

Journey of the Isolated Variable, Part 2

Solving Multi-Step Equations

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Grade Level	8th – 9th Grade	**Time Frame**	135 minutes
Subject	Mathematics	**Duration**	3 class periods
Course	Algebra 1, Pre-Algebra		

Essential Question

How do I isolate a variable in a multi-step equation?

Summary

This lesson focuses on the properties of real numbers, properties of equality, and inverse operations to help students deepen their understanding of solving linear equations. Students will learn to isolate variables and apply this knowledge to more complex problems. By the end of the lesson, students will solve multi-step equations using properties of rational numbers and algebraic properties. This is the second lesson in the "Journey of the Isolated Variable" series.

Snapshot

Engage

Students activate prior knowledge by creating Picture Notes for key algebraic vocabulary terms.

Explore 1

Students use an Amplify Classroom activity to investigate how to manipulate an equation to create the smallest solution possible.

Explain 1

Students reason and abstractly argue that their expression creates the smallest possible solution through a Think-Pair-Share activity.

Explore 2

Students work in pairs to solve multi-step equations and peer-review each other's work using the Pass the Problem strategy.

Explain 2

Students review their equation-solving strategies through a Flowchart and practice solving problems using the GUS Method.

Extend

Students create word problems based on items bought and sold in a theater during a station-based Drive-in Theater activity.

Evaluate

Students demonstrate understanding through an Exit Ticket.

Standards

ACT College and Career Readiness Standards - Mathematics (6-12)

A302: Solve one-step equations to get integer or decimal answers
A403: Solve routine first-degree equations
A502: Solve real-world problems by using first-degree equations

Oklahoma Academic Standards Mathematics (8th Grade)

PA.A.4.1: Solve mathematical problems using linear equations with one variable where there could be one, infinitely many, or no solutions. Represent situations using linear equations and interpret solutions in the original context.
PA.A.4.2: Represent, write, solve, and graph problems leading to linear inequalities with one variable in the form $px + q > r$ and $px + q < r$, where p, q, and r are rational numbers.

Attachments

- Create Your Own Problem—Journey of the Isolated Variable, Part 2 - Spanish.docx
- Create Your Own Problem—Journey of the Isolated Variable, Part 2 - Spanish.pdf
- Create Your Own Problem—Journey of the Isolated Variable, Part 2.docx
- Create Your Own Problem—Journey of the Isolated Variable, Part 2.pdf
- Exit Ticket—Journey of the Isolated Variable, Part 2.docx
- Exit Ticket—Journey of the Isolated Variable, Part 2.pdf
- Flowchart—Journey of the Isolated Variable, Part 2 - Spanish.pdf
- Flowchart—Journey of the Isolated Variable, Part 2.pdf
- Just Give Me a Reason—Journey of the Isolated Variable, Part 2 - Spanish.docx
- Just Give Me a Reason—Journey of the Isolated Variable, Part 2 - Spanish.pdf
- Just Give Me a Reason—Journey of the Isolated Variable, Part 2.docx
- Just Give Me a Reason—Journey of the Isolated Variable, Part 2.pdf
- Lesson Slides—Journey of the Isolated Variable, Part 2.pptx
- Note Catcher—Journey of the Isolated Variable, Part 2 - Spanish.docx
- Note Catcher—Journey of the Isolated Variable, Part 2 - Spanish.pdf
- Note Catcher—Journey of the Isolated Variable, Part 2.docx
- Note Catcher—Journey of the Isolated Variable, Part 2.pdf
- Picture Notes—Journey of the Isolated Variable, Part 2 - Spanish.docx
- Picture Notes—Journey of the Isolated Variable, Part 2 - Spanish.pdf
- Picture Notes—Journey of the Isolated Variable, Part 2.docx
- Picture Notes—Journey of the Isolated Variable, Part 2.pdf

Materials

- Lesson Slides (attached)
- Picture Notes (attached; one per student)
- Note Catcher (attached; one per student)
- Just Give Me a Reason (attached; one set per pair)
- Flowchart (attached; one per student)
- Create Your Own Problem (attached; one set per 5 stations; front only)
- Exit Ticket (attached; one-half sheet per student)
- Pencils
- Paper
- Chromebooks or student devices with internet access
- Student dry-erase boards (optional)

10 minutes

Engage

Teacher's Note: Lesson Order

The order of this lesson is as follows: Engage, Explore 1, Explain 1, Explore 2, Explain 2, Extend, Evaluate.

