Grade 4 Learning Activity
What's My Rule?

OVERVIEW

This learning activity provides an introduction to the use of variables and examines the inverse relationship between multiplication and division. Using a literature connection, students discover the relationship between input and output values, then plot points on a graph.

Prior to this learning activity, students should have had some experience with creating charts, making graphs, modelling patterns with concrete materials, and drawing diagrams on grid paper.

BIG IDEA

Variables, expressions, and equations

CURRICULUM EXPECTATIONS

This learning activity addresses the following **specific expectations**.

Students will:

- determine, through investigation, the inverse relationship between multiplication and division (e.g., since $4 \times 5 = 20$, then $20 \div 5 = 4$; since $35 \div 5 = 7$, then $7 \times 5 = 35$);
- determine the missing number in equations involving multiplication of one- and two-digit numbers, using a variety of tools and strategies (e.g., modelling with concrete materials, using guess-and-check with and without the aid of a calculator);
- identify, through investigation (e.g., by using sets of objects in arrays, by drawing area models), and use the commutative property of multiplication to facilitate computation with whole numbers (e.g., "I know that $15 \times 7 \times 2$ equals $15 \times 2 \times 7$. This is easier to multiply in my head because I get $30 \times 7 = 210$.").

These expectations contribute to the development of the following **overall expectation**.

Students will:

- demonstrate an understanding of equality between pairs of expressions, using addition, subtraction, and multiplication.

TIME

2 hours

ABOUT THE LEARNING ACTIVITY

MATERIALS

- interlocking cubes or coloured tiles
- graph paper
- chart paper
- **PA.BLM4b.1: What's My Rule? Home Connection** (1 per student)

MATH LANGUAGE

- array
- T-chart
- equality
- decompose
- symbol (variable)
- output
- input

INSTRUCTIONAL GROUPING:

whole class, pairs

ABOUT THE MATH

In algebra terminology, a **variable** is a letter or symbol that is used to represent an unknown value (as in $5x = 15$) or a varying quantity (such as the input and output values in $P = 4s$, where output is P and input is s).

The symbols x and y are often used to represent variables. However, any letter (a or b or c …), any symbol ( or ), or any concrete material (such as a colour tile) may be used to represent a variable.

GETTING STARTED

Start by reading *Six Dinner Sid* (Inga Moore, 1991; ISBN 0-671-7319-8), a story about a clever cat who loves to eat dinner. If the book or video is not available, use the following text to explain the premise of the story:

"The story *Six Dinner Sid* is about a very clever and manipulative cat named Sid. He has convinced six people living on the same street that he belongs to them and to them alone. As a result, he is able to enjoy six dinners a day. Unfortunately, this also means that when he gets sick, he has to visit the vet six times and take six doses of medicine, which leads to a humorous predicament."

Discuss what else Sid might have access to in all six homes (e.g., How many people will he have to pet him? How many chairs will he have to sit on?).

WORKING ON IT

PART 1: CREATING THE T-CHART

Tell the class that they are going to focus on Sid's dinners, and use this story to explore the pattern in the number of dinners that Sid consumes, and then plot the pattern on a bar graph. Set up a T-chart on the board showing days as the input and dinners as the output. Pose the question: "How many dinners would Sid eat in one day?" Write "1" in the input column and "6" in the output column. Say, "In one day Sid would eat 6 dinners."

Input	Output
1	6
2	12
3	18
4	24
...	...
10	60

Teacher note: Notice the symbols used for input and output. Let the class choose the symbols for the T-chart.

Continue prompting the class with:

- How many dinners would Sid have in 2 days? Explain.
- How many dinners would Sid have in 3 days? Can you see a pattern?
- How many dinners would Sid have in 4 days?

Typical student responses might include statements such as:

- "Every day he gets 6 more."
- "I added 6 more each day."
- "I see that you can multiply the days by 6 because he gets 6 more each day."
- "There is one more group of 6 each day."
- "It's like counting by 6s."

Teacher note: As the students respond, prompt them to say the same thing in different ways. Remind them that multiplication is the same as repeated addition.

