**Color Harmonies and Algebra Tiles** **Instructor Sheet** C. Wilson

## INTRODUCTION

This is primarily a design project that focuses on composition, color harmonies and geometric shapes. The geometric shapes (squares and rectangles) are actually also cleverly disguised (!) Algebra Tiles. This allows us at the conclusion of the project and critique to translate student designs into math expressions. The math needed for this project is Elementary Algebra.

Algebra tiles appeal to me because they can be very helpful to people who have difficulty with algebra. I never did particularly well in Algebra and I just figured I couldn't do it. Variables didn't make sense to me. I wanted them to have a specific value that didn't change. Sounds silly, I guess, but x and y or a, b, and c didn't mean anything to me. I didn't understand what to do with them. THEN I discovered Algebra Tiles! Even though they still represented variables the shapes were concrete, I could touch them, move them around, color them! And something clicked in my brain. I hope that this activity will help algebra "click" for some of your students!

**Contents:**

**INSTRUCTOR OVERVIEW**

To introduce this lesson I discuss the two basic shape types (organic and geometric) with the students. Because this project focuses on geometric shapes I show them slides of Theo van Doesburg (especially his COMPOSITION (THE COW) c. 1917 oil on canvas) and Piet Mondrian's work (check out his COMPOSITION WITH RED, BLUE, AND YELLOW, 1930 and BROADWAY BOOGIE-WOOGIE, 1942-43), Kasimir Malevich's Suprematist paintings and maybe some of Louise Nevelson's "wall" assemblage pieces, and discuss the use of geometric shapes in them. Piet Mondrian was a 20th century Dutch painter whose mature work utilized squares and rectangles in primary colors. His studio walls were white and he used to arrange his squares and rectangles of red, yellow and blue on the wall until he came up with an arrangement (composition) that he liked. Then he would paint it. "For Mondrian, the universal elements were straight lines, the three primary colors, and rectangular shapes. He reduced painting to four elements: line, shape, color and space." (*From **Prebles' Artforms*** by Patrick Frank). We also look at the principle of balance and discuss symmetry and asymmetry. Most people like symmetry, but if it is perfect symmetry a design can seem somewhat boring or repetitive like a pattern. Asymmetry can seem very exciting and full of movement in contrast.

I go through the Color Wheel handout and the Color Harmonies handouts in class and try to find examples of all the color harmonies in well-known artworks. If you don't have access to images showing the various color schemes just have the students color in their large Color Wheel and an example of each harmony shown on the handout.

Some students may prefer to leave their shapes white/uncolored while working out the designs and then use color pencils on their sketches to see which color scheme they wish to use. However, most students will be better served to choose their colors first because color intensity and value (darkness or lightness of a surface) will affect their designs.

I had left it open to students whether their final composition was symmetrical or asymmetrical, but now think it would be a good idea for them to at least have to sketch out 10 compositions that are symmetrical and 10 that are asymmetrical so they will consciously work with both types of balance. You must insist that your students do all 20 sketches because *they'll* insist that they have the perfect design after doing 5 (which is rarely the case!).

As students are working I will walk around the room and discuss designs with them one on one and suggest changes they might make. I also encourage them to get up and take a look at what the others in the room are doing. I would say that presenting the assignment, discussing the color wheel and color harmonies could take an hour. The drawing/designing, coloring the pieces and attaching them to the board would take another 2 hours.

The purpose of the critique is to get everyone thinking about the successful parts of the designs and to be able to articulate them - to use art/design vocabulary and to elicit suggestions for improving the work.

*What color scheme did Patty use in her design?* Primary triad. *Why do you think that she used that color scheme?* Because the colors look very intense. Because the colors really contrast with each other. Because they are the most basic colors.

