Grade 7 Numerical Patterns

7.PR.1	
Demonstrate an understanding of oral and written patterns and their equivalent relations.	1. Formulate a relation to represent the relationship in an oral or written pattern. 2. Provide a context for a relation that represents a pattern. 3. Represent a pattern in the environment using a relation.

7.PR.2	
Construct a table of values from a relation, graph the table of values, and analyze the graph to draw conclusions and solve problems.	4. Create a table of values for a relation by substituting values for the variable. 5. Create a table of values using a relation and graph the table of values (limited to discrete elements). 6. Sketch the graph from a table of values created for a relation, and describe the patterns found in the graph to draw conclusions (e.g., graph the relationship between n and $2n + 3$). 7. Describe the relationship shown on a graph using everyday language in spoken or written form to solve problems. 8. Match a set of relations to a given set of graphs. 9. Match a set of graphs to a given set of relations.

Clarification of the outcome:

- The two outcomes are strongly connected. They should be combined for that reason.
- The distinctions between the grade 6 and grade 7 patterning outcomes is that in grade 7, more emphasis is placed on using algebraic language (e.g. C = 2N + 3) and on graphing (discrete line graphs/dot graphs: whole number values only).
- The complexity of input/output rules should mostly involve linear relations (e.g. output = 2 x input + 3). However, one or two relations that are not linear should be included (see activity #3).
- The term 'relation' is synonymous with the term 'input/output rule'. Either one can be used to describe a relationship between variables. The term 'table of values' is synonymous with the term 'T-chart/T-table'.

Required close-to-at-hand prior knowledge:

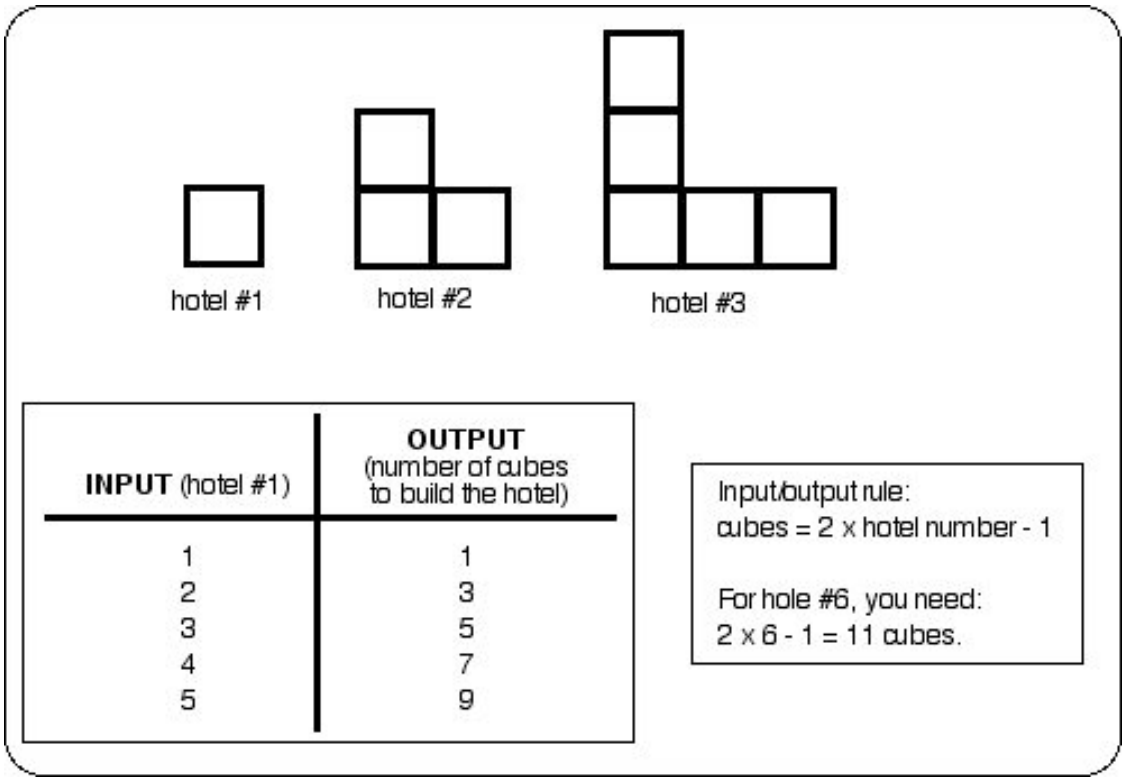
- Proficiency with mental arithmetic, including basic facts.
- Understand grade 6 patterning.
- Understand there is an input/output relationship between two variables.