Prompt the students to predict the output for 5 days, and then for a full week. You might then ask, "If Sid had 60 dinners, how many days would that have taken? How do you know?" Responses might include:

"I put 60 cubes into 6 piles and there were 10 in each pile."

"I put one cube down for dinner at each house and when I used all 60 cubes I had 10 under each house."

"I continued the pattern of adding 6. I knew he ate 42 dinners in a week, so I added 3 groups of 6 to get 60. That meant 10 days."

"I divided 60 into 6 groups, and 60 meals divided by 6 per day gives 10 days."

Teacher note: Encourage students to see that multiplying by 6 and dividing by 6 are related. If they know the input value they can multiply by 6 to determine the outcome, and if they know the output value they can divide by 6 to determine the input.

DEVELOPING A RULE

Ask for suggestions on how to reword the rule to use terms such as input value and output value.

> ***Teacher Note***: Have manipulatives available so that students can model the problem.

The chart should help students to see that the rule could be expressed in different ways:

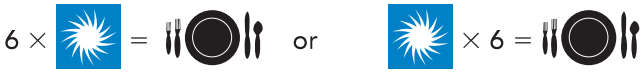
- input value × 6 = output value
- input value + input value + input value + input value + input value + input value = output value
- output value ÷ 6 = input value

> **Teacher prompts:** *The sun represents the input value, the number of days. What do we have to do to the input value to get the output value? We could write 6 ×*  *or*  *× 6 to show this part of the rule. What does the dinner plate represent?*

Look at the first rule: input value × 6 = output value. Ask the class: "How could we represent the input value without having to write out the words each time? Is there a short form?" Brainstorm different ideas. Also, offer the suggestion that they could use the sun symbol (or the input symbol the class has chosen) to represent the number of days.

Now ask the class: "How could we represent the output value without having to write out the words each time? Is there a short cut?" Brainstorm ideas. One option is to use the dinner plate (or the output symbol the class has chosen).

The first rule (the input value multiplied by 6 = output value) could be written as:



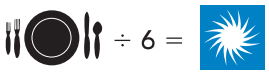
CHECKING THE RULE

Tell the class, "Let's see if our rule works. What number do I put in for the sun? Let's start with 1. 1 × 6 is 6 and Sid does have 6 dinners in 1 day, so it works. Let's see if it works for 2 days. I put 2 in for the sun and 2 × 6 is 12. Yes, he has 12 dinners in 2 days. Work in your groups and see if the rule works for the whole week." Circulate and look at how the students are substituting numbers for symbols. Ask questions to see if everyone has a clear understanding.

WRITING THE RULE A DIFFERENT WAY

Say: "Let's look at another way of writing the rule. Could we write the rule without using multiplication?" The rule could be written as:

Have students work in their groups to substitute values and see if the rule works for the week. Continue: "Let's look at yet another way of writing the rule. Could we write the rule without using multiplication or addition?" The final rule (output value ÷ 6 = input value) could be written as:



Have students work in their groups to substitute values and see if the rule works for the whole week.

Teacher prompts: *"If we start with the output, which is the number of dinners, and if we divide the output into 6 groups, it equals the input. If we put in the symbol for output, the dinner plate, and we divide the output into 6 groups, we should get the input, which is the sun."*

PART 2: CREATING THE SECOND T-CHART

Tell the story of Four-Meal Fred: "Fred is a St. Bernard dog with a voracious appetite. He is not quite as clever as Sid but he is able to convince four different families that he belongs to them. They all feed him, of course, so Fred gets four meals a day. You will now work in pairs to determine how many meals Fred would receive in a week."

