LESSON OVERVIEW

Lesson 5
Add Using Arrays

Lesson Objectives

Content Objectives

- Describe an array of up to 5 rows and 5 columns.
- Calculate the number of items in an array using repeated addition and skip counting.
- Write an equation to express the sum of items in an array.

Language Objectives

- Tell the number of rows in an array.
- Tell the number of objects in each row of an array.

Standards for Mathematical Practice (SMP)

1 Make sense of problems and persevere in solving them.

3 Construct viable arguments and critique the reasoning of others.

4 Model with mathematics.

5 Use appropriate tools strategically.

7 Look for and make use of structure.

8 Look for and express regularity in repeated reasoning.

Prerequisite Skills

- Add 3 one-digit numbers.
- Visually recognize groups of 2 through 6.
- Skip count by 2s and 5s.
- Write an addition equation.

Lesson Vocabulary

- **array** a set of objects arranged in equal rows and equal columns
- **row** the horizontal groups of objects in an array
- **column** the vertical groups of objects in an array

Learning Progression

In Grade 1 students add up to 3 one-digit numbers. They use equations to express a variety of situations that involve addition. Students also apply counting skills to add, including skip counting.

In Grade 2 students work toward fluency with sums to 20. They continue to use addition equations and skip counting to model addition.

In this lesson students apply their knowledge of addition and skip counting to an array. They analyze arrays, recognizing them as sets of objects organized in equal rows and columns. They recognize that adding 3 groups of 4 or adding 4 groups of 3 results in the same sum. This structure lays the foundation for the extension of the commutative property to multiplication.

In Grade 3 arrays are used as a tool to help students understand the structure of multiplication and division of whole numbers. The array is used to model the commutative and associative properties and as an introduction to area concepts.

Lesson Pacing Guide

Whole Class Instruction

Day 1
45–60 minutes

Toolbox: Interactive Tutorial*
Add Using Arrays

Introduction
- Opening Activity *15 min*
- Use What You Know *10 min*
- Find Out More *15 min*
- Reflect *5 min*

Practice and Problem Solving
Assign pages 37–38.

Day 2
45–60 minutes

Modeled and Guided Instruction
Learn About Adding Using Arrays
- Picture It/Model It/Model It *15 min*
- Connect It *20 min*
- Try It *10 min*

Practice and Problem Solving
Assign pages 39–40.

Day 3
45–60 minutes

Guided Practice
Practice Adding Using Arrays
- Example *5 min*
- Problems 7–9 *15 min*
- Pair/Share *15 min*
- Solutions *10 min*

Practice and Problem Solving
Assign pages 41–42.

Day 4
45–60 minutes

Independent Practice
Practice Adding Using Arrays
- Problems 1–6 *20 min*
- Quick Check and Remediation *10 min*
- Hands-On or Challenge Activity *15 min*

Toolbox: Lesson Quiz
Lesson 5 Quiz

*We continually update the Interactive Tutorials. Check the Teacher Toolbox for the most up-to-date offerings for this lesson.

Small Group Differentiation

Teacher-Toolbox.com

Reteach
Ready Prerequisite Lessons *45–90 min*

Grade 1
- Lesson 13 *Understand* Sums Greater than 10
- Lesson 14 Make a Ten to Add

Teacher-led Activities
Tools for Instruction *15–20 min*

Grade 1 *(Lessons 13 and 14)*
- Doubles Addition Facts
- Make a Ten to Add within 20

Student-led Activities
Math Center Activities *30–40 min*

Grade 2 *(Lesson 5)*
- 2.13 Skip Count by 5s
- 2.9 Use Array Vocabulary
- 2.10 Use Arrays to Add

Personalized Learning

i-Ready.com

Independent
i-Ready Lessons* *10–20 min*

Grade 1 *(Lessons 13 and 14)*
- Addition Number Sentences
- Addition Facts for 10

Opening Activity

Build Arrays

Objective Learn the terms *row* and *column*, and arrange a set of objects in equal rows and columns.

Time *20–30 minutes*

Materials for each student

- Square tiles (cut from Activity Sheet 3, 1-Inch Grid Paper)

Overview

Students arrange square tiles in equal rows and equal columns. They discover that there can be more than one way to do this.