Teacher's Note: Terminology

Students use the **Picture Notes** handout in this portion of the lesson. Some students may not know every term initially; encourage them to fill in what they can. This handout serves as a reference throughout the lesson and the unit.

Introduce the lesson using **Lesson Slides**. Display **slide 3** to share the essential question: "How do I isolate a variable in a multi-step equation?" Display **slide 4** to review the learning objective. Discuss these slides as needed.

Display **slide 5** and distribute **Picture Notes** handout. Instruct students to independently create Picture Notes for different algebraic vocabulary terms (e.g., associative property, inverse property, like terms, and coefficient).

Give students five minutes to work independently. Walk around the classroom to assess prior knowledge and identify areas where students may need additional guidance. Once students have completed their Picture Notes, have them set the handout aside. Inform students that they will revisit this handout later in the lesson.

15 minutes

Explore 1

Teacher's Note: Desmos Classroom Activity Preparation

To prepare for the Amplify Classroom activity in this phase of the lesson, go to *Amplify Classroom: Smallest Solution*. Sign up to create an account or log in. Select the "Assign" dropdown button, and then select "Create single session code." Adjust the settings as desired, then select "Create Invite Code." Prepare this session invitation code to distribute to students during the lesson. For help assigning an Amplify Classroom activity, see k20.ou.edu/AssignActivity.

For more information about getting started with Amplify Classroom, go to k20.ou.edu/StartAmplify.

Display **slide 6** and provide students with your session code. Then have them go to student.amplify.com/join and enter the session code.

Teacher's Note: Sign-in Options

If students sign in with their Google or other account, then their progress automatically saves, and they can resume the activity or view their work later. If students continue without signing in, they can complete the activity, but they must do so in one sitting. It is strongly recommended that students sign in; otherwise, they risk losing their work.

Distribute the **Note Catcher** handout to each student. Explain that this handout will provide them with space to record their findings and equations during the activity. Alternatively, students may use a piece of notebook paper if they prefer.

Instruct students to work individually through six screens in the Amplify Classroom activity. Each screen requires them to explore how to manipulate an equation to produce the smallest possible solution for x. Explain that "smallest" refers to the value of xx after applying the absolute value (ignoring the sign).

Ask students to record the equations they create on their Note Catcher so they can refer to their work later. This will help them build evidence to support their reasoning during the next activity. Remind students that there is no right or wrong answer for this activity and that they should explore independently. At this stage, they should not seek assistance from their peers.

15 minutes

Explain 1

In this activity, have students use the strategy Think-Pair-Share to reason abstractly and structurally why they believe their expression produces the smallest solution.

Display **slide 7**. Have students individually write down why they believe their equation produces the smallest solution on their original piece of paper or their Note Catcher. Give them a few minutes to process their thoughts.

Once all students are done writing their arguments, have them turn to a partner and take turns sharing their equations and why they believe their equation produces the smallest value. During that time, they also demonstrate how they got the solution. In pairs, instruct students to eliminate any misconceptions or mistakes and pick an equation they would like to share with the whole class.

Have each pair then share the equation they chose with the class. After every pair has presented their equation, have students vote on which equation produces the smallest solution.

20 minutes

Explore 2

Display **slide 8**. Have students find a partner or assign partners. Distribute a copy of the first two pages of the attached **Just Give Me a Reason** handout: Problems 1–2, to each pair of students.