Input □	Output ▲
1	4
2	8
3	12
4	16
5	20
6	24
7	28

Make clear the scope of the task. Each pair needs to:

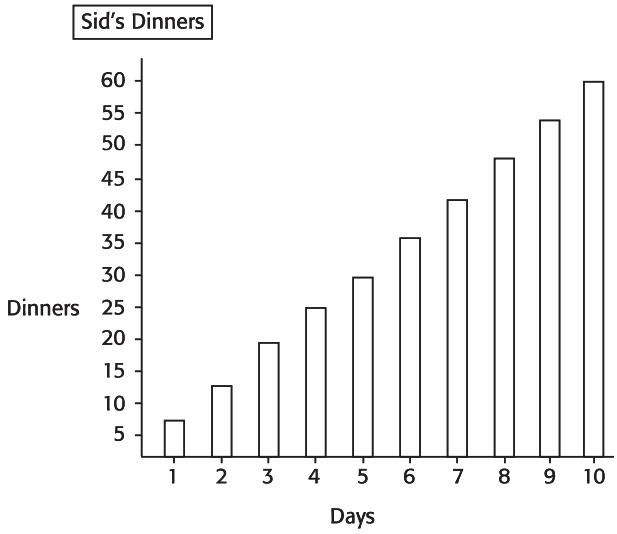
- create a T-chart with values;
- write at least one rule in words;
- represent the rule in symbols;
- check that the rule is correct.

Extend the problem:

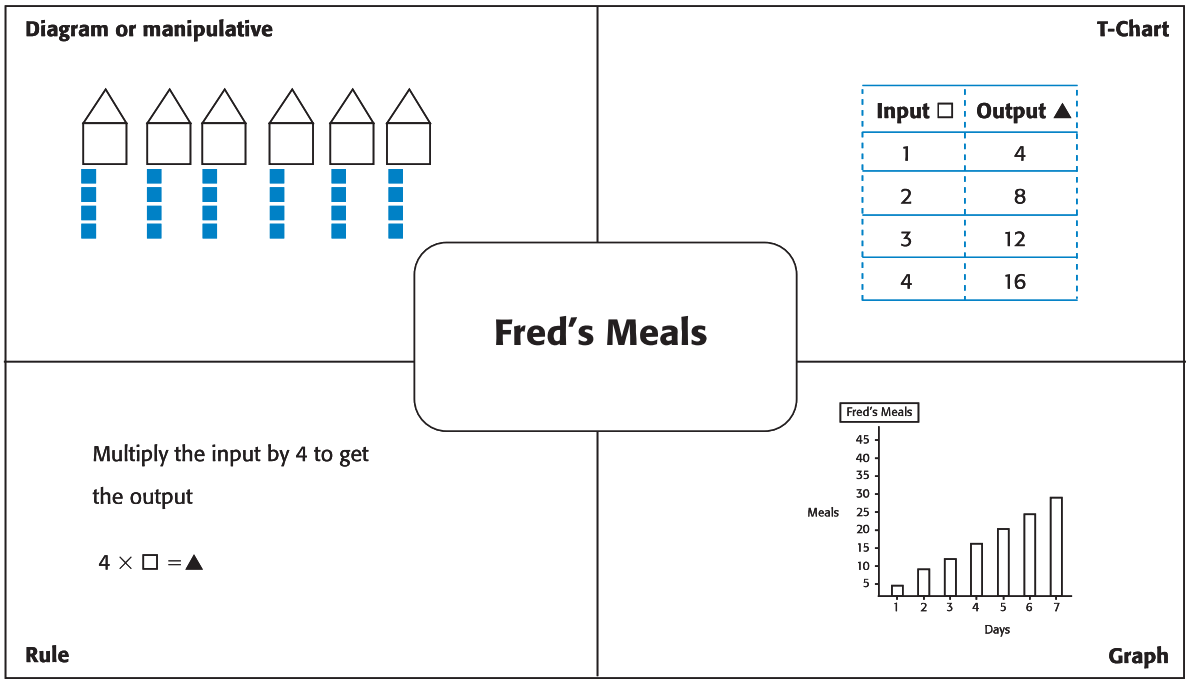
- How many meals might Fred receive in a month?
- How many days would it take for Fred to have 56 meals?

PART 3: GRAPHING SID'S DINNERS AND FRED'S MEALS

Explain to students that they will be using the data they gathered on Sid's dinners and representing it as a bar graph, with the input numbers on the horizontal axis and the output numbers shown as bars.