Step By Step

1 Model equal rows and columns.

- Model an array with 2 rows and 3 columns of tiles. Ask students how many tiles there are going across and down. Then have students find the total number of tiles. [3 across; 2 down; 6 total]
- Move the tiles to make an array with 3 rows and 2 columns. Encourage students to compare this array with the previous one. Help them recognize that the total number of tiles is the same in both arrays, but the number going across and down is different.

2 Introduce the terms *row* and *column*.

- Explain that the tiles are arranged in *rows* (going across) and *columns* (going down).
- Ask students what they notice about the number of tiles in each row. [The number of tiles in each row is the same.] Ask what they notice about the number of tiles in each column. [The number of tiles in each column is the same.]

3 Make equal rows and columns with 8 tiles.

- Give individual students 8 tiles, and ask them to arrange the tiles in equal rows and equal columns.
- Once students have finished making their arrays, invite volunteers to describe what the arrays look like by telling the number of tiles in each row and column.
- Draw pictures of the arrays on the board. Guide students to understand that there is more than one way to arrange objects to make an array. Encourage them to find all possible ways to arrange the 8 tiles. [1 × 8, 8 × 1, 2 × 4, 4 × 2]
- You may want to challenge students to think of an easy way of finding the total number of tiles in the array.

Teacher Notes

Introduction

At A Glance

Students analyze an array and write an equation with equal addends to find the total number of objects in the array. Then students examine a different representation of the array, using dots instead of pictures of hats. They learn array vocabulary and analyze an array.

Step By Step

- Work through **Use What You Know** as a class.
- Instruct students to look at the picture of hats on shelves. Ask what they notice about the way the hats are arranged.
- Have students read the problem at the top of the page. Complete Parts a–e together.
- If necessary, instruct students to circle the group of 4 hats on each shelf for visual reinforcement.
- Make sure students write the equation as a sum of the addend 4 repeated 3 times.

Note: Repeated addition is an underlying concept of multiplication and division. Recognizing 12 in terms of 3 groups of 4 leads to the understanding of multiplication as the process of combining equal-sized groups and division as the process of separating into equal-sized groups.

SMP TIP Model with Mathematics
Help students recognize that writing an equation is a way to represent the addition found in the visual model by asking them to explain how the equation relates to the picture of the hats. *(SMP 4)*

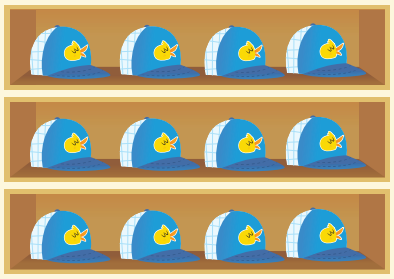
▶ Mathematical Discourse

▶ Concept Extension

Use What You Know

Review adding 3 one-digit numbers.

Rob's team has shelves for their hats. How many hats are there in all?



a. Does each shelf have the same number of hats? yes

b. How many hats are on each shelf? 4

c. How many shelves are there? 3

d. Look at the lines at the right. Each line shows one shelf. Use numbers to write how many hats are on each shelf.

4
4
4

e. Use your answer to Problem d. Write an equation to show the total number of hats.

4 + 4 + 4 = 12

▶ Mathematical Discourse

Why is it helpful to add 4 three times rather than just counting all the hats on the shelves?

Listen for responses that indicate students recognize that the repeated addition is a faster way to calculate.

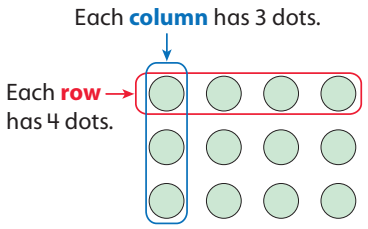
▶ Concept Extension

Develop the concept of an array as a rectangular shape.

- Ask: *How would the hats be arranged if there were 4 shelves and each shelf had an equal number of hats? Why?* Provide students with small counters to explore this idea. You may want to provide lined paper for them to use as shelves.
- Watch to make sure students arrange the counters on their paper to form 3 columns and then point out the rectangular shape of the hats on the shelf.
- Challenge students to arrange the 12 counters in different numbers of equal rows and columns. Students can make the following arrays: 1×12, 12×1, 2×6, 6×2.

