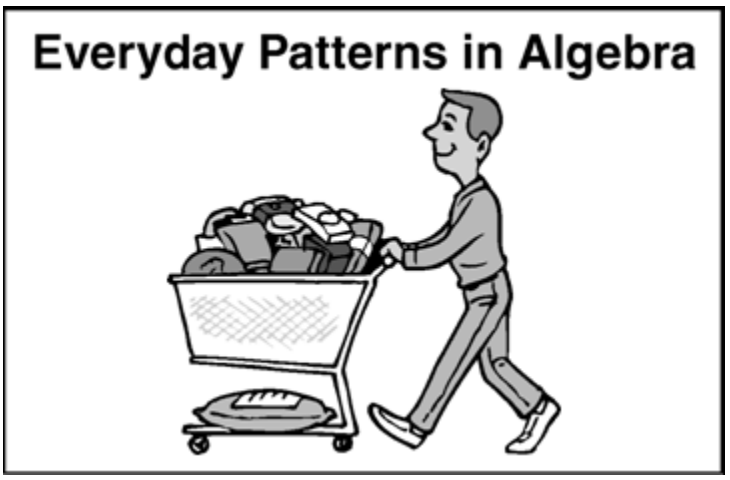
SITES-M Mathematics Challenge



Level: Grade Two

Standard: Algebra

Learning Target: Focus on Patterns

Checks for Understanding

0206.2.1	Starting at any number, count by fives and tens up to 1000.
0206.3.1	Given rules, complete tables to reveal both arithmetic and geometric patterns.
0206.3.2	Given a description, extend or find a missing term in a pattern or sequence.

SITES-M Mathematics Challenge

Grade 2–Focus on Patterns
Everyday Patterns in Algebra

The purpose of the Mathematics Challenges is to provide opportunities for students to develop and demonstrate understanding of important mathematical concepts and standards. Each Challenge includes a set of tasks that require higher-order thinking skills. Because these types of tasks may be new for students and they will have varying levels of understanding, the student responses will vary. The Challenges and guiding questions were designed to help teachers plan their implementation and elicit, analyze, and act on evidence of student understanding.

You will be able to choose which Mathematics Challenge Packet to implement each month, according to the learning needs of your students and your teaching context. Each packet contains all the materials necessary to implement the Mathematics Challenge including a grade-appropriate Challenge, the Mathematics Challenge Meeting Protocol, and the Guiding Questions for Analyzing Student Responses to Mathematics Challenges.

For each Challenge, you will complete a six step process of planning, implementation, and analysis and reflection.

The Mathematics Challenge Process

Stage	Step	Task
Planning	Step 1.	Review the Mathematics Challenge Meeting Protocol
	Step 2.	Review and solve the Mathematics Challenge prior to your Professional Learning Community (PLC) meeting. Think about your responses to the guiding questions on the Meeting Protocol
	Step 3.	Hold your PLC meeting and discuss your responses to the Guiding Questions on the Meeting Protocol
Implementation	Step 4.	Implement the Mathematics Challenge with your class
Analysis and Reflection	Step 5.	For your own planning and documentation, respond to the Guiding Questions on the Analyzing Student Responses Protocol
	Step 6.	To help us improve the Challenges and to provide recommendations for teachers implementing them in future years, complete the Mathematics Challenge Feedback Log and provide copies of all student work to the Assessment Coordinator

SITES-M Mathematics Challenge

Grade 2–Focus on Patterns
Everyday Patterns in Algebra

Mathematics Challenge Meeting Protocol

Each month, your Professional Learning Community will meet to discuss the implementation of one Mathematics Challenge. In preparation for your monthly meeting, please print and review this month's Mathematics Challenge, solve all tasks within the Challenge, and think about the guiding questions below. These questions will be used to facilitate a group discussion regarding the implementation of the upcoming Mathematics Challenge.