SET SCENE stage

The problem task to present to students:

Present the following patterning problem. [Refer to the diagram.]

Ask students to build the next two hotels in the series, using multi-link cubes. Ask them to record the data in a T-chart, determine the input/output rule, and predict the number of cubes needed to build hotel #6. Have them build hotel #6 to confirm their prediction.



INPUT (hotel #1)	**OUTPUT** (number of cubes to build the hotel)
1	1
2	3
3	5
4	7
5	9

Input/output rule:
cubes = 2 x hotel number - 1

For hole #6, you need:
2 x 6 - 1 = 11 cubes.

Comments:

The main purpose of the task is to refresh grade 6 patterning. This is one way to SET SCENE.

DEVELOP stage

Note:

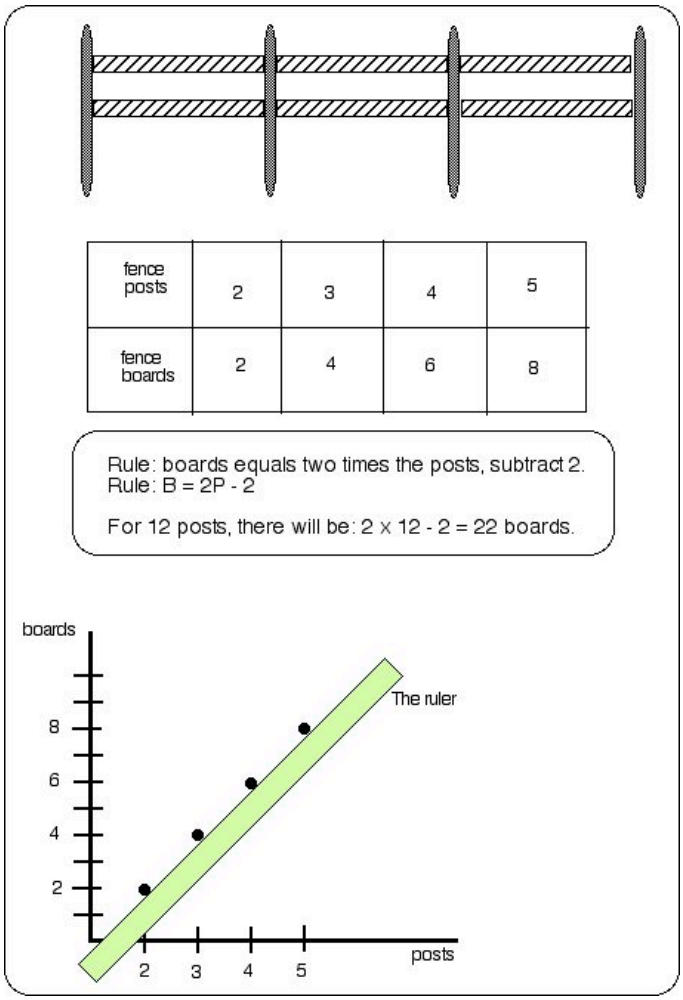
Sometimes the following activities involve T-charts (table of values) written vertically and sometimes horizontally. Students should be comfortable with either orientation.

Activity 1: Revisits SET SCENE and addresses indicators, 1, 2, 3, and 5.

- Ask selected students to present their solution to the SET SCENE task. Discuss as needed.