Find Out More

The hats on shelves on the previous page show an **array**. An array has **rows** and **columns**. Here is the same array made out of dots instead of hats.



In an array,

- every row has the same number of objects.
- every column has the same number of objects.

Reflect Work with a partner.

1 Talk About It Kimi makes an array using 10 stamps. Her array has 2 rows. How many stamps are in each column? Explain how you know.

Write About It Each column has 2 stamps. Possible answer: Put 10 objects into 2 rows. There are 5 stamps in each row. So there are 5 columns in the array and 2 stamps in each column.

Step By Step

- Read and discuss **Find Out More** as a class.
- Draw attention to the vocabulary words *array, row,* and *column*. Discuss each term, ensuring students understand their meanings.

English Language Learners

- To reinforce the idea that the dots on the page represent any object, use the Hands-On Activity.

Hands-On Activity

- Instruct students to complete the **Reflect** question with a partner. Allow students to use tiles or counters, if necessary, to make sense of the problem.
- Encourage students to share their solutions using the vocabulary words they learned. If no one mentions it, point out that the number of rows is the same as the number in each column. Also, the number of columns is the same as the number in each row.

Real-World Connection

Ready Mathematics PRACTICE AND PROBLEM SOLVING

Assign *Practice and Problem Solving* **pages 37–38** after students have completed this section.

English Language Learners

Reinforce the vocabulary by replicating the array of 12 dots on the board. Write the word *array* above it and label the rows and columns. Keep the drawing on display throughout the lesson.

Hands-On Activity

Use classroom objects to make arrays.

Using a variety of classroom objects, ask students to replicate the array of 12 dots. Students might use connecting cubes, counters, tiles, and so on. Discuss how all of these arrays are alike. [They all have 3 rows with 4 objects in each row, and 4 columns with 3 objects in each column.] Tell students that the array of dots can be used as a picture to stand for any of the arrays of real objects they made.

Real-World Connection

Arrays are used in the real world as an organizational structure. Encourage students to generate ideas of places where they have seen arrays. Responses may include: desks in a classroom, seats in a theater, eggs in a carton, stamps on a sheet, boxed items such as glassware, etc. You may want to have some array examples available for students to examine.

Modeled and Guided Instruction

At A Glance

Students use an array as a representation for solving an addition problem. They write an equation and use skip counting to model the number of objects in the array. Then students use an equation and skip counting to find the total number of items in the array.

Step By Step

- Read the problem at the top of the page together as a class. Make sure students understand the situation posed.

Picture It

- Instruct students to look at the array and tell how many rows and how many columns they see. If necessary, project the array or draw it on the board and ask students to come up and point to and count each row and column.
- Use Mathematical Discourse question 1 to reinforce the concept of an array.

▶ **Mathematical Discourse 1**

Model It

- Direct students to look at the equation. Ask how many 5s are added together. [4] Connect this to the 4 groups of 5, or 4 rows of 5, in the array.

Model It

- Ask students to relate the skip counting to both the array and the equation. It is important that they understand the relationship among all representations.

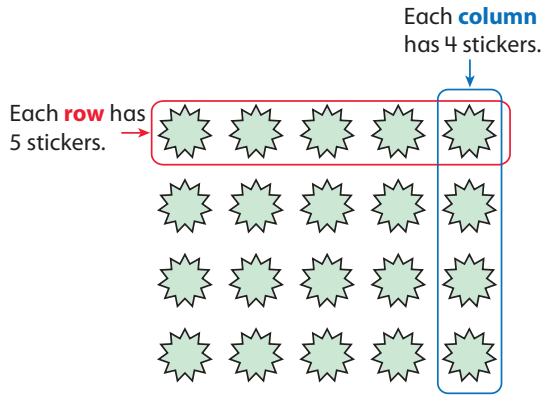
SMP TIP Model with Mathematics
The representations on the page reinforce that repeated addition and skip counting by a number are both ways to find the total items in an array. *(SMP 4)*

Learn About **Adding Using Arrays**

Read the problem. Then you will look at ways to use an array.

Mike puts some stickers into an array. Each row has 5 stickers. Each column has 4 stickers. How many stickers are there in all?

Picture It **You can draw an array.**



Model It **You can use the rows in the array to write an equation.**

Add the number of stickers in each row.
Each row has 5 stickers ⟶ 5 + 5 + 5 + 5 = ?