*Where do your eyes go first in Kevin's design?* Mine go right to the middle. *Why?* Because both of

his big squares are in the middle. Because he painted his big squares yellow and they are the lightest and brightest colors in his design. *Where else do you look in Kevin's design?* I'm stuck in the middle. The yellow is so bright that it is hard to look anywhere else. It's kind of like a target. *How could Kevin make it easier for you to look at the other parts of his composition?* Maybe separate the big squares more. Paint one big square yellow and the other square blue-violet. (Kevin's color scheme is split-complement: yellow, blue-violet and red-violet.) He could paint some of his little squares yellow, and maybe one of them could be in a corner. The length of the critiques can vary a lot. If you have a talkative group of students who are comfortable with each other you can easily spend an hour discussing the designs,

When the class has finished discussing the design aspects/elements of their pieces you can then tell them that the shapes they have been using can also be used to do algebra problems.
One website for algebra tiles suggests letting *students* assign names or designations for the shapes. The little squares can be called ones, littles, units, etc., the rectangles are usually called rectangles or maybe longs and the large square can be call Large Squares or Big Squares, LS or BS(or maybe not!). The symbols used can be u - for units, or just show them equalling one (1), the rectangles can be shown as r or x or L and the big squares as r2 or x2 or L2, because a long is the same length as a side of the large squares.

Now the students can apply these symbols to their designs. A design with 2 large squares, 8 rectangles and 5 units can be expressed as: $2x^2 + 8x + 5$. I usually have each student tell the class what their design's math expression is, or you could throw it open to the whole class so no one feels pressured. After all the designs have been mathematically translated, have each student go back to their 15 drawings and write the appropriate math expression for each one. Young students would probably enjoy doing all of them even if they used the same number of shapes in several of the designs. Older students could just write out the expressions for the designs that have different numbers of shapes.

**Color Harmonies and Algebra Tiles** **Instructor Sheet**

***Selected Project Terms:***

***Design:*** *To choose and arrange elements in such a way that they satisfy an artistic and/or functional intention*

***Geometric Shape:*** *A shape created according to mathematical laws, such as a square, triangle, etc.*

***Symmetrical Balance:*** *Formal placement of identical figures on either side of an imaginary central line; also called "formal balance."*

***Asymmetrical Balance:*** *The use of figures of different visual weights to create an overall impression of balance; sometimes called "informal balance."*

**Objectives:** To gain experience in the organization of shapes the use of space.
To design using exclusively geometric shapes.
To experiment with color harmonies.

**Materials:** 10" x 13" cold press board (or mat board) All-purpose paper (or sketchbooks)
2B pencil, colored pencils Acrylic paints, brushes
Ruler, masking tape
Geometric shapes packet (contains 4 large squares-4"x 4", 8 rectangles-4"x 1" and 12 small squares-1"x 1") *

**Procedure:** After discussing Color Theory and looking at various color schemes ask each student to select a specific (3) three-color harmony and color the 3 different geometric shapes from their packet. (*See color harmony handout) If you chose a Primary Triad Color Scheme the large squares could be colored blue, the rectangles red and the small squares yellow.
Students are welcome to use a (4) four-color harmony. Four colors would definitely add more variables to the math component of the project or the fourth color could be used for the board/background.

Acrylic paints are great for getting strong, bright color and would be preferred if you are set up for painting. It is more difficult to get intense color with colored pencils, but they work well for less money and might be preferred if you don't have sinks, paints and don't have time for preparation and cleanup.

After coloring all of the shapes in the packet have the students experiment with their colored shapes to make many different arrangements of the shapes on their 10 x 13 board. It is important to work with the 10 x 13 board so that the format for the shapes is consistent and the shapes are contained within the borders of the board. *The size of the board can certainly be changed larger or smaller, especially if the algebra tiles used are smaller.*
Each time the student arranges a good or interesting design they should make a sketch of it on their drawing paper (their preliminary sketches). Each student must have a ***minimum*** of 15 preliminary composition sketches. The preliminary sketches are considered part of the project and must be turned in. After sketching out 15 – 20 compositions, select the best one, lay your geometric shapes out on your board and glue the shapes to the board. *If you want the designs to be temporary and/or you wish to use the tiles again simply attach them with a sausage like roll or two of masking tape on the back of each piece.*

Let the students know that they may use ALL of the shapes in their packet if they wish, but fewer shapes may be easier to organize. *Again, your packets could certainly contain a different number of shapes.* **They must use a minimum of 2 large squares, 4 rectangles and 6 small squares, *or their equivalent***. For example, they could trade a large square for 4 of the rectangles.