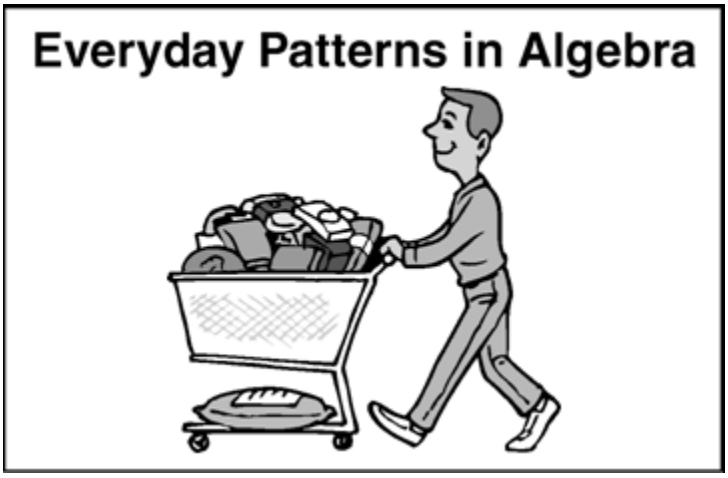
Guiding Questions for Implementing the Mathematics Challenges

1. What is the title of the Challenge that you will use this month?
2. What skills or standards is this Challenge measuring?
3. Where does this Challenge fit within your curriculum? Within which unit?
4. At what point during the unit will you administer this Challenge (e.g., At the beginning of a unit to determine what students do or do not know, at the end of a unit to assess what students have or have not learned, in the middle of a unit to determine where to go next instructionally)?
5. How will your students complete this Challenge (e.g., individually, one-on-one, in small groups, as a class)? Why?
6. Are there any prerequisite skills, common misunderstandings, or vocabulary needs that you will have to address? What are they?
7. What difficulties do you anticipate your students will have with the Challenge? How will you address them?
8. Are these skills and difficulties different for special needs students, ELL students, etc.? How? Will you do anything different for these students? What?
9. How will you evaluate student responses (e.g., grade responses with the provided rubric, scan responses to identify common mistakes/misconceptions, have students evaluate one another's responses, have students evaluate their own response)?
10. What will student responses to this Challenge tell you about student understanding?
11. How might you use this evidence of student understanding to adapt your teaching and learning?
12. What other materials, resources, or support might you need? Where can you get them?
13. How can your colleagues assist you in the analysis of student understanding?
14. What other questions or concerns do you have about this Mathematics Challenge?

After you have implemented the challenge with your class, be sure to respond to the Guiding Questions on the Analyzing Student Responses Protocol.

SITES-M Mathematics Challenge

Grade 2–Focus on Patterns



Standard: Algebra

Learning Target: Focus on Patterns

Claims:
Students should understand and be able to explain or demonstrate how to:

- ✓ Given rules, complete tables to reveal both arithmetic and geometric patterns;
- ✓ Given a description, extend or find a missing term in a pattern or sequence;
- ✓ Starting at any number, count by fives and tens up to 1000.

Task Preparation:
Each student will need a copy of the Student Response Sheet and a pencil.

Stimulus Cards (Drawing or Word Description):
None

Manipulatives/Supplies:
Pencils

SITES-M Mathematics Challenge

Grade 2–Focus on Patterns

Cues/Directions:

Distribute student response sheets. Students should be directed to look carefully at each figure. Allow students time to answer.

Instruct students to follow along as you read aloud and say: **Patterns can be used in different ways at the grocery store. Let's look at some of those ways.**

1. Say: **Look below at the pattern of flags outside the grocery store. (TEACHER NOTE:** Have students look at the pattern of flags.**) Look where the question mark is. Circle the flag below that you can put there to continue the pattern. (TEACHER NOTE:** Students should circle the correct flag.**) Circle the rule that describes the pattern of flags. (TEACHER NOTE:** Students should circle the correct pattern.**)**

2. **Each flag below has a number under it. Write the numbers for the first three striped flags. (TEACHER NOTE:** Students should write the correct numbers on the blanks.**) Write the numbers for the next two striped flags in the pattern. (TEACHER NOTE:** Students should write the correct numbers on the blanks.**) How do you know? (TEACHER NOTE:** Students should write their explanations in the box.**)**

