Solving by Substitution

Students learn substitution as one swap that turns a two-variable system into a one-variable Unit 1 equation, with the reasoning for why the swap is allowed, the five-step procedure, back-substitution, and the check.

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, Lesson 1.
MATERIALS	Student worksheet (PDF), the Deep Dive 5 interactive page for this lesson, pencil
PRIOR KNOWLEDGE	Solving one-variable equations with distributing and combining like terms (Unit 1, Lessons 4 and 5). Solving for a variable (Unit 3, Lesson 6). What a solution of a system is (Lesson 1).
STANDARDS	NC Math 1 NC.M1.A-REI.6 (solve systems of linear equations algebraically).
KEEP OUT	Elimination (Lesson 3). Systems with no or infinitely many solutions beyond a first glimpse (Lesson 4).

Learning goals

1. Explain why one equation's expression may replace the variable in the other: the solution satisfies both, so the variable is the same number in both.
2. Solve a system by the five steps: solve one for a variable, substitute with parentheses, solve the one-variable equation, back-substitute, check the pair in both.
3. Choose the variable that comes free most easily and recognize when substitution fits best.
4. Get exact answers, including fractions, that a graph could only estimate.

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
Substitution	swap it in	One equation's expression replaces the variable in the other.
Back-substitute	get the other one	Into the already-solved equation.
One variable	a Unit 1 equation	Distribute, combine, add opposites, reciprocal.
Check the pair	both into both	Both true.

> THE ONE SENTENCE TO SAY OUT LOUD
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> Solve one for a variable, swap it into the other, and two variables become one. Solve it the Unit 1 way, back-substitute, check both.

Lesson timeline (40 minutes)

0:00 to 0:05	Warm-up: the same y. $y = 2x + 1$ and $3x + y = 11$. Ask: at the solution, what is y equal to according to the first equation? So what can we write instead of y in the second? Write $3x + (2x + 1) = 11$ and let the student solve it.
0:05 to 0:15	Mini-lesson: why, then the five steps. Say the why out loud: same y at the same point. Then the steps on the board with a system that needs step 1 ($x + 2y = 8$, $3x – y = 3$), stressing parentheses and the distributive property. Back-substitute, check in both, and show the point on the grid.
0:15 to 0:34	Practice. The practice problems or Worksheet Parts A and B. Same buttons: Hint, Show next step, Reveal answer, Hide help. Include the fraction system from Lesson 1 so the exactness pays off, and the no-solution glimpse.
0:34 to 0:40	Exit ticket. Worksheet Part D. Success looks like the five steps in order and (2, 4) with both checks.

Misconceptions to listen for

- **Substituting back into the same equation.** That gives 0 = 0 and no information. Use the other equation.
- **Dropping parentheses.** 3(8 – 2y) is 24 – 6y, not 24 – 2y.
- **Stopping at x.** A solution is a pair. Back-substitute.
- **Checking in only one equation.** It must work in both.
- **Panicking at a strange final line.** A false statement means no solution; a true one means infinitely many (Lesson 4).

Support and stretch

Support

Start with both equations solved for y (set them equal). Highlight the expression in one color and the variable it replaces in the other. Use a five-step card.

Stretch

Give a system where neither variable has coefficient 1 and ask whether substitution is still the easiest road (previewing elimination). Ask for a system whose solution is (1/2, 3).

Where this goes next

Lesson 3: solving by elimination. Add the equations so one variable cancels, using opposite coefficients, the make-a-zero-appear idea from Unit 1.

> THE HABIT TO BUILD
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> Swap it in, with parentheses. Two variables become one. Check the pair in both.