* There are several websites that feature Algebra Tiles and they have "pattern" sheets with the three algebra tiles shapes ready to print out and cut apart. I made my algebra tiles from mat board according to the sizes listed above. The mat board is sturdier than card stock or regular paper and stands up to coloring and repeated use better.

There are commercially made Algebra Tiles out there in several different colors, but I wouldn't want to paint those.

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These are questions that the student should consider as they work. When their piece is completed they should assess their design prior to all the pieces being hung on the wall so that the class can critique the project. These questions are about the concrete aspects of the composition and it is helpful to ask them to refer to their responses on this sheet to get the critique started.

When all students have completed their boards, have them hang them on the wall and discuss the variety of compositions, the different color schemes that have been used, which compositions are more active or energetic, which appear "quieter" or perhaps static, and why they think that is, point out which compositions use symmetry and which use asymmetry, overall success of the compositions, etc.

**Things to consider while you work on your composition:**

1. Have you tried both vertical and horizontal designs?

2. What is different in a vertical composition compared to a horizontal composition?

3. Which do you prefer?

4. What sort of balance does your composition use?

5. How have you directed the viewer's eye through your composition?

6. How have you used line, color, contrast, etc.?

7. How have you distributed color throughout the composition? Try not to group too many like colors together or clump like shapes together.

8. Do you have the minimum number of shapes in your composition?

**Color Harmonies and Algebra Tiles** **Instructor Sheet** C. Wilson

After the class has responded to the design aspects of their geometric compositions, tell them that the shapes they have been working with are Algebra Tiles. Explain to them that there are values that can be assigned to the shapes, usually so that the small squares can be called units (equal to 1), the rectangles could be called r (for rectangle) or x, and that the large squares could be called s (for square) or $x^2$ (since each side of the square is the same as the length of the rectangles which are x).

Once it has been decided what name will represent each shape, ask them if they can *translate* their design into a math expression. Usually I'll do the first one (probably on a design that I did) then ask each student to tell us what the math expression for their design is. See the example below. Sometimes several students will end up with the same expression which shows that it doesn't matter how the shapes are organized as long as the numbers of the shapes are the same.

**Example of translating a design to an algebraic expression:**
(2 large squares, 5 rectangles and 8 units would be $2x^2 + 5x + 8$)

Prior to a math colleague coming to one of our critiques I had more or less ignored the distribution of colors amongst the shapes. However, my colleague pointed out that some of the compositions used 2 or even 3 different colors for the same pieces, and that the colors could be represented algebraically as well. One example was a design using red, blue and yellow and it had blue and red large squares, 3 red, 2 yellow and 5 blue rectangles and 6 red small squares which was translated into $R(\text{red})^2 + B(\text{blue})^2 + 3r + 2y + 5b + 6$ (which would have been $2x^2 + 10x + 6$ without splitting into different colors).

Several students asked if color could be used to indicate positive and negative numbers and if they could subdivide the compositions into positive and negative areas. You could explore this idea with your students by assigning certain colors negative or positive values, and then have them re-translate their design into a new algebraic expression.

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After coloring all of the shapes in the packet, experiment with your colored shapes to make many different arrangements of the shapes on your 10 x 13 board. It is important to work with the 10 x 13 board so that the format for the shapes is consistent and the shapes are contained within the borders of the board. Each time you make a design that you like, you should make a sketch of it on your drawing paper (these are your preliminary sketches).

Each student must have a ***minimum*** of 15 preliminary composition sketches. The preliminary sketches are considered part of the project and must be turned in. After sketching out 15 – 20 compositions, select the best one, lay your geometric shapes out on your board and glue the shapes to the board.

You may use ALL of the shapes in your packet if you wish, but fewer shapes may be easier to organize. **You must use a minimum of 2 large squares, 4 rectangles and 6 small squares, *or their equivalent*.** For example, you could trade a large square for 4 of the rectangles.

Below are questions that you should consider as you create your design. When your piece is completed you should assess your design prior to all the pieces being hung on the wall so that the class can critique the project. These questions are about the concrete aspects of the composition, and we will be referring to your responses on this sheet to get the critique started.

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2. What is different in a vertical composition compared to a horizontal composition?

