

Title: Exploring Growing Patterns

Brief Overview:

In this unit students will utilize problem solving strategies and reasoning skills in order to analyze patterns. It begins with a question about what students know about patterns, a discussion is launched regarding repeating and growing patterns their relationship with numeric patterns extending the data to function tables.

NCTM Content Standard/National Science Education Standard:

- describe, extend, and make generalizations about geometric and numeric patterns;
- represent and analyze patterns and functions, using words, tables, and graphs.

Grade/Level:

Grade 4/5

Duration/Length:

The unit consists of three 60-minute lessons and one summative assessment

Student Outcomes:

Students will:

- Be able to identify repeating and growing patterns
- Describe and extend growing patterns
- Analyze numeric patterns
- Develop function tables

Materials and Resources:

- K-W-L chart (Use template or student generated)
- Large sheet of construction paper for teacher to create a class K-W-L Chart
- Masking Tape (to tape Construction paper to the board)
- Colored Markers (for teacher)
- Overhead Sheets

- Construction Paper
- Colored Pencils/Crayons
- Pattern Blocks or 2 color counters
- Teacher Resource Sheet 1

Development/Procedures:

Lesson 1 Describing & Extending Patterns Numerically

Preassessment –

- Teacher will create a K-W-L and give a copy to each student. (Student Resource Sheet # 1)
- Pose the question “What do you know about patterns?”
 - Students will Think/Pair/Share and fill out their K-W-L Charts. Give students time to brainstorm about what they know about patterns.
 - Post large construction paper on the board and call on each group of 2 to share ideas with the class for the K-W-L. Post their responses on the chart.
 - Have students explain what they know about patterns. Have students create, maintain and revisit their own K-W-L Chart throughout the three lessons.

Launch –

- It is suggested that Teacher Resource # 1 be made into an overhead to be shared with the class. The teacher may elect to draw the symbols on the board.

Teacher Facilitation –

- Elicit definitions for *patterns* and *core* from students based on what they observe with the examples. If the definitions were given through the K-W-L, have students explain the definitions through the examples provided.
- A *pattern* is an order of objects or a sequence that repeats over and over again or grows a certain amount each subsequent step. Patterns that repeat the same thing over and over again are *repeating patterns*. The portion of the pattern that repeats is called the **core**. For example # 1, the core of the problem is $\Omega \Omega + \odot$. It repeats 5 times. The term is the place or position in the sequence of each object.
- *Growing patterns* are sequences that change from term to term. In example #3 the term grows by one. In example #2, the term grows by one row. The letters **aba** stay the same. Ask students to extend each pattern and explain what they did. Write above and below each term how it grew from the previous term.

- *Example:*

<i>aba</i>	<i>aba</i>	<i>aba</i>	<i>aba</i>	<i>aba</i>
	<i>aba</i>	<i>aba</i>	<i>aba</i>	<i>aba</i>
		<i>aba</i>	<i>aba</i>	<i>aba</i>
			<i>aba</i>	<i>aba</i>
				<i>aba</i>

The pattern grows by one row with the same grouping of letters.

Student Application –

- Have students work in pairs. Give each student construction paper, colored paper or crayons, pattern blocks or 2 color counters (the red/yellow chips). Have students make examples of

growing patterns with the manipulatives you provide. Students will write three terms and record the number on the sheet of paper.

- Example: Step 1

First student creates a pattern with the manipulatives and writes it numerically.

1	3	5
+	+++	+++++
	+	+ +
0	1	2

- Example: Step 2: After they have made their examples, have students remove their manipulatives. Only the numbers will be showing. First student gives the second student this information

	3	5
0	1	2

- Example: Step 3:

Second student duplicates the pattern their way & extends it two additional terms.