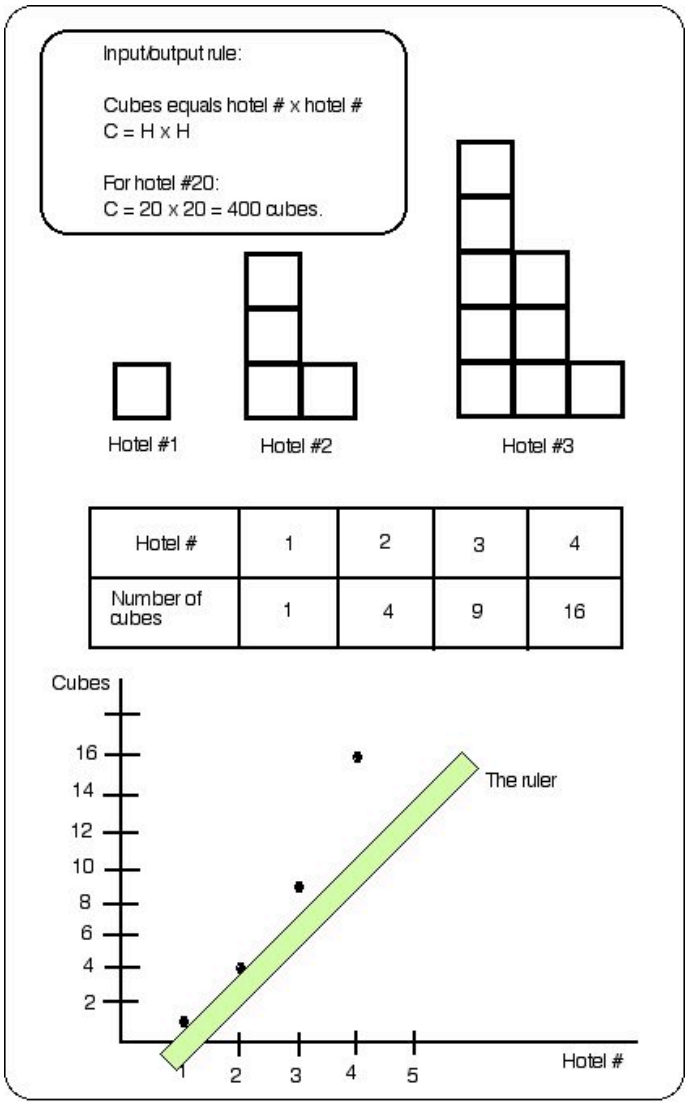
Activity 2: Addresses achievement indicators 1, 2, 3, 5, and 6.

- Provide students with a diagram, showing fence posts and fence boards. Ask them to draw a fence having 5 posts. Ask them to make a T-chart showing the number of fence posts (2, 3, 4, 5) and the corresponding number of boards needed to make the fence. Ask them to determine the number of boards needed to make a fence that has 12 posts, by using an input/output rule, expressed in natural language, and also in algebraic language. Assist as required.
- Ask them to make a dot graph of the data in the T-chart. Discuss why it does not make sense to join the dots. ENSURE they realize that there always must be a whole number of posts (e.g. you cannot have 1 3/4 posts).
- Ask them to lay a ruler alongside the dots. Discuss what is observed. ENSURE they realize that the dots lying along the ruler form a line.
- Make the connection between the observed line and the fact that the output value in the T-chart (the number of boards) goes up by the same amount each time (2, in this case).



Activity 3: Addresses achievement indicators 1, 2, 3, 5, and 6.

- Provide students with a diagram, showing the number of cubes needed to build a series of hotels. Ask them to build the next hotel, using multi-link cubes. Ask them to make a T-chart showing the hotel number (hotel #1, 2, 3, and 4) and the corresponding number of cubes needed to build each hotel. Ask them to determine the number of cubes needed to build hotel #20, by using an input/output rule, expressed in natural language, and also in algebraic language. Assist as required.
- Ask them to make a dot graph of the data in the T-chart. Discuss why it does not make sense to join the dots. Ensure that they realize that The number of hotels must be a whole number.
- Ask them to lay a ruler alongside the dots. Discuss what is observed. Ensure they realize that the dots DO NOT lie along a line.



- Make the connection between the observation that the dots do not lie along a line and the fact that the output value in the T-chart (the number of cubes) does not go up by the same amount each time (the increase in the number of cubes increases each time).

Activity 4: Addresses achievement indicators 1, 2, and 4.

- Present students with the following problem: "*Each month, my nice aunt sends me a package of trading cards. My aunt sent me two cards the first month. After that, she sent me two more cards than the month before. My father makes me give half of the cards to my sister. But my sister doesn't trust me so she insists that I give her one more card. I sort of like my sister so I do as she asks. I keep the rest of the cards. How many cards will I get to keep in the 12th month? How many cards will my sister get?*"
- Ask students to solve the problem by recording the data for four months in a table of values having four rows (see below), and then figuring out the input/output rules and using them to determine the answers for the 12th month.

MONTH	1	2	3	4
Total cards sent	2	4	6	8
Sister gets	2	3	4	5
I get	0	1	2	3

SC = M + 1 (Sister gets rule)

MC = M - 1 (I get rule)

Activity 5: Addresses achievement indicators 4, 5, 6, and 9.

- Provide students with a relation (e.g. C = 5N + 2). Ask students to create a table of values (T-chart) for N = 1, N = 2, N = 3, . . , N = 6). Ask them to graph the relation (using a dot graph). Ask students to describe the patterns found in the graph (e.g. the vertical value goes up by 5 each time).
- Repeat for other relations.

