

Lesson 1.3 ~ Solutions to Linear Equations

At a Glance

 I can determine if a linear equation in one variable has no solution, one solution or infinitely many solutions.

Standards Overview

Focus Content Standard(s): 8.EE.C.7 (Major)

Focus Math Practice Standard: SMP1

Materials

Required: None

Starter Choice Board Overview

Storyboard: Write and solve equations (8.EE.C.7)

Building Blocks: Solve two-step equations (7.EE.B.4)

Blast from the Past: Analyze rates (7.RP.A.1)

Fluency Board Skills: Add and subtract integers, multiply and divide integers, multiply fractions

Lesson Planning Overview

Minutes Day 1

5-10 **Starter Choice Board:** BB or BftP

15-20 **Explore! Activity:** “What Works?”

15-20 **Lesson Presentation**

HW **Practice:** Student Lesson or Online Practice

Minutes Day 2

5-10 **Starter Choice Board:** Storyboard

20 **Teacher Gem:** ASN, CTL or TT

10 **Exit Card or Target Tracker**

HW **Practice:** Leveled Practice

Learning Outcomes

All students should be able to determine the number of solutions given a multi-step equation.

Most students should be able to explain the meaning of the types of solutions given contextual and non-contextual situations.

Exit Card

Solve each equation. There may be one solution, no solutions, or infinitely many solutions.

1. $2x + 6 = 6x - 22$

2. $2x + 8 = 2x - 3$

3. $3(x - 4) = x + 2x - 12$

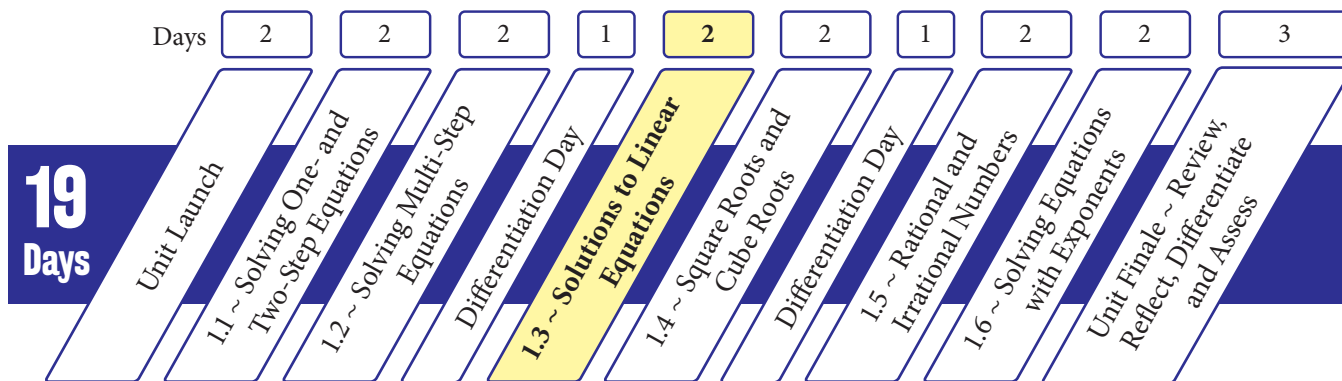
Example: Student Lesson Exercise #12

Tara and Alice joined the same movie club. Tara said her monthly fee is represented by the expression $2x + 8$. Alice said her monthly fee is represented by the expression $2(x + 4)$. In both expressions, x is the number of movies rented in a month. Who got the better deal? Explain how you know.

Lesson 1.3 ~ Solutions to Linear Equations

Deep Dive

 I can determine if a linear equation in one variable has no solution, one solution or infinitely many solutions.



Focus Content Standards

8.EE.C.7 (Major): Solve linear equations in one variable.

- Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form $x = a$, $a = a$, or $a = b$ results (where a and b are different numbers).
- Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.

Lesson Planning Guidance: Day 1

Starter Choice Board: Building Blocks or Blast from the Past (5-10 minutes)

In this lesson, the “Building Blocks” task asks students to access background knowledge on solving two-step equations. Use this activity if many of your students need support in recalling this skill. Consider using Expert Crayons to have students move around the room supporting each other. Choose the Starter Choice Board’s “Blast from the Past” task to give students an opportunity to utilize problem solving skills involving analyzing rates.

Explore! Activity: “What Works?” (15-20 minutes)

Students start the activity “What Works?” by solving one equation from the top of the activity sheet. They then find a partner who solved the same problem and compare solution pathways. In this activity, one equation’s solution will be something they are familiar with (one solution) but the other equations either have no solution or infinitely many solutions. Students will have opportunities throughout the Explore! to explain how many solutions they think an equation has and why.

Implementation Option #1: Project the three equations. Assign each of the three equations to one-third of the students in the class. Have students solve their equation and then join with others who solved the same equation to discuss their solution(s). Have groups share their ideas before skipping to Step 5. Have students complete Steps 5-6 individually and then discuss as a class.

Implementation Option #2: Use the Explore! activity sheet as provided and allows students to pick an equation and then complete Steps 2-5 with the partner they found for Step 2. Finally, have students return to their seats and discuss Step 6 together before summarizing in their notes.