1	3	5	7	9
x	xxx	xxxxx	xxxxxxxx	xxxxxxxxxx
	x	x x	x x x	x x x x
0	1	2	3	4

- Students should switch with their partners and the partner will duplicate what was done with the manipulatives of their choice to show how the pattern grows. They will extend the pattern 2 terms.
- Explain what happened from term to term in complete sentences on the construction paper.
- Draw the extension (terms 4 & 5) onto the construction paper. Have the partners switch back and determine if they are correct.
- **Keep data from today's lesson. It will be used for tomorrow's lesson.**

Embedded Assessment –

- Students' writing should explain how the pattern grew from one term to the next. It should also adequately explain how they determined the fourth and fifth terms.

Reteaching/Extension –

- For those who have not completely understood the lesson, work with them in a small group and present another problem for them all to solve.
- Peer tutoring with a successful student.
- For those who have understood the lesson, have them challenge another classmate to try to stump them with another growing pattern.
- Revisit the K-W-L chart. Have students fill in their own chart. Call on students to add to the teacher chart.

Lesson 2

Digging Deeper: Making Tables

Launch-

- Have students Think/Pair/Share and revisit their K-W-L Chart. Make revisions to their personal charts. Share with the class and record on the main K-W-L.
- Review terms with students: Core, term, repeating pattern, growing pattern.
- Ask students to summarize previous lesson.

Teacher Facilitation – Teacher Resource Sheet # 2

1. Example 1: The terms increase by one. Once recorded, the term and the total number of dots is exactly the same.

#3 from Teacher Resource 1

Pattern	•	••	•••	••••	•••••
Term	1	2	3	4	5
Total # of dots	1	2	3	4	5

2. Example 2: We are counting the total number of letters in each term (adding three to each term). We will notice an increase of 3 for each term.. Each term is an additional three more letters than the previous term. Students will probably recognize the three times tables here.

#4 From Teacher Resource 2

Pattern	Aba	Aba aba	aba aba aba	aba aba aba aba	aba aba aba aba aba
Term	1	2	3	4	5
Total # of letters	3	6	9	12	?

3. Example 3: For this set we increase the row and column by one. The first term is one dot. The second term increases the column by one dot and an additional row is added with the new column. We increase from one to four. The next term increases a column and a row. These are square numbers. We want students to identify the total number of dots, not the rule. Students can determine how to create the next term.

Pattern	•	•• ••	••• ••• •••	•••• •••• •••• ••••	?
Term	1	2	3	4	5
Total # of dots	1	4	9	16	?

4. There are two rows of stars. The top row increases by one and the bottom row increases by one. The total increase each term is two stars.

Pattern	*** *	**** **	***** ***	***** ****	?
Term	1	2	3	4	5
Total # of stars	4	6	8	10	?

Student Application –

- Have students work with a buddy.
- Take their data created yesterday and record their data as tables. Have students share their information with the class. Either generate information on overhead, or chalkboard for the entire class to see and analyze.

Embedded Assessment –

- Students should identify pattern, term and total count for each pattern.
- Students should show at least 5 terms

Reteaching/Extension

Lesson 3 The Search For Relationships: What's My Rule

Preassessment – Crossword Puzzle – Finding Patterns (Student Resource # 5)

Launch-

- Have students Think/Pair/Share and revisit their K-W-L Chart. Make revisions to their personal charts. Share with the class and record on the main K-W-L.
- Ask students “How can we put our data into a table?”

Teacher Facilitation –

- Develop understanding of functional relationships (creating a function table) or what is happening from the term (input) to the total number shown (output).
- Tell students that the input does not have to follow sequential order.
- The functional relationship becomes our formula or rule. First try to find consistency from the input to the output. If not, try to find the consistency from output to output. The rule can be used to find any term.
- “There is no single best method for finding relationship between input and the output.” (Van de Walle pg. 422)
- Explain that tables can be written horizontally or vertically.

Teacher Resource Sheet: What's My Rule

Table 1: The rule is multiply by 1. The number does not change

from the input to the output. The 5th term is 5

Pattern	.	..	...	....	.....
Term	1	2	3	4	5
Input					
Total # of dots output	1	2	3	4	5

The
by
is

Pattern	.	..	...	....	.....
	
		
			
			
Term	1	2	3	4	5
Total # of dots	1	4	6	12	25

Table 2:
rule is n^2 or the
number multiplied
itself. The 5th term
25

Table 3: The rule is multiply by 3 or $3n$.. The 3rd term is 9.

