Exponent Rules Storyboard

Lesson Overview
In this lesson, students will use the laws of exponents to solve expressions. Students will create and storyboard the three forms of writing exponents as well as the law of exponents they have learned in this unit to demonstrate application.

Standards Addressed
7.EEI.5 Understand and apply the laws of exponents (i.e., product rule, quotient rule, power to a power, product to a power, quotient to a power, zero power property) to simplify numerical expressions that include whole-number exponents.

Disciplinary Literacy Strategies
Gallery Walk

Computational Thinking
Strategy Used: Storyboarding
Cornerstone(s) Addressed:
- Decomposition: Students will determine the rule needed as they break down the given problem. Rules will need to be broken down by steps for the storyboard. Students will also need to break the problems into bases and exponents to apply the rules.
- Pattern Recognition: Students will look for patterns between the standard form, factored form, and the exponential form of problems.
- Algorithmic Thinking: Students will solve each exponential problem by applying algorithms for exponential properties.

Lesson Plan
Time required: One 60-minute class period
Focus Question(s): How are exponent rules applied to simplifying exponential expressions?
Disciplinary Vocabulary: exponent, expression, coefficient, constant, distribute, like-terms, product rule, quotient rule, power to a power, product to a power, quotient to a power, zero power property
Materials needed:
- *Chart Paper*
- *Colored pencils, markers, crayons*
- *Notebook paper*
- *Pencil*
- *Math Notebook*
- *Homework Sheet*
- *Practice Sheets*
- *Chromebook or another device (if needed)*

Engage:
Students will engage in a model storyboard activity (developed by the teacher) focused on recognizing bases and exponents/powers. The storyboard should include a description of exponential, factored, and standard forms. *See 8 sample slides following the lesson.*

Explore:
Students should be placed in 6-12 groups depending on group size and number of students. *3 per group is the recommendation*. There should be at least one group per property type. Properties include: product rule, quotient rule, power to a power, product to a power, quotient to a power, zero power property.

Student will work in trios (preferably) to solve multiple problems based on their assigned property. *These should be provided by the teacher – a few examples are given at the end of the lesson.* They should look for patterns while solving to help them start to formulate a storyboard based on the rules and steps for simplifying.

Explain:

Students will create a story board based on their assigned property to explain the rule. The storyboard should include the process or rule for simplifying their type problem, relation to exponential, factored, and standard forms, examples following the rules given and problems (without solutions explained) for the class to complete.

NOTE: Students are free to use paper or google slides on the Chromebook (or another device) to create their storyboard.

Elaborate:

After storyboards are completed by each group, they will be displayed around the room (on the wall or at tables). Student groups will do a gallery walk around the room reviewing the storyboards and working the sample problems provided. The rules and the sample problems with any work should be captured by each group in their math notebooks as they review each of the groups' storyboards.

Evaluate:

Students will self-check their work as storyboard groups share the correct answers to their problems presented in their storyboard for classmates to solve. *These were solved in student's math notebooks as they circulated to review one another's' storyboards.* The teacher will provide a practice sheet for classwork or homework for students to complete and submit. This should be graded as a summative grade. *There is sample practice sheet following the lesson.*