Explain to students how to complete the handout using the Pass the Problem strategy. Begin by instructing each student to complete the first step of their assigned problem by modeling the algebraic equation. This involves drawing the number of variables and keeping the constant written in its algebraic form. Use **slide 9** to provide an example of this step.

Once students complete step 1, explain that they are to write their reasoning for their step in the second column of that row. Note that the reasoning for step one has already been completed in the handout. Take time to ensure students understand the procedure for this activity.

Move to **slide 10** and instruct students to trade papers with their partners. Guide students as they check the work completed by their partner and proceed to complete the second step. If students have difficulty articulating their reasoning, encourage them to reference the vocabulary activities from this lesson or the Journey of the Isolated Variable, Part 1.

Teacher's Note: Guiding the Activity

Use the hidden **slides 11–12** to get an idea of what Steps 1–4 might look like. If needed, unhide these slides and display them to the class to help students understand the process more clearly.

Once students have completed Problems 1–2, display **slide 13**. Provide each pair of students with a copy of the third page of the **Just Give Me a Reason** handout. Direct students to work collaboratively to solve Problem 3.

As students complete Problem 3, bring the class together for a whole-group discussion. Ask students, "What is different about Problem 3?" Encourage students to share their observations and reasoning as part of the discussion. Use this conversation to transition into the next portion of the lesson, where you introduce a flowchart.

30 minutes

Explain 2

Display **slide 14** and pass out the attached **Flowchart**. Direct students to insert the equation shown on the slide into the top box of the flowchart. Walk students through the procedure for using the flowchart, explaining how their "Yes" or "No" responses lead them step by step to the final answer.

Move to **slide 15**. Using the GUS Method, give students an opportunity to practice solving equations while using the flowchart. Provide students with either a piece of paper or student dry-erase boards for this activity.

Instruct students to solve the equation displayed on the slide. Ask students to label their work in the top-right or top-left corner of their paper or board with one of the following:

- **G**: Guessed the answer and have no clue how to solve the problem.
- **U**: Unsure if they completed all the steps correctly.
- **S**: Sure they understand and completed all steps correctly.

Teacher's Note: Guiding the Activity

If students are using student dry-erase boards, consider having them show their final results at the end of each question, including their "G," "U," or "S" indicator.

Display **slides 16 and 17** to give students two more equations to solve using the flowchart and the GUS Method.

Teacher's Note: Formative Assessment

Walk around the classroom as students work. Observe their problem-solving processes and evaluate their confidence based on their GUS reflections. Use this time to identify students who need additional support and those who have a strong understanding of the material.

If needed, provide mini-lectures to address common misconceptions, assist struggling groups, or pull students aside for one-on-one guidance. Ensure that every student is on the same page before moving on to the next activity.

Display **slide 18**. Instruct students to retrieve their Picture Notes handouts from the Engage section of the lesson. Ask students to review their notes and identify if there is anything they need to add or revise based on what they have learned during the lesson.

If students have any words they are still not sure about, allow them to ask questions of you or their classmates. You may choose to provide formal definitions at this time if students have any missing definitions or parts they don't fully understand.

40 minutes

Extend

Teacher's Note: Drive-in Theater Activity Preparation

Arrange your classroom into stations where groups of three can work at each station. Students will rotate between stations during this modified **Pass the Problem** activity. Determine the direction or path that students will follow to move between stations. Use a timer or stopwatch to ensure students do not spend too long at each station.

The **Create Your Own Problem** handout includes enough pages for six stations. Print enough copies so that there are two pages—a **Question A page (#A)** and a **Question B page (#B)**—at each station. For example, for a class of 30 students, print the handout twice.

Display **slide 19** and show students the video on the slide, *Winchester Drive-In Theatre [Oklahoma City]*. After the video, ask students:

- "If you were the owner of a drive-in theater, what would you spend money on?"
- "What might be good things to offer to customers?"
- "If you were a customer, what would you spend money on?"

