**Lesson for Square Table Tops**

In this lesson, students will explore square numbers. They will use square tiles to model the product of a number times the same number, explore how squares grow, and record equations to show the product of a whole number times itself is equal to the number of square units in the model.

**NC Mathematics Standard(s):**

**Explore patterns of numbers.**

**3.OA.9** Interpret patterns of multiplication on a hundreds board and/or multiplication table.

Standards for Mathematical Practice:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.

Student Outcomes:

* I am able to use square tiles to model the product of a number times the same number. Examples: 1 x 1; 2 x 2; etc.
* I can build squares and explain that when the whole number of both rows and columns is the same number, the result will be a square.
* I can find a square number when I multiply another number by itself. For example, 5 times 5 equals 25 and I can build a square number and explain.
* I can draw pictures of “Growing Squares” on grid paper, label the squares, and record the number of small squares needed to make the next largest square.
* I can see how the squares grow by adding squares down one column and across one row and then add one more square in the bottom right corner to build the next largest square.
* I am able to write equations to show the product of a whole number times itself is equal to the number of square units in the model.
* I can use pennies, round counters, beans, toothpicks, etc. to build square numbers and I can prove that the number of rows and columns are equal.

Materials:

* Color tiles (square tiles) or snap cubes for each students
* Pennies or other round counters
* Two centimeter or ½ inch grid paper per student
* Color pencils for grid paper
* Handout for students
* Document Camera
* Completed multiplication table (1-100)

Advance Preparation:

* Students should know and understand some multiplication facts and/or ways to find products.
* Students should be familiar with the array model for multiplication and division.
* Students should have knowledge of rows and columns when building an array.
* Students should have experiences in building and drawing models.
* Students should have experiences proving problem situations using various models including manipulatives, drawings, equations and explanations.
* Students should recognize that the equal sign indicates a relationship (quantities on each side are equivalent).
* In grade 3, students should be able to predict the next element in a sequence by examining a specific set of examples such as even and odd numbers.

Directions: (Teacher)

* Introduce the “Building Square Table Tops**”** as written on the student handout**.**
* Teacher and students should build Table Top #1 and Table Top #2. Teacher or student will model Table Top #2. Each student should build the Table Tops. (Teacher allows students to share the models and explain their thinking/reasoning throughout the lesson.)
* Ask students to describe Table Top#3 in small groups. Select several students to explain and share ideas with the class.
* Ask students to continue by building Table Top #4.
* Ask students to find the difference between the squares and to look for patterns. For example from 1 to 4 is 3; from 4 to 9 is 5; from 9 to 16 is 7. (Students need time to find patterns for themselves, with a partner or in a small group.)
* Allow time for groups or partners to discuss questions 5-8 on their handout. Select students from several groups to share their thinking. If possible, use a document camera.
* Ask students to find the difference between Table Top #4 and Top #5. (The difference is 9.)
* Ask students to extend this pattern by explaining where they find the difference in the squares from Table Top #1, Table Top #2. Table Top #3, Table Top #4 and Table Top #5. Describe the pattern. Is this a “growing pattern”?
* Continue following students’ worksheets. It is important that students work with partners and in small groups. Students will record Square #1 - #6 on grid paper.
* Students share ideas and examples in small groups as well as with the whole class, using a document camera.
* It is important for all students to transfer their models to squares on grid paper.
* This gives students an opportunity to transfer their models to drawings and to label each square and also label the number between the squares. (Example:
* Between square 2 and 3, students should see that 5 squares are added to build Table Top #3. Continue to follow student handout.’
* Be sure students have pennies or counters to create a square using 9 or 16 objects
* If you have students who are able to see how the squares are building, allow them to share on the document camera. Students should ask questions of students who are sharing their ideas. (It is easier to see the pattern beginning with 2 x 2 = 4; Add 1 row, 1 column and 1 square in the bottom right corner. 3 x 3 = 9 so add1 column of 3 and 1 row of 3 and add 1 square or circle in the bottom right corner.
* Students may have different ways to describe the growth pattern.



* Give each student a completed multiplication table.
* Ask students to find square numbers on a completed multiplication table.
* Allow students to share patterns, using a document camera or in small groups. Allow time for students to ask questions as well as sharing ideas.

Extension:

**Option of using 2 colors of squares for Building a Growing Square**

Using blue squares build a (2 x 2) square.

Using red squares, add red squares to Square #2 to build Square #3.

Next use a different color of squares to add squares to Square #3 to build Square #4. Can you explain how the squares are growing?

Visual aids can help you find square numbers.

(This may be modeled by the teacher, several students, etc.)

**Questions to Pose:**

Before:

* How would you define a square?
* Can you find examples of squares in our classroom?
* Are all squares the same size?
* What do you know about a square?

During:

* What did you notice when you built Table Top #2 and Table Top #3?
* Did anything surprise you?
* What do you plan to build for Table Top #4?
* Can you describe how the squares are “growing”?

After:

* Does order matter? Explain. (Commutative Property) (During discussions, support students in using vocabulary: factor, product, even, odd, patterns, square numbers, equations)
* What squares did you build that have an even number? Explain why some squares are even and some squares are odd? (This is an opportunity to see which students understand even and odd numbers and even and odd products.)

Examples: (An even number times an even number will always generate an even product. (An odd number times an odd number will always generate an odd product).

* What patterns did you find?
* Describe where you found square numbers on the multiplication chart.
* What other findings do you want to share?

