Traditional Lotus Flower

Instructor Guide

Math concepts/skills:

- Patterns
- Multiplication
- Square Numbers
- Properties of squares

Objectives:

- Students will analyze and check for patterns within the given information.
- Students will illustrate square numbers geometrically.

Vocabulary:

- **Area:** The amount of space inside the boundary of a flat (2-d) object.
- **Angle**: The amount of turn between two straight lines that have a common end point (the vertex). An angle is measured in degrees.
- **Even and odd numbers:** A number that can be divided exactly by 2, and odd numbers cannot be divided exactly by 2. Two people can share an even number of objects, but an odd number of objects will have one object left over.
- **Interior angles**: An angle inside of a shape. The inner of the two angles formed where two sides of a polygon come together.
- **Square:** A 4-sided flat shape with straight sides where, all sides have equal length and every interior angle is a right angle.
- **Square numbers**: Square numbers represent the areas of squares that have sides of whole numbers. For example, 25 is a square number because it is the area of a 5 x 5 square. Simply, square numbers are the number of tiles needed to build a square.
- **Theorem:** Theorem is a name for a mathematical idea that can be proven always to be true.

Supplies:

- Mesh paper for model
- 9 x 9 paper for exploration
- Origami tool
- Origami notebook
- Coin battery
- Battery holder
- LED light
- Button
- Transparency paper
- Vis-à-vis markers
- Tiles
- 11 x 17 cardstock

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Video:

https://www.youtube.com/watch?v=vwd7zxZHoXU

Introduction:

Square numbers are easy to illustrate geometrically. They are simply the numbers that make actual square shapes. We can build a 2 x 2 square shape to illustrate the square number 4, a 3 x 3 shape to illustrate 9, and so forth. The *first part* of this activity involves using small tiles to build squares of various dimensions. This will illustrate the concept of a square number in a visual way.

The *second part* of the activity explores an interesting theorem (idea) about odd numbers and square numbers: If you add a list of odd numbers starting at 1, you always get a square number! For example, 1 + 3 + 5 = 9, so the sum of the first three odd numbers is 9. Here's another one: 1 +3 + 5 +7 +9 = 25, so the sum of the first five odd numbers is 25. Geometrically, by using actual shapes, we can build each new square number by adding another odd number.

We have a complicated-sounding mathematical theorem – the fact that the sum of the first n odd numbers is always n x n or n^2 - illustrated in something as simple as an array of square.

The *third part* of the lesson, students will explore embedded squares within a larger square. The problem of counting the number of squares on a checkerboard is a classic inquiry problem and is frequently used as an example of the problem-solving strategies "think of a simpler problem" and "look for patterns".

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This problem sharpens visualization skills because students are challenged to see the smaller squares of various sizes embedded in the larger square. By encouraging students to look for patterns, these problems help develop algebraic thinking.

Folding a lotus flower consists of making smaller and smaller squares with each series of folds. Students will partially fold a lotus flower (stop before making the petals) with the 9 x 9 paper and look at the pattern in the fold lines to determine how many total squares are in the one sheet of paper.

Finally, students can fold an additional lotus flower with the mesh paper and add a button and LED light.

Procedure:

Part One: Hand out the activity sheet and tiles. Each student should get 25 tiles. Building the squares with different colors (using different colored tiles each time they add the next odd number) may make the idea clearer.

Have the students start with one tile. If necessary, discuss the concept of 1 being a square number because the outline of one tile looks square. In other words, 1 x 1 = 1. Student should write down how many cubes it took to build the 1 x 1 square in their table.

Next, have students construct a 2 x 2 square and record in the table the number of tiles they used.

Repeat the process for a 3 x 3, 4 x 4, and 5 x 5 square.

Explain to the students that the number of tiles they use for each square is a square number because they can build a square out of that number of tiles.

Part Two: This activity involves adding odd numbers to squares. Review the concept of odd and even numbers before counting.

Have students start with one tile. Ask how many pieces they need to add to create a 2 x 2 square, then have them build it.

Ask how many pieces they need to add to the 2 x 2 square to create a 3 x 3 square, then have them build it.

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Ask the students if they notice anything special about the numbers they are adding to each square to make the next highest size. (They should recognize 3 and 5 as odd numbers).

Next ask students how many cubes are in their current squares (9). They started with 1 tile, added 3, and then added 5 for a total of 9 tiles. Do they notice a pattern here? Guide the discussion to assist students to understand that adding successive odd numbers together, starting with 1, will always create a square number. Note: notice that 9 is the third square number and that you have to add three odd numbers together to get 9!

Have students continue adding odd numbers to their squares to create the next largest square.

Part Three: Give each student a sheet of the 9 x 9 origami paper.

Guide students through the folding process step by step, *stopping at step 7* (before folding the petals).

When the paper is unfolded, notice how many squares have been created by the fold lines with each succession of folds. How many squares can you find? Is it possible to find all the possible combinations? Yes!

Hand out the student handout. Have students work together in small groups to answer the questions. Have students color each of the sets of squares they find a on a different transparency sheet. When done, transparencies can be overlaid to reveal each of the sets of squares.

When finished, students can fold a completed lotus flower with a button in the center and LED light with the mesh paper. Close with a class discussion.

Extension:

Student can use other shapes to show the idea of square numbers. This idea works no matter what shapes you use to illustrate it, as long as you are using the same shape repeatedly. They could start with a triangle, then add three more triangles to make the next biggest triangle. Rectangles, diamonds, and other parallelograms will work too!

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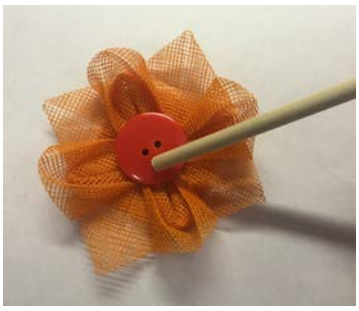
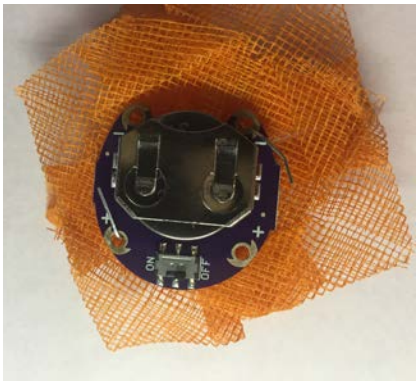
Assemble the button and LED light:

Place a button in the center of the flower.



Thread the LED legs through the button and through the mesh flower.

Place a battery holder on the back side of the flower. Thread the LED legs through the battery holder. Make sure to match the negative with negative and positive with positive. The longer leg on the LED is positive and the shorter leg is negative.



Insert the coin battery into the holder. Positive side goes up. Use the power switch to turn the LED light on. Enjoy!