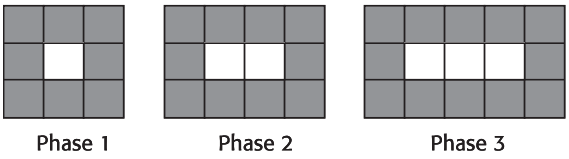
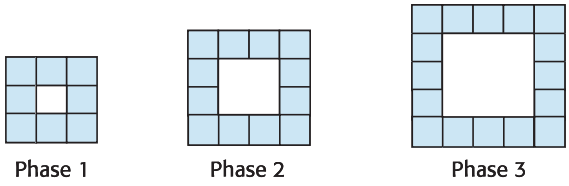
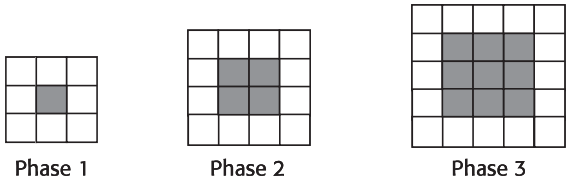
Grade 4 Learning Activity
Picnic Partners

OVERVIEW







This learning activity can be used to introduce students to the exploration of growing patterns (sequences). The context is the seating around a picnic table. Students learn about or review the use of T-charts and are introduced to the concept of pattern rules. By solving the problem, students will represent their thinking about patterns in a variety of ways, including concrete materials (manipulatives), numbers, words, tables, diagrams, and graphs. As students model and explain their representations of the patterns, they will build connections from concrete experiences toward generalizations of their findings using mathematical language.

Prior to this learning activity, students should have had some experience with extending simple number patterns, using charts to display data, using concrete materials to represent patterns, and representing simple geometric patterns with the aid of a number sequence, a number line, or a bar graph.

BIG IDEA

Patterns and relationships

CURRICULUM EXPECTATIONS

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

Students will:

- extend, describe, and create repeating, growing, and shrinking number patterns (e.g., "I created the pattern 1, 3, 4, 6, 7, 9, … . I started at 1, then added 2, then added 1, then added 2, then added 1, and I kept repeating this.");

- connect each term in a growing or shrinking pattern with its term number (e.g., in the sequence 1, 4, 7, 10, …, the first term is 1, the second term is 4, the third term is 7, and so on), and record the patterns in a table of values that shows the term number and the term;
- create a number pattern involving addition, subtraction, or multiplication, given a pattern rule expressed in words (e.g., the pattern rule "start at 1 and multiply each term by 2 to get the next term" generates the sequence 1, 2, 4, 8, 16, 32, 64, …);
- make predictions related to repeating geometric and numeric patterns.

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

Students will:

- describe, extend, and create a variety of numeric and geometric patterns, make predictions related to the patterns, and investigate repeating patterns involving reflections.

TIME:
2 hours

ABOUT THE LEARNING ACTIVITY

MATERIALS

- interlocking cubes or two-coloured tiles (about 80 per pair of students)
- graph paper
- grid chart paper, markers
- calculators
- **PA.BLM4a.1: Space Station Challenge** (1 per student)
- **PA.BLM4a.2: Space Station Challenge Home Connection** (1 per student)

MATH LANGUAGE

- growing pattern
- sequence
- border
- perimeter area
- T-chart

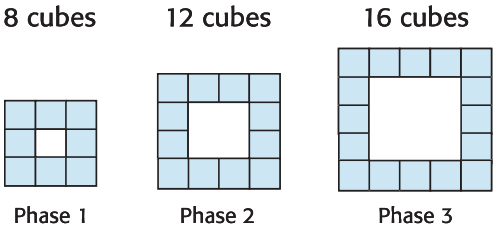
ABOUT THE MATH

INSTRUCTIONAL GROUPING:

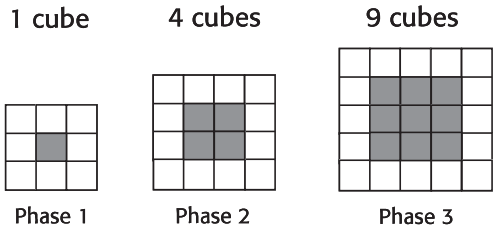
whole group, pairs/small group

DIFFERENT GROWTH PATTERNS

Consider the difference between these two growth patterns. The first pattern grows when the same number is added to each term – that is, the pattern grows at a constant rate of 4. The second pattern grows when an increasing amount is added to each term – that is, the growth rate of the pattern is not constant.