Pattern	aba	aba aba	aba aba aba	aba aba aba aba	
Term	1	2	3	4	5
Total # of letters	3	6	9	12	

Table 4: The rule is multiply by 2 and add 2

Pattern	*** *	**** **	***** ***	***** ****
Term	1	2	3	4
Total Number of stars	4	6	8	10

Student Application

Embedded Assessment

Reteaching/Extension

Summative Assessment:

This section should describe how teachers would determine student's progress towards understanding the concept of the lesson (similar to state assessments like the MSA or HSA).

Authors:

Brenda Paige
Thomas Pullen School of the Performing Arts
Prince George's County Public Schools

Derrick Lin Grubb
Dodge Park Elementary
Prince George's County Public Schools

Student Resource Sheet # 1

K	W	L
(What I Know)	(What I Want to Know)	(What I have learned)

Using an overhead, record student answers below. Answers may vary

K	W	L
(What I Know)	(What I Want to Know)	(What I have learned)

(Use during Teacher Facilitation after elicited responses from KWL Chart)

WHAT IS THE CORE OF THE FOLLOWING PATTERNS?

CAN YOU IDENTIFY THE TERMS FOR EACH PATTERN?

1) Ω Ω † ☀ Ω Ω † ☀ Ω Ω † ☀ Ω Ω † ☀ Ω Ω † ☀
(OMEGA,OMEGA,CROSS, SUN) (5)

2) ☺ ☹♥ ☺ ☹♥ ☺ ☹♥ ☺ ☹♥ ☺ ☹♥

(SMILEY FACE, SMILEY FACE, HEART) (3)

HOW WOULD YOU DESCRIBE THE FOLLOWING PATTERNS?

3) ● ●● ●●● ●●●● ●●●●●

4) aba aba aba aba
 aba aba aba
 aba aba
 aba

5) ** **** **** ****

3) increasing by one each time, 4) adding a row for each term 5) increasing by 2

Exploring Patterns

Brief Constructed Response

1.) ▲□●▲□●▲□●▲□●

2.) ▲▲ ▲▲▲ ▲▲▲▲
 ▲ ▲▲ ▲▲▲

Step A

Which pattern above is growing pattern?

Step B

Use what you know about growing patterns to explain why your answer is correct. Use words and/or numbers/symbols in your explanation.

Brief Constructed Response
Exploring Patterns
Brief Constructed Response



Step A

Which pattern above is growing pattern?

(The second pattern is a growing pattern)

Step B

Use what you know about growing patterns to explain why your answer is correct. Use words and/or numbers/symbols in your explanation.

(Answers will vary i.e. growing patterns change from term to term)

1.

Pattern	.	..	...	....	.....
Term	1	2	3	4	5
Total Number of dots	1	2	3	4	5

2.

Pattern	aba	aba aba	aba aba aba	aba aba aba aba
Term	1	2	3	4
Total # of letters	3	6	9	12

3.

Pattern	.	..	...	....
	
		
		
Term	1	2	3	4
Total # of dots	1	4	9	12

4.

Pattern	*** *	**** **	***** ***	?
Term				
Total Number of stars				

Brief Constructed Response

Exploring Patterns

What is the total number of dots that you need for the third term?

Pattern	****	**** ****	?	**** **** **** ****
Term	1	2	3	4
Total Number of dots	4	8	?	16

Step A

Step B

Use what you know about growing patterns to explain why your answer is correct. Use words and/or numbers in your explanation.

Brief Constructed Response Exploring Patterns

What is the total number of dots that you need for the third term?

Pattern	****	**** ****	?	**** **** **** ****
Term	1	2	3	4
Total Number of dots	4	8	?	16

Step A

(12 Dots)

Step B

Use what you know about growing patterns to explain why your answer is correct. Use words and/or numbers in your explanation.