3. **Each flag below has a number under it. Write the numbers for the first two dotted flags. (TEACHER NOTE:** Students should write the correct numbers on the blanks.**) Write the numbers for the next three dotted flags in the pattern. (TEACHER NOTE:** Students should write the correct numbers on the blanks.**) How do you know? (TEACHER NOTE:** Students should write their explanations in the box.**)**

4. **Every 5 minutes on one day, the store gives a prize to a different shopper. Complete the pattern below to show the number of minutes when the first eight prizes are given. (TEACHER NOTE:** Students should write the correct numbers on the blanks.**)**

5. **The spaces in the parking lot at the grocery store have numbers. The numbers form a pattern. What are the three missing numbers? (TEACHER NOTE:** Students should write the correct numbers on the blanks.**) Explain why one of the missing numbers CANNOT be 33. (TEACHER NOTE:** Students should write their explanations in the box.**)**

6. **(TEACHER NOTE:** This task may be a stretch for some students. If you feel it is beyond the scope of your class, you may omit it, use it as enrichment, or use it as a whole-class or small-group activity.**) The cereal boxes below are stacked in a pattern. (TEACHER NOTE:** Have students look at the rows of cereal boxes.**) There are 10 boxes left. Is that enough to fill in Row 4 and continue the pattern? Check one of the boxes. (TEACHER NOTE:** Students should check the correct box.**) How did you get your answer? (TEACHER NOTE:** Students should write their explanations in the box.**)**

SITES-M Mathematics Challenge

Grade 2–Focus on Patterns

Student Response Sheet

Everyday Patterns in Algebra

Name: _____ **Date:** _____

Patterns can be used in different ways at the grocery store. Let's look at some of those ways.

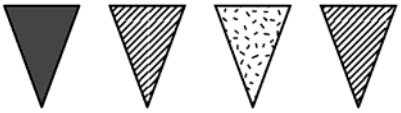
1. **Look below at the pattern of flags outside the grocery store.**

Look where the question mark is. Circle the flag below that you can put there to continue the pattern.

Circle the rule that describes the pattern of flags.

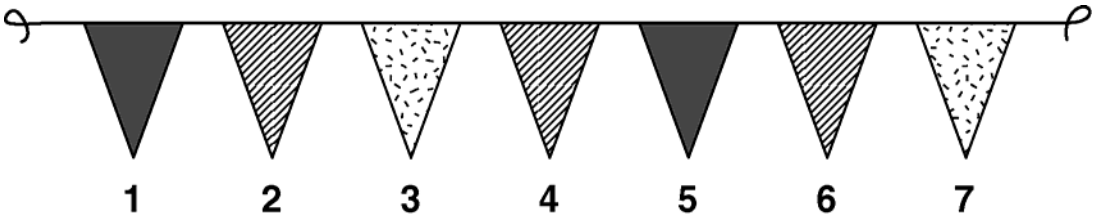
a. 

b. 

c. 

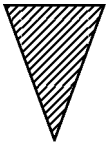
d. 

2. Each flag below has a number under it.



Write the numbers for the first three  **flags.**

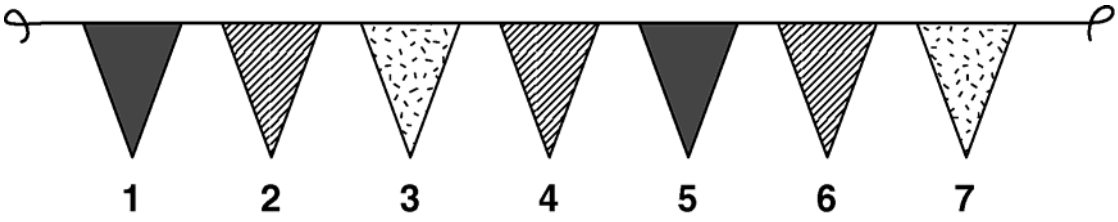
_____ _____ _____

Write the numbers for the next two  **flags in the pattern.**

_____ _____

How do you know?

