

Square Building 1

Topics: Counting, Addition, Subtraction, Geometry, Data, Area

Materials: Square tiles, graph paper

Common Core: 2.OA.B.2, 2.OA.C.4, 2.OA.G.2, 3.OA.D.9, 3.MD.6, 3.MD.7, 4.OA.1, 4.OA.5, MP1, MP3, MP6, MP7, MP8

How many squares does it take to build bigger squares?

Why We Love Square Building

Square tiles create a fluid ladder from concrete counting to the abstraction of geometric arrays, multiplication, and division. This lesson lays out a dynamic pathway that allows kids to explore these ideas at the right depth for them.

Launch

To launch the lessons, build a few squares out of square tiles, count how many tiles you need to make each one, and record those numbers.

Then ask the class: *Is there a pattern in the number of square tiles it takes to build a larger square?*

Example Launch

Teacher: I've got all these square tiles. I wonder if I can build a square out of them. Of course, I could build a square using just one tile. But what if I wanted to build the next largest square? How many tiles would I need? Think about it, then share with the person next to you. [Students hold whispered discussion.] How many tiles would I need?

Student: 4.

Teacher: [demonstrating] I see. I'd just put them together like this. Now let's get tougher. How many tiles would it take to make the next biggest square? Try to imagine it, then share with the person next to you. [Students discuss.]

Teacher: Any thoughts?

Students: [Expect multiple answers here] 8, 12, 16, 9.

Teacher: This is exciting! It seems like there could be a lot of different answers here. Who thought 8? Can you show us how 8 square might fit together. [Student volunteers, ends up with a 2 by 4 rectangle.] So eight tiles built a rectangle, but not a square. Can anyone tell me why this isn't a square? What needs to be true about squares?

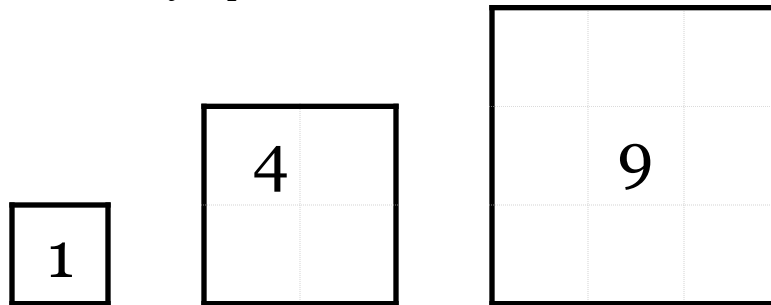
Student: All the sides have to be the same length.

Teacher: Right. All the side have to be the same length. So this side is 2 edges long, and this one is 4 edges long. Not a square. But maybe we could move them around... [moves tiles to make a 3 by 3 square missing a corner.] Is this a square?

Student: It needs one more!

Teacher: So it wasn't 8 tiles we needed. It was 9! This looks like a pattern starting. I'll write it down. [Writes: Squares we can build: 1, 4, 9, ...]

Teacher: Your job today will be to find the next numbers in the sequence by building larger squares. Make sure your squares are actually squares! All the sides need to be the same length. Also, try to make your list complete. If we can, we always want to find the next largest square, and not jump ahead.



The Work

Give students 15-20 minutes to build squares of different sizes and write down their list of numbers. They can also use graph paper and draw out the squares. After students have their lists, have them compare them with another classmate or two to see if they found the same numbers. Challenge students who have found patterns to make predictions for what number comes next, and then try to build or draw it to check that they're right.

Questions and Prompts

- How do you know that is the next largest square?
- How do you know that's a square?
- What makes a square a square?
- How did you make that square? (Did you use the last square as a starting point?)
- How did you count the tiles? (One by one, or some other way?)
- How do you know that you didn't make a mistake in your counting?
- Do you all agree that this is the correct count?

The Wrap

Bring the class together and have the students give you the numbers they found. The beginning should look like this: 1, 4, 9, 16, 25, 36, 49, 64, 81, 100,

Discuss patterns, and have students share patterns they found.

Some patterns students may have found include:

- Looking at the pattern of odds and evens (odd, even, odd, even, etc.)
- Noticing how much each number in the pattern increases by.
For square numbers, this is +1, +3, +5, +7.
- Noticing that the numbers are 1×1 , 2×2 , 3×3 , 4×4 , etc.

Leave students with the question: how can all these patterns be true at once?

Tips for the Classroom

1. It's worth mentioning to your students that these numbers, which represent the number of little squares it takes to make a bigger square, are called *square numbers*. Nifty name, and sensible too.
2. While a good target for students is to build and find the first 10 square numbers, it is okay if not all students get up to the highest numbers. It's also okay if students went higher without building every single square. In fact, it's great if they start finding patterns that help them predict what the larger square numbers will be. If students can use the patterns on the chart to predict which numbers they might expect to come next, then they can try to build those missing squares as well.
3. Another interesting pattern in the square numbers is in the last digits, where there is a repeating symmetrical pattern (1, 4, 9, 6, 5, 6, 9, 4, 1, 0, 1, 4, 9, 6, etc.). Some students might notice this, and there's definitely something to explore here. But in this context, it's better to leave this as an unanswered question for students to ponder on their own.
4. Use ten-frames to help students build to larger numbers.