Same number added to each term



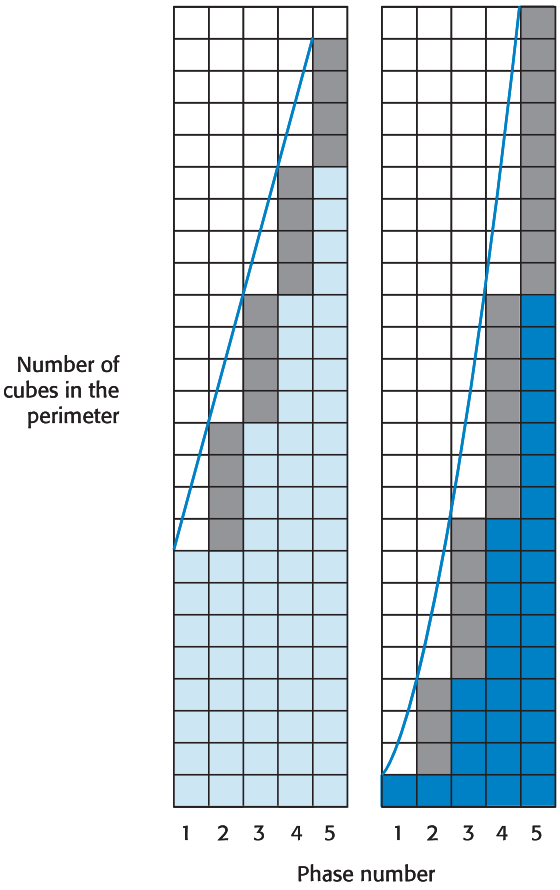
Increasing number added to each term

The bar graphs on the right show the number of shaded squares in the patterns. Notice that the bars that grow by adding the same number form a straight line pattern while the bars that grow by adding an increasing amount form a curve.

Legend

= border cube
= inner cube
= cube representing growth

Number of cubes by phase number



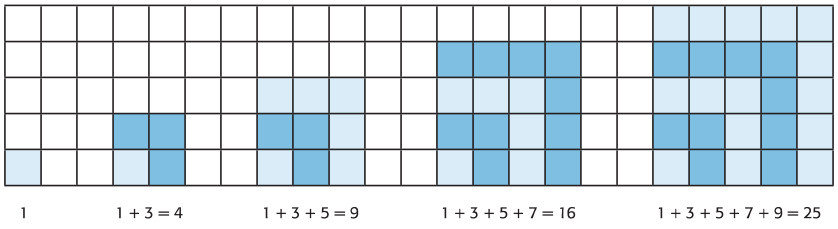
THE GROWTH PATTERNS

The table below shows how the two types of pattern grow.

Dimensions of the Phases	Number of Border Cubes	Border Growth	Number of Inner Cubes	Inner Growth
3×3	8		1	
		$+ 4$		$+ 3$
4×4	12		4	
		$+ 4$		$+ 5$
5×5	16		9	
		$+ 4$		$+ 7$
6×6	20		16	
		$+ 4$		$+ 9$
7×7	24		25	

Notice that the border-cubes pattern grows at a constant rate (4 squares each time), while the inner-cubes pattern does not. The inner-cubes pattern starts with 1 cube, then 3 more are added, then 5 more are added, then 7 more, and so on. The inner-cubes growth is represented by odd numbers, but notice that when consecutive odd numbers starting with 1 are added together, the sum is a square number. Examples: $1 + 3 = 4$, $1 + 3 + 5 = 9$, $1 + 3 + 5 + 7 = 16$.

The diagram below offers a visual representation of the growth pattern of the inner cubes.



Growth pattern of inner cubes

GETTING STARTED

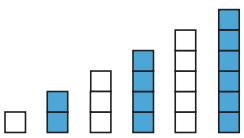
(Part 1 of the Three-Part Lesson)

INTRODUCING THE PROBLEM

The Getting Started part of the lesson provides an opportunity for students to activate their prior knowledge about exploring and generating patterns. Distribute 30 cubes or colour tiles, half in one colour and half in a second colour, to each student. Ask students:

What pattern can you create with coloured tiles? When you have finished, turn to your learning partner and ask them to analyse your pattern to discover the rule for your pattern.

Some anticipated student responses might include:



By observing the students' patterns and the questions they ask each other to determine the rule, the teacher assesses the range of thinking about patterns. The teacher can think about which students are using colour only as their pattern, which students show growth patterns in their work, and which students selected repeating patterns in their work. Creating the patterns activates the students' knowledge about patterns before engaging in the focus problem of the lesson, and it provides the teacher an opportunity to think about how the lesson will engage each learner in further development of their understanding.

