Grade Level/Course: 4th and 5th

Lesson/Unit Plan Name: Patterns: Foundations of Functions

Rationale/Lesson Abstract: In 4th grade the students continue a sequence of numbers based on a rule such as *start at 1, add 3,* and reflect on characteristics of the sequence. By 5th grade the students need to generate two sequences, reflect on their relationship to one another, and plot coordinates based on corresponding values in the two sequences.

Students learn to reflect on features within the sequences, learn to find similarities between patterns, and begin to explore proportionality. This lays the foundation for working with functions in the Expressions and Equations domain of grades 6-8.

Students will generate sequences, look for correlations between sequences, and plot points in quadrant 1 of the coordinate plane.

Timeframe: 2-3 days

Common Core Standard(s):

Grade 4: 4.OA.5 Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself.

Grade 5: 5.OA.3 Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane.

Instructional Resources/Materials:

Pattern Blocks
Graph Paper

Activity/Lesson: Part 1

Generating Repeating Patterns with Shapes

Build *square, trapezoid, rhombus, square, trapezoid, rhombus* with the pattern blocks.

Ask students to look at the pattern and think of three things they know about it. Have students share their thoughts with a partner. Record several students' ideas.

Ideas may include: all are quadrilaterals, the pattern repeats, ABC pattern, three shapes repeat, etc.

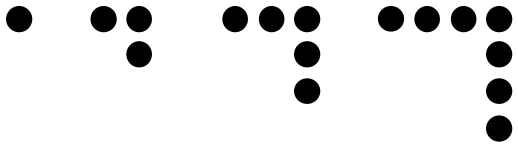
Ask what the next shape will be. [square}
Ask what the 15th shape will be. [rhombus] How do you know? Have students discuss with partners to justify their conjecture. [Rhombus is the third item of the pattern. Positions in the sequence that are multiples of three will also be rhombi. Therefore, the 15th piece will also be a rhombus.]

Ask what the 101st piece will be. [trapezoid] How do you know? Again, have students discuss with partners. [The pattern has 3 pieces, so it repeats after every third piece. 3x33=99. 101-99=2. The second piece is the trapezoid.]

Have students build a 4-piece repeating pattern. Then have them write two questions and answers about their patterns. Have partners work together to look at each other's patterns and answer each other's questions.

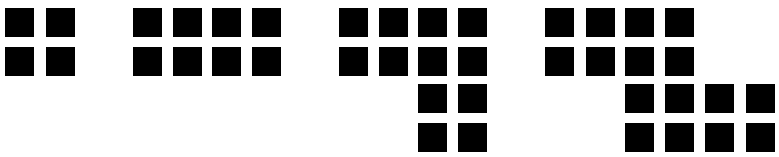
Generating Sequences with Shapes

Ex. 1: Draw the first three terms of the sequence. Have the students tell a partner what the 4th term will be. Ask for ideas. They may include a single dot (repeating pattern), a figure like the 3rd term containing a dot to complete the triangle, and the 4th term shown below.



After recording the 4th term, have students write a sentence describing how the pattern increases.
[For each new term, add a dot to left end and to the bottom of the figure. Add two more dots each time.] Have students compare sentences and then share with the class.

You Try: Add the next three figures to this pattern. Describe how the pattern increases.



Activity/Lesson: Part 2

Generating Number Sequences

Look back at the first shape sequences. Ask how many dots were in the first term and how many were added for each new term. [1, 2] Clarify that you started with one and added two for each successive term. Rewrite the sequences as numbers. [1, 3, 5, 7] Write: *Start at 1, add 2.*

You Try: Make a number sequence and write the rule for the shape sequences of blocks.
[4, 8, 12, 16, 20, 24, 28] *Start at 4, add 4.*

Write the rule: Start at 2, add 3. Say: Show me on your fingers what the first number is. [2] Begin completing the sequence 2, 5, 8, 11, 14. Have the students add the next 3 terms [17, 20, 23] Write the word *features* on the board. Ask students to look at the sequence and tell a partner several things they notice. Record their answers. [the numbers alternate even/odd, the numbers increase by three, the digits in the one's place begin to repeat after the 10^{th} term] *Point out that the features are characteristics of the sequence that are not part of the rule. Ask: *Should we include, 'The numbers increase by three,' as a feature?* [no]

