbols. In this process, the new image will evolve into a painting on paper by which solid colors, rings of color, or colored symbols occupy each square on the grid. Although the final portrait will be representational, the viewer can change the

image simply by moving further from or closer to the piece. In a minimal way, the piece takes on the role of an optical illusion. Additionally, these portraits present an opportunity for the introduction to abstract art: distorted perspective and proportion, objects and people removed from reality (English Language Arts Model Lessons, Project CLEAR).



The use of the grid will expose the students to a form of art that is unique to the 20th century. The grid evolved in art in the 20th century as a result of a movement in which artists repeatedly broke art rules. This had come before. For example, Jackson Pollock, Clifford Still, and Mark Rothko all reached beyond the establishment to mark their fingerprints in a way that had profound implications for the future of art. Unlike perspective, which organizes a landscape, a cluster of people, or an interior of a room, the

grid is motionless and nothing within it changes place (Krause 10). A grid can be as cold and intimidating as a blank canvas. The grid lesson has the added benefit of being in compliance with the TEKS objective, which states: “The student is expected to integrate a variety of ideas about self, life events, family and community in original artworks” (TEKS Art).

ARCHITECTURE AND DESIGN

Building a three-dimensional project for the study of architecture may be beyond the boundaries of the architectural lesson. Two resources will be explored instead. Through the use of the CD-ROM titled “Fun with Architecture,” and the video “The Mathematics of Architecture: Building By Numbers,” the students will be introduced to yet another art form that utilizes geometry concepts. The two resources move from the historical aspects of architecture and its use of geometry in building design to a hands-on experience using a computer program to design buildings. The students will get some idea of how the program works.

GEOMETRY IN MIDDLE EASTERN ART

A little less than three years ago, most Americans were not overly knowledgeable about Middle Eastern cultures. Fortunately, Houston is a city that has diversity within its population. Restaurants, retail establishments, and houses of worship, all with Middle Eastern roots are in evidence throughout the city. Even Jack In The Box, a major fast food restaurant, serves Middle Eastern fare (pita bread). However, since the events of September 11, 2001, there is a need for the uninformed to have opportunities to learn the specifics of these vital cultures and their presence in the American landscape.

Mehndi is a widely used art form in both Middle Eastern and North African cultures. The process uses henna, a natural dye, to paint symbols on various body parts of women and young girls. These intricate designs serve to commemorate rights of passage as well as good fortune. Hands, forearms, palms, feet, and legs are decorated with designs, oftentimes with repeating patterns from nature. In terms of geometry, this lesson will include, but not be limited to, simple repeating patterns, reflective symmetry, measuring, lines, and rotational symmetry. Rather than paint the symbols on flesh, the students will create the images initially in a sketchbook, transfer them to tracing paper, then to cardstock paper. The design will then be traced in pen and ink.

CONCLUSION

This seminar has opened the world of geometry to me and how I, as an educator and artist, can incorporate some of the vastness of this discipline into my teaching practice. In the process of learning the language of geometry and how it dovetails into art, I feel the possibilities for enriching my students’ knowledge is not only limitless but a daunting task. Participating in this type of continuing education has enlightened me as to the

volume of information we educators are expected to know and bring to our students. My purpose in the unit described in this paper is to provide my future students with a thought-provoking look into the world of geometry and how it exists in the world around us.

LESSON PLANS

Lesson Plan 1: Photography—A Hunt At Home

The lesson, which opens the unit, will be introduced with a scavenger hunt, initially on the school campus. For homework, the hunt will continue in the home of the child.

Objectives

The students will locate items in their home that show lines of symmetry, geometric shapes (two dimensional and three dimensional), lines, and edges.

The students will use a camera to identify the items outlined above. (TEKS 113.4).

Materials Needed

Twelve disposable cameras.

A list of objects to look for

A list of terms

A questionnaire for each object

Cardboard frames of various sizes

Procedure

We will begin by discussing the vocabulary words: symmetry, two dimensional and three dimensional objects, lines, edges, and vertices. It will show examples of these within the classroom. We will also review the concepts of photography. Each student will be given a cardboard frame. With these, they will have an opportunity to “frame” various objects and people. This will give them an idea of how the camera works and how the viewer has the opportunity to capture what eventually is in the frame of a photograph. Working in groups, the class will then receive a list of objects to hunt for around the campus (i.e. ask for an ice cube from the office staff—to be used for evidence of vertices), a fact sheet to be completed on each object, and a camera.