Activity 6: Addresses achievement indicators 1, 7, 8, and 9.

- Provide students with five different graphs. Each graph is a visual for a linear relation (input/output rule): e.g. Y = 2x - 3; D = 4R + 1, etc.). Ask students to match the graph to the relation by creating a table of values for each graph, and then using the table to determine the inout/output rule that matches the graph.

Activity 7: Addresses achievement indicators 2, 3, 4, 5, 6, and 7.

- Present students with a linear input/output rule (e.g. 2N + 5). Ask them to create a situation (such as the ones in activities 2 and 3) that could be represented by the given rule. Ask students to draw diagrams for the first four cases of the situation they provide and to record the data in a T-chart. Ensure that the data fits the rule.
- Ask students to draw a dot graph for the rule. Discuss the result.

Activity 8: Revisits SET SCENE & addresses indicators 1, 2, 3, 5, 6, & 7, & practice.

- Revisit the SET SCENE task. Organize students into groups of 2. Ask each group to create a different hotel situation. Ask them to make a table of values, graph the data, and determine the input/output rule (relation).
- Have selected groups present their hotel situations , table of values, graph, and input/output rule (relation).

Activity 9: Assessment of teaching.

- Provide students with a T-chart consisting of four pairs of values for a linear rule (e.g. Z = 2B + 3). Ask them to determine the input/output rule for the given T-chart, to graph the data using a discrete line graph, to extend the T-chart for three more pairs of values, and to explain their thinking.

If all is well with the assessment of teaching, engage students in PRACTICE (the conclusion to the lesson plan).

An example of a partially well-designed worksheet follows.

The worksheet contains a sampling of question types. More questions of each type are needed.

The MAINTAIN stage follows the sample worksheets.

Question 1.

Complete the table of values.

R	T
1	2
2	5
3	8
4	
150	

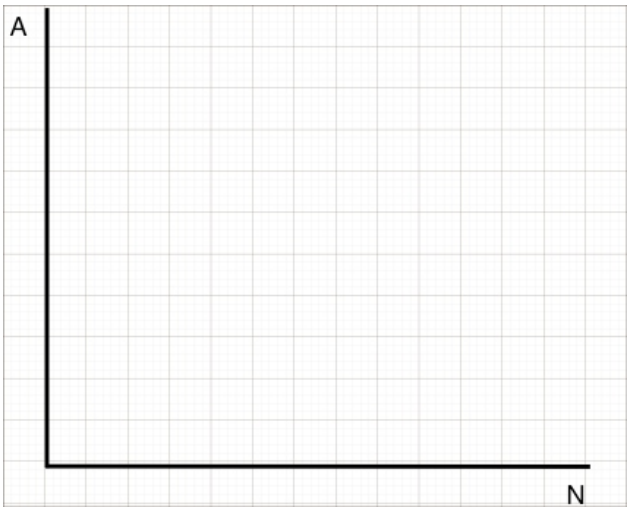
What is the input/output rule? _____

Question 2.

Complete the table of values for the input/output rule, A = 3N - 2.

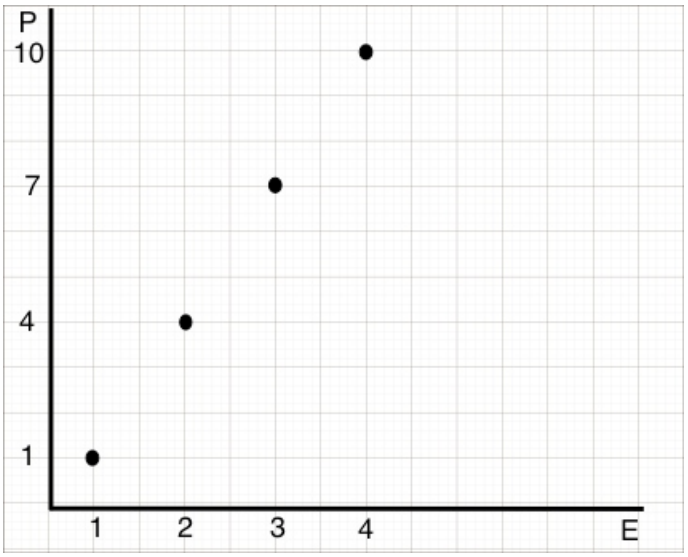
N	A
2	
3	
5	
8	

Graph the table of values data.



Question 3.

Make a table of values based on the graph.