You Try: Start at 6, add 4. List the first 8 terms in the sequence and describe two features.
[6, 10, 14, 18, 22, 26, 30, 34] [all of the terms are even, the digits in the one's place repeat after the 5^{th} term, none of the terms are divisible by 4]

Example: Start at 8, add 5. [8, 13, 18, 23, 28, 33, 38, 43] Features: even/odd, one's digit alternates between 8 and 3] Ask what will be in the one's place for the 20^{th} term? [3] How do you know? [every second term ends in 3]

Example: Start at 5, multiply by 2. List the first 8 terms. Describe the features you notice. Have the students check their work with a partner. Have a volunteer record the sequence for the class and describe the features she found. [5, 10, 20, 40, 80, 160, 320, 640] [all terms are multiples of 5, the first term is the only odd term] Ask why this sequence increases so rapidly compared to the other sequences. [the rule uses multiplication instead of addition]

You Try: Create your own rule. Record the first 10 terms. Describe some of its features. Have students exchange rules to replicate the sequences and describe their features. Have several partners debrief their work in front of the class.

Example: Start at 48, subtract 6. List the first 8 terms. [48, 42, 36, 30, 24, 18, 12, 6, 0]
Features: Even, decreasing multiples of 6.

Exit Ticket: Pass out index cards or sticky notes. Have the students put their names on their card, generate a sequence and describe the features of the rule: Start at 7, add 9
Collect the exit tickets, and use them to check for understanding.
[7, 16, 25, 34, 43, 52, 61, 70, 79, 88, 97, 106, 115, 124] [odd/even, one's digits descending order 7-6-5-4…, sum of the digits for each term is 7 or 16]

Activity/Lesson: Part 3

Generating Dual Sequences and Plotting Ordered Pairs

Discuss what *dual* means. Review generating a sequence and describing its features. Now we are going to use two sequences, describe their features, and then look for connections between the two.

Sequence A: start at 0, add 2
Sequence B: start at 0, add 4

Make a T-chart.

seq. A	0	2	4	6	8	10	12	14	16
seq. B	0	4	8	12	16	20	24	28	32

Features:

Sequence A- even, 0 and the multiples of 2
Sequence B- even, 0 and the multiples of 4

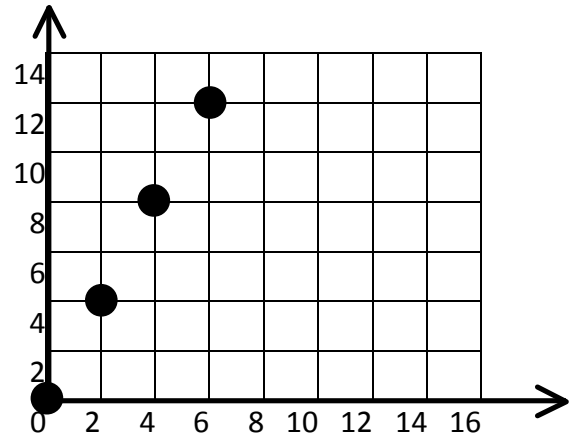
Connections:

Each term of A is half of the matching term in B.
Each term of B is twice the matching term in A.

Form *Ordered Pairs* by using the corresponding terms from each sequence.

(0, 0); (2, 4); (4, 8); (6, 12)

Plot the points on a coordinate plane (quadrant 1 only).



*Notice that there are only points plotted. We cannot connect these points with a line because the ordered pairs are formed by the corresponding terms in the two sequences, rather than by a function. For example in sequence A, the rule states start at 0, add 2. $\frac{1}{2}$ is not a term in sequence A, nor is there a corresponding term ***1*** in sequence B. Therefore, you cannot plot the point ($\frac{1}{2}$, 1).