WORKING ON IT

(Part 2 of the Three-Part Lesson)

Organize students for whole-group discussion (e.g., sitting in a circle at their desks or on the floor). Pose this problem for the students:

The Grade 1 teacher has asked our class to help her with a problem. She is planning a picnic for her class, and each student is going to bring one visitor. She started planning the seating by drawing a picture of the picnic table. (Draw Table 1 on the board.)

She thinks that 8 people can sit at one table, but that won't be enough seating for every student and every guest. She wants everyone to be able to sit at the same table.

If she pushed two tables together, 10 people could sit down.

1 Table 2 Tables

How many picnic tables will the Grade 1 class need to seat 30 people?

STAGE ONE: UNDERSTAND THE PROBLEM

Whole Group: Ask the students to turn to a partner and describe what they think the problem is asking them to do? Ask for a volunteer who feels able to explain to the class what the problem is asking. After the student provides the explanation, ask the class, "Is there anyone else who can explain it in a different way?" This exchange allows students to think about and articulate the problem. Tell students, "If you understand the problem, show me a 'thumbs up'; if you do not understand the problem, show me a 'thumbs down'." The teacher is able to quickly assess who understands the problem and is ready to work. Continue the conversation until all the students fully understand the problem.

STAGE TWO: MAKE A PLAN

Small Group: Provide each small group (3 or 4 students) with centimetre grid paper, markers, interlocking cubes, and colour tiles. Remind students that they may use any other tools or materials (manipulatives, calculators, or found materials) they want in order to solve the problem.

Allow students time to organize themselves and to discuss their thinking about how their group will solve the problem.

STAGE 3: CARRY OUT THE PLAN – SOLVE THE PROBLEM

Small Group: Students continue to work on solving the problem in their small groups. As students work, the teacher observes the groups and asks them questions to help them focus their thinking. It is critical that the teacher refrain from telling students how to solve the problem or from providing hints, as this will interfere with the students' construction of their own understanding. The teacher may ask questions such as:

- Can you tell me what you are doing?
- I don't understand that; can you explain it to me again?
- What are you noticing about the number of tables and the number of guests?
- Why did you choose to use the table of values to work on the problem?
- I'm still not sure if I understand how many picnic tables you think you will need. Can you tell me again?

STAGE FOUR: LOOK BACK AND REFLECT

Small Group: Ask each group of students to hang their solution on the board or wall. Provide students with sticky notes and direct them to take a gallery walk around the room to view each solution. While they are viewing the solutions, ask them to put any questions they have about the solutions on sticky notes and attach them to the group's solution.

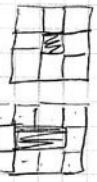
Whole Group: Provide opportunities for the students to meet with their groups to discuss the questions on the sticky notes. Ask each group to answer the sticky note questions in front of the whole group.

REFLECTING AND CONNECTING

(Part 3 of the Three-Part Lesson)

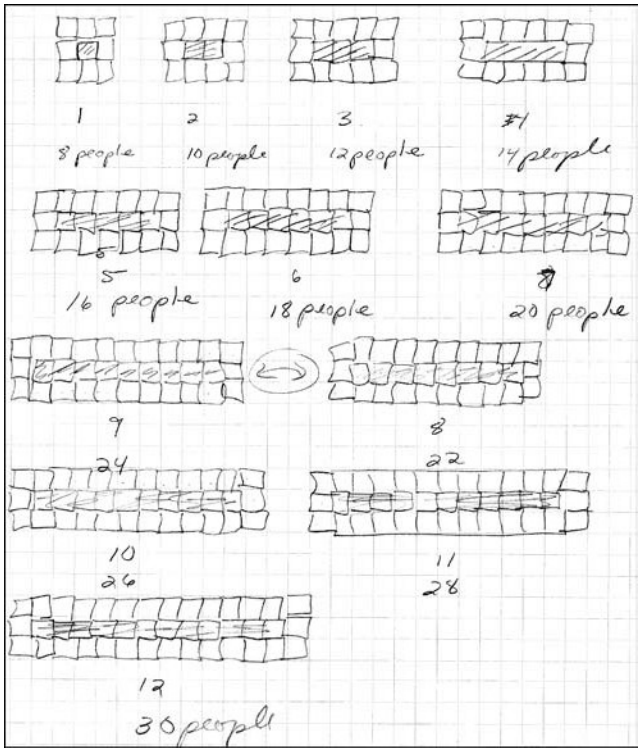
At this point in the lesson, students have had ample opportunity to solve the problem and record their thinking and representations on chart paper. The teacher selects three or four samples to use for the consolidation of the lesson. Different representations of the problem and the solution should be chosen to provide opportunities for rich discussion and dialogue about the mathematics. Anticipated student responses may include similar examples to these:

picnic tables	people
1	8
2	10
3	12
4	14
5	16
6	18
7	20
8	22
9	24
10	26
11	28
12	30



It goes up 2 each time.

