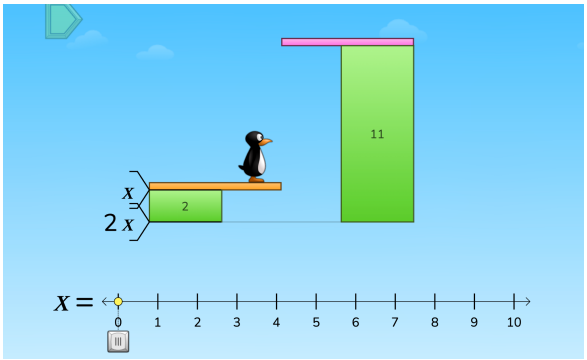
# Puzzle Talk Facilitation Guide

*This is a guide to provide support for facilitating student thinking as teachers engage students in academic discourse around math concepts and strategies using ST Math puzzles. This talk can be done over multiple days.* ***Pre-work can be given to encourage students to think about the concept prior to the Puzzle Talk.*** *Read the Puzzle Talks Overview to learn more.*

Grade Level: Eighth
Objective: Solving Two-Step Equations
Game: Variable Stacks with Like Terms




## Teacher Prep

### Description

- **Purpose:** Focus on how to solve one-step and multi-step one-variable linear equations with rational number coefficients and solutions. Students will solve symbolic equations in the form of px + q = r, where p, q, r, and x are any integer value. Use guiding questions for each step in the Problem Solving Process to support student thinking and the development of problem solving skills.
- **Materials Needed:** Provide students with whiteboards and markers
- **Puzzle Location:** Grade 8 > Solving Two-Step Equations > Variable Stacks with Like Terms
- **Game in a Minute:** View video
- **Duration:** Multiple days
- **Time:** May vary 10 - 20 minutes each session

### Look Fors

**How does the student:**

- identify the variables in the equation?
- recognize the need to combine like terms?
- apply basic algebraic operations (add, subtract, multiply, divide)?
- use inverse operations to undo the operations and solve for the variable?
- isolate the variable?
- represent the puzzle with an equation?

### Puzzle Progression

Students will encounter puzzles with a number line 0 to 10 and two visual models that represent variable stacks. Puzzles begin with variables that can be combined as like terms on one side of an equation (stack) and may include two steps. The two steps include adding and multiplying by $2x$ or more. As students progress through the levels, they will encounter negative integers and negative variables.

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## Facilitation Suggestions (This is what a student-led discussion might look like.)

*This would occur over multiple days.*

### Notice and Wonder

- Display the first puzzle from Level 1.
- Ask students: "What do you notice?"
- Allow a few students to share out. Listen for ideas that might include the following:
  - "I notice two blocks labeled with numbers."
  - "JiJi is standing on the block with the number 2."
  - "There are two x's."
  - "There is a number line from 0 to 10 that x is equal to."
- Ask: "What do you wonder about this puzzle?" Allow students to share out. Listen for ideas that might include the following:
  - "What could we click on this puzzle?"
  - "How could we make the stacks the same height?"

### Predict and Justify

- Ask students to think individually about how they could solve the puzzle, then turn and share with a partner before sharing as a class.
- Students should provide mathematical reasoning for the idea they want to try. They can use their whiteboard to represent the puzzle.
- List these ideas for the class to consider.

### Test and Observe

- Choose one of the ideas for the class to try. Typically, a teacher might choose an incorrect answer the first time in order to allow for enhanced discussion and exploration of why JiJi was unable to cross the screen.
- Play the puzzle and ask students to observe what happens in the puzzle. *Remember to use the animation control features to replay or stop during points in the feedback to highlight important ideas.*
- Based on what they have learned from the feedback, ask students to choose another idea to try.
- Play the puzzle and ask students to observe what happens in the puzzle, using the animation control features and stopping when appropriate.
- Consider:
  - "What does it mean when the puzzle shows $2x$ and $x$ with the same stack?"
    - For example, students might notice that there is a total of $3x$. This idea can be confirmed by watching the feedback from the puzzle.
  - "Does this puzzle represent multiplication, addition, or both operations?"

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        - For example, some students might say that there are 3 groups of $x$ to describe multiplication while other students say $2x + x = 3x$ to describe addition.
    - "What is a number that we know will NOT work? Why?"
- You can use the animation controls to pause the puzzle while students check if their answer matches the puzzle on the screen. Discuss how this might provide evidence for why the solution will work or will not work.

## Analyze and Learn

- Continue with puzzles from Level 1.
- Discuss ways to get JiJi across the screen.
    - "What is an equation that we could write to represent this puzzle?"
        - For example, students can write different equations and discuss how they might represent the puzzle. This provides an opportunity to discuss whether $2x + 5 + x$ is equivalent to $3x + 5$.
    - "What are ways that combining like terms might be useful in this puzzle?"
        - For example, combining like terms simplifies the expression and could require less work to determine the value of $x$ by requiring fewer steps to solve.
- You can use the animation controls to replay and examine what happens in the puzzle.
    - If the answer was incorrect, discuss what was learned and what they think is best to try next. Have students share why that is the best way to solve the puzzle.
    - If the answer was correct, how can they take what they learned and apply it to the next puzzle?

## Connect and Extend

- Continue with puzzles from Level 2.
- As you discuss the puzzles, ask questions such as these:
    - "What is an equation that could be used to represent this puzzle?"
    - "What operation is used in this equation?"
    - "How can we combine like terms?"
    - "What steps could you write down to undo the operations in this puzzle?"
    - "How might our solution process change when the equation involves negative values?
- Using one of the puzzles, ask students to write at least two different equations to represent the puzzle. For example, a puzzle could be represented by

$-4 = x + 2 + x$ or $-4 = 2x + 2$. Ask students to solve for $x$ using both equations. Discuss the steps that were needed to solve each equation. Do students have a preference for one equation rather than the other? Was combining like terms necessary to solve for $x$?