Lesson Plan Topic: Exponent Rules Pattern Investigation
Subject/Grade: Math 8

Materials

Handout: "Exponent Rules Pattern Investigation"

Georgia Performance Standards

M8N1. Students will understand different representations of numbers including square roots, exponents, and scientific notation.

i. Simplify expressions containing integer exponents.

Enduring Understandings

I want students to understand the exponents are a shortcut method to write repeated multiplication. I also want students to understand how the exponent rules are derived so they are more likely to remember them, as well as develop greater algebraic understanding.

EQ(s)

Choose from or use all of the following:

- How can I simplify and evaluate algebraic expressions with exponents?
- When are exponents used?
- Why are exponents important?

Opening

Remind students that much of what they learn in math is related to patterns since the human brain is adept at recognizing and understanding patterns. Give students a few patterns (i.e. linear relationships) to identify. Add more if needed or students are interested.

Pattern 1:

x	y
0	0
1	2
2	4
3	6

Pattern: 2x = y

Pattern 2:

x	y
0	1
1	3
2	5
3	7

Pattern: 4x + 1 = y

Pattern 3

x	y
0	-1
1	1
2	3
3	5

Pattern: 2x – 1 = y

Mini-lesson

Briefly reteach students about exponents and bases and their purpose. Make sure students can convert between exponential form and expanded form (and back). Also, remind students that any number divided by itself is 1 (ex: $\frac{4}{4} = 1$ or $\frac{x}{x} = 1$).

Work Period

Have students complete the Exponent Rules Pattern Investigation. They will used five of the six level of Bloom's Taxonomy. Help students verbalize their "rule" for each category of exponent operations, and let them write it in their own language. Attempt to have students use the proper vocabulary in their "rule," but that language will emerge in the summary regardless. Stress the ideas rather than the vocabulary.

Differentiation

Students can be paired to complete the activity. All students are required to complete the same pattern investigation.

- Struggling learners will need more help at the beginning of each section as well as verbalizing their "rule."
- Have accelerated learners work on verbalizing and writing an explanation for the rule

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Summary	The following topics should emerge during the summary • A reminder of the purpose of a base and an exponent • The rules (verbal) for multiplying with exponents, dividing with exponents, and raising an exponent to another exponent • The reasons that each of these rules work mathematically • The algebraic notation for each of these rules
Assessment	1. Teacher observation of students working (formative) 2. Student handout (summative) 3. Possible assessment: Have students apply their rules to new expressions; would also use an additional level of Bloom's Taxonomy (summative)

Exponent Rules Pattern Investigation

_____
(name / date / period)

Remember

Identify the base in 4^3. What information does it give you?

Identify the exponent in 4^3. What information does it give you?

Understand

Explain how 2^3 different from $2 \bullet 3$?

Analyze and Create: Write the **Problem** expression in **E•x•p•a•n•d•e•d F•o•r•m**, then simplify the expression by writing the correct **Exponential Form**. At the bottom of each section, write a rule explaining to other people how to simply expressions with many exponents.

Multiplying Numbers with Exponents

Problem	E•x•p•a•n•d•e•d F•o•r•m	Exponential Form
1. $2^2 \bullet 2^3$	$\underline{2 \bullet 2} \bullet \underline{2 \bullet 2 \bullet 2}$	
2. $3^4 \bullet 3^2$		
3. $4^2 \bullet 4^5$		
4. $5^2 \bullet 5^4 \bullet 5^3$		
5. $(10^3)(10)$		
6. $(10^5)(10^3)(10^2)$		
7. $(x^2)(x^3)$		
8. $(p^4)(p^5)(p)$		

Look at the original exponents in the **Problem** *and the exponents in the* **Exponential Form** *. Write the rule for multiplying numbers with integer exponents:*

Exponents Raised to an Exponent (a.k.a. Power to a Power)

Problem	E•x•p•a•n•d•e•d F•o•r•m	Exponential Form
1. $(2^3)^2$	$2^3 \bullet 2^3 = \underline{2 \bullet 2 \bullet 2} \bullet \underline{2 \bullet 2 \bullet 2}$	
2. $(2^2)^3$		
3. $(2^2)^4$		
4. $(2^3)^3$		
5. $(2^2)^4$		
6. $(a^5)^2$		
7. $(w^5)^3$		
8. $(g^5)^3$		

Look at the original exponents in the **Problem** *and the exponents in the* **Exponential Form** *. Write the rule for an exponent raised to an exponent:*

Dividing Numbers with Exponents

Problem	E•x•p•a•n•d•e•d F•o•r•m	Exponential Form
1. $2^5 \div 2^2 = \frac{2^5}{2^2}$	$\frac{2 \bullet 2 \bullet 2 \bullet 2 \bullet 2}{2 \bullet 2}$	
2. $4^6 \div 4^2 = \frac{4^6}{4^2}$		
3. $5^6 \div 5^2 = \frac{5^6}{5^2}$		
4. $3^5 \div 3^3 = \frac{3^5}{3^3}$		
5. $10^7 \div 10^4 = \frac{10^7}{10^4}$		
6. $r^4 \div r^2 = \frac{r^4}{r^2}$		
7. $s^7 \div s^3 = \frac{s^7}{s^3}$		
8. $m^{10} \div m^3 = \frac{m^{10}}{m^3}$		

Look at the original exponents in the **Problem** *and the exponents in the* **Exponential Form** *. Write the rule for dividing numbers with integer exponents:*

Create and Evaluate

Rewrite your rule for multiplying numbers with exponents.	Which rule is the same as your rule? A. $x^a \bullet x^b = x^{a+b}$ B. $\frac{x^a}{x^b} = x^{a-b}$ C. $(x^a)^b = x^{a \bullet b}$
Rewrite your rule for a power raised to a power.	Which rule is the same as your rule? A. $\frac{x^a}{x^b} = x^{a-b}$ B. $(x^a)^b = x^{a \bullet b}$ C. $x^a \bullet x^b = x^{a+b}$
Rewrite your rule for dividing numbers with exponents.	Which rule is the same as your rule? A. $x^a \bullet x^b = x^{a+b}$ B. $(x^a)^b = x^{a \bullet b}$ C. $\frac{x^a}{x^b} = x^{a-b}$