5E Lesson Plan Format

# The Geometry of Pentominoes

***teach*HOUSTON Student Name(s):**

**Mentor Teacher Name:** **Grade Level:** 4th

**Lesson Teaching Date and Time:**

**Concept Statement:** Transformations describe how figures change; these changes can be in location (translations), orientation(rotations and reflections), or size (dilations). Exploring transformations helps student develop spatial reasoning skills.

**TEKS:** The student is expected to:

4.9.A demonstrate translations, reflections, and rotations using concrete models.
4.9.B use translations, reflections, and rotations to verify that two shapes are congruent.
4.11.A estimate and use measurement tools to determine length (including perimeter), area…
4.13.A use concrete objects or pictures to make generalizations about determining all possible combinations of…objects in a problem situation.
4.14.D use tools such as real objects, manipulatives, and technology to solve problems.
4.15.A explain and record observations using objects, words, pictures, numbers, and technology.

| Objectives | Evaluation Questions for each Objective |
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| Determine whether two shapes are congruent using translations, reflections, and rotations with concrete materials. | |
| Identify all possible combinations of a given number of tiles. | |
| Calculate the perimeter and area of a geometric shape. | |

**Materials List**
For the teacher:

- Five (overhead) Color Tiles
- 1 set of (overhead) pentominoes,
- Reminder Bubble Cards
- Pentominoes PowerPoint

For each student:

- Pentomino Recording Sheet
- A set of pentominoes
- Three sheets of squared paper

For each group:

- Approximately 100 Color Tiles

**Advanced Preparations:**

- Group materials for easy distribution during the lesson (Color Tiles, a set of Pentominoes, Pentomino Recording Sheet and squared paper)
- Prepare Reminder Bubble Cards

| **Engagement** | | |
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| **What the Teacher Will Do** | **Eliciting Questions/ Student Responses** | **What the Students Will Do** |
| The teacher will introduce Mr. Monomino (a single square region—one Color Tile).<br>"Mr. Monomino is a unique character…he is one of a kind. He is a little square but he has all the right angles, he is perfectly balanced, he has beautiful symmetry, all sides of him are equal, in short…he has pizzazz." | When we push two monominoes together, we get a new figure. What would you call this new shape?<br>*duomino*<br>*binomino*<br>*dinomino*<br>*domino* | |
| The teacher will introduce the term "domino".<br><br>"A domino is a shape constructed of two joined square regions with a side in common." | Can we form another shape with the two square tiles?<br>*No* | Students will experiment with two Color Tiles to form possible domino shapes. |

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| The teacher will define polyomino rules and simultaneously post the Reminder Bubble Cards:<br>a) a reflection of a shape is not a new shape,<br>b) 1 whole side must touch another whole side,<br>c) a rotation of a shape is not a new shape,<br>d) no corner to corner only connections. | What is a reflection?<br>*A flip*<br>*A mirror image*<br><br>Show us a vertical reflection of the given domino.<br><br>What is a rotation?<br>*A turn*<br>*Turn in a circle*<br><br>Show us a 90 degree clockwise rotation of the given domino. | Students will conclude there is only one unique domino shape. |
| The teacher will introduce the term “tromino”.<br><br>“A tromino is a shape formed of three connected square regions. A reflected or rotated version of a tromino does not generate a new tromino.” | How many unique trominoes can you generate?<br>*There are only 2 trominoes.*<br><br>Prove to us that these two trominoes are congruent and hence are the same figure.<br>*Rotate or reflect the given tromino to form the 2nd tromino* | Students will experiment with three Color Tiles to form possible tromino shapes.<br><br>Students will conclude there are only two unique tromino shapes. |
| The teacher will introduce the term “tetromino”.<br><br>“A tetromino is a shape formed of four connected square regions. A reflected or rotated version of a tetromino does not generate a new tetromino.” | How many unique tetrominoes can you generate?<br>*There are only 5 tetrominoes.*<br><br>What is one possible shape?<br>*L, I, Z, T, or square shapes*<br><br>What is another possible shape?<br><br>Is there another possible shape? Are you certain that shape is not a reflection or rotation of one of the shapes already | Students will experiment with four Color Tiles to form possible tetromino shapes.<br><br>Students will conclude there are only five unique tetromino shape. |