As each group gathers and records information, a photograph of each specified object is taken as evidence. As practice for their homework assignment, each student will have an opportunity to take several pictures. Once the film is developed, the students will make a poster that will display their group photographs. Additionally, they will label each photograph. In preparation for the following lesson, each student will take several close-up, frontal photographs of family members (to show symmetry).

Lesson Plan 2: A Portrait on the Grid, A Little Chuck Close

Objectives

The students will use a grid to transform a photograph into a drawing using a photograph of a family member (TKES 113.4). The students will study the art of a famous artist (TKES). The students will use various art mediums (TKES). The students will understand the similarities and differences that exist among families (TKES).

Materials Needed

Portrait photographs taken by the students
12" x 24" paper
Rulers
Pencils and erasers
Oil pastels

Procedure

The students will use a close up photograph of a family member that they made as part of a homework assignment. We will begin by briefly discussing the art of the contemporary artist Chuck Close. Close has been working as a photographer and painter for more than forty years. His unique style relies on portraiture that he paints or prints onto a surface of square grids. In this style, he invents symbols to represent color, shading, and value. Each sheet of paper will be lined out in one inch squares using a ruler and pencil. The horizontal lines will be lettered and the vertical lines will be numbered. The original photograph will have been photocopied in color and enlarged. This photograph will also have lines drawn and labeled with numbers and letters. Next, the students will recreate their portrait by replacing the solid colors with symbols drawn with oil pastels. Each square on the grid will have a symbol or other colored representation that simulates the original photograph.

Lesson Plan 3: Architecture

Objectives

The students will experience realism in styles of illustration (Project CLEAR Model Lessons English Language Arts Grade 4). The students will demonstrate an understanding of art history and culture as records of human achievement (TEKS-Art).

Materials

“Mathematics of Architecture” video
“Fun With Architecture” CD-ROM
Computer Lab

Procedure

After viewing the video “Mathematics of Architecture,” the students will work with the CD-ROM, “Fun With Architecture.” This program gives the students the experience of

building a variety of projects. The program is easy and exciting. After their building experience, they will print the projects on the color printer.

Lesson Plan 4: Art from the Middle East

Objectives

By analyzing artistic styles and historical periods, students will develop respect for the traditions and contributions of diverse cultures. The students will learn how to balance positive and negative space. The students will use rotational and reflective symmetry, patterns and line. The students will gain a better understanding of a Middle Eastern art form.

Materials

Tracing paper
Construction paper
Pencils and erasers
Pens and ink

Procedure

After giving the students a visual introduction to geometric figures and styles found in art from the Middle East, the students will sketch their ideas for a Mehndi design. The design requires at least one central figure (organic, original, geometric) and a border. The border will consist of a repeat pattern. From the final sketch, the students will transfer the design onto tracing paper and then onto construction paper. The designs will be drawn in with pen and ink technique.

Lesson Plan 5: How Many Ways Can You Mondrian?

Objectives

By viewing examples from the book *Piet Mondrian*, the students will be introduced to a style of abstract art. The students will review the words parallel, horizontal, vertical, square, rectangle, and line. The students will use a ruler to draw the shapes and lines so that their shapes have right angles. The students will demonstrate an understanding of a complete body of work from figurative to abstract art as shown in the work of Piet Mondrian. The students will experiment with various media in the process of imitating the geometric patterns that appear in the work of Piet Mondrian.

Materials

“Piet Mondrian,” catalogue from the exhibition at the Museum of Modern Art
Rulers
12” x 12” paper
12” x 12” cotton squares
Glue
Construction paper

Felt squares in primary colors
Tempera paint in primary colors

Procedure

To begin the lesson, the students will study works from the retrospective exhibition catalogue of the work of Dutch artist Piet Mondrian. The work provides the viewer with a historic look that spans from representational art to romanticism to abstraction. Toward the middle of his life, Mondrian began to work with grids and primary colors to create abstract work. The students will be given three sets of supplies from which to create or imitate a Mondrian abstract piece of art. Felt and cotton will be one combination; colored paper will be the second; paper and tempera paint or paper and black construction paper will be the third.

To review the terms horizontal, vertical, and parallel, the class will stand in lines. With arms straight above their heads, they will review the term vertical. With arms parallel to the floor, they will see the term horizontal. From this starting point, the students will create their own Mondrian works that reflect his style of using only squares, rectangles, lines, primary colors, and the colors black and white.

