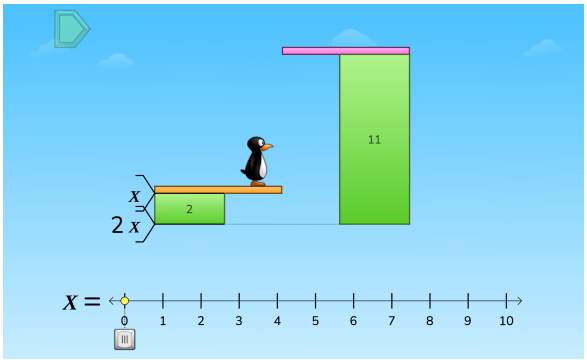
Puzzle Talk Facilitation Guide

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 Linear Equations
Game: Variable Stacks



Teacher Prep

Description

- **Purpose:** Focus on how to solve visual representations of the form $px + q = rx$ where p, q, r, s, t, u, and x represent 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 Linear Equations > Variable Stacks
- **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?
- represent the puzzle with an equation?
- apply basic algebraic operations (add, subtract, multiply, divide)?
- use inverse operations to undo operations on both sides of the equation and solve for the variable?
- isolate the variable?

Puzzle Progression

Students will encounter puzzles with a number line labeled 0 to 10 and two visual models that represent variable stacks. Initially, puzzles include a single unknown variable on one side of an equation (stack) and may include two steps. The two steps include adding a constant value and multiplying by $2x$ or more. As puzzles continue, students will encounter a variable on both sides of the equation (represented in both stacks) as well as negative integers.

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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 with numbers."
  - "JiJi is standing on the block with the number 3."
  - "There are two x's."
  - "There is a number line from 1 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 from 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:
  - "In this puzzle, what does the variable represent?"
    - For example, students can describe how the unknown amount is represented in the puzzle.
  - "What operation do we use to make the stacks equivalent?"

ST Math

        - For example, students identify whether the puzzle uses addition, multiplication, or both operations. They might also describe how these operations are represented in the puzzle.
    - "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 Levels 1 and 2.
- Discuss ways to get JiJi across the screen.
    - "What is an equation that we could write to represent this puzzle?"
        - For example, if there is a block with a height of 3 and a variable on the left side of the screen and a block with a height of 8 on the right side of the screen, students might suggest the equation 3 + x = 8.
    - "What happens in the animation as the puzzle is solved?"
        - For example, students might describe a puzzle involving addition as showing the same number being removed from the stacks on each side of the screen.
    - "How might we record the solution steps that we see in this puzzle?"
        - For example, if 3 is removed from each stack, students might write the equation and show subtraction of 3 from each side of the equation.
- You can use the animation controls to replay and examine what happens in the puzzle.
    - If the puzzle was correct, discuss why the strategy used was successful.
    - If the puzzle was incorrect, analyze what happened and consider how to adjust the strategy to try again.

Connect and Extend

- Continue with puzzles from other levels within *Variable Stacks*.
- 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? Is there more than one operation? How do we know?"
    - "What steps could you write down to undo the operations in this puzzle?"
    - "What is a number that will be too small? What will happen if we try it?"
    - "What is a number that will be too big? What will happen if we try it?"
- Give students equations, such as $9 = 3x$ or $2x + 6 = 12$, and challenge them to

draw a *Variable Stacks* puzzle. Students can pair with a partner to explain how their puzzle represents the given equation.

- Brainstorm how a selected puzzle might change if it used different values. For example, if a puzzle represents $9 = 3x$, how might the puzzle change if it becomes $6 = 3x$? What other parts of the equation could be changed, and how will the changes influence the puzzle?
- Give students a starting number, such as 4. Tell them that 4 is multiplied by 2 and has a 3 added. Ask them to draw what this might look like as a *Variable Stacks* puzzle.