You Try:

Sequence A: Start at 0, add 3

Sequence B: Start at 0, add 9

seq. A	0	3	6	9	12	15	18	21	24
seq. B	0	9	18	27	36	45	54	63	72

Features:

Sequence A- odd/even, 0 and the multiples of 3

Sequence B- odd/even, 0 and the multiples of 9

Connections:

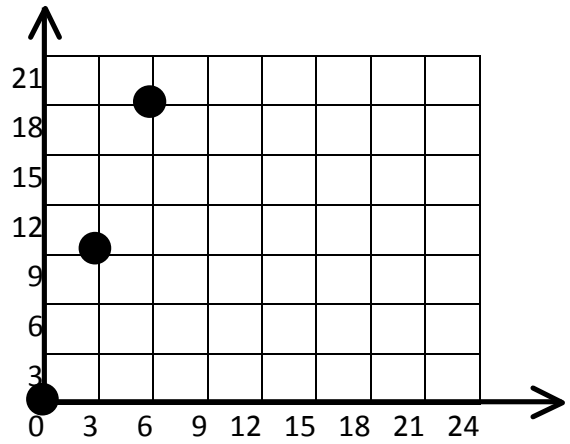
Each term of A is a third of the corresponding term in B.

Each term of B is three times the corresponding term in A.

Form *Ordered Pairs* by using the corresponding terms from each sequence.

(0, 0); (3, 9); (6, 18); (9, 27)

Plot the points on a coordinate plane (quadrant 1 only).



Example:

Sequence A: Start at 2, add 10

Sequence B: Start at 2, add 2

seq. A	2	12	22	32	42	52	62	72	82
seq. B	2	4	6	8	10	12	14	16	18

Features:

Sequence A- even, 2 is always the digit in the ones place

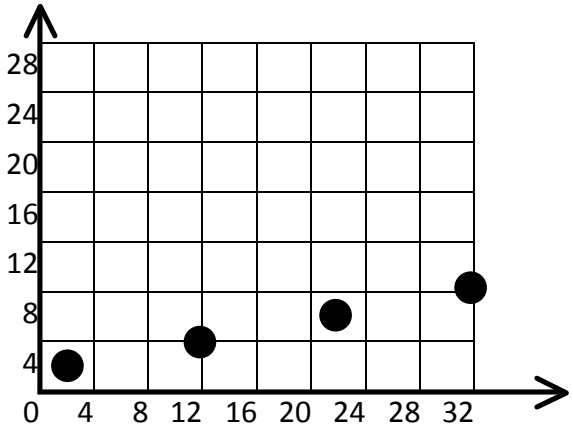
Sequence B- even, multiples of two

Connections:

Each term in sequence B is a multiple of 8 smaller than its corresponding term in sequence A. 4 is *8 less* than 12, 6 is *16 less* than 22, 8 is *24 less* than 32.

Ordered Pairs:

(2, 2); (12, 4); (22, 6); (32, 8)



You Try:

Have students work in partners. Each student should create a rule to generate a sequence. Switch rules and generate the first 8 terms in your partner's sequence. Together record both sequences and 5 ordered pairs. Plot the points on a coordinate plane.

Invite several partners to show and debrief their work.

Assessment:

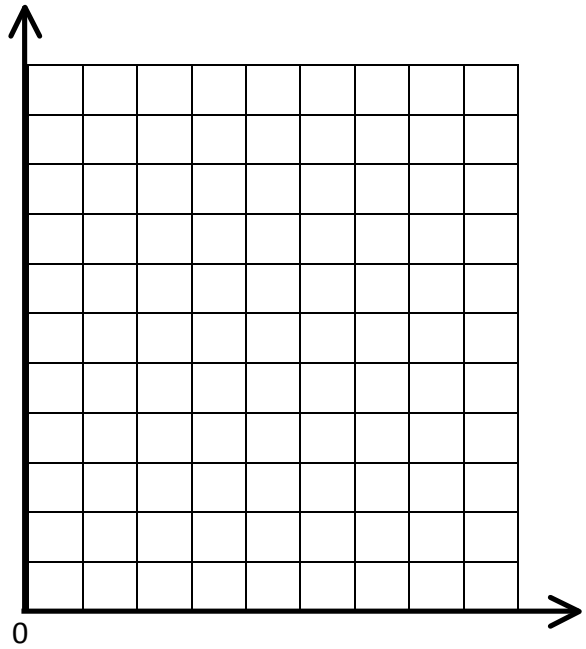
Use the following two rules to answer the questions.