3. Each flag below has a number under it.



Write the numbers for the first two  **flags.**

_____ _____

Write the numbers for the next three  **flags in the pattern.**

_____ _____ _____

How do you know?

4. Every 5 minutes on one day, the store gives a prize to a different shopper.

Complete the pattern below to show the number of minutes when the first eight prizes are given.

1st prize: 5 minutes

2nd prize: 10 minutes

3rd prize: _____ minutes

4th prize: 20 minutes

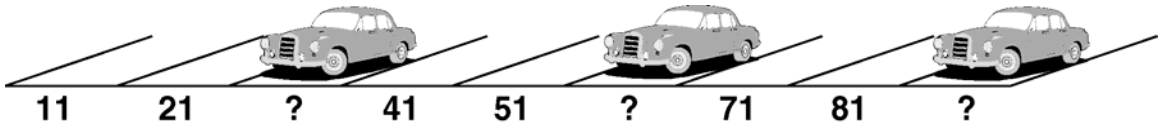
5th prize: _____ minutes

6th prize: _____ minutes

7th prize: 35 minutes

8th prize: _____ minutes

5. The spaces in the parking lot at the grocery store have numbers. The numbers form a pattern.



What are the three missing numbers?

_____ _____ _____

Explain why one of the missing numbers can NOT be 33.

6. The cereal boxes below are stacked in a pattern.

Row 1 

Row 2 

Row 3 

Row 4

There are 10 boxes left. Is that enough to fill in Row 4 and continue the pattern?

Check one: ☐ **Yes, 10 boxes are enough**

☐ **No, 10 boxes are <u>not</u> enough**

How did you get your answer?

Learning and Teaching Considerations

Task 1:

A) Be sure students understand the concept of a repeating pattern and how a pattern is extended or continued.

B) Be sure students understand that the core of the repeating pattern is the shortest string of elements that repeats. The teacher could use manipulatives such as pattern blocks or colored tiles to create a pattern, show two iterations of the pattern, and then ask students to use the pattern blocks to show how to continue the pattern and explain their thinking.

C) Students may have the misconception that the core of the repeating pattern is shorter or longer than the shortest string of elements that repeats. If this happens, ask them to convince you and the class that their pattern will always work

D) Students may have the misconception that the pattern does not continue after one or two iterations. Be sure students understand that patterns are continuous and go on infinitely.

Task 2:

A) Be sure students understand that the number patterns found in number sequences are based on a particular rule.

B) Be sure students understand that a rule is something that will always work. For example, the student might notice a recursive pattern in which the previous number is operated on to get the next number.

C) Students may have the misconception that the core of the repeating pattern is shorter or longer than the shortest string of elements that repeat.

D) Students may answer in words, symbols (such as the addition symbol), numbers, or by using manipulatives. They may also use number lines or charts. Be sure they understand that they can get the correct answer using any of these strategies. The teacher can also encourage them to link these strategies and/or representations to each other as a way to provide a convincing solution.

E) Students may describe even numbers.

F) Students may add 2 to the previous number each time to get the next number.

G) Students may skip 1 flag or 1 number each time to get the next number.

Task 3:

A) Students may add 4 to the previous number to get the next number.

B) Students may skip 3 flags or 3 numbers to get the next number.

C) If a student says or writes, "I just know," prompt him or her by saying something like, "I'm glad you know, but it's important in math to be able to explain your answers so other people can understand what you're thinking."

D) If a student says or writes, "I don't know," say something positive like, "Let's start with what you do know about this problem." Students often know more than they think or say, and encouraging them to vocalize or write about that knowledge is all they may need.

E) Be sure that students understand that the number pattern appears in that order and the numbers cannot be reversed or switched.

Task 4:

A) Students may add 5 to the previous number to get the next number. This is an example of a "recursive" rule; that is, a rule that uses the previous term to get the next term.

B) Students may multiply the prize number by 5 to get each number. This is an example of a "closed" rule; that is, a rule in which the term can be found directly from the row number. Students who produce a closed rule are thinking at a slightly higher level than those who produce a recursive rule.