E	P

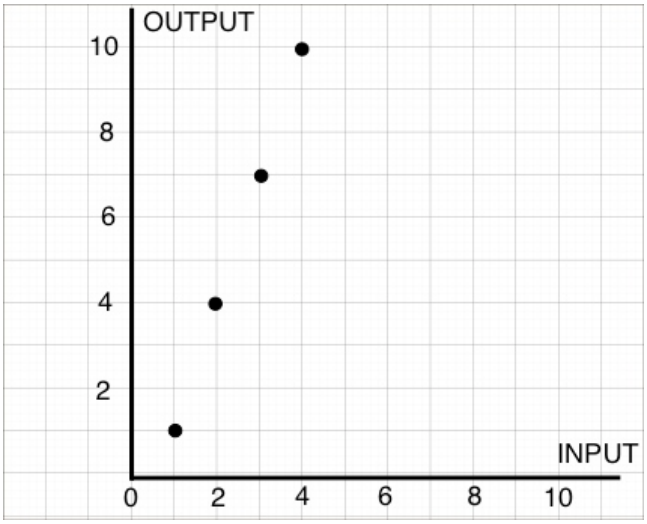
What is the input/output rule? _____

What is the value of P when E is 203. _____

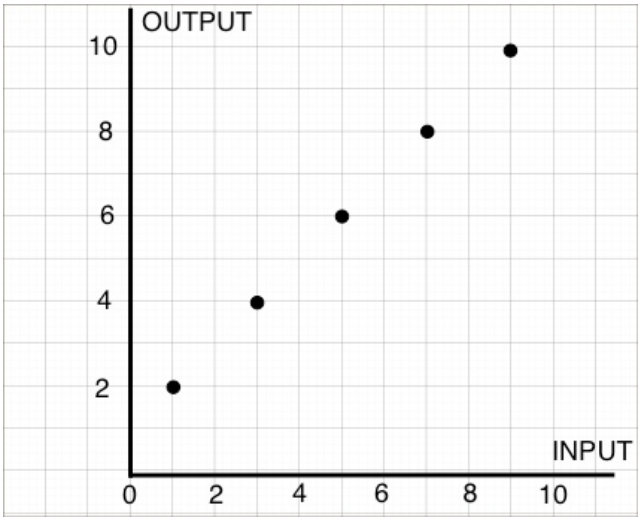
Question 4.

Match the graph
to the input/output rule.

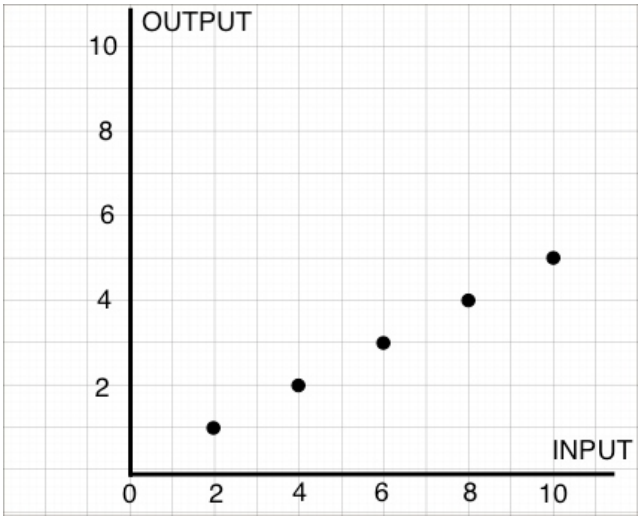
OUTPUT = INPUT/2



OUTPUT = INPUT + 1



OUTPUT = 3 x INPUT – 2



MAINTAIN stage

Mini-task example

Every so often:

- Present a relation (input/output rule) and ask students to create a table of values for it and to draw a dot graph of the data.

Rich Learning Task

Present the following problem:

A customer wants a border of 1 metre by 1 metre concrete slabs placed entirely around his square flower garden. The size of the garden is 200 m by 200 m. How many 1 m x 1 m slabs will be needed to make the slab border?

Ask students to solve the problem by drawing on grid paper a border around a garden that is 1 m by 1 m, 2 m by 2 m, and 3 m by 3 m in size (see diagram).

Have them make a T-chart, make a dot graph, determine an input/output rule for calculating the number of 1 m x 1 m slabs for the border, and use the rule to predict the number of slabs needed for a garden 200 m by 200 m.

Have them verify their prediction by solving the problem, using their knowledge of area of composite squares/rectangles.

Comments

This is a rich-task because it is a complex problem.