Assessment Notes: For the storyboard, students should be assessed on their content knowledge on the topic, creativity and accuracy in their storyboarding, as well as interactions with one another in getting the activity completed.
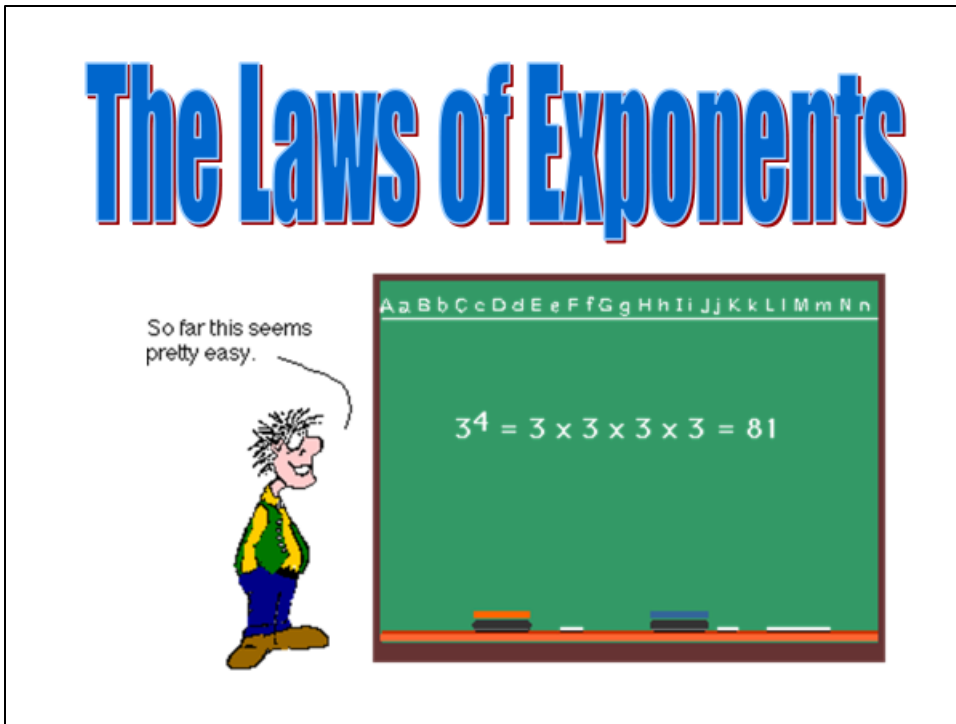
Teacher Biographical Information

Ayienne Waring

7th grade Mathematics teacher

3 years of experience, GT endorsed

SAMPLE STORYBOARD FOR TEACHER INTRO EXAMPLE AND CONTENT TO REVIEW (8 slides)

The Laws of Exponents

So far this seems pretty easy.

A a B b C c D d E e F f G g H h I i J j K k L l M m N n

$$3^4 = 3 \times 3 \times 3 \times 3 = 81$$

Exponents

exponent

Power $\longrightarrow \left\{ 5^3 \right.$

base

Example: $125 = 5^3$ means that 5^3 is the exponential form of the number 125.

5^3 means 3 factors of 5 or 5 x 5 x 5

Writing Powers:

Exponential form:

The exponent of a power indicates how many times the base multiplies itself.

$$x^n = \underbrace{x \cdot x \cdot x \cdots x \cdot x \cdot x \cdot x}_{n-times}$$

n factors of x

Example: $5^3 = 5 \cdot 5 \cdot 5$

Writing Powers:

FACTORED FORM

$$2^3 = 2 \times 2 \times 2$$

factors

Writing Powers:

STANDARD FORM

$$2^3 = 2 \times 2 \times 2$$

$$4 \times 2$$

$$8$$

POWERS AND EXPONENTS

Exponent Form	Factor Form	Standard Form
4^3	4 x 4 x 4	64
7^2	7 x 7	49
m^5	m x m x m x m x m	

- it's important to know when to include a negative
  sign in your multiplication as part of the base

$3^4 = 3 \times 3 \times 3 \times 3$

$\quad\quad = 81$

because the "3" is
directly left of the
exponent 4.

$-3^4 = -(3 \times 3 \times 3 \times 3)$

$\quad\quad = -81$

- because the "3" is directly
  left of the exponent 4, the
  "3" is the base and the
  negative is "kept out in front"

Exponent Laws

- Product Rule
- Quotient Rule
- Power of a Power Rule
- Product to a power
- Quotient to a power
- Zero Power Property

Group Practice Problems
(These are a few examples…depending on group needs, the teacher should provide additional examples)

Simplify:

GROUP 1: PRODUCT RULE
1. $n^2 * n^5$ 2. $2^2 * 2^3$ 3. $(-2)^2(-2)^5$ 4. $z^{10} * z^3$

GROUP 2: QUOTIENT RULE
5. $\dfrac{r^4}{r^3}$ 6. $\dfrac{m^5}{m^2}$ 7. $\dfrac{15^4}{15}$ 8. $\dfrac{x^{15}}{x^7}$