C) Students may multiply the previous number by 5 to get the next number. This is a mistake that mixes together a recursive rule and a closed rule.

Task 5:

A) Students may recognize that the ones place always stays the same (with a 1) and the tens place increases consecutively.

B) Students may add 10 to the previous number to get the next number. Again, this is a recursive example.

C) Students may multiply the space number (beginning with space 1) by ten and add 1 each time. This is a closed-rule example.

D) Students may multiply the previous number by 10 to get the next number. This is a mistake that mixes together a recursive rule and a closed rule.

Task 6:

A) Students may add 3 boxes to the previous row to get the number of boxes in the next row.

B) Students may have the misconception that 11 boxes won't visually fit in row 4 and provide that reason.

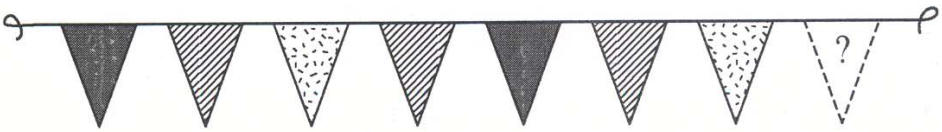
C) Students may multiply the row number, beginning with row 1, by 3, then subtract 1, to get the next number of boxes.

D) Students may multiply the previous number of boxes in each row by 3 to get the number of boxed in the next row. This is a mistake that mixes together a recursive rule and a closed rule.

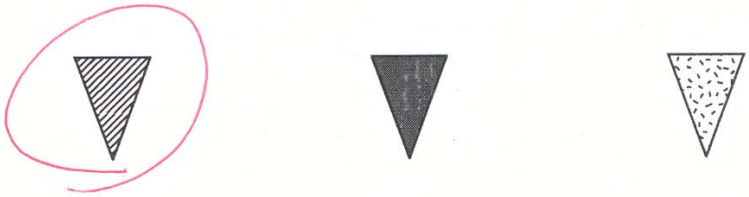
Name: ANSWER KEY Date: _____

Patterns can be used in different ways at the grocery store. Let's look at some of those ways.

1. **Look below at the pattern of flags outside the grocery store.**



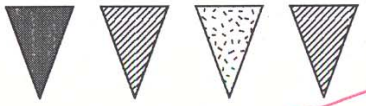
Look where the question mark is. Circle the flag below that you can put there to continue the pattern.



Circle the rule that describes the pattern of flags.

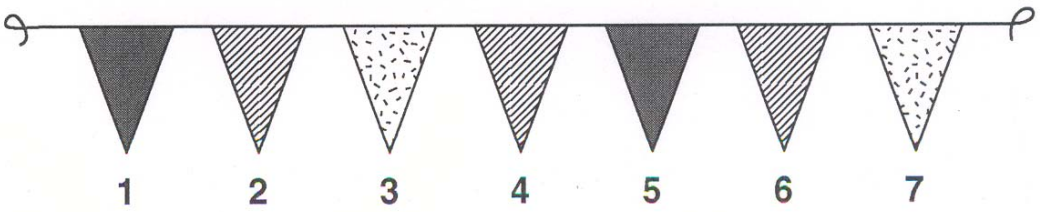
a. 

b. 

c. 

d. 

2. Each flag below has a number under it.



Write the numbers below for the first three  **flags.**

2 _____ 4 _____ 6 _____

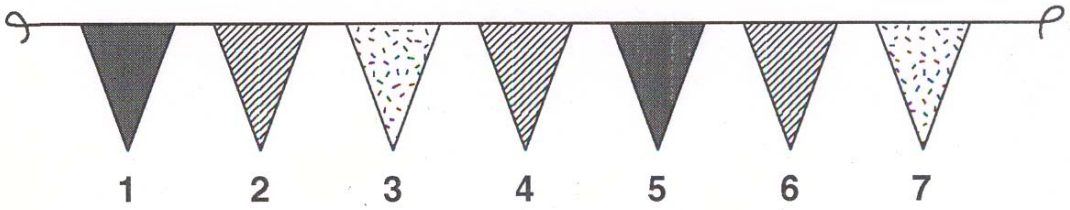
Write the numbers for the next two  **flags in the pattern.**

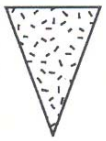
8 _____ 10 _____

How do you know?