Lesson Presentation (15-20 minutes)

Have students utilize their interactive textbooks or composition notebooks to participate in guided note taking using the Lesson Presentation. Have students attempt Extra Examples with partners, in small groups or independently. Use “Communication Break” slides as opportunities for meaningful discourse.

Communication Break – Expert Crayons: Gather enough crayons to use as Expert Crayons (approximately enough crayons for one-fourth to one-third of the class). For Extra Example 2, have students work independently and then raise their hand for you to check their work. If correct, sign your initials to their notebook or Interactive Textbook and then leave them with an Expert Crayon. The students with Expert Crayons become the coaches to initial the remainder of the students’ papers. Repeat this until all Expert Crayons have been handed out. This can also be done with “local” experts so that students are wandering around less, if desired.

Communication Break – Think, Ink, Pair, Square: Use the prompt “What does it mean for an equation to have infinite solutions?” Have students think and write independently before joining with a partner to share. Then have two partner sets join together. Ask one group to start and the other group respond using the sentence stems provided.

Independent Practice: Student Lesson Exercises or Online Practice

Have students complete all exercises from the first three sections of the Student Lesson: “Practice My Skills,” “Reason and Communicate,” and “Apply to the World Around Me.” Differentiate based on student need by reducing the exercise set to odd numbers only or extending by only assigning the “Gem” exercises to specific students. If time allows, consider using the Spiral Review as an additional component. If choosing the Online Practice, consider using the Online Practice template for students to record their work and reflect on their results on either (or both) the Online Practice or Online Challenge Practice.

Lesson Planning Guidance: Day 2

Starter Choice Board: Storyboard Starter (5-10 minutes)

In this Storyboard Starter, students write and solve equations. Consider having students read the Storyboard frame and have silent think time for 1-2 minutes before working with table partners. Another option is to have one or two students in each group read the characters’ statements and then work together to answer the prompt.

Teacher Gem: Always Sometimes Never, Climb the Ladder or Ticket Time (20 minutes)

ALWAYS

SOMETIMES

NEVER

CLIMB THE



Video



Instructions



Best to use when students need deeper understanding of the vocabulary and concepts introduced in the lesson.

Video



Instructions



Best to use when many students are ready to progress to higher depths of knowledge incrementally using the four ladders.

Video



Instructions



Best to use when wanting to provide immediate feedback and gather classroom data around lower depth of knowledge questions based on the lesson’s learning target.

Exit Card and Target Tracker (10 minutes)

Use the pre-printed Exit Card or have students use their own paper with the last slide of the Lesson Presentation. Have students update their Target Tracker using their Exit Card data and their Teacher Gem experience. Use the Exit Card data to provide guidance for Leveled Practice assignments or for an upcoming Differentiation Day.

Independent Practice: Leveled Practice

Hand out the Proficient and Challenge Leveled Practice copied front to back. Have students select the side they feel would be appropriate practice based on their self-reflection or assign specific students to specific sides based on information you have gathered during the lesson. Make answers available, if desired, by printing the answers and posting them in the room or posting them to your online platform so students have access to feedback as they work.

Formative Assessment Guidance

Many components in the EdGems Math program can be used to provide formative assessment data for teachers and students. The recommendations below provide suggested components for this lesson and guidance for using this data to differentiate instruction.

Option 1 – Student Lesson Exercises: Have students complete Student Lesson Exercises 3, 7, 12 (one of the simpler problems from each of the first three sections) on their own and bring them to the teacher for feedback. If all three problems are correct, have students complete the remaining “Reason and Communicate” and “Apply to the World Around Me” exercises. If students miss 1 or 2 of the items, have them complete the “Practice My Skills” section independently. If students get all three problems incorrect, bring these students together for a small group with an “Expert” or the teacher for guided practice using the “Practice My Skills” exercises.

Option 2 – Ticket Time: Reserve two tickets from the Ticket Time Teacher Gem activity to be done individually to provide students with tangible evidence of progress. Students who are unable to answer either ticket correctly can join a small group to complete the Tiered Leveled Practice with the teacher or an “Expert.”

Option 3 – Student Error Analysis: Select evidence of student thinking from a Teacher Gem activity that illustrates incorrect solution pathways using items such as Ticket Time tickets or Climb the Ladder half-sheets (these may be retained prior to having students fix their work so that you have good examples of common errors). Project student work (names not shown) and have students individually try to locate the error in the solution pathway. Afterwards, have students reflect on their own understanding of the concept using the Target Tracker. Use this data to assign differentiated practice such as Leveled Practice or subsets of the Student Lesson exercises.

Focus Math Practice

In this lesson, students will have many opportunities to solve problems that require them to make sense of and persevere in problem solving (SMP1). Have students use the Mathematical Practices Tracker to reflect on situations where they exhibited this practice (i.e., Explore! activity, Lesson Presentation, Climb the Ladder).



I can make sense of problems and persevere in solving them.

I made sense of the problem and planned how to solve it.

I persevered when a problem was difficult.