Sequence A: Start at 8, add 12
Sequence B: Start at 4, add 6

1. (Y) (N) All of the terms in both sequences are even.
2. (Y) (N) Each terms in sequence B is double the corresponding term in sequence A.
3. (Y) (N) Each term in sequence A is a multiple of 4.
4. (Y) (N) The sixth term in sequence B is half of the 6^{th} term of sequence A.
5. (Y) (N) The first 4 ordered pairs are: (0, 0); (12, 6); (24, 12); (36, 18)
6. Make a T-Chart for sequence A and sequence B.
7. Record the first 5 ordered pairs.
8. Plot the first 3 ordered pairs. (*hint, use an interval of 4*)

seq. A									
seq. B									

(,); (,); (,); (,); (,)



Assessment Key:

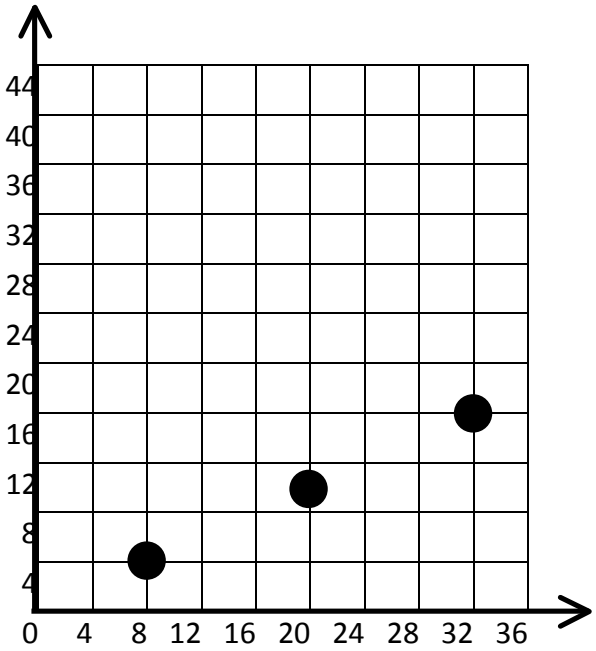
Use the following two rules to answer the questions.

Sequence A: Start at 8, add 12
Sequence B: Start at 4, add 6

1. (Y) (N) All of the terms in both sequences are even.
2. (Y) (N) Each terms in sequence B is double the corresponding term in sequence A.
3. (Y) (N) Each term in sequence A is a multiple of 4.
4. (Y) (N) The sixth term in sequence B is half of the 6^{th} term of sequence A.
5. (Y) (N) The first 4 ordered pairs are: (0, 0); (12, 6); (24, 12); (36, 18)
6. Make a T-Chart for sequence A and sequence B.
7. Record the first 5 ordered pairs.
8. Plot the first 3 ordered pairs. (*hint, use an interval of 4*)

seq. A	8	20	32	44	56	68	80	92	104
seq. B	4	10	16	22	28	34	40	46	52

(8, 4); (20, 10); (32, 16); (44, 22); (56, 28)



Warm-Up

CST/SBAC: 5.OA 1.

For each expression in *A-D*: answer Yes or No if the expression is equivalent to the product of 7 and 9.

A $7 \times (1 + 8)$ ○ **Yes** ○ **No**

B $9 \times (3 + 6)$ ○ **Yes** ○ **No**

C $(2 \times 5) + (5 \times 4)$ ○ **Yes** ○ **No**

D $(9 \times 2) + (9 \times 5)$ ○ **Yes** ○ **No**

Review: 4.NBT.6

Find the quotient at least two different ways:

$$267 \div 6$$

x

Current: 4.OA.5

Complete each sequence by filling in the missing terms.

A 7, 14, _____, 28, _____, 42, 49

B 80, 70, 60, _____, _____, 30, _____

C _____, _____, 8, 4, 0

D 12, 17, _____, _____, 32, 37

Other: 5.G.1

Label the coordinate plane.
Plot the ordered pairs and label the points.

A (4, 6) B (7, 3) C (6, 4) D (0, 8)