3. Which do you prefer?

4. What sort of balance does your composition use?

5. How have you directed the viewer's eye through your composition? What shapes do you look at first and why?

6. How have you used line, color, contrast, etc.?

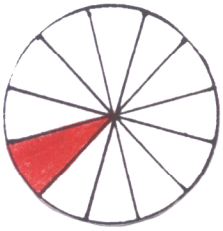
7. How have you distributed color throughout the composition? Try not to group too many like colors together or clump like shapes together.

8. Do you have the minimum number of shapes in your composition?

COLOR SCHEMES

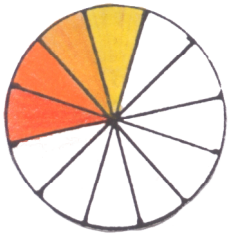
**Harmonious Color Schemes:**

1. **Monochromatic:** A monochromatic color scheme is built on one hue and the variations of that hue made by mixing it with white (to create tints), with black (to create shades) and gray (to create tones).



Ex. Red (pure hue) with pink (tint) and maroon (shade).

2. **Analogous:** The analogous color scheme is made of hues next t each other on the color wheel. Three of four steps in either direction from a given hue work best. All the colors in an analogous scheme should share a *common hue*.

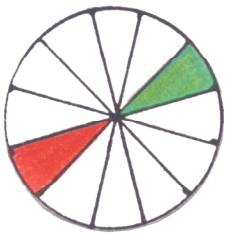


Ex. Yellow, yellow-orange, orange and red-orange. The common hue is yellow, it is found in all the colors listed. A three steps example would be red-violet, red and red-orange. The common hue is red.

**Contrasting Color Schemes:**

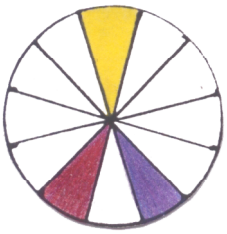
In strongly contrasting color schemes, colors are far enough apart so that they do not have a hue in common. Color Triads and Direct Complements are good examples of this. Split-Complements, Double Complements and Tetrads are also contrasting, but the amount of contrast varies. The colors used in Direct Complements, Triads are equidistant from each other on the color wheel.

3. **Direct Complements:** Colors opposite from each other on the color wheel. In their pure form direct complements placed side by side appear to intensify, but when mixed together they neutralize each other.



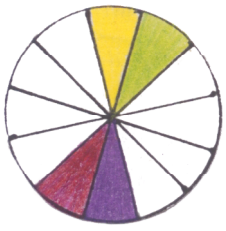
Ex. Yellow and Violet; Red and Green.

4. **Split-Complements:** This scheme is very similar to the Direct Complement. It is made of a color and the two colors to rather side of the direct complement, instead of the direct complement itself.



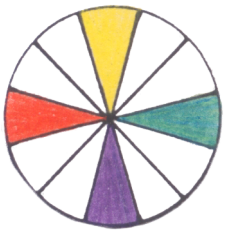
Ex. Yellow, Blue-Violet and Red-Violet

5. **Double Complement:** Two colors next to each other on the color wheel and their direct complements.



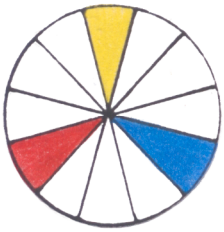
Ex. Yellow & Violet; Yellow-green & Red-Violet.

6. **Tetrad:** A set of complements and the set of tertiary complements (four colors total) which from a 90 degree angle, or vertical and horizontal cross relationship.



Ex. Yellow & Violet; Red-Orange & Blue-Green.

**7. Triad:** Colors which are equidistant from each other and which form a triangle. The primary triad is the most contrasting because the colors used are very different from each other while the secondary triad consists of color which are formed from two primary colors.



Ex. Red, Yellow and Blue; Green, Orange and Violet.

COLOR: The character of a surface that reflects a certain wavelength of light identified as red, blue, yellow.