Model It **You can use the rows in the array to skip count.**

There are 5 stickers in each row. Skip count by 5s ⟶ 5, 10, 15, 20.

▶ **Mathematical Discourse**

1 *If Mike had 3 more stickers, could he make another row or column in this array? Why or why not?*

Students should respond that he could not make another row or column because there aren't enough extra stickers to fill up an entire row or an entire column.

Connect It Use the array and models to solve the problem.

2 Look at the first *Model It* on the previous page. Why is 5 written four times in the equation?

I have to add the four rows of 5 stickers.

3 Write an equation you could use to find the total number of stickers using the columns.

4 + 4 + 4 + 4 + 4 = ?

4 Look at the second *Model It* on the previous page. Why do you skip count by 5s?

You skip count by 5s to add each row of 5 stickers.

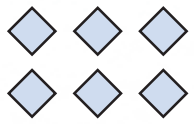
5 **Talk About It** Work with a partner.

Do you need to see the array from *Picture It* to solve the problem on the previous page?

Write About It Possible answer: No. You don't have to see the array if you know how many rows and columns it has.

Try It Try another problem.

6 Write two equations you could use to find the total number of shapes in this array.



3 + 3 = 6

2 + 2 + 2 = 6

Mathematical Discourse

2 *Why do you think adding the stickers in the columns gives you the same answer as adding the stickers in the rows?*

Listen for responses that indicate students recognize that the total number of stickers remains the same no matter how they are added.

3 *How could you skip count to find the total number of stickers by using the columns?*

Students should recognize that they can skip count by 4s, since there are 4 stickers in each column: 4, 8, 12, 16, 20.

Step By Step

Connect It

- Organize students in pairs to complete the questions.
- Remind students that the questions in **Connect It** refer to the problem on the previous page.
- Tell students that Problem 3 asks them to think about the array in a different way. Make sure they understand that they are now adding the number in each column.

SMP TIP Look for Structure
Adding both the number of objects in each row and in each column to get the same total can help students recognize the commutative nature of an array. *(SMP 7)*

Mathematical Discourse 2

- After students complete Problem 4, ask Mathematical Discourse question 3 to help students recognize that they can also skip count using the columns.

Mathematical Discourse 3

Try It

6 **Solution**
3 + 3 = 6 and 2 + 2 + 2 = 6; Students write one equation in which the addends are the number of shapes in each row and another equation in which the addends are the number of shapes in each column.

Error Alert Students who write the equation 2 + 3 = 5 added the number of rows and number of columns in the array.

Ready Mathematics PRACTICE AND PROBLEM SOLVING

Assign *Practice and Problem Solving* **pages 39–40** after students have completed this section.

Guided Practice

At A Glance

Students practice what they know about repeated addition and skip counting to solve array problems.

Step By Step

- Draw students' attention to the example problem. Lead them to recognize that when there is an even number of rows or columns, grouping doubles can make mental calculation easier.
- Instruct students to solve the problems individually. Direct their attention to the hints given to help them think about and solve the problems. For Problem 9, encourage students to use the open space to draw the array and check the given response for reasonableness. Then they can look back at the original problem to see why Vic may have chosen B.
- **Pair/Share** As students complete the problems, have them Pair/Share with a partner to discuss solutions.

Solutions

7 **Solution**
15 pieces; Students may add 5 three times or add 3 five times. Students may also skip count.
DOK 2

Practice Adding Using Arrays

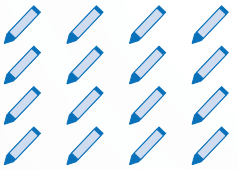
Study the model below. Then solve Problems 7–9.

Example

There are 4 rows of crayons in a box. Each row has 4 crayons. How many crayons are in the box?

You can show your work using an array.

4 rows of 4
4 columns of 4



4 + 4 + 4 + 4
8 + 8 = 16

Answer 16 crayons

7 In a game, players put pieces in 3 columns. Each column holds 5 pieces. How many pieces fill all 3 columns? Draw an array as part of your answer.

Show your work.