I used more than one strategy to solve a problem.

Math Practices: Teacher and Student Moves

Math Practice	Teacher Moves	Student Moves
SMP1 <i>Make sense of problems and persevere in solving them.</i>	After the Explore! activity, have students look at three equations on the board (i.e., $x = 2$, $4 = 4$ and $5 = 7$). Ask students which statement is never true, always true or sometimes true. This will reinforce making sense of the types of solutions that arise from different situations.	Use the similarities between equations that have the same types of solutions to make predictions about the number of solutions for an equation prior to solving. Check predictions by actually solving the equation.
SMP2 <i>Reason abstractly and quantitatively.</i>	Utilizing the Explore! activity is a great way to cultivate a community of growth mindset learners as students come across unfamiliar situations when solving equations (no solution or infinitely many solutions). Relate these to real-world problems such as Student Lesson Exercises #12-15.	Analyze a problem and ask questions when solving equations where the variable “disappears” in the Explore! activity. Support each other to try to figure out what these equations might mean in terms of their solution.
SMP3 <i>Construct viable arguments and critique the reasoning of others.</i>	Develop students’ ability to justify methods and compare their responses to their peers when students discuss other groups’ arguments for their answers to each prompt in the Always Sometimes Never Teacher Gem activity.	Recognize errors and make changes to correctly solve the problem when given immediate feedback from peek sheets in the Teacher Gem activity Ticket Time.
SMP4 <i>Model with mathematics.</i>	For students who are struggling with the abstract concept of equations having no solution or infinitely many solutions, consider representing the two sides of the equation as a scale to show what happens when the variable terms are the same on both sides.	Discuss real-world situations that can be modeled with equations with one solution, many solutions and no solution. Explain how you know an equation will result in one solution, many solutions, or no solution without solving.
SMP6 <i>Attend to precision.</i>	There are many solution pathways that students can take to simplify and solve problems. Allow for flexibility in determining the number of solutions in an equation. You may even consider letting students mentally determine the number of solutions based on patterns as long as they can justify their answer.	Maintain flexibility and accuracy while solving equations, especially those with rational number coefficients and constants. Adapt procedures for performing calculations while working with whole numbers, fractions and decimals.
SMP7 <i>Look for and make use of structure.</i>	Use Student Lesson Exercise #9 to have students reason about the type of solution that comes from equivalent expressions being set equal to each other. Draw connections between concepts of equivalent expressions and solving.	Look for similarities among problems that have the same type of solution. Summarize discoveries in a way that goes beyond just what the final equation will look like after solving.
SMP8 <i>Look for and express regularity in repeated reasoning.</i>	Use the Explore! activity to help students look at different types of solutions and make conjectures using repeated reasoning about when problems have one solution, no solution or infinitely many solutions.	Pay attention to what happens to the variable when solving equations that lead to different solution types. Determine “shortcuts” that help find the number of solutions without having to completely solve each equation.

Common Misconceptions

Some students will state that the equation $x = 0$ has no solution, since the zero has value of zero. Ask them to determine why it is a solution (i.e., because 0 is a number).

Students might be able to spot equations with equivalent expressions when they have the opportunity to examine different equations with many solutions throughout the equation solving process. Encourage students to examine their equivalent equations along the way.

A common error students make involves applying the distributive property when negative integers are involved, such as $-2(-x - 4)$. The error occurs when they try to multiply the -2 and the -4 . Students need repeated exposure to equations of this type. Prompting students to consider “minus 4” as “plus negative 4” helps correct the misconception.

Mathematical Language Routines

Designed by Stanford Graduate School of Education’s Understanding Language, mathematical language routines are structured but adaptable formats designed to help teachers “amplify, assess and develop students’ language” in math class. Three language routines specific to this lesson are given below.

MLR 1 – Stronger & Clearer Each Time: During the Teacher Gem activity Always Sometimes Never, instruct students to add examples and counterexamples on their evidence cards. Groups then exchange their evidence cards with 2 - 3 other groups to get feedback on how to improve their explanations. When students receive their evidence cards back with the feedback, they revise their explanations. While groups are providing feedback, display the following questions to help them think about what types of feedback will be helpful:

- Did the group answer the question?
- Did the group provide examples and counterexamples to support their answer?
- Did the group justify their reasoning, referencing the examples and counterexamples?
- How can the group make their explanations stronger?

MLR 5 – Co-Craft Questions: Display the equations in the box from the Explore! activity.

$$2(x + 5) = 2x + 10$$

$$5x - 11 = 3x - 3$$

$$14 + 3x - 5 = 2x + 3 + x$$

Allow students 5-10 minutes to work with a partner to create problem situations that can be represented by one or more of these equations. Display the questions. If time allows, choose one or two situations to discuss as a class.

MLR 7 – Compare & Connect: After students complete Student Lesson Exercises #4-6, instruct them to share their equations with a partner. Partners check each other’s work to make sure the equations meet the criteria. If needed, students revise their work. The partners then discuss the similarities and differences for the answers to each Exercise. Then, they summarize their understandings about equations that have no solution, one solution, and infinitely many solutions.