She needs 12 tables.

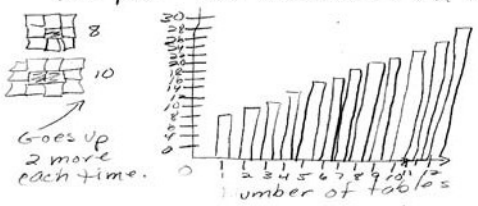


picnic tables	people
1	8
2	10
3	12
4	14
↓	↓
12	30

Grade 1's need 12 tables.

We saw that each table had six on both sides so every time we had to add 6. The double of the number of tables plus six tells how many people

We put our numbers in a graph.



When you get to 12 tables, you have 30 places for people to sit.

Provide time for each group of students to describe their solution. Ask them how they decided to represent their thinking. As students talk about their thinking, place strips of paper over the samples to notate their work (e.g., Table of Values, Graphics, Graphs, Number Sentence). Allow the students in the class to ask the group any clarifying questions after they have explained their solution. Then ask a student from the class to repeat in his or her own words what the group explained about their solution.

To demonstrate their understanding, students may have elected to:

- construct the table shapes with manipulatives;
- draw/shade a grid;
- complete a T-chart;
- explain a pattern rule;
- extend the pattern to 12 tables.

Scaffolding questions:
Does your model match the diagram? How many pieces did you need for each part? How many more did you use each time? Was it always the same?

Students may say that they were able to find the solution by counting desks and adding tables, by using a T-chart, by seeing a pattern. Students may say that the number of tables is doubled and then 6 is added to find out how many people can sit at the tables. As students describe this, the teacher can annotate on the board:

Student says: Double the number of tables and add 6.

Teacher writes: # of tables + # of tables + 6 = number of people.

The teacher may ask students if they can think of another way to write the rule of the pattern from the problem. Student responses might include:

2 × the # of tables plus 6.

2 × tables + 6 = # of people for the picnic.

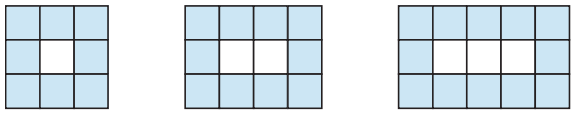
The process of using three or four samples from the students' work to discuss solutions, strategies, and representations is referred to as a "math congress". This term was coined by Cathy Fosnot in her work with elementary students. Mathematicians meet in a congress to discuss their ideas, provide proofs, and dialogue about math. The "math congress" provides students with an opportunity to learn through problem solving and creates differentiated instruction for all students in the learning environment. The congress helps students to construct the meaning of the mathematics as opposed to rigidly following rules that they may not understand.

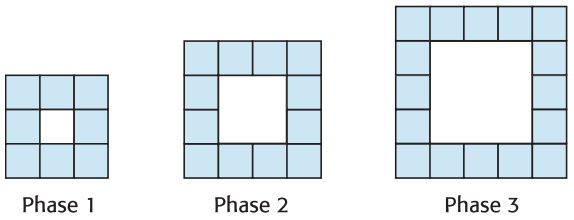
TIERED INSTRUCTION

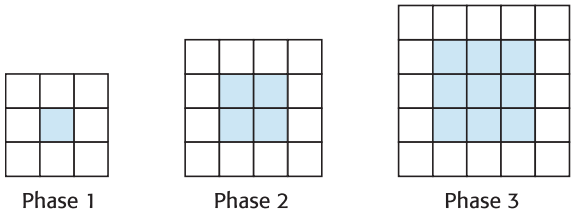
Supports and extensions can be beneficial for all students. For any given activity, there will always be some students who require more or less support, or for whom extensions will increase interest and deepen understanding.

EXTENSION

Students may want to consider the relationship discussed in the introduction to this activity. Distribute **PA.BLM4a.1.** Students will be able to build on their experience with the middle row below to try and discover the rule for the first and third rows below.







Pattern: Row 1
(as in the problem solved by students)

Phase	Pieces
1	8
2	10
3	12
4	14
5	16

Multiply the phase number by 2, then add 6 to get the number of pieces.

Pattern: Row 2

Phase	Pieces
1	8
2	12
3	16
4	20
5	24

Multiply the phase number by 4, then add 4 to get the number of pieces.