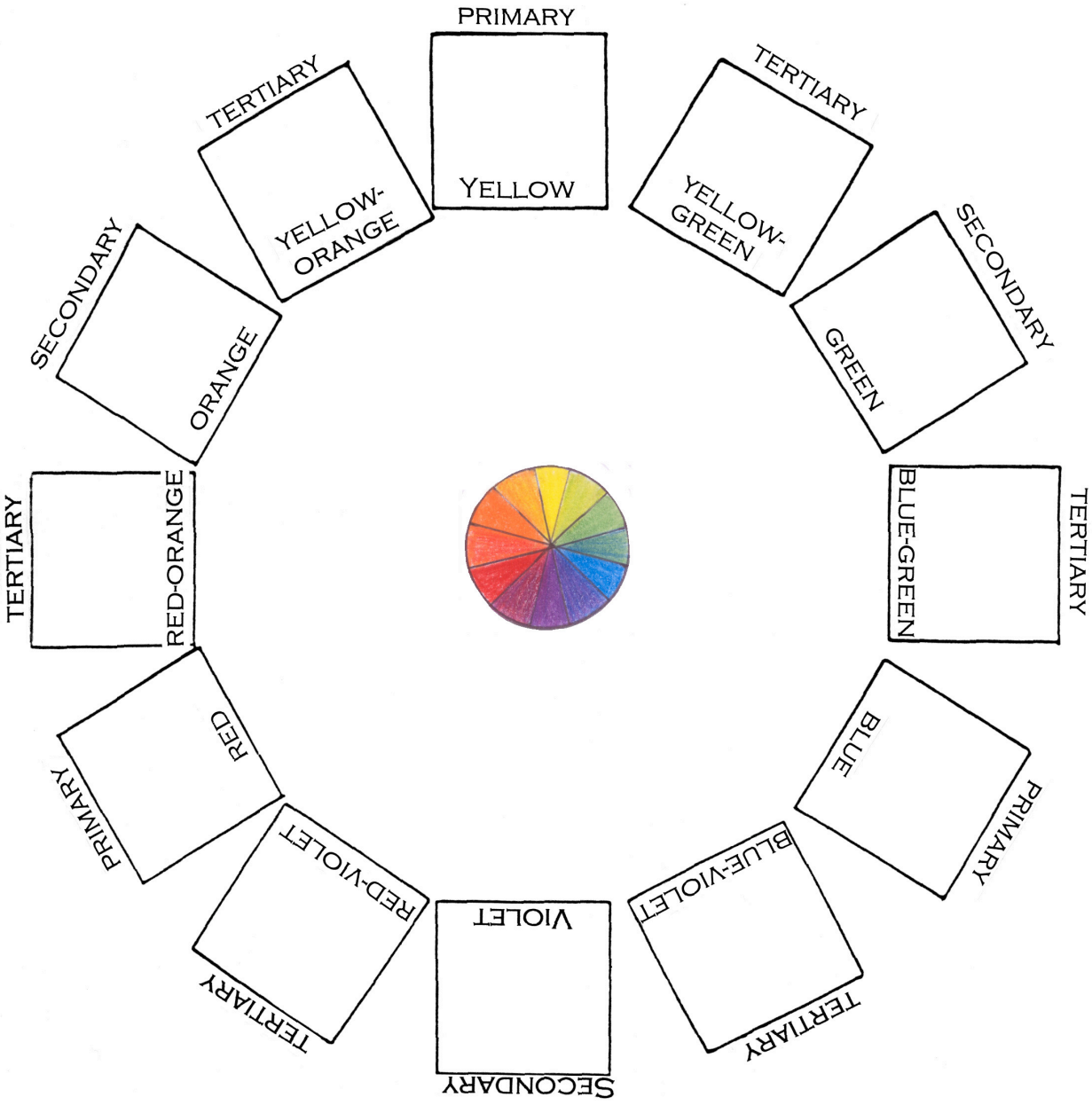
The Characteristics of Color are:

- **Hue** – the *name* of a specific color; for example, **red**.
- **Value** – the relative lightness or darkness of a surface, also called ***key***. ***High key*** indicates a light surface, ***Low key*** a dark one.
- **Intensity** – The strength or purity of a color. Full intensity indicates that a color is fully saturated, you can't add more of the same color into it to make it any stronger.

The **12 Step Color Wheel** contains three (3) **primary colors** which cannot be mixed from other color, three (3) **secondary colors** which are made by mixing two primary colors together (red + blue = violet) and six (6) **tertiary or intermediate** colors which are made by mixing an adjacent primary and secondary color (yellow + green = yellow-green).