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| | shown?<br><br>What shape is similar to your shape?<br><br>Describe how the two shapes are different.<br><br>Are the tetromino shapes familiar? Where have you seen them before?<br>*The video game Tetris uses tetrominoes* | |

| **TRANSITION** |
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| We have investigated several types of polyominoes: Mr. Monomino, dominoes, trominoes, and tetrominoes. We are going to extend this investigation to pentominoes. This investigation will provide us with the opportunity to strengthen our spatialskills, to visualize rotations and reflections, and to determine all possible combinations of five square regions. |

| **EXPLORATION** | | |
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| **What the Teacher Will Do** | **Eliciting Questions/ Student Responses** | **What the Students Will Do** |
| The teacher will introduce the term “pentomino”.<br><br>“A pentomino is a figure formed of five connected square regions. Each region must share at least one complete side with one other region. A reflected or rotated version of a tetromino does not generate a new tetromino.”<br><br>Whereas very little time is devoted to the investigation of unique dominoes, trominoes, and tetrominoes, the teacher will provide a significant period of time for the students to generate all 12 pentomino shapes. | | Students will experiment with four Color Tiles to form possible pentomino shapes. |

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| | What is one possible shape?<br>*D, F, I, L, N, T, U, V, W, X, Y, Z*<br><br>What is another possible shape? Are you certain that shape is not a reflection or rotation of one of the shapes already shown? How can you be certain?<br><br>Have you identified a systematic approach to moving the Color Tiles to assure you have found all the possible combinations? What system are you using?<br>*Start with a straight row of 5 squares. Move one tile along the length of the remaining four to see how many unique pentominoes can be found. Then work with three tiles in a row and examine possible locations for the remaining two tiles. This system allows you to generate 11 of the 12 pentominoes.*<br><br>Describe any patterns you noticed while making your pentominoes? Did the patterns help you find other shapes that were missing?<br><br>How many unique pentominoes can you generate?<br>*There are 12 tetrominoes.* | As students determine possible pentomino shapes, they will record each unique shape on their Pentomino recording sheet.<br><br>The students will leave each unique pentomino shape on their table until they have found all possible shapes. |

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| As groups complete their work, the teacher will ask questions about the attributes of pentominoes. This will allow groups to continue investigations while other groups complete the initial task. | What are some of the attributes of pentominoes?<br>*Pentominoes must be made of 5 connected squares; pentominoes must be connected by a common side; a reflection or rotation of a pentomino does not constitute a new shape*<br><br>How many squares make up a pentomino?<br>*5*<br><br>Do all pentominoes have the same perimeter?<br>*No…one pentomino (D) has perimeter 10 inches; all others have perimeter 12 inches*<br><br>Why does the D have a smaller perimeter?<br>*Its shape is more compact. The square part of the D absorbs two extra perimeter units. For example, when you move from the V to the D, two perimeter units get embedded in the shape.*<br><br>Do all pentominoes have the same area?<br>*Yes…5 square inches*<br><br>Why?<br>*All pentominoes are made up of 5 Color Tiles, and each Color Tile has area 1 square inch.* | Students investigate attributes of pentominoes. |

| **TRANSITION** |
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| You have worked together to find all possible combinations of the 5 square regions using the polyomino rules. We are now going to share our findings and discuss strategies that were used to find all of the possible shapes. We will also discuss attributes of Pentominoes. |

