FLUENCY, ORIGINALITY FLEXIBILITY & ELABORATION

Lego Arrays

In this lesson, students will explore the relationship between multiplication and division using arrays. This lesson engages students in the Fluency, Originality, Flexibility, and Elaboration Thinking Strategy by having students explain how they developed multiplication and division equations to represent arrays they create. The total number of objects in the arrays are purposeful because they will allow students to represent the total using different arrays. When students are able to come up with many ideas (fluency), combine ideas in new ways or come up with unusual ideas (originality), then categorize and develop their ideas (flexibility and elaboration), they are more able to make inventive or creative connections between ideas.

For information about the interpreting multiplication and division as arrays see the *Math Matters* book (p. 76-80).

CCSS.MATH.CONTENT.3.OA.A.1
Interpret products of whole numbers e.g., interpret 5 × 7 as the total number of objects in 5 groups of 7 objects each.

CCSS.MATH.CONTENT.3.OA.A.2
Interpret whole-number quotients of whole numbers, e.g., interpret 56 ÷ 8 as the number of objects in each share when 56 objects are partitioned equally into 8 shares, or as a number of shares when 56 objects are partitioned into equal shares of 8 objects each.

Standards for Mathematical Practice
MP7: Look for and make use of structure.

Time Frame: 2 days
Day 1: Engage, Explore, and Explain 45-60 min
Day 2: Elaborate/ Extend and Evaluate 45-60 min

Make sure you have enough lego pieces for students to explore and manipulate materials.

Materials
Variety of manipulatives (enough for pairs to have 48 objects)
Lego blocks that are 1x __ (1x1, 1x2, 1x3, 1x4, 1x6)
Pictures provided in lesson

Sticky notes
Copies of exit ticket
Paper/pencils

Engage
Present this picture to the class (and have copies available for students, see below).

Pose the question, "How many Lego heads are in the array?" Depending on students' prior knowledge, have a couple of students remind the class what an array is. Allow for student think time and consider having students share solutions with a partner. Facilitate a discussion with the whole class about the number of Lego heads in the picture and how students determined their answers. Begin by asking students to share just the number and record all student answers on a chart or whiteboard, even those that are incorrect (if there are any). If multiple answers are shared, tell students that everyone will evaluate the answers as we share solution strategies.

This question engages students in using fluency because they may come up with multiple ideas of how to solve for how many.

Then ask the students to explain how they determined the number of Lego heads in the picture. Some student responses might include counting each individual Lego head, repeatedly adding the number of heads in the rows or columns, multiplying the number of rows and columns, etc. The teacher should ask students to record the matching equation for each of their strategies, if applicable. For example, a student who repeatedly added the columns would write 3+3+3+3=12 or a student who multiplied could write 3x4=12 (read as 3 rows of 4 heads equals 12 heads) or 4x3=12 (read as 4 columns of 3 heads equals 12 heads). This discussion will help students begin to create their own understanding of the equations being represented by the array.

Evaluating answers reflects flexibility and elaboration because they must assess and develop ideas.

This task engages in originality and fluency because students must show new ways to express their ideas about different ways to represent 24 as an array

Explore

Have students pair up with a partner for this part of the lesson. Each partner group will work to create an array for the number 24. Students may use any manipulative that the teacher has available, and pairs do not all have to use the same type of manipulative. Tell students that they should write as many multiplication and division equations they can to represent the array they created. Allow plenty of time for students to explore this task. As time allows, students can also create a different array to represent 24.

Look For

- Students using both multiplication and division equations instead of just one or the other. (Perceptive)
- Students who develop multiple arrays to represent 24, especially if students use 1x24 or 24x1 and explain why this is an array. (Creative)
- Students who use manipulatives from prior lessons or real life to represent the equation (Resourceful)
- Students who continue to work on the task even if unsuccessful the first time. (Resilient)

The connection between multiplication and division shows flexibility and elaboration because students must categorize and develop their ideas and connections between ideas.

Explain

Based on the Explore task, facilitate a discussion of the equations students developed to represent the array of 24 objects. Have students record their equations on a chart or whiteboard as they share out and explain their reasoning for each equation. Be sure that students do not just use numbers in their explanations. Student responses should use the context of the situation when describing how the equation matches the array. For example, a pair of students might create an array of 24 blocks using 3 rows of 8 blocks and represent it using the equation 24=3x8.

During this discussion, also make sure to address the relationship between multiplication and division. This should come from the student ideas that are presented. However, the teacher can also think out loud: “I notice that there are 8 blocks in each row and 3 blocks in each column. I know that I can make this a multiplication equation by arranging them into 8 equal groups of 3 or show it by writing 8x3=24 or 3+3+3+3+3+3+3+3=24.