Color Wheel: An arrangement of colors based on the sequence of hues in the visible spectrum.

*Definition from **Design Basics** by Davi d A. Lauer and Stephen Pentak, Sixth Edition*


PRIMARY
YELLOW
TERTIARY
YELLOW-
GREEN
SECONDARY
GREEN
TERTIARY
BLUE-GREEN
PRIMARY
BLUE
TERTIARY
BLUE-VIOLET
SECONDARY
VIOLET
TERTIARY
RED-VIOLET
PRIMARY
RED
TERTIARY
RED-ORANGE
SECONDARY
ORANGE
TERTIARY
YELLOW-
ORANGE

**SHAPE** **C.WILSON**

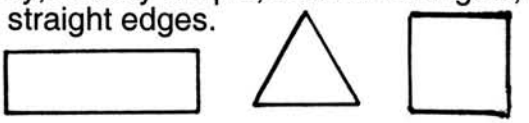
The functions of shape are:

1) To achieve order, harmony and variety in a composition (all related to the principles of organization).
2) To create the illusion of mass, volume and space on the surface of the picture plane.
3) To extend observer attention and interest span.

Some shape definitions:

**Organic shape -** irregular shapes with freely developed curves found in nature, also called biomorphic shape. Organic shapes are the most common in nature – soft, relaxed curvilinear and irregular.

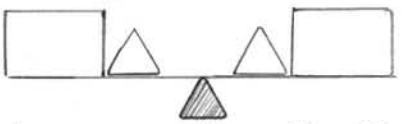
**Geometric shape: -** shapes related to geometry, usually simple, such as triangles, squares, etc. They are symmetrical shapes with clean, straight edges.



**Negative shape -** the unoccupied or empty space left after the positive elements have been created by the artist.

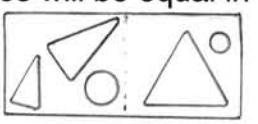

**THE PRINCIPLE OF BALANCE**

**Symmetrical balance –** The exact duplication of appearances in mirror-like repetition on either side of the central axis.



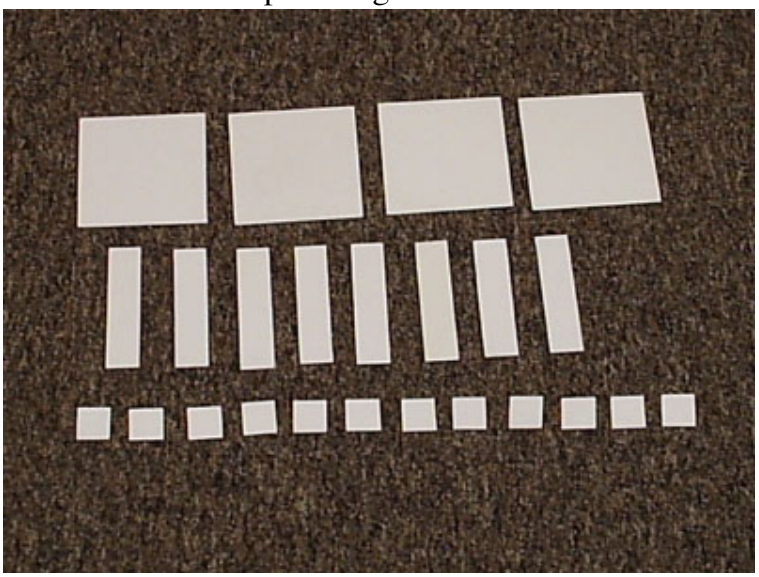
**Approximate symmetry –** the use of similar imagery on either side of the central axis to prevent monotony.

**Asymmetrical balance –** the two imaginary halves will be equal in visual weight, but will form an unequal division of parts.