Have students use the data from Fred's meals to create their own graph, using graph paper or graphing software. Have them create a variety of representations for Fred's meals. They could use the following template:



REFLECTING AND CONNECTING

Draw the input/output chart for Fred's meals on the board or on an overhead transparency, and encourage students to fill it in. Prompt the class to give a rule for what's happening. Students will have to make up their own symbols (variables). For example:

☐ × 4 = ▲, ☐ + ☐ + ☐ + ☐ = ▲, ▲ ÷ 4 = ☐, 4 × ☐ = ▲

Teacher note: Students may think that ☐ × 4 = ▲ and 4 × ☐ = ▲ are different. Use simple examples to show the *commutative property* of multiplication (e.g., 3 × 4 is equal to 4 × 3).

TIERED INSTRUCTION

Supports and extensions can be beneficial for all students. For any given activity, there will always be some students who require more or less support, or for whom extensions will increase interest and deepen understanding.

SUPPORTS FOR STUDENT LEARNING

Scaffolding suggestions:

- For students who require a lower-level entry, provide a similar but simpler activity from the book *Two of Everything* (by Lily Toy Hong, 1993; ISBN 0-807-58157-7) which uses a doubling pattern.
- Have students draw houses on chart paper and model houses with tiles.
- Leave examples of the Sid problem posted as a model.
- Do a "gallery walk" to see what other students are doing.
- Provide a checklist, with the following steps to be completed:
  - create a T-chart with headings;
  - use manipulatives to model;
  - check for a pattern;
  - pair/share: orally describe the pattern;
  - write the rule;
  - use symbols to state the rule;
  - check by substituting a number.

EXTENSIONS

- Have students write a different problem based on Sid's experiences.
- Have students read *Anno's Mysterious Multiplying Jar* (by Mitsumasa Anno, 1999; ISBN 0-698-11753-0) to find the rule for the jar.
- Have students read *Multiplying Menace* (by Pam Calvert, 2006; ISBN 1-570-91890-2) and look for the secret of the stick.

Other literature connections:

- *Two of Everything*, by Albert Whitman. ISBN 0-807-58157-7
- *100 Angry Ants*, by Elinor J. Pinczes. ISBN 0-395-97123-3
- *Spaghetti and Meatballs for All*, by Marilyn Burns, 1997. ISBN 0-590-94459-2
- *The Number Devil (The Third Night)*, by Hans Magnus Enzensberger, 1997. ISBN 0-8050-6299-8

HOME CONNECTION

See **PA.BLM4b.1: What's My Rule? Home Connection**.

ASSESSMENT

Observe students in order to assess their use of

- an efficient strategy;
- math language to explain the solution;
- appropriate symbols (variables) in pattern rules;
- appropriate diagrams/models.

WHAT'S MY RULE? HOME CONNECTION

Dear Parent/Guardian:

In math, we have recently explored a pattern based on multiples of six (6, 12, 18, 24, etc.), introduced in a book called *Six Dinner Sid*. Sid, the cat, is very manipulative and very clever. He has convinced six people living on the same street that he belongs to them and to them alone. As a result, he is able to enjoy six dinners a day. Students recorded terms from this pattern on a chart and wrote rules to model the relationship, such as 6 ×  =  . Ask your child to explain the chart and the rule.

Your child's new task is to create a new rule. For example, the rule 3 ×  =  might represent the number of meals your child eats each day (breakfast, lunch, and dinner). Or 10 ×  =  might represent the number of hours your child sleeps each day. Encourage your child to develop his or her own rule. Ask your child to complete a table such as the one on the right, leaving three of the output spaces blank.

In class, your child will be asking other students to try to complete the table and to work out the rule. To prepare for that activity, your child should try to determine the rule and describe it to you (using words, diagrams, physical materials, or mathematical symbols).

 Input	 Output
1	6
2	12
3	18
4	24
…	…
10	60

Input	Output
1	
2	
3	
4	
5	
…	…
10	