The Family of Lines: One Form, Many Members

Students see all straight lines as one family, y = mx + b, with each line a member picked out by its parameters m and b. They learn what each number does (b slides, m tilts), touch parallel lines lightly, and meet the habit that every later family will use.

TIME	40 minutes (one student with a parent or tutor, or a small group)
WHO	Math 1 (algebra readiness), about age 12. Follows Unit 3, Lesson 2 (slope-intercept form).
MATERIALS	Student worksheet (PDF), the Deep Dive 5 interactive page for this lesson (the explorer needs a screen), pencil, graph paper, ruler
PRIOR KNOWLEDGE	y = mx + b and the two jobs of m and b (Lesson 2). Graphing by plotting b and stepping by m.
STANDARDS	NC Math 1 NC.M1.F-BF.3 (the effect on the graph of changing a parameter), NC.M1.F-LE.5. Seeds the family idea for exponential (F-LE) and quadratic (Math 2) functions.
KEEP OUT	Parallel lines only as same slope means parallel. Perpendicular lines and the negative-reciprocal rule are Unit 4.

Learning goals

1. Say what a family of graphs is and why all straight lines are one family, using the words member and parameter.
2. Predict and describe the effect of changing b (slides, stays parallel) and of changing m (tilts around the y-intercept; steeper, flat, or falling).
3. Match an equation to its graph by elimination: the sign of m first, then b, then the size of m, naming the rule that ruled out each wrong choice, without plugging in points.
4. State the three questions to ask about any new family.

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
Family of graphs	same form, different numbers	All lines: y = mx + b.
Member	one line	Picked out by its own m and b.
Parameter	m or b	A number that picks out one member.
Slide, tilt	change b, change m	b moves the line up or down; m turns it around (0, b).
Parallel	same m	Same steepness, never meet.

> THE ONE SENTENCE TO SAY OUT LOUD
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> Name the family. Find its numbers. b slides the line, m tilts it. Same m means parallel. Ask the same questions of every family.

Lesson timeline (40 minutes)

0:00 to 0:05	**Warm-up: what do these have in common?** Show six equations: $y = x$, $y = 2x - 3$, $y = -x + 4$, $y = 1/2\ x + 2$, $y = -2$, $y = -3x - 1$. Ask what is the same (the form) and what is different (the numbers). Name it: a family.
0:05 to 0:15	**Mini-lesson: b slides, m tilts.** On one grid draw $y = x$ with $b = -3, 0, 2, 4$: same tilt, sliding up. Say parallel, once, as same slope means parallel. On a second grid draw $b = 1$ with $m = 3, 1, 1/4, 0, -2$: a fan around (0, 1). Name the special members: flat ($m = 0$), the 45-degree line ($m = 1$), gentle, steep.
0:15 to 0:25	**Explorer, then eliminate.** The student drives the sliders. Give targets: a steep climber, a gentle faller, the flat line, a line through the origin, a line parallel to the current one. Then teach match by elimination: one equation, four described graphs, cross out by the sign of m, then b, then the size of m. Say: do not plug in points; read what the equation forces. Then the matching activity.
0:25 to 0:35	**Practice.** The practice problems or Worksheet Parts A to D. Same buttons: Hint, Show next step, Reveal answer, Hide help. Require the words slid and tilted in every comparison.
0:35 to 0:40	**Looking ahead, and the exit ticket.** Show the three family pictures (line, exponential, quadratic) and state the three questions. Exit ticket: Worksheet Part F or an index card. Success looks like: same m, different b, slid down 5, parallel; any $y = mx - 2$ with m less than -1.

Misconceptions to listen for

- **Changing b tilts the line.** It slides. Only m changes the steepness.
- **Same b means parallel.** Same b means the same starting point. Parallel is same m.
- **A bigger m always means higher.** m is tilt, not height. Height at the y-axis is b.
- **The flat line is not a member.** $y = b$ is $y = 0x + b$, a member with $m = 0$.
- **Family means similar-looking.** Family means same form. A steep faller and a gentle climber are both lines.
- **Reaching for perpendicular.** Some students will ask about lines that cross at right angles. Unit 4.

Support and stretch

Support

Use a ruler as the line and a pin (a finger) at (0, b): sliding the pin up shows b, turning the ruler shows m. Keep the explorer targets one slider at a time before mixing them.

Stretch

Ask for the equation of the line that is $y = 2x + 1$ reflected to fall just as steeply ($y = –2x + 1$). Ask how many members of the family pass through the point (2, 5) (infinitely many; ask for three). Ask what family $y = x \times x + 1$ might be in, and what its picture looks like.

Where this goes next

Lesson 4: writing the equation of a line from whatever you are given (a graph, a table, two points, a slope and a point), plus the x-intercept. Then Lesson 5 puts m and b into stories.

> THE HABIT TO BUILD
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> Whenever you see a graph or an equation, ask: what family is this, what are its numbers, and what does each number do?