GROUP 3: POWER TO A POWER
9. $(2^4)^3$ 10. $(x^6)^5$ 11. $(3z^2)^2$ 12. $(-5x)^2$

GROUP 4: PRODUCT TO A POWER
13. $(xy^8)^3$ 14. $(6r^2t^4)^2$ 15. $(3x^4y^7)^2$ 16. $(5^3x^3y^5)^2$

GROUP 5: QUOTIENT TO A POWER
17. $\left(\dfrac{x^2}{t}\right)^3$ 18. $\left(\dfrac{y^4}{q}\right)^4$ 19. $\left(\dfrac{rst^2}{rs}\right)^3$ 20. $\left(\dfrac{t^2}{t}\right)^3$

GROUP 6: ZERO POWER
21. $(-0.3)^0$ 22. $(7y)^0$ 23. $7y^0$ 24. $(6x^2y^7)^0$

CLASSWORK/HOMEWORK PRACTICE: LAWS OF EXPONENTS

1. PRODUCT RULE:

    A. $x^3 \cdot x^8$ B. $2^4 \cdot 2^2$ C. $(x^2y)(x^3y^4)$

2. QUOTIENT RULE:

    A. $\dfrac{x^5}{x^2}$ B. $\dfrac{3^5}{3^8}$:   C. $\dfrac{x^2y^5}{xy^3}$:

3. ZERO EXPONENT RULE:

    A. y^0 B. 6^0 C. $7(a^3b^{-1})^0$

4. POWER RULE:

    A. $(x^3)^2$ B. $(3^2)^4$ C. $(z^5)^2$

5. EXPANDED POWER RULES:

A. $(2a)^3$

B. $(6x^3)^2$

C. $\left(\dfrac{x^2}{y}\right)^4$ =

D. $\left(\dfrac{2x}{3y^2}\right)^3$

SOLUTIONS TO CLASSWORK/HOMEWORK PRACTICE

EXPONENT RULES & PRACTICE

1. **PRODUCT RULE:** To multiply when two bases are the same, write the base and ADD the exponents.
$$x^m \cdot x^n = x^{m+n}$$

Examples:

A. $x^3 \cdot x^8 = x^{11}$ 　　　　 B. $2^4 \cdot 2^2 = 2^6$ 　　　　 C. $(x^2y)(x^3y^4) = x^5y^5$

2. **QUOTIENT RULE:** To divide when two bases are the same, write the base and SUBTRACT the exponents.
$$\frac{x^m}{x^n} = x^{m-n}$$

Examples:

A. $\frac{x^5}{x^2} = x^3$ 　　　　 B. $\frac{3^5}{3^8} = 3^2$ 　　　　 C. $\frac{x^2y^5}{xy^3} = xy^2$

3. **ZERO EXPONENT RULE:** Any base (except 0) raised to the zero power is equal to one.
$$x^0 = 1$$

Examples:

A. $y^0 = 1$ 　　　　 B. $6^0 = 1$ 　　　　 C. $(7a^3b^{-1})^0 = 1$

4. **POWER RULE:** To raise a power to another power, write the base and MULTIPLY the exponents.
$$(x^m)^n = x^{m \cdot n}$$

Examples:

A. $(x^3)^2 = x^6$ 　　　　 B. $(3^2)^4 = 3^8$ 　　　　 C. $(z^5)^2 = z^{10}$

5. **EXPANDED POWER RULE:**

$$(xy)^m = x^m y^n \qquad \left(\frac{x}{y}\right)^m = \frac{x^m}{y^m}$$

Examples:

A. $(2a)^3 = 2^3 a^3 = 8a^3$

B. $(6x^3)^2 = 6^2(x^3)^2 = 36x^6$

C. $\left(\frac{x^2}{y}\right)^4 = \frac{(x^2)^4}{y^4} = \frac{x^8}{y^4}$

D. $\left(\frac{2x}{3y^2}\right)^3 = \frac{(2x)^3}{(3y^2)^3} = \frac{2^3 x^3}{3^3 (y^2)^3} = \frac{8x^3}{27y^6}$