A New Family That Multiplies

Students meet the exponential family through doubling stories, contrast constant difference with constant ratio, learn exponents as repeated multiplying, and discover the zero power and one negative power by walking a table backward.

TIME	40 minutes (one student with a parent or tutor, or a small group)
WHO	Math 1 (algebra readiness), about age 12. Follows Unit 6. Opens the second family of graphs; read the family-of-graphs note first.
MATERIALS	Student worksheet (PDF), the Deep Dive 5 interactive page for this lesson, pencil, a sheet of paper to fold
PRIOR KNOWLEDGE	Lines add a constant amount (Unit 3). The multiplicative identity 1 (Unit 1, Lesson 1). Tables with constant differences (Unit 3, Lesson 5).
STANDARDS	NC Math 1 NC.M1.F-LE.1 (distinguish situations that grow by equal differences from those that grow by equal factors) and NC.M1.F-LE.3. Exponent rules are Unit 13.
KEEP OUT	The form y = a times b to the x (Lesson 2). Rules for multiplying powers (Unit 13).

Learning goals

1. Say the thread: lines add, exponentials multiply; constant difference versus constant ratio.
2. Decide from a table with equal x steps whether it adds, multiplies, or neither, by subtracting and then dividing.
3. Read a power: name the base and exponent and work out small powers, including the zero power and one negative power.
4. Explain why any base to the zero power is 1 by walking the table backward.

Vocabulary: say both, every time

The rule for the whole lesson: whenever the adult or the student says a math word, they follow it with the plain-English version. Proper term first, plain English second, until the student does it without being asked.

TERM	LOOKS LIKE	PLAIN ENGLISH
Exponent, base, power	2^5	How many, what is multiplied, the whole thing.
Constant difference	subtract	The line pattern.
Constant ratio	divide	The exponential pattern.
Exponential function	multiplies each step	The second family.
Zero power	1	The do-nothing number.

> THE ONE SENTENCE TO SAY OUT LOUD
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> Lines add, exponentials multiply. Subtract to find a difference, divide to find a ratio. Anything to the zero power is 1.

Lesson timeline (40 minutes)

0:00 to 0:06	**Warm-up: fold and count.** Fold a sheet of paper and count layers: 1, 2, 4, 8, 16. Ask what happens each fold. Then write a line's table (1, 3, 5, 7, 9) beside it. Ask how each column moves.
0:06 to 0:16	**Mini-lesson: subtract or divide.** Down the line: subtract, always 2. Down the doubling: divide, always 2. Name constant difference and constant ratio. Say the thread and have the student say it back. Run the interactive table builder.
0:16 to 0:26	**Exponents, then walk backward.** Write $2 \times 2 \times 2 \times 2 \times 2$ and shorten it. Name base, exponent, power. Warn: 2^3 is 8, not 6. Then walk the powers of 2 left: 8, 4, 2, 1, one half. Tie $2^0 = 1$ to the do-nothing number.
0:26 to 0:36	**Practice.** The four decide tables, then the practice problems or Worksheet Parts A to D. Same buttons: Hint, Show next step, Reveal answer, Hide help.
0:36 to 0:40	**Exit ticket.** Worksheet Part F. Success looks like 81 with base 3 and exponent 4; the walk-backward explanation; exponential with ratio 3.

Misconceptions to listen for

- $2^3 = 6$. The exponent counts copies of the base. $2 \times 2 \times 2 = 8$.
- $2^0 = 0$. Walk backward: 1. Nothing multiplied yet.
- Stopping at differences. If differences change, divide before deciding.
- Ratios need to be bigger than 1. 80, 40, 20 has ratio one half: still exponential.
- Reaching for exponent rules. Unit 13. Here, read and count.

Support and stretch

Support

Keep the paper folding and the two tables on the desk. Use the table builder for several steps. Say the thread aloud at each transition.

Stretch

Ask what 2^{10} is and how many folds it would take to pass 1,000. Ask for a table that multiplies by 1 and what family it belongs to (a flat line: multiplying by 1 changes nothing).

Where this goes next

Lesson 2: the form y = a times b to the x. The three family questions: what family, what are its numbers, what does each number do.

> THE HABIT TO BUILD
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> Subtract for a difference, divide for a ratio, and say which family.