THEY ARE EVEN NUMBERS.
OR EACH NUMBER IS 2 MORE THAN THE ONE BEFORE IT.
OR SKIP EVERY OTHER NUMBER

3. Each flag below has a number under it.



Write the numbers below for the first two  **flags.**

3 _____ 7 _____

Write the numbers for the next three  **flags in the pattern.**

11 _____ 15 _____ 19 _____

How do you know?

KEEP ADDING 4 TO GET THE NEXT NUMBER.

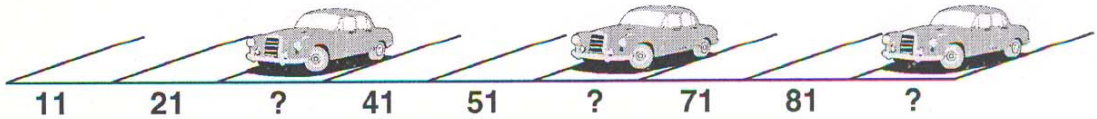
OR SKIP 3 NUMBERS BETWEEN EACH.

4. Every 5 minutes on one day, the store gives a prize to a different shopper.

Complete the pattern below to show the number of minutes when the first eight prizes are given.

1st prize:	5	minutes
2nd prize:	10	minutes
3rd prize:	15	minutes
4th prize:	20	minutes
5th prize:	25	minutes
6th prize:	30	minutes
7th prize:	35	minutes
8th prize:	40	minutes

5. The spaces in the parking lot at the grocery store have numbers. The numbers form a pattern.



What are the three missing numbers?

31 61 91

Explain why one of the missing numbers can NOT be 33.

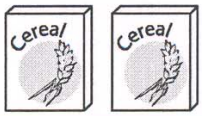
33 DOES NOT END IN 1.

OR COUNT BY 10s STARTING WITH 11 AND YOU DON'T GET 33.

OR EACH SPOT IS 10 MORE THAN THE ONE BEFORE & YOU DON'T GET 33.

HIGH LEVEL RESPONSE: 10n+1 WHERE n=1 IS THE FIRST SPACE & 33 DOESN'T FIT 10n+1.

6. The cereal boxes below are stacked in a pattern.

Row 1	
Row 2	
Row 3	
Row 4	

There are 10 boxes left. Is that enough to fill in Row 4 and continue the pattern?

Check one: ☐ **Yes, 10 boxes are enough**

☒ **No, 10 boxes are <u>not</u> enough**

How did you get your answer?

ROW 4 NEEDS 11 BOXES,
EACH ROW IS 3 MORE THAN
THE ROW BEFORE AND 8+3=11.

HIGH LEVEL RESPONSE: 3n−1, WHERE
n=1 IS ROW 1, n=2 IS ROW 2, ETC.

SITES-M Mathematics Challenge

Grade 2–Focus on Patterns
Rubric

CATEGORY	4	3	2	1
Mathematical concepts	**Response shows complete understanding of the mathematical concepts used to solve the problem(s).**	**Response shows substantial understanding of the mathematical concepts used to solve the problem(s).**	**Response shows some understanding of the mathematical concepts needed to solve the problem(s).**	**Response shows very limited understanding of the underlying concepts needed to solve the problem(s), OR the response is not written.**
	Response shows evidence in at least 5 of the following 6 tasks. **Task 1**. Student circles only flag with stripes and circles only choice c. **Task 2**. Student lists 2, 4, 6; student lists 8, 10. Student shows evidence of understanding pattern. **Task 3**. Student lists 3, 7; student lists 11, 15, 19. Student shows evidence of understanding pattern. **Task 5**. Student lists 31, 61, 91. Student shows evidence of understanding that 33 is not in pattern. **Task 6**. Student answers no only and shows evidence of understanding pattern.	Response shows evidence in only 4 of the tasks described; may exhibit the following errors. **Task 1**. Student circles more than one flag (including the striped flag). Student circles choice C and another choice. **Task 2**. Student describes a correct pattern for either dotted or shaded flag, or describes a pattern for all of the flags; e.g., add 1 to previous number. **Task 3**. Student describes a correct pattern for either striped or shaded flag, or describes a pattern for all of the flags; e.g., add 3 to previous number. **Task 4**. Student doubles previous number. **Task 5**. Student gives correct explanation with no numbers, or gives correct numbers with no explanation. **Task 6**. Student answers yes because of an addition error.	Response shows evidence in only 3 of the tasks; may exhibit errors as described in category 3.	Response shows evidence in 2 or fewer of the tasks; may exhibit errors as described in category 3.

