Teacher Guide: No Alien Left Behind

Learning Objectives

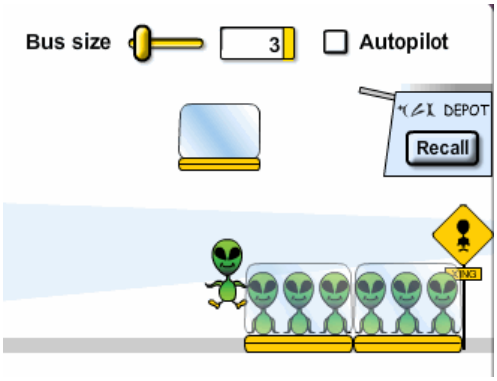
Students will…

- Model division of whole numbers.
- Solve whole number division problems with the aid of a model.
- Understand the concept of a remainder.

Vocabulary

dividend, divisor, quotient, remainder

Lesson Overview



The *No Alien Left Behind* Gizmo™ helps students develop an understanding of division with remainders. Students build a model for division by grouping alien students in buses for a field trip. The number of buses filled with aliens is the quotient; the aliens "left behind" represent the remainder.

The Student Exploration sheet contains three activities:

- Activity A – Students use the model to represent division without remainders.
- Activity B – Students use the model to explore the concept of remainders.
- Activity C – Students look for patterns in remainders to extend their understanding of division and remainders.

Suggested Lesson Sequence

1. **Prior to using the Gizmo** (10 – 15 minutes)
   Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class. You might also ask them if "it's possible" to divide 10 by 3. (It is possible, of course, but it does not come out evenly. You will get a remainder of 1.) Afterwards, if possible, use a projector to introduce the Gizmo and demonstrate its basic operations.

2. **Gizmo activity** (15 – 20 minutes per activity)
   Assign students to computers. Students can work individually or in small groups. Have students work part of the Student Exploration sheet using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.

   It would probably be overwhelming for students to do all of the activities in the Student Exploration in one sitting. We recommend starting with the first page of the Student Exploration sheet (Prior Knowledge Questions and Gizmo Warm-up) plus one of the three activities. Extend the lesson if you want using the extensions below. Return to the Gizmo and the unused activities in future class periods to reinforce the concepts.

3. **Extending the Gizmo** (15 – 20 minutes)
Here are some suggestions for extending the activities in the Student Exploration sheet:

Paper and pencil models – As part of Activities A and B, students draw division models using pencil and paper. Having students draw additional models is an excellent follow-up to those two activities. Start by having them draw models to represent a situation like the one in the Gizmo (aliens grouped in buses) and then try switching to a different context. (e.g., "A class of 19 students is sitting at tables that have 4 chairs each. How many full tables will there be? How many students will be left over?")

Remainders as fractions – After Activity B or C, have students turn the **Remainder as fraction** checkbox on. Then have them use the Gizmo to investigate how remainders can be expressed as fractions. Have students work in pairs or small groups to write a rule for writing remainders as fractions. Then give groups the chance to explain their rules to their classmates. Use the resulting discussion to explore the meaning of the numerator and denominator in the remainders. Afterwards, have students redo Activity C with the **Remainder as fraction** option turned on.

Another way to extend students' work with the Gizmo is class discussion. After students are done with their activity, discuss the following questions:

- Is it right to say, "you can't divide 13 by 4"? Why or why not? Could you rephrase the statement to make it more accurate?
- If we're grouping aliens in groups of 3, could you finish the grouping and have 3 aliens remaining? Why or why not? (Students may need to draw a picture or use the Gizmo to formulate an answer.)
- If we're dividing a number by 3, is it possible to have a remainder of 3? Why or why not?

4. **Follow-up activity: Division stories** (30 – 40 minutes)
Have the class brainstorm situations where something is being divided. Then have students work individually or in pairs to write division story problems. They will need to write a few sentences to set up their story or situation, followed by one to three division questions based on the story. Then have students/pairs exchange story problems. Students must then draw a picture and solve their classmates' problems.

The story problems and their illustrated solutions can be posted on a bulletin board or even bound together to create a "division story book."

Mathematical Background

Before students begin solving long division problems, they need to understand the concept of a remainder. The first step in building this understanding is shedding the misunderstanding that certain numbers cannot be divided, e.g. "13 can't be divided by 4." A more accurate phrasing is "13 can't be divided evenly by 4" or "13 can't be divided by 4 without a remainder."

It is also useful if students understand the patterns in remainders for a given divisor. For example, when dividing by 3:

6 ÷ 3 = **2**	9 ÷ 3 = **3**	12 ÷ 3 = **4**
7 ÷ 3 = **2 R1**	10 ÷ 3 = **3 R1**	13 ÷ 3 = **4 R1**
8 ÷ 3 = **2 R2**	11 ÷ 3 = **3 R2**	etc.

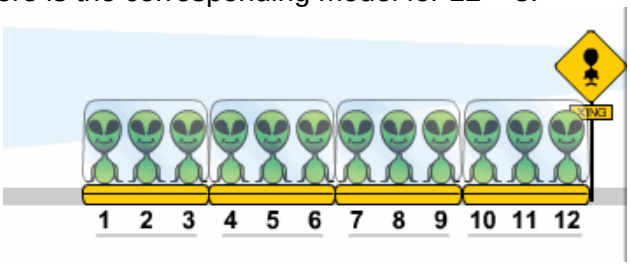
Knowing that the remainder is always less than the divisor can help students catch their mistakes when solving division problems; a student who understands remainders will know that "68 ÷ 3 = 21 R5" is incorrect just by looking at it. (When dividing by 3, the biggest possible remainder is 2.)

In middle school, an understanding of remainders will help students solve problems with patterns. For example, finding the 106th term in the pattern "REDREDRED…" can be accomplished by dividing 106 by 3 (the number of letters in RED). The answer, 106 ÷ 3 = 35 R1, means that there are 35 complete REDs and then one additional letter, R. So the 106th term in the pattern is R.

Another model for division is repeated subtraction. 12 ÷ 3 can be solved by repeatedly subtracting 3 from 12. (In fact, you can do it exactly 4 times, as shown below.)

12 – 3 = 9 9 – 3 = 6 6 – 3 = 3 3 – 3 = 0

The Gizmo can also be used to model this. Turning on the **Alien numbers** checkbox displays numbers beneath the aliens. This provides a number-line that can be used to keep track of repeated subtraction. Here is the corresponding model for 12 ÷ 3:



Have students start with 12 aliens. After they have filled one bus (effectively subtracting 3 aliens from the number waiting for a bus), ask them how many aliens remain (9). Then ask them to keep adding buses, always checking to see how many aliens remain (6, 3, 0). Help them make a connection between this "counting down" with the aliens and more abstract questions such as, "How many groups of 3 are in 12?" and "How many times can 3 be subtracted from 12?"

Once they have gotten comfortable with the repeated subtraction model for division, have them use it to model division problems with remainders. If students get to the point where they can solve problems like "23 ÷ 5" by drawing a number line on paper and using it to repeatedly subtract 5 from 23, they will have a strong foundation for understanding their later work with formal division algorithms.

Selected Web Resources
A remainder of one: http://www.education-world.com/a_tsl/archives/05-1/lesson008.shtml
Modeling division lesson: http://www.homeschoolmath.net/teaching/md/not_exact_division.php
Division with money: http://www.moneyinstructor.com/lesson/divisionmoney.asp
Division as repeated subtraction:
http://www.homeschoolmath.net/teaching/md/division-repeated-subtraction.php