Possible student work:

5 + 5 + 5 = 15

Answer 15 pieces

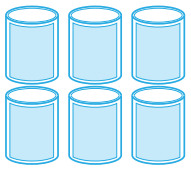
Teacher Notes

8 A package has 2 rows of soup cans. Each row has 3 cans. How many cans of soup are in the package? Draw an array as part of your answer.

Show your work.

You can add the numbers in each row or the numbers in each column.

Possible student work:



2 + 2 + 2 = 6

Answer 6 cans of soup

9 Some students line up in 2 rows to play catch. Each row has 8 students. How many students play catch?

A 8

B 10

C 16

D 18

What number can you skip count by to find the answer?

Vic chose **B** as the answer. This answer is wrong. How did Vic get his answer?

Possible answer: Vic added 8 + 2. He should have added 8 + 8.

Teacher Notes

Solutions

8 Solution

6 cans; Encourage students to describe the strategy they used to solve the problem.

DOK 2

9 Solution

C; Add 8 (the number of students in a row) 2 times (the number of rows).

Explain to students why the other two answer choices are not correct:

A is not correct because 8 is the number in only 1 row.

D is not correct because 8 + 8 = 16, not 18.

DOK 3

Ready **Mathematics** PRACTICE AND PROBLEM SOLVING

Assign *Practice and Problem Solving* **pages 41–42** after students have completed this section.

Independent Practice

At A Glance

Students solve problems involving arrays that may appear on a mathematics test.

Solutions

1 **Solution**

A and **B**; Adding the number in each row or column will result in the correct response.

DOK 1

2 **Solution**

B; The array is organized in 2 rows of 5.

DOK 1

3 **Solution**

B and **C**; Adding the number in each row or column will result in the correct response.

DOK 2

Practice Adding Using Arrays

Solve the problems.

1 Which equation shows the total number of hearts in this array? Circle all the correct answers.

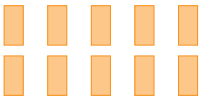
(**A**) $6 + 6 + 6 = 18$

(**B**) $3 + 3 + 3 + 3 + 3 + 3 = 18$

C $6 + 3 = 9$

D $3 + 3 + 3 = 9$

2 Which doubles fact can you use to find the total number of shapes in this array? Circle the correct answer.



A $5 + 2 = 7$

(**B**) $5 + 5 = 10$

C $2 + 2 = 4$

D $10 + 10 = 20$

3 Olga draws an array of dots. The array has 3 columns. The first column has 4 dots. Which equation can you use to find the total number of dots? Circle all the correct answers.

A $3 + 3 + 3 = ?$

(**B**) $3 + 3 + 3 + 3 = ?$

(**C**) $4 + 4 + 4 = ?$

D $4 + 4 + 4 + 4 = ?$

Quick Check and Remediation

- Jeremy makes an array of marbles. He makes 4 rows and 5 columns. How many marbles does he have? [20]
- For students who are still struggling, use the chart to guide remediation.
- After providing remediation, check students' understanding by posing the following problem: There are 8 juice boxes in a package. There are 2 rows of boxes. How many are in each row? [4] Ask students to explain how they found the total number in each row. Help students recognize that the number in each row is the same as the number of columns.

If the error is . . .	Students may . . .	To remediate . . .
9	have added the given numbers.	Ask students to draw the array, ensuring they are making equal-sized rows and columns. Help them understand how to use addition to find the answer.
10	have added two 5s instead of four 5s.	Have students reread the problem. Ask how many rows there are and how many are in each row. Lead them to see that 5 is added 4 times, or 10 is added 2 times.
any other number	have drawn the array incorrectly.	Remind students that an array has the same number of items in each row and the same number in each column. Help students correct their drawings and try to solve the problem again.

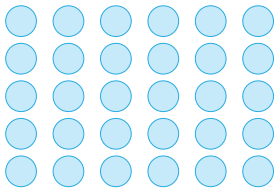
4 Dana makes an array using these rules.

- The number in each row is different from the number in each column.
- There is more than one row and more than one column.

Tell if each number could be the number of objects in Dana's array. Circle *Yes* or *No* for each number.

a.	6	(Yes)	No
b.	17	Yes	(No)
c.	9	Yes	(No)
d.	15	(Yes)	No

5 Draw an array with 5 rows. Put 6 objects in each row. Show how to use doubles facts to find the total number of objects.