SITES-M Mathematics Challenge

Grade 2–Focus on Patterns
Rubric

CATEGORY	4	3	2	1
Strategy and procedures	**Student typically uses an efficient and effective strategy to solve the problem(s).**	**Student typically uses an effective strategy to solve the problem(s).**	**Student sometimes uses an effective strategy to solve the problem(s), but not consistently.**	**Student rarely uses an effective strategy to solve the problem(s).**
	Response shows evidence in ALL of the following tasks. **Task 2**. Student shows evidence of a correct strategy or rule (related to even numbers, adding 2, or skipping 1 flag or number). **Task 3**. Student shows evidence of a correct strategy (adding 4 or skipping 3 flags or numbers). **Task 6**. Student shows evidence of a correct strategy (adding three boxes to the previous row).	Response shows evidence in only 2 of the tasks described in category 4.	Response shows evidence in only 1 of the tasks described in category 4.	Response shows no evidence of a correct strategy or rule.

SITES-M Mathematics Challenge

Grade 2–Focus on Patterns
Rubric

CATEGORY	4	3	2	1
Explanation and communication	**Explanation is detailed and clear; uses appropriate terminology and/or notation.**	**Explanation is clear; uses some appropriate terminology and/or notation.**	**Explanation is a little difficult to understand, but includes critical components; shows little use of appropriate terminology and/or notation.**	**Explanation is difficult to understand, is missing several components, and does not use or include appropriate terminology and/or notation.**
	Response shows evidence in ALL of the following tasks. **Task 2**. Student describes adding 2 to previous number, or says numbers are even, or numbers are not odd, or skipping one flag each time, or skipping one number each time. **Task 3**. Student describes adding 4 to previous number, or skipping 3 flags each time, or skipping 3 numbers each time. **Task 5**. Student says that 33 does not end in 1, or there is always a 1 in the ones place, or the pattern is add ten to the previous parking space. Higher-level thinking: the rule is $10n + 1$, where $n = 1$ is the first parking space, $n = 2$ is the second space, and so on. **Task 6**. Student describes adding 3 boxes to the previous row. Higher-level thinking: the rule is $3n - 1$, where $n = 1$ is row 1, and so on.	Response shows evidence in ALL of the tasks, but may lack detail in explanation, as evidenced by the following. **Tasks 2 and 3**. Student is not specific about what is added to the number, or does not say it is added each time, or shows the addition between 2 flags without showing that the pattern continues that way. **Task 6**. Student is not specific about what the number 3 is being added to, or the + 3 isn't near the third or fourth row.	Response shows evidence in only 1 or 2 explanations.	Response shows no explanations.

SITES-M Mathematics Challenge

Grade 2–Focus on Patterns
Rubric

CATEGORY	4	3	2	1
Mathematical accuracy	**All or almost all of the steps and solutions have no mathematical errors.**	**Most of the steps and solutions have no mathematical errors.**	**Some of the steps and solutions have no mathematical errors.**	**Few of the steps and solutions have no mathematical errors.**
	Student provides correct answers for at least 5 of the following 6 tasks. **Task 1**. Student circles both striped flag and choice c. **Task 2**. Student answers 2, 4, 6 in that order and 8, 10 in that order. **Task 3**. Student answers 3, 7 in that order and 11, 15, 19 in that order. **Task 4**. Student answers 15, 25, 30, 40 in that order. **Task 5**. Student answers 31, 61, 91 in that order. **Task 6**. Student answers No.	Student provides correct answers for only 4 of the tasks described in category 4.	Student provides correct answers for only 2 or 3 of the tasks described in category 4.	Student provides a correct answer for only 1 task or none of the tasks described in category 4.

