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# 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 solve linear equations on a deeper level. The goal is for students to understand the fundamentals of isolating a variable and to apply that knowledge to more complex problems. Students will then be able to solve multi-step equations by applying properties of rational numbers and algebraic properties. This is the second lesson of four in the "Journey of the Isolated Variable" lesson series.

## Snapshot

**Engage**

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

**Explore 1**

Students use a Desmos 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**

In groups, students form strategies to solve more complex multi-step equations and then peer-review their classmates' work.

**Explain 2**

Students review their equation-solving strategies through a flowchart and then practice solving problems while implementing the GUS Method.

**Extend**

Students create their own word problems by considering items bought and sold in a theater.

**Evaluate**

Students demonstrate their understanding through an Exit Ticket.

## Standards

*Oklahoma Academic Standards for Mathematics (Grades 9, 10, 11, 12)*

**A1.A.3.1:** Solve equations involving several variables for one variable in terms of the others.

## 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 - Spanish.docx
- Exit Ticket—Journey of the Isolated Variable, Part 2 - Spanish.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 handout (attached; one per student; printed front only)
- Note Catcher handout (attached; one per student; printed front only)
- Just Give Me a Reason handout (attached; one set per pair; printed front only)
- Flowchart (attached; one per student; printed front only)
- Create Your Own Problem handout (attached; one set per 5 stations; printed front only)
- Exit Ticket handout (attached; one-half sheet per student; printed front only)
- 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 will use the attached Picture Notes handout in this portion of the lesson. Some students will be able to fill out every box, but some may not know every term upfront, and that is okay. Encourage them to do their best and remind them that this handout will be revisited later in the lesson. This will be a handout they can refer to throughout the lesson and the unit.

Introduce the lesson using the attached **Lesson Slides**. Display **slide 3** to share the lesson's essential question: "How do I isolate a variable in a multi-step equation?" Display **slide 4** to go over the lesson's learning objective. Review these slides with students to the extent you feel necessary.

Go to **slide 5**. Pass out the attached **Picture Notes** handout. Individually, have students review their knowledge of different algebraic vocabulary terms (associative property, inverse property, like terms, coefficient, etc.) by creating Picture Notes. Direct students to generate their own definitions by creating a sketch, a statement, or an example to represent each term.

Give students five minutes to work independently and walk around to see how much they know before the lesson begins. Once students are at a stopping point, have them set the handout aside. Let students know they will come back to it later in the lesson.

15 minutes

# Explore 1

### Teacher's Note: Desmos Classroom Activity Preparation

To use this Desmos Classroom activity, select the following link: "Smallest Solution." Create an account or sign in under the "Activity Sessions" heading. After you log in, the green "Assign" dropdown button will be active. Click the arrow next to the word "Assign," then select "Single Session Code." After making some setting selections, select "Create Invitation Code" and give the session code to students. For more information about previewing and assigning a Desmos Classroom activity, go to https://k20center.ou.edu/externalapps/using-activities/.

For more detailed information about Desmos features and how-to tips, go to https://k20center.ou.edu/externalapps/desmos-home-page/.

Display **slide 6** and provide students with your session code. Then, have students go to student.desmos.com and enter the session code.

### Teacher's Note: Sign-in Options

If students sign in with their Google or Desmos accounts, then their progress is saved, 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.

Give each student a copy of the attached **Note Catcher** handout to use for the Desmos Classroom activity, as they need space to investigate equations. Students could use a piece of notebook paper instead.

Instruct students to individually go through the six screens and create an equation that has the smallest possible solution for $x$, where "smallest" is intended to mean the value of the number after applying the absolute value (i.e. ignoring the sign of the solution). Make sure they write the equations they create on their Note Catcher so they can remember the equations they believe would create the smallest possible solution for $x$.

Remind students there is no right or wrong answer and no need to ask for help from their peers at this point. This is a time for them to explore their knowledge and find evidence to prove their argument during the next activity.

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 and give each pair a copy of the first two pages of the attached **Just Give Me a Reason** handout: Problems 1–2.

Explain to students how to complete the handout using the Pass the Problem strategy. Each student starts the first step of their problem by modeling the algebraic equation by drawing the number of variables, keeping the constant written in its algebraic form. Use **slide 9** to give students an example of this step.

After students complete step 1, explain that they are to write their reasoning for their step in the second column of that row. The reason for step one has already been completed, but help students understand the procedure for this activity. Move to **slide 10** and have students trade papers. Guide students to check the work of their partner and then complete the second step. If students are struggling to write their reasoning, encourage them to use the vocabulary activities from this and the "Journey of the Isolated Variable, Part 1" lesson.

### 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 to help students understand the process.

Once students complete Problems 1–2, display **slide 13**. Give one copy of the third page of the **Just Give Me a Reason** handout to each pair of students. Direct students to work together to solve Problem 3.

As students finish Problem 3, bring the class together for a discussion and ask, "What is different about Problem 3?" Use this discussion to transition to 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 on the slide in the top box of the flowchart. Walk students through the procedure of using the flowchart and how their "Yes" or "No" responses lead them to the final answer.

