Grade 5

In and Out Boxes

Purpose:

To give students opportunities to think and reason with numbers by recognizing and describing patterns in a T-chart, with words, and algebraically.

Description:

Patterns and functions are important ideas in mathematics. A function is a relationship in which two sets of numbers are linked by a rule that pairs each element of the first set with exactly one element of the second set. In this routine, students will describe in words or symbols rules for relating inputs and outputs and construct inverse operation rules.

Materials:

- function machine run on transparencies
- copies of the function machines for pairs of students to work with
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In	Out
1	6

Directions:

1. Display the function machine on the overhead.
2. Tell students you have a secret rule for changing numbers. They are to guess your rule.
3. Write the first number in each column. (e.g., 1 in the first column, 6 in the second column.
4. Ask pairs of students to discuss possible rules that could cause the number in the first column to become the number in the second column. (e.g., add 5, multiply by 6, multiply by 3 and add 3)
5. Write the second number in each column. (e.g., 2 in the first column, 9 in the second column.)
6. Ask the students to check the rules they came up with for the first pair of numbers to see which rule still applies to both sets of numbers. If they still have more than one rule that applies, give them a third pair of numbers. (e.g., 3 in the first column, 12 in the second column)
7. Ask students to write/discuss with their partner what another pair of numbers could be.
8. Ask for volunteers to say or write on the transparency what they think that pair of numbers could be. (e.g., "I think another pair of numbers could be 10 and 33.)

9. Check to see if all groups agree. If there are other numbers some students think should be there, record them on the "machine" as well. Have partners discuss all the pairs on the transparency to see if they agree with all the suggested answers or if what they believe the rule is does not apply to one (or more) pair.
10. Have partners discuss what they believe the rule is for changing the first number in a pair to the second number in the pair.
11. Ask for volunteers to say or write on the transparency what they think the rule is.
12. Check to see if all groups agree on a rule. If there are other rules some students think apply to these number pairs, record them on the "machine" as well. Have partners discuss all the rules on the transparency. (e.g., How are the rules different? How are they the same? Do the rules apply accurately to each of the pairs of numbers? Facilitate a class discussion about how the rules work. (e.g., "Sue said she multiplied the first number by 3 and then added 3 more. But Julian said he added 1 to the first number then multiplied **that** number by 3. Why do these two rules still work?")
13. Once the class agrees on a rule, ask the partners to figure out what other pairs of numbers would follow this rule.
14. Ask volunteers to share out some of their pairs as you record them. Have students explain why each pair of numbers follows the rule.
15. Ask partners to "translate" the rule written in words to the same rule written with mathematical symbols. (e.g., For the example above, the rule is to multiply the first number by 3 and then add 3 OR add 1 to the first number and then multiply that number by 3. In math symbols it would be $3n + 3$ and $3(n + 1)$. These expressions are 2 forms of the same rule, just written in different ways)

Note: Remind students that when we talk about "any number" instead of a specific number, we can represent "any number" with any letter like "n".

Scaffold

- Use smaller numbers and/or rules with only 1 operation.

Extensions:

- Include rules with more than one step. (e.g., multiply by 2, then subtract 1)
- Use fractions or decimals as the numbers in the first column. (e.g., 0.2—multiply by 2…0.4; or start with 2/3….multiply by 3…2)
- Give the students the first pair of numbers as explained above. Then give the "out" number in the set, and ask the students to find the "in" number in the set. Working backwards provides opportunities for using inverse operations to find missing elements and writing rules. (e.g., The In-Out rule is $n \times 4$; the Out-In rule is $n \div 4$.)

In	Out
24	96
___	100
n	n x 4
n ÷ 4	n

Note: n x 4 can also be represented by 4 • n and 4n.

Examples:

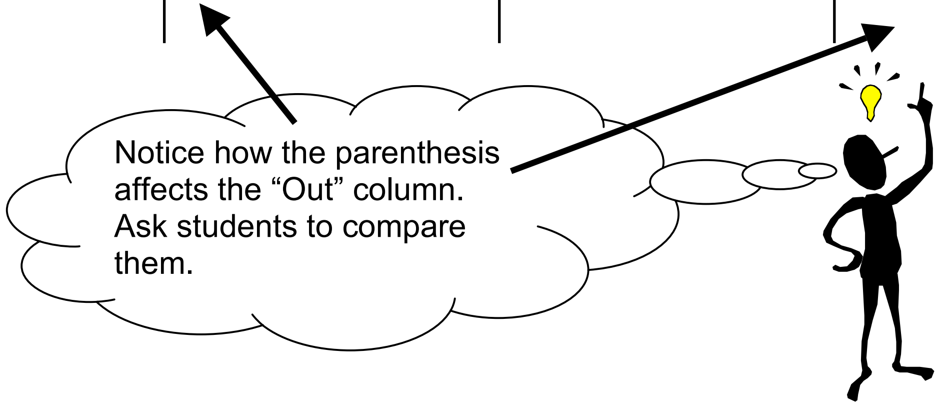
In	Out
0.3	1.9
0.5	2.5
0.9	3.7
n	3n + 1

In	Out
$\frac{1}{2}$	3
1	4
$1\frac{1}{2}$	5
n	2(n + 1)

In	Out
1	1
2	4
3	9
n	n^2

In	Out
$\frac{1}{2}$	2
1	3
$1\frac{1}{2}$	4
n	2n + 1

In	Out
$\frac{1}{3}$	3
$\frac{2}{3}$	4
1	5
n	3n + 2



<u>For students who need more support</u>

In	Out
1	3
2	6
3	9
n	3n or

In	Out
1	2
2	3
3	4
n	n + 1

In	Out
1	0
2	1
3	2
n	n - 1

In	Out
1	1
2	3
3	5
n	2n - 1

In	Out
1	3
2	5
3	7
n	2n + 1

In	Out
0	0
-1	1
-4	4
8	8
n	|n|

In	Out
-4	1
-2	3
0	5
5	10
n	n + 5

Blackline masters
Function machine

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