Possible Misconceptions/Suggestions:

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| **Possible misconceptions** | **Suggestions** |
| Students may not see how the squares are growing.Students may not see that you do not need squares to build a square. | Give students lots of opportunities to build squares. Focus on how the squares are growing especially with 2 x 2, 3 x 3, 4 x 4 (Students work in small groups and have conversations to describe what numbers make a square. How are the squares growing?Build the same squares from pennies or round counters.Help students make sense of the completed multiplication table. Using this table will support students who are trying to remember basic facts. |

**Special Notes:**

* Students need many visual representations to make sense of growth patterns and connect to relationships.
* Students are resources to one another as they make sense of mathematical ideas.
* Working in a collaborative inquiry supports students in sense making.

#### Building Square Table Tops

The third grade class is responsible for the table arrangements for the school math fair. Students decided the top of each table should be in the shape of a square. The math fair needs lots of different sizes of square Table Tops.

The Table Tops will be constructed from square tiles. The smallest table will be constructed from exactly one square tile. With a partner or in table groups, use square tiles to create models for the Table Tops needed for the school math fair.

1. Using square tiles, all students build Table Top #1 on a blank sheet of unlined paper. Record the numeral 1 to show the number of tiles for the first Table Top.
2. With a partner or in a small group, each student will use color tiles (same color) to build Table Top #2 and Table Top #3.
3. Build each table top on your paper. All Table Tops are square. Are they arrays?
	* Explain what you know about an array.
4. Underneath each square, record the number of square tiles needed to build the square.
	* What does the 3 represent between Table Top #1 and Table Top #2?

What number should go between Table Top #2 and Table Top #3? Explain.

Table Top #2 Table Top #3

Table Top #1

3

1

4

4

?

1. Each additional Table Top will need enough square tiles to make the next largest square table.
	* Predict the number of additional squares needed for Table Top #4.

Build Table Top #4. Record the number of squares needed to build Table #4. Record the number of squares between Table top #3 and Table Top #4.

1. What do you know about the “rows” and “columns” for each of the Table Tops?
	* Describe how the squares are growing each time. What patterns do you notice? Record.
2. Write an equation for each Table Top #1, #2, #3 and #4.
	* Example: Equation for Table Top #1 (1 x 1 = 1, 2 x 2 =?)
3. In table groups, predict the number of squares needed to build Table Top #5.
	* Explain how you decided on the number of tiles needed for Table Top #5.
4. Build Table Top #5. Record the number of squares needed to build Table Top #5.
	* How many additional squares were needed to build Table Top #5? Record your answer between square Table Tops #4 and #5.
5. Build Table Top #6. Record the number of tiles needed to build Table Top #6.
	* After building Table Top #5, how many more squares did you need to build Table Top #6? Record.
	* Record any different patterns you have noticed. Share ideas.
6. Write an equation for Table Top #5 and an equation for Table Top #6.
	* How might you explain equations for square numbers?
7. Using 2 centimeter or half-inch square grid paper, draw the squares to match each of the models you constructed with square tiles.
	* Label each square, using the information you recorded on the square tile models.
	* Record equations to show the number of tiles needed for under each square.
	* Record the number of additional squares needed between each square
8. Continue drawing and recording Table Top #7, Table Top #8, Table Top #9, and Table Top #10 on Grid paper. (Others may want to create larger squares.)
	* Record the equations for each Table Top drawn on the grid paper.
	* Record the number of squares for each Table Top drawn on the grid paper.
	* Record the number of additional squares needed between each consecutive Table Top. Record between 2 squares on grid paper.
9. Can you show square numbers with round counters or pennies?
	* Prove your answer by creating models. Share with partners or the class.
10. Why are these numbers often referred to as square numbers?
	* Do you think this will be true for larger numbers beyond 10? Explain.
	* Record examples using equations. Explain your thinking?
	* Find an example to share with others. Be sure you can justify your example.
11. Find squares you created with square numbers on the multiplication table.
	* Use color pencils to find a way to show the patterns for square numbers to others.
	* Describe other patterns you notice about square numbers.
12. You can have fun building square numbers with square crackers. Other ideas?

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| **x** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| **0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **1** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **2** | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 |
| **3** | 0 | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 |
| **4** | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 |
| **5** | 0 | 5 | 10 | 15 | 16 | 25 | 30 | 35 | 40 | 45 | 50 |
| **6** | 0 | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 |
| **7** | 0 | 7 | 14 | 21 | 28 | 35 | 42 | 49 | 56 | 63 | 70 |
| **8** | 0 | 8 | 16 | 24 | 32 | 40 | 48 | 56 | 64 | 72 | 80 |
| **9** | 0 | 9 | 18 | 27 | 36 | 45 | 54 | 64 | 72 | 81 | 90 |
| **10** | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |

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| **x** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| **0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **1** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| **2** | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| **3** | 0 | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 |
| **4** | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 |
| **5** | 0 | 5 | 10 | 15 | 16 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
| **6** | 0 | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 | 66 | 72 |
| **7** | 0 | 7 | 14 | 21 | 28 | 35 | 42 | 49 | 56 | 63 | 70 | 77 | 84 |
| **8** | 0 | 8 | 16 | 24 | 32 | 40 | 48 | 56 | 64 | 72 | 80 | 88 | 96 |
| **9** | 0 | 9 | 18 | 27 | 36 | 45 | 54 | 64 | 72 | 81 | 90 | 99 | 108 |
| **10** | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 121 | 120 |
| **11** | 0 | 11 | 22 | 33 | 44 | 55 | 66 | 77 | 88 | 99 | 121 | 132 | 132 |
| **12** | 0 | 12 | 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 120 | 132 | 144 |