| Explanation | | |
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| **What the Teacher Will Do** | **Eliciting Questions/ Student Responses** | **What the Students Will Do** |
| The teacher will ask pairs of students to present a possible pentomino to the class.<br><br>"Group 1…draw on the overhead projector one of your pentominoes. Group 2…draw another pentomino. Continue until all 12 pentominoes are presented." | How can you be sure your pentomino isn't a reflection or rotation of one of the pentominoes already drawn?<br><br>Show a vertical (or horizontal) reflection of your pentomino.<br><br>Show a 180 degree rotation of your shape.<br><br>What is unique about your pentomino?<br><br>Several groups did not find your pentomino. How did you think to form that particular pentomino? | Each group (pair) of students will present one pentomino until all 12 pentominoes are identified.<br><br>Students will explain how their pentomino is unique from those already presented. |
| The teacher will ask questions about the attributes of pentominoes. | What are some of the attributes of pentominoes? *Pentominoes must be made of 5 connected squares; pentominoes must be connected by a common side; a reflection or rotation of a pentomino does not constitute a new shape*<br><br>How many squares make up a pentomino? *5*<br><br>Do all pentominoes have the same perimeter? *No…one pentomino (D) has perimeter 10 inches; all others have perimeter 12 inches*<br><br>Why does the D have a | Students investigate attributes of pentominoes. |

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| | smaller perimeter?<br>*Its shape is more compact. The square part of the D absorbs two extra perimeter units. For example, when you move from the V to the D, two perimeter units get embedded in the shape.*<br><br>Do all pentominoes have the same area?<br>*Yes…5 square inches*<br><br>Why?<br>*All pentominoes are made up of 5 Color Tiles, and each Color Tile has area 1 square inch.* | |

| **TRANSITION** |
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| **What is the goal of the next activity? Why does the student need to do it? How does the activity relate to the previous activity?** |
| We have agreed that there are 12 unique pentomino shapes and each shape has area 5 square inches. We are now going to use this information to solve a puzzle that has been investigated throughout the world. Children your age in China or Africa or Mexico or India may be solving the Pentomino puzzle at this same moment. |

| **ELABORATION** | | |
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| **What the Teacher Will Do** | **Eliciting Questions/ Student Responses** | **What the Students Will Do** |
| The teacher will distribute a set of pentominoes to each student. | Do these pieces match the ones you created?<br><br>Is your set of pentominoes complete? Please match the pentomino pieces to your Color Tile pentomino creations. | Students will match Pentomino pieces to those they created with the Color Tiles. |
| Pentominoes have been studied and used for recreation for many years. The 12 Pentomino pieces fit together to form a | After students have attempted to form the rectangle for 3-4 minutes, ask the following questions. | Students will use the Pentomino pieces to form a rectangle. |

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| rectangle. In fact, there is more than one rectangle that can be created with the 12 Pentominoes. Take your 12 Pentomino pieces and form a rectangle. | What might be the area of your rectangle?<br>*Since each Pentomino has area 5 square inches and there are 12 Pentomino pieces, then the area should be*<br>*5 square inches/piece x 12 pieces or 60 square inches*. | |
| | If the area is 60 square inches, then what are possible dimensions of the rectangle?<br>*1 x 60, 2 x 30, 3 x 20, 4 x 15, 5 x 12, 6 x 10* | Students will use information about possible dimensions of the rectangle to assist them in forming the rectangle with the 12 Pentomino pieces. |
| Solutions for the 6 x 10, 5 x 12, 4 x 15, 3 x 20 rectangles are shown in the PowerPoint Presentation. Don't be too eager to share the solutions. Give students at least a couple of days to work on the solution. | Can we eliminate any of the possible dimensions?<br>*Yes, some of the pieces are units high or wide so the 1 x 60 and 2 x 30 can be eliminated* | The puzzle takes time to solve so the students may not be able to complete the task in a short period of time. Provide the students with squared paper so they can make their own set of Pentominoes and continue to work on the puzzle. |

## EVALUATION

**An evaluation instrument is to be created. It should have at least 3 questions. Each question should have the objective number that matches that question.**

# Pentominoes

## Find all possible Pentominoes using Color Tiles.

1. **With a partner, use 5 Color Tiles of 1 color to make a pentomino. A *pentomino* is a shape made of 5 connected squares, each of which has at at least 1 full side touching 1 full side of another square.**

2. **Record your pentomino on this sheet. Leave the pentomino on your table.**

3. **Make another pentomino and record it. Leave the pentomino on your table.**

4. **Continue making and recording pentominoes until you have found all possible pentominoes.**

**Recording of Pentominoes**

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