HOME CONNECTION

Extend the activity further by providing students with a different but similar pattern to work on at home. Distribute **PA.BLM4a.2** to students. This activity follows a format similar to the activity completed in class. Ask students to share with their parents what they have learned, and demonstrate their understanding of the concept using numbers, pictures, and words.

ASSESSMENT

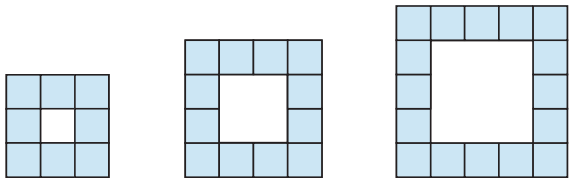
Use the students' discussions and representations to identify areas of focus for the next lesson. Assessment for learning uses observation and data collected by the teacher during the lesson to plan the next instructional focus. Assessment opportunities include:

- an interview or informal discussion during the activity;
- observation of progress as students move from one part of the lesson to the next;
- student responses to questions posed by fellow students at the math congress;
- written representations of the math on the solution charts.

SPACE STATION CHALLENGE

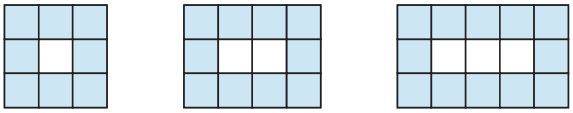
Part 1: Design A

The Canadian government wants to build an expandable space station that could provide classrooms for students who are studying outer space. Here is the design proposed by one company. The company provided a model made of cubes to show how the station might grow. The diagram shows the first three phases of the project. If the space station were to grow 2 more times, what would it look like?



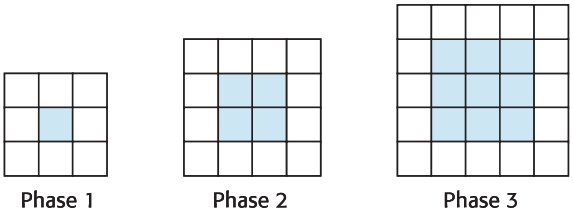
Part 2: Design B (Do not begin until Part 1 of the Project Status form is signed.)

Another company has submitted a different proposal for the space station. The first phase is also made up of 8 cubes. The model and its growth in the first three phases are represented at right. Compare Design B with Design A. At Phase 8, which design will involve more cubes? How do you know?

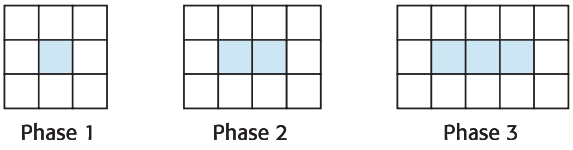


Part 3: Designs C and D

Each of the two companies also submitted a second design that is a variation on their first design. Notice that in Designs C and D the space station is constructed in the central space of Design A or Design B. Look at the central space created by Design A. Phase 1 is the size of 1 cube, Phase 2 is the size of 4 cubes, and Phase 3 is the size of 9 cubes. How large would the central space be for phase 5? Model the problem, record your results on a T-chart, and develop a pattern rule.



Design D uses the central space of Design B. Phase 1 is the size of 1 cube, Phase 2 is the size of 2 cubes, and Phase 3 is the size of 3 cubes. How large would the central space be for Phase 5? Model the problem, record your results on a T-chart, and develop a pattern rule.



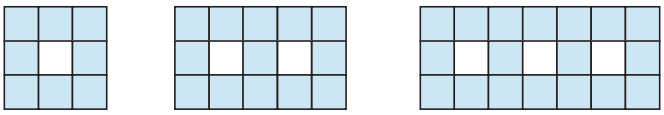
SPACE STATION CHALLENGE HOME CONNECTION

Dear Parent/Guardian:

In math we are currently exploring many types of patterns. The class has already examined four possible designs for an expandable space station to provide classrooms for students who might one day study in outer space.

This home task builds on the activity by presenting a new design for consideration. Please ask you child to investigate the following problem:

The Canadian government has just considered four proposals for the design of an expandable space station. A fifth design has been submitted, and as with the other designs, a model made of cubes demonstrates how this design would grow. The diagrams below show the first three phases of construction. If the space station were to grow 2 more times, what would it look like? How many cubes would there be in that phase (Phase 5)? What is the pattern rule?



Phase 1 Phase 2 Phase 3

Your child could solve this problem by building a model, drawing a diagram, or using a T-chart (shown on the right).

Back in class, students will be asked to share their solutions with their classmates.

Phase	Pieces
1	8
2	
3	
4	
5	