Have students brainstorm ideas. Encourage them to think of expenses that the owner pays and to not just consider what the customers buy.

Embedded video
https://youtube.com/watch?v=S5FP28yDChI?si=k5zajTEF9VSKE8zT

Sample Student Responses

Some costs include electricity, movie tickets, popcorn, employee wages, etc.

Teacher's Note: Materials Setup

Before beginning, place two pages of the Create Your Own Problem handout at each station (one **Question A** and one **Question B** page). For example, Station 1 should have **pages 1A and 1B**, Station 2 should have **pages 2A and 2B**, and so on. For classes with more than five stations, repeat the page sequence (e.g., Station 6 receives **pages 1A and 1B**).

Display **slide 20** and walk students through solving the word problem shown on the slide. Explain that they will create their own story problems and should consider how to solve a problem when writing it.

Display **slide 21** and have students get into groups of three at each station. Explain that they will write their own story problems and solve their peers' story problems in a process similar to the earlier **Pass the Problem** activity. This time, however, students will rotate between stations rather than passing papers.

Activity Procedure:

Round 1: Students write the first story problem on **page A** (e.g., 1A, 2A, 3A, 4A, or 5A). Allow a few minutes for students to fill in the story problem template.

Round 2: Students leave their pages at their current station and rotate to the next station. At the new station, they write their second story problem on **page B** (e.g., 1B, 2B, 3B, 4B, or 5B). Allow five minutes for this round.

Round 3: Students rotate to the next station, where they read both story problems (A and B) left at the station. Students write the algebraic equation they would use to solve one of the problems but do not solve it. Allow five minutes for this round.

Round 4: Students rotate again. At this station, they read the story problems, check the equation written by the previous group, and solve it. Allow ten minutes for this round.

Round 5: Students rotate to the next station, where they substitute the solution back into the equation to check the work done by their peers. If the solution is incorrect, they should review the steps, identify the mistake, and circle it. Allow five minutes for this round.

Round 6: Students return to their original station to review the work done by their peers. Have the group discuss whether the final solution aligns with their expectations. If they find a circled mistake, they should correct it and verify the solution.

After all rounds, encourage volunteers to share their group discussions and findings with the whole class. Students can explain mistakes they encountered, how they resolved them, and what the correct process should have been.

If time allows, use this discussion to review key concepts and reinforce problem-solving strategies.

5 minutes

Evaluate

Display **slide 22** and use the Exit Ticket strategy to individually assess what students have learned. Distribute the **Exit Ticket** handout to each student. Direct students to read the question carefully and to write a sentence for their final answer.

Alternative Pacing

This could also be done as bellwork the following day. Consider giving the Exit Ticket handout as homework, then starting the next day with a 3–5 minute review of the question.

Teacher's Note: ACT Prep

This question is similar to what students would see on the ACT. Students need to be able to accurately create an equation from a word problem, a skill tested frequently on the ACT.

Resources

- Desmos Classroom. (n.d.). *Smallest solution* [Interactive activity]. Amplify Classroom. https://classroom.amplify.com/activity/582615b63e43a0e4058569c6
- K20 Center. (n.d.). Amplify classroom. Tech Tools. https://learn.k20center.ou.edu/tech-tool/1081
- K20 Center (n.d.). Bell ringers and exit tickets. Strategies. https://learn.k20center.ou.edu/strategy/125
- K20 Center. (n.d.). GUS method. Strategies. https://learn.k20center.ou.edu/strategy/76
- K20 Center. (n.d.). Pass the problem. Strategies. https://learn.k20center.ou.edu/strategy/151
- K20 Center. (n.d.). Picture notes. Strategies. https://learn.k20center.ou.edu/strategy/104
- K20 Center. (n.d.). Think-Pair-Share. Strategies. https://learn.k20center.ou.edu/strategy/139
- Spielventure. (2020). *Winchester drive-in theatre* [Oklahoma City]. [Video]. YouTube. https://www.youtube.com/watch?v=S5FP28yDChI