(Answers will vary)

Finding Patterns

1 P	2 R	E	D	I	C	T
	E					
	P				3 V	
	E				A	
4 P	A	T	5 T	E	R	N
	T		E		I	
	I		R		A	
	N		M		B	
	G				L	
		6 R	U	L	E	

Clues

Down

2. occurring again
3. a letter or symbol used to represent a number
5. A number a variable or a product of numbers and variables

Across

1. to tell what you think will happen next
4. a set of numbers or objects that are generated by following specific rule
6. something to follow to determine an outcome

Finding Patterns

1	2					
					3	
4			5			
		6				

Clues

Down

2. occurring again
3. a letter or symbol used to represent a number
5. A number a variable or a product of numbers and variables

Across

1. to tell what you think will happen next
4. a set of numbers or objects that are generated by following specific rule
6. something to follow to determine an outcome

Brief Constructed Response

Pattern	◆◆◆	◆◆◆ ◆◆◆ ◆◆◆	◆◆◆ ◆◆◆ ◆◆◆ ◆◆◆	◆◆◆ ◆◆◆ ◆◆◆ ◆◆◆	
Term	1	2	3	4	5
Total # of letters	3	6	9	12	

Step A

Questions:

What is my rule? _____

What is the fifth term? _____

Step B

Use what you know about [mathematical concept(s)] to explain why your answer is correct. Use words and/or numbers in your explanation.

Brief Constructed Response

Pattern	◆◆◆	◆◆◆ ◆◆◆ ◆◆◆	◆◆◆ ◆◆◆ ◆◆◆ ◆◆◆	◆◆◆ ◆◆◆ ◆◆◆ ◆◆◆	
Term	1	2	3	4	5
Total # of letters	3	6	9	12	

Step A

Questions:

What is my rule? (Add 3) _____

What is the fifth term? (Five rolls of five
Total#15) _____**Step B**

Use what you know about [mathematical concept(s)] to explain why your answer is correct. Use words and/or numbers in your explanation.

What's My Rule?

(Use with overhead to demonstrate growing pattern during Teacher Facilitation)

Pattern	.	..	...	....
Term	1	2	3	4	5
Total Number of dots	1	2	3	4	

What is my rule? _____

What is the fifth term? _____

2.

Pattern	aba	aba aba	aba aba aba	aba aba aba aba	
Term	1	2	3	4	5
Total # of letters	3	6	9	12	

What is my rule? _____

What is the fifth term? _____

Pattern	.	..	...	....
Term	1	2	3	4
Total # of dots	1	4	9	12

What is my rule? _____
 What is the third term? _____

4.

Pattern	*** *	**** **	***** ***	?
Term	1	2	3	4
Total Number of stars	4	6	8	

What is my rule? _____
 What is the fourth term? _____

What's My Rule?

1.

Pattern	.	..	...	....	.....
Term	1	2	3	4	5
Total Number of dots	1	2	3	4	5

What is my rule? $n \times 1$

What is the fifth term? 5

2.

Pattern	aba	aba aba	aba aba aba	aba aba aba aba	aba aba aba aba aba
Term	1	2	3	4	5
Total # of letters	3	6	9	12	15

What is my rule? $n \times 3$ or $3n$

What is the fifth term? 15

3.

Pattern	.	..	...	....
	
		
		
Term	1	2	3	4
Total # of dots	1	4	9	12

What is my rule? n
What is the fifth term?

4.

Pattern	*** *	**** **	***** ***	***** ****	***** ****	?
Term	1	2	3	4	5	10
Total Number of stars	4	6	8	10	12	?

What is my rule? $2n + 2$
What is the fifth term? 12
What would the 10th term be? 22 ($2 \times 10 + 2 = 22$)

What Is My Rule?

1.

Input	Output
1	3
2	7
3	11
4	15
5	?
10	?

What is my rule? _____

2.

Input	Output
1	5
2	10
3	15
4	20
5	25
10	?

What is my rule? _____

3.

Input	Output
1	1
2	3
3	5
4	7
5	9
10	?

What is my rule? _____

4.

Input	Output
1	8
3	10
6	13
7	?
10	?

What is my rule? _____

What Is My Rule? Answer Key

1.