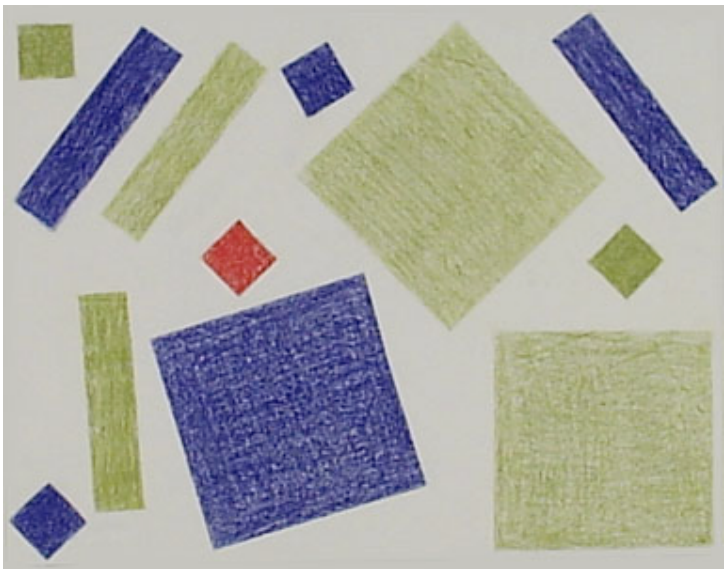


**Radial balance –** Like symmetrical balance but has a configuration emanating from a central location.

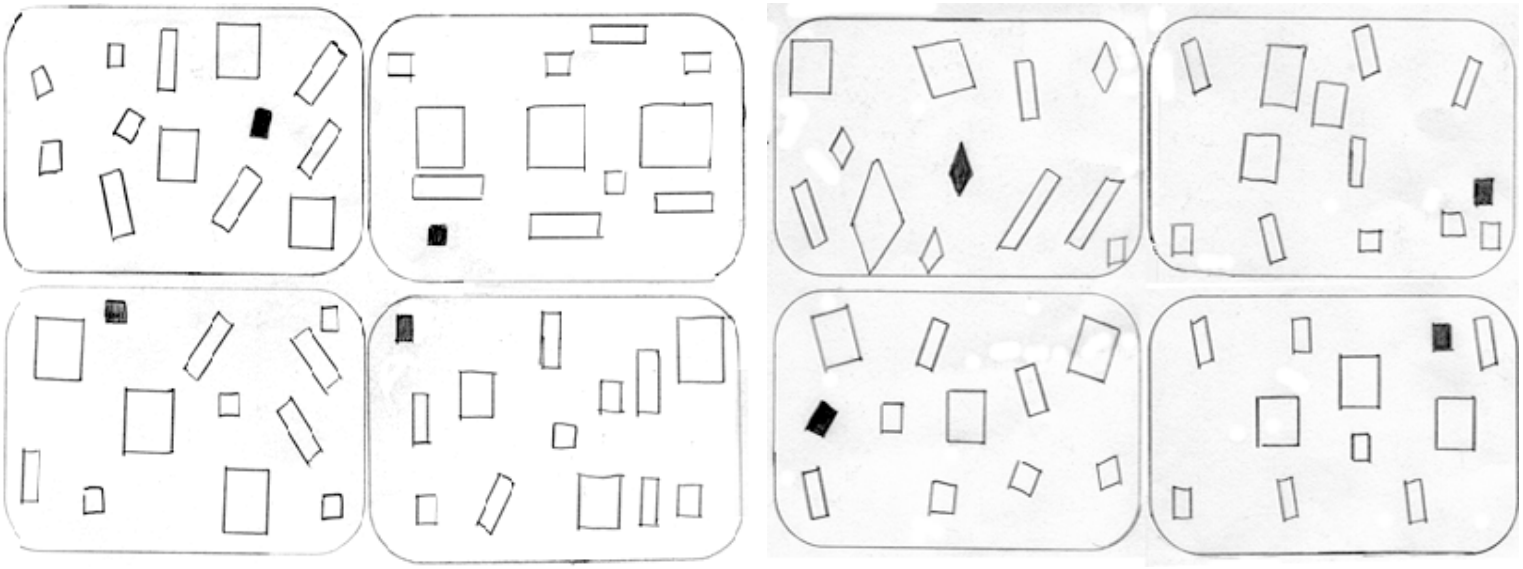
Complete Algebra Tile set



3x^2 + 4x + 5



8 of 20 preliminary sketches for 3x^2 + 4x + 5



More Students Works Examples