Go to **slide 15**. Using the GUS Method, give students the opportunity to practice while using the flowchart. Have students use either a piece of paper or student dry-erase boards for this activity. Instruct students to solve the equation on the slide. In the top-right or top-left corner of their piece of paper or dry-erase board, direct them to write a G, U, or S.

- G means they guessed the answer and have no clue how to solve the problem.
- U means they are unsure if they completed all the steps correctly.
- S means they are completely sure and understand the material.

**Teacher's Note: Guiding the Activity**

If your students are using student dry-erase boards, consider having them all show their final results at the end of each question, indicating the G, U, or S as well.

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 while students are working, examine their work, and see how they feel based on the GUS reflection method. This will give you an idea of who you need to help moving forward and who is understanding the concept. Feel free to time this activity at a pace appropriate for the class.

This is your time to lecture if needed, help different groups, or pull students to your desk who are completely lost to make sure everyone is on the same page and understands the material before moving on.

Go to **slide 18**. Invite students to get out their Picture Notes from the Engage section of the lesson. Have students check to see if there is anything they need to add to their Picture Notes or anything they need to change based on what they have learned so far in 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 and students can move between stations. Students will start at their station and move to three other stations during this modified Pass the Problem activity. Determine the direction, or path, that students will follow. Use of a timer or stopwatch can help ensure that students do not spend too long at a station.

The Create Your Own Problem handout has enough pages for five stations, print enough additional pages such that there are two pages—a Question A page (#A) and a Question B page (#B)—at each station. For example, print the handout twice for a class of 30 students.

Go to **slide 19** and show students the video on the slide, "Drive-In Movie Theaters Make Comeback During COVID-19 Crisis." Ask the class: "If you were the owner of a drive-in theater, what would you spend money on? 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=Czzt9l9qnZ4

### Sample Student Responses

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

Display **slide 20** and show students how to solve the given word problem. Tell students that they will be creating a story problem and need to consider how to solve one when writing story problems.

Show **slide 21** and have students get into groups of three at each station. Explain to students that they will be writing their own story problems and solving their peers' story problems. Explain that this will be similar to the Pass the Problem activity from earlier in the lesson, except this time, they will be moving instead of their papers. Explain the following procedure for the activity:

1. **Round 1**: Students write two story problems—one on each of the pages at their station. This round is approximately ten minutes.
2. **Round 2**: Students leave their story problems at that station, get up, and move to the next station. Here, students read the story problems at this station and write the algebraic equation that one could use to solve the story problem. They are not solving the problem. This round is approximately five minutes.
3. **Round 3**: Students leave their papers at that station, get up, and move to the next station. Here, students read the story problems, check the equations written by the previous group, and then solve the equations. This round is approximately ten minutes.
4. **Round 4**: Students leave their papers at that station, get up, and move to the next station. Here, students take the answer and use substitution to check the work done by their peers. This round is approximately 5 minutes.
5. **Round 5**: Students leave their papers at that station, get up, and move back to their original station. Here students review the work done by their peers. This round should take approximately 5 minutes.

After reviewing the procedure, give each group two pages of the **Create Your Problem** handout such that each group has a Question A page and a Question B page. For example, group 1 should get pages 1A and 1B; group 2 should get pages 2A and 2B, etc. If you have more than five groups, give the sixth group pages 1A and 1B, etc.

Begin Round 1, and encourage students to start with the template pages (pages 1A, 2A, 3A, 4A, or 5A). Have them complete the story problem template for their first question. Then have students create a second story problem on the second page (pages 1B, 2B, 3B, 4B, or 5B). Tell students that they can use the template question as a guide but they should try to be creative with their second story problem.

Begin Round 2, and remind students to leave their papers at their station and move to the next station. Remind students that they are only writing the equation. They are not solving the equation during this round.

Begin Round 3, again, reminding students to leave their papers at the station before moving to the next station. Tell students that they need to check the equation before solving the equation.

Begin Round 4, and remind students that they are plugging in the solution into the equation to check the work of their peers. If they find that the solution is not the correct solution, encourage students to look through the work of their peers and circle the mistake.

Begin Round 5, and have students go back to their original station to review the work done by their peers. Have the group discuss if what they see written on their paper is what they expected. And if they see a circled mistake, have them correct the mistake and find the solution.

If time allows, have volunteers share with the whole class what they discussed in their smaller groups and to share any mistakes that were made and what the correct process should have been.

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]. Desmos. https://teacher.desmos.com/activitybuilder/custom/582615b63e43a0e4058569c6
- K20 Center (n.d.). Bell Ringers and Exit Ticket. Strategies. https://learn.k20center.ou.edu/strategy/125
- K20 Center. (n.d.). Desmos Classroom. Tech tools. https://learn.k20center.ou.edu/tech-tool/1081
- 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
- NBC News. (2020, May 5). *Drive-in movie theaters make comeback during COVID-19 crisis* [Video]. YouTube. https://www.youtube.com/watch?v=Czzt9l9qnZ4