Lesson Plan 6: Follow the Spark Park Path

Objective

The students will design a walkway for the school's Spark Park. By viewing ceramic tile patterns from various periods in time and various cultures, the students will develop an understanding of the traditions in tiling.

Materials

Graph paper
Tape measures
Rulers
Pencils
Colored pencils

Procedure

The class will view various examples of floor patterns as used by artists in Renaissance Italy, Spain, The Czech Republic, Turkey, and Houston, Texas. After this introduction, the class will measure the sidewalk that enters the existing Spark Park. At present, the sidewalk is a simple concrete walkway. Working in groups of five, the students will plan their project based on the use of terracotta square pavers, rectangular bricks, and triangles.

ANNOTATED BIBLIOGRAPHY

Works Cited

- Bois, Yve-Alain, Hans Janssen, Joop Joosten, and Angelica Zander Rudenstine. *Piet Mondrain*. New York: Leonardo Arte, 1994.
Museum catalogue containing 200 illustrations; traces the artist Piet Mondrian's entire career.
- Brooks, Mona. *Drawing With Children*. New York: Putnam's Sons, 1996.
Provides instruction in teaching all levels of drawing and creating the proper environment for nurturing creativity.
- Burns, Marilyn. "10 BIG MATH IDEAS." *Scholastic Instructor* 113 (2003): 16-19.
Article updating teaching strategies for mathematics.
- Danko-Mcgee, Katherina, and Ruslan Slutsky. "Preparing Early Childhood Teachers To use Art in the Classroom." *Art Education* 54 (2003): 12-18.
Article on the importance of Art in Early Childhood based on the Reggio Emilia (Italy) program.
- "Texas Administrative Code 117." *Texas Essential Knowledge and Skills*. Austin: TEA, 1997.
Guidelines for public school teachers as applied to all subjects.
- Krauss, Rosalind. "Grids." *October* 9 (1979): 8-22.
Devoted to the history of the grid as it began to surface in painting at the onset of the twentieth century.
- Nicolaides, Kimon. *The Natural Way To Draw*. Boston: Houghton Mifflin, 1941.
Provides a working plan for the study of drawing, based on the author's theory that drawing is as natural as the impulse to talk.
- Ridgeway, Chandria. "Memorandum to the author." Askew Elementary School, Houston. 10 Dec. 2003.
Memorandum from the Chapter One Coordinator regarding TAKS.

Supplemental Resources

Teacher Resources

- Adler, David A. *Shape Up! Fun With Triangles and Other Polygons*. New York: Holiday House, 1998.
The world of polygons through the eyes of a child.

- Brockhampton Reference Dictionary of Art*. London: Brockhampton Press, 1995.
Concise definitions of terms and artists.
- Clevenot, Dominique. *Ornament and Decoration in Islamic Architecture*. New York: Thames & Hudson, 2000.
Contains spectacular images of pattern and design used in Islamic Architecture.
- “Fun With Architecture.” *Princeton: Films for the Humanities and Sciences*. CD-ROM. Princeton, 1997.
This program features shapes, textures, and colors to create an unlimited variety of buildings.
- Geehan, Wayne, and Cindy Neuschwander. *Sir Cumference and the First Round Table: A Math Adventure*. Watertown: Charlesbridge, 1997.
Children’s book explaining geometry terms.
- Gleb, Michael J. *How to Think Like Leonardo da Vinci*. New York: Delacorte Press, 1998.
Designed to assist one with the discovery of ones full potential.
- Hillenbrand, Robert. *Islamic Art and Architecture*. London: Thames and Hudson, 1999.
Traces the range of art forms including architecture, painting, ceramics, and textiles as they appear in the Islamic culture.
- Mathematics of Architecture: Building by Numbers*. Videocassette. New York: The Metropolitan Museum of Art, 1997.
Math and architecture meet as architects discuss their work.
- Smith, Ray. *The Artist’s Handbook*. New York: Alfred A Knopf, 2002.
The definitive guide to all the tools and techniques of the visual arts.
- Stierlin, Henri. *Islam From Baghdad to Cordoba*. Koln: Taschen, 2002.
A survey of more than six hundred years of Islamic architecture.
- Vance, Peggy, and Celia Goodrick-Clarke. *The Mosaic Book, Ideas, Projects and Techniques*. London: Conran Octopus Limited, 1994.
A practical guide to the art of mosaic, with step-by-step pictures and illustrations.