Using the same array, the teacher can explain that the same array of 24 blocks can be represented with division as well. For example, the teacher could explain that with division we could break the whole set into equal groups. This can be shown with repeated subtraction 24-8-8-8=0 (this shows 3 groups of 8 being subtracted from 24 with no remainder) or as 24÷8=3 (this equation could be interpreted in two ways - as 24 divided into 8 equal groups of 3 or 24 divided into equal groups of 8 and there are three groups).

Have students describe how the multiplication 3x8=24 or 8x3=24 and division 24÷8=3 or 24÷8=3 equations are related. Students might talk with a partner first and then have partners share out with the class.

Look For

- Students who clearly articulate their reasoning/justification for how multiplication and division are related. (Communicative)
- Students who share out ideas for their groups and discuss all participants' ideas. (Leadership)

Elaborate/Extend (Day 2)

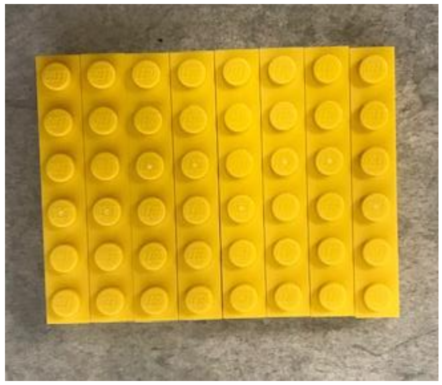
Remind students of what occurred during the previous day's lesson.

Introduce the use of Lego bricks as a manipulative that can be used in mathematics. The raised dots on the top of the bricks can each be thought of as "1." For example, you might show students one of the 1x6 pieces and explain that this would be 1 row of 6 dots. Provide pairs of students with Lego blocks.

This task targets originality because students are asked to investigate and create an array.

Target Task

The task is for students to use the Lego bricks to create their own array using the dots on the blocks. Consider allowing students to select the number they want to work with, but constrain the numbers students can use in their investigation to the following numbers - 48, 60, 72, 84. Tell students that they should create as many arrays that show the number they selected as possible. An example of a Lego Array for the number 48 is (don't show this to students before they investigate):



As students are working, observe and ask questions to have students explain their work or strategy. Some sample questions:

- *How many arrays can you create to represent this number?*
- *How else can we represent this number?*
- *Which of these ideas is most unusual? Why?*
- *How did you figure out what numbers to use in your array?*
- *What information is needed to build this array?*
- *How can you use what you know to build an array of another number?*
- *How can you build onto your array to represent a bigger number?*

Extend the Task
Students who have previously demonstrated that they can identify multiple arrays can be encouraged to use numbers that are larger, such as 96 or even 108. Even though these numbers have the same number of factors (12) as 84 and 60, these numbers have more factors that are greater than 12, making the task more complex.

As students are working the teacher can observe and ask questions to have students explain their work or strategy. Some sample questions include:

- *How can you use what you know to build an array of another number?*
- *How can you build onto your array to represent a bigger number?*
- *What other lego sizes could you use to build the array, if you had them?*

Scaffolding and Support
If pairs seem to need more support, consider that they try using the materials in a specific way. For example:

- Students could be provided with a specific number of Lego bricks of the same size.
- Students could be provided with exactly enough Lego bricks to build an array for the number 48.

As students are working the teacher can observe and ask questions to have students explain their work or strategy. Some sample questions include:

- *How would you use these materials provided?*
- *Should we look at columns or rows first?*

Look For

- Students who would see the patterns and connect the relationship of multiplication and division with addition and subtraction. (Perceptive)
- Students who create their array and develop multiple equations. (Creative)
- Students who manipulate the Lego bricks to determine all of the possible arrays for the selected number. (Resourceful)
- Students who use different shapes and sizes of legos to create their arrays (originality)

Evaluate
Have the students conduct a "gallery walk" around the classroom to view the Lego arrays and corresponding equations. The Lego arrays can be left at students' work areas with the equations written next to them on sticky notes. Ask students to observe the array representations that have been created and how the multiplication and division equations match the arrays that are shown.

As an exit ticket, have students revisit the relationship between multiplication and division by asking students to write a response to the following prompt (see end of lesson plan for page to print):
Here is an image of a Lego array:

Explain why both 3x5=15 and 15÷3=5 are equations that could be used to represent the array.

Collect student exit tickets to evaluate their understanding of interpreting products and quotients.

Picture for Engage (copy for students)

Name: ______________________________

Exit Ticket

Here is an image of a Lego array:

Explain why both 3 x 5 = 15 and 15 ÷ 3 = 5 are equations that could be used to represent the array.