Possible answer:

5 + 5 + 5 + 5 + 5 + 5
10 + 10 + 10 = 30

6 Show or explain how you can use skip counting to check your answer to Problem 5.

Possible answer: There are 6 columns with 5 in each column. I can count by 5 six times. 5, 10, 15, 20, 25, 30

Self Check **Now you can solve problems using an array. Fill this in on the progress chart on page 1.**

Solutions

4 Solution

a. **Yes**; b. **No**; c. **No**; d. **Yes**; 6 objects can be arranged in an array with three rows of two; 15 objects can be arranged in five rows of three objects.

DOK 3

5 Solution

The arrays should be in a rectangular shape with 5 rows, 6 in each row. Students might add the number in each column since there is an even number of columns.

DOK 3

6 Solution

Students may count by 5s or by 6s.

DOK 2

▶ Hands-On Activity

Create and record arrays.

Materials: counters

- Give each student 18 counters and have them arrange the counters in 2 equal rows. Check to make sure the counters are arranged in 2 rows, with 9 counters in each row. Discuss how many counters are in each row and column, and how many there are in all.
- Challenge students to work with a partner to find as many arrays as possible for the number 18. [Possible arrays: 1×18, 18×1, 2×9, 9×2, 3×6, 6×3]

▶ Challenge Activity

Search for prime numbers.

Materials: counters

- Provide students with 20 counters. Ask them to arrange groups of 2, 3, and 5 counters in separate arrays. Ask what all these arrays have in common. [Each array has only 1 row or 1 column.]
- Challenge students to find other numbers (to 20) that can only be arranged in either 1 row or 1 column when making an array. [7, 11, 13, 17, 19]
- Discuss students' findings.

LESSON QUIZ

Lesson 5
Add Using Arrays

Teacher-Toolbox.com

Overview

Assign the Lesson 5 Quiz and have students work independently to complete it.

Use the results of the quiz to assess students' understanding of the content of the lesson and to identify areas for reteaching. See the Lesson Pacing Guide at the beginning of the lesson for suggested instructional resources.

Tested Skills

Problems on this assessment form require students to be able to interpret an array with up to 8 rows and 8 columns, calculate the number of items in an array using repeated addition and skip-counting, and write an equation to express the sum of items in an array. Students will also need to be familiar with adding 3 one-digit numbers, and skip-counting by numbers up to 10.

***Ready*® Mathematics**

Lesson 5 Quiz

Solve the problems.

1 Clara makes an array with lemons. She puts 3 lemons in each row. She has 4 rows of lemons.

Which equation can be used to find how many lemons are in Clara's array?

Circle all the correct answers.

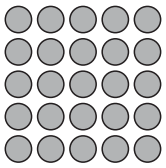
A $4 + 4 + 4 = ?$

B $4 + 4 + 4 + 4 = ?$

C $3 + 3 + 3 = ?$

D $3 + 3 + 3 + 3 = ?$

2 Josh makes this array.



He finds the number of dots in all by skip-counting the columns. What numbers does Josh use to skip-count?

Circle the correct answer.

A 3, 6, 9, 12, 15

B 5, 10, 15, 20, 25

C 6, 12, 18, 24

D 36, 42, 48, 54

Lesson 5 Quiz continued

3 Mark makes an array using these rules:

- The number in each row is the same as the number in each column.
- There are more than two rows and more than two columns.

Tell if each number can be the total number of objects in Mark's array.

Circle *Yes* or *No* for each number.

a. 25 Yes No

b. 12 Yes No

c. 10 Yes No

d. 4 Yes No

4 Reba has rows of flowers in her garden. Each row has the same number of flowers.

Reba says there are $8 + 8 + 8 = 24$ flowers.

Draw an array that shows Reba's equation.

Common Misconceptions and Errors

Errors may result if students:

- mistakenly add the number of rows and columns instead of the number of objects in each row.
- began skip-counting from the wrong number or by the wrong number.
- confuse the terms *rows* and *columns*.
- count the number of objects in a row or column incorrectly.

***Ready*® Mathematics**

Lesson 5 Quiz Answer Key

1. A, D
DOK 2

2. B
DOK 1

3. **a.** Yes
b. No
c. No
d. No
DOK 3

4. Students should draw an array with 3 rows of 8 objects or an array with 8 rows of 3 objects.
DOK 2