

CONSTRUCTING TASK: SCAFFOLDING DIVISION THROUGH STRIP MODEL DIAGRAMMING

Adapted from:

<http://exit10a.blogspot.com/2014/04/trying-to-make-some-sense-out-of-long.html>

<http://nicoraplaca.com/tape-diagram-division/>

STANDARDS FOR MATHEMATICAL CONTENT

MCC4.NBT.6 Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.

MCC5.NBT.6 Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.

MCC6.NS.2 Fluently divide multi-digit numbers using the standard algorithm.

STANDARDS FOR MATHEMATICAL PRACTICE

- 1. Make sense of problems and persevere in solving them.** Students will need to solve this problem specifically using the most efficient strategy possible.
- 2. Reason abstractly and quantitatively.** Students will work through this task and reason abstractly by opening and breaking down the fewest number of pallets, cartons and boxes as possible.
- 3. Construct viable arguments and critique the reasoning of others.** As students work throughout the task they should be questioning each other on an ongoing basis and not just in summary.
- 4. Model with mathematics.** The modeling of the math in this task is extremely important because it will allow students to conceptually understand how the standard algorithm for division works.
- 6. Attend to precision.** Students should be referring to numbers based on place value understanding and not as digits.
- 7. Look for and make use of structure.** Students make the connection between evenly distributing the donuts and relate their modeling to

ESSENTIAL QUESTIONS

- How is place value important in long division?
- Which strategies are helpful when dividing multi-digit numbers?
- How can I use models to explain the process and meaning of long division?

MATERIALS REQUIRED

- Construction paper cut into fourths (length ways)
- Math journal or blank paper

TIME NEEDED

- Minimum of 2 days

GROUPING

- partner

TEACHER NOTES

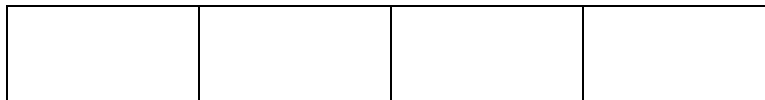
Language plays an enormous role in thinking conceptually about standard division algorithm. Most teachers and students are accustomed to saying “*goes into*” which is hard to let go. Traditionally if we were to do a problem such as $583 \div 4$, we might say “4 goes into 5, one time.” Initially, this is mysterious to students. How can you just ignore the “83” and keep changing the problem? Preferably you want students to think of 583 as 5 hundreds, 8 tens, and 3 ones **NOT AS INDEPENDENT DIGITS 5, 8, AND 3!**

Although the following task is scripted the teacher should lead the lesson through guided questioning. **This lesson suggests a minimum of 2 days but students must be moved through this task at their own pace. DO NOT FORCE or scaffold this lesson too quickly!!!** It is also extremely important for the teacher to model this task using precise language such as quotient instead of answer (SMP #6).

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION:

Part 1

- Hand out a piece of construction paper (cut in $\frac{1}{4}$ length ways)
 $145 \div 4$
- Place the following equation on the board and tell the student that the value of the whole strip is 145.
- Pose the question “*if the value of the whole strip is 145, how many parts do we need to partition the strip into?*” Students might need to see that the strip needs to be partitioned into 4 parts. Have students fold the strip into fourths. On the board the teacher should model the students’ strip



- *If the whole strip is 145 how much do we want to start partitioning into each fourth?* It will be important for students to understand that each fourth has an equal amount. What students are doing is using partial quotients. The following example is how it could be done but it is not the only way. **LET THE STUDENTS DICTATE WHAT QUOTIENTS TO USE!**
 - Student 1 says to put 20 in each box (it will be important to record the remaining dividend on the board next to the strip diagram)
 - Student 2 says to put 10 more in each box
 - Student 3 says that we 25 left so we’ll put 6 more in each fourth
 - Student 4 says that we have 1 left over so that can be our remainder or we can partition it into $\frac{1}{4}$ or 0.25

20	20	20	20
10	10	10	10
6	6	6	6

$$\begin{array}{r} 145 \\ -80 \\ \hline 65 \\ -40 \\ \hline 25 \\ -24 \\ \hline 1 \end{array}$$

- Using the strip model students just created ask them what **total quotient** is for the equation $145 \div 4$
 - Total Quotient for $145 \div 4$ is equal to *36 remainder 1* or $36\frac{1}{4}$ or 36.25

- Hand out more strips to students and have them model the following expressions individually or in small groups for 10-15 minutes

$$201 \div 3$$

$$467 \div 5$$

$$694 \div 4$$

- Once students have completed modeling partial quotients using their strip diagram, have them share their solution. This is an extremely important part of the lesson because students need to see that there are multiple solution paths. This also gives the teacher great insight into students' number sense. (Example: a student that is able to partition the dividend by multiples of 10 has a stronger sense of number than the student that only removes 10 at a time). There is no right or wrong way to solve, however the emphasis should be on the more efficient solution paths.

Part 2

- Tell the students you are going to try the same thing but this time you are not going to use the strips. Students will draw the strips instead.

$$423 \div 5$$

423				
40	40	40	40	40
40	40	40	40	40
4	4	4	4	4

$$\begin{array}{r}
 423 \\
 \underline{-200} \\
 223 \\
 \underline{-200} \\
 23 \\
 \underline{-20} \\
 3
 \end{array}$$

Remainder 3 or $\frac{3}{5}$ or 0.6

- Place some more equations on the board and have the students solve them using the horizontal strip model.

Part 3

- Tell students that today that you are going to do the exact same thing as yesterday but this time you want them to draw their strip diagram horizontally and instead of showing the subtraction/remaining divisor outside of the diagram you'd like them to include it as part of the diagram.

$$874 \div 4$$

218 r2	
200	874
15	<u>-800</u>
3	74
200	<u>-60</u>
15	14
3	<u>-12</u>
	2
200	
15	
3	
200	
15	
3	

- This time have students record the quotient total on top of the vertical strip diagram
- Place some more equations on the board and have the students solve them using the vertical strip model.

Part 4

- After students have had had ample time and practice using the vertical strip model, pose the following question “*We are writing a lot of partial quotients each time. Is there anything we can eliminate or get rid of?*” Guide the students to see that they don’t need to repeatedly draw the boxes and write the exact same numbers in each one. After the students have arrived to this point have them write the number of boxes the need next to the dividend box/strip. Partial quotients are recorded at the top of the vertical strip.

$$691 \div 8$$

50+30+5+1 remainder 3

8	691
	<u>-400</u>
	291
	<u>-240</u>
	51
	<u>-40</u>
	11
	<u>-8</u>
	3

- Place some more equations on the board and have the students solve them using the vertical strip model without the partial quotient boxes. As students become more flexible in their thinking and using the largest possible product with the remaining dividend they will be modeling the standard algorithm for division but with place value understanding. Here is an example using the previous equation $691 \div 8$

80+6 remainder 3

8	691
	<u>-640</u>
	51
	<u>-48</u>
	3

PART 5

- Pose a problem on the board using the traditional long division symbol and tell the students that the box is not finished. If they want they can draw it or leave it open.

70+5 r4

7	529
	<u>-490</u>
	39
	<u>-35</u>
	4