SITES-M Mathematics Challenge

Grade 2–Focus on Patterns

Scoring Notes Checklist

Task	Check Yes	Category
Task 1		
Circles only flag with stripes and circles only choice c.		Concept
Correctly circles both striped flag and choice c.		Accuracy
Task 2		
Lists 2, 4, 6. Lists 8, 10. Shows evidence of understanding pattern.		Concept
Evidence of a correct strategy or rule (related to even numbers, adding 2, or skipping 1 flag or number).		Strategy
Describes adding 2 to previous number, or says numbers are even, or numbers are not odd, or skip one flag each time, or skip one number each time.		Explanation
Answers 2, 4, 6 in that order and 8, 10 in that order.		Accuracy
Task 3		
Lists 3, 7. Lists 11, 15, 19. Shows evidence of understanding pattern.		Concept
Evidence of a correct strategy (adding 4 or skipping 3 flags or numbers).		Strategy
Describes adding 4 to previous number, or skipping 3 flags each time, or skipping 3 numbers each time.		Explanation
Answers 3, 7 in that order and 11, 15, 19 in that order.		Accuracy
Task 4		
Answers 15, 25, 30, 40 in that order.		Accuracy
Task 5		
Lists 31, 61, 91. Shows evidence of understanding that 33 is not in pattern.		Concept
Says that 33 does not end in 1, or there is always a 1 in the ones place, or the pattern is add ten to the previous parking space. Higher-level thinking: the rule is the parking space number (ordered consecutively) times 10 +1 (10n+1).		Explanation
Answers 31, 61, 91 in that order.		Accuracy
Task 6		
Answers No only. Shows evidence of understanding pattern.		Concept
Evidence of showing a correct strategy (adding three boxes to the previous row).		Strategy
Describes adding 3 boxes to the previous row. Higher-level thinking: The rule can also be multiply the previous row number by 3 then add 2 [3(n-1)+2].		Explanation
Answers no.		Accuracy

SITES-M Mathematics Challenge

Grade 2–Focus on Patterns

Analyzing Student Responses Protocol

The purpose of the Mathematics Challenges is to provide opportunities for students to develop and demonstrate understanding of important mathematical concepts and standards. They include extended responses, open-ended tasks, and tasks that require higher-order thinking skills. Because these types of tasks may be novel for students and they will have varying levels of understanding, the student responses will vary.

The guiding questions below were designed to assist you in analyzing your class' response to the Challenge and determining appropriate next steps for your teaching and learning. Responses to these questions are for your reflection and documentation and will not be collected.

Guiding Questions for Analyzing Student Responses to the Mathematics Challenges

1. When completing the Challenge, what did your students do well? How do you know?

2. When completing the Challenge, what did your students struggle with? How do you know?

3. When your students completed the Challenge, did they implement multiple correct solutions strategies? What insightful approaches to problem solving did you observe?

4. What, if any, patterns (e.g., common errors/misconceptions) did you observe across your student responses?

5. What questions or concerns did your students have when working through this Challenge or a particular task? Are these things you should address for the class as a whole?

6. What, if any, feedback did you provide to your class? How did you provide it?

7. What did you learn about your students' mathematical understanding based on their responses to this Challenge?

Reminders:

1) After you have completed the Challenge with your class and responded to these Guiding Questions for Analyzing Student Responses, please complete the Challenge Feedback Log. A link to this Log is e-mailed to you each month. Responses will be used to improve the Challenges and to provide recommendations for teachers implementing the Challenges in future years.

2) Please provide copies of all student work to the Assessment Coordinator.