Input	Output
1	3
2	7
3	11
4	15
5	19
10	39

What is my rule? Multiply by 4 Sub 1

2.

Input	Output
1	5
2	10
3	15
4	20
5	25
10	50

What is my rule? Multiply by 5

3.

Input	Output
1	1
2	3
3	5
4	7
5	9
10	?

What is my rule? Multiply by 2 Sub 1

4.

Input	Output
1	8
3	10
6	13
7	14
10	17

What is my rule? Add 7

Name _____

Date _____

Summative Assessment

1). Choose the growing pattern _____.

- a. ●● ○○ □□
- b. ☺☺ ☹☺ ☺☹ ☺☺☹☺
- c. ▲▼◀ ▲▼◀ ▲▼◀
- d. ■■■●●□□■■■●●□□■■■●●□□

2). Write the next 3 numbers in the pattern

2, 4, 6, 8, _____, _____, _____,

24, 21, 18, _____, _____, _____

3). Find the rule.

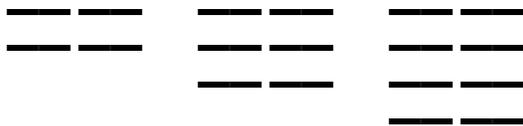
INPUT	OUTPUT
5	8
11	14
18	21
42	45
38	41

INPUT	OUTPUT
7	2
13	8
21	16
6	1
50	45

Rule _____

Rule _____

4) Complete the next two terms pattern



MSA Brief Constructed Response “Kid Speak” Mathematics Rubric Grades 1 through 8

Score	
2	<p>My answer shows I completely understood the problem and how to solve it:</p> <ul style="list-style-type: none"> • I used a very good, complete strategy to correctly solve the problem. • I used my best math vocabulary to clearly explain what I did to solve the problem. My explanation was complete, well-organized and logical. • I applied what I know about math to correctly solve the problem. • I used numbers, words, symbols or pictures (or a combination of them) to show how I solved the problem.
1	<p>My answer shows I understood most of the problem and how to solve it:</p> <ul style="list-style-type: none"> • I used a strategy to find a solution that was partly correct. • I used some math vocabulary and most of my reasons were correct to explain how I solved the problem. My explanation needed to be more complete, well-organized or logical. • I partly applied what I know about math to solve the problem. • I tried to use numbers, words, symbols or pictures (or a combination of them) to show how I got my answer, but these may not have been completely correct.
0	<p>My answer shows I didn’t understand the problem and how to solve it:</p> <ul style="list-style-type: none"> • I wasn’t able to use a good strategy to solve the problem. • My strategy wasn’t related to what was asked. • I didn’t apply what I know about math to solve the problem. • I left the answer blank.

Mathematics BCR Rubric**2 The response demonstrates a complete understanding and analysis of a problem.**

- Application of a reasonable strategy in the context of the problem is indicated.
- Explanation¹ of and/or justification² for the mathematical process(es) used to solve a problem is clear, developed, and logical.
- Connections and/or extensions made within mathematics or outside of mathematics are clear.
- Supportive information and/or numbers are provided as appropriate.³

1 The response demonstrates a minimal understanding and analysis of a problem.

- Partial application of a strategy in the context of the problem is indicated.
- Explanation¹ of and/or justification² for the mathematical process(es) used to solve a problem is partially developed, logically flawed, or missing.
- Connections and/or extensions made within mathematics or outside of mathematics are partial or overly general, or flawed.
- Supportive information and/or numbers may or may not be provided as appropriate.³

0 The response is completely incorrect, irrelevant to the problem, or missing.⁴*Notes:*

¹ **Explanation** refers to students' ability to communicate **how** they arrived at the solution for an item using the language of mathematics.

² **Justification** refers to students' ability to support the reasoning used to solve a problem, or to demonstrate **why** the solution is correct using mathematical concepts and principles.

³ Students need to complete rubric criteria for *explanation, justification, connections* and/or *extensions* as cued for in a given problem.

⁴ Merely an exact copy or paraphrase of the problem will receive a score of "0".