**Name of Lesson:** Divergent Thinking in Algebra?

**Topic:** Primary Algebraic Reasoning Lesson # 6  
Approximate time: 2 sessions

**Gifted Standard and element(s):**  
G1CG1: Convergent Thinking: Students will reason logically using induction, deduction, and abduction.  

d. Solve problems using logical reasoning.  
e. Solve algebraic equations using logical reasoning.  
f. Develop verbal and nonverbal communication skills to convey logical reasoning. (Specific vocabulary and symbols to use when discussing algebraic reasoning and solving equations.)

G1CG2: Divergent Thinking: Students will think creatively to generate innovative ideas, products, or solutions to problems.  
c. Develop cognitive and affective components of divergent thinking.  
e. Develop verbal and nonverbal communication skills to convey divergent thinking.  
f. Collaborate with peers to develop the components of divergent thinking.

**Supports CCGPS:**  
1.OA.8 Determine the unknown whole number in an addition or subtraction equation relating three whole numbers.

**Standards for Mathematical Practice:**  
2. Reason abstractly and quantitatively.  
3. Construct viable arguments and critique the reasoning of others.  
6. Attend to precision. ("... communicate precisely...")  
8. Look for and express regularity in repeated reasoning.

**Unit Essential Question(s):**  
*How can I use the mathematical meaning of “equivalence” to solve problems?*  
*How can I use variables to solve problems?*  
How can I use patterns, rules, and relationships to solve problems?

**Lesson Questions:**  
How can I represent situations using equations?

**Lesson Summary:**  
Students will represent word problems using many different equations. **Key ideas:** Subtraction situations can be represented as “missing addend” addition problems. This will facilitate the use of the number balance to solve them. There are many ways to represent the same situation using equations with variables.

**Assessment Description/Performance Task:**  
☒ Constructed response  ☒ Informal assessment  
☐ Performance task  ☐ Selected response

**Brief Description of Assessment:**  
Students will write several ways to represent a word problem or mathematical situation. (See student sheet.) During discussions, the teacher takes note of students who may need extension (especially those who quickly see connections and have clear reasoning) and of those who need more support.
**Instructional Methods:**

- **Hook/Activator:** Remind students of or introduce the meaning of divergent thinking, especially the concept of flexibility (thinking in many different ways). Have the class brainstorm “How many different ways can you scratch an itch?” Record and discuss the answers, the point of emphasis should be on the fact that there are many ways to accomplish the same goal.

- **Teaching Strategy:**

  Present the following situation: Joel caught 4 pop flies at Monday’s practice. He caught 5 at Wednesday’s practice. How many pop flies did he catch at those two practices? Guide students to write a number sentence using a variable to represent the situation. Make sure they can state what part of the situation is represented by the variable. (y represents the total)

  \[ 4 + 5 = y \]

  Have someone demonstrate how to solve this problem using the number balance. Discuss how the child knows which parts of the problem are shown on which side of the number balance.

Now present the following situation: Mary and Justin shared a package of 8 pencils their mother bought them. Mary got 5 of the pencils. How many did Justin get? Have students write a number sentence, using a variable, to represent the situation. Have volunteers write their number sentences on the board (or give them strips of paper, which will make grouping them later much easier). The goal is to get as many different number sentences as possible, so if students have more than one idea, it is fine for them to post them all. After everyone has had a chance to post answers, challenge groups to come up with even more, different ways to represent the situation using a number sentence that includes a variable. Important: Accept all answers at first—even those that are incorrect.

After all have been posted, have small groups discuss whether they are all correct. Lead a class discussion about any they disagree with, making sure that those who posted the ones in question share their reasoning. If possible, allow the children to persuade one another, but make sure that the incorrect number sentences are removed or corrected. Then have students analyze all the equations and group those that are the same except for using a different variable. For example, “5 + a = 8” would be grouped with “5 + g = 8” and “5 + ☐ = 8.”

If they do not generate all of the following forms of number sentences for the given situation, use guiding questions to lead them to find these:

<table>
<thead>
<tr>
<th>5 + y = 8</th>
<th>q + 5 = 8</th>
<th>8 – 5 = ☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 = 5 + z</td>
<td>8 = b + 5</td>
<td>☐ = 8 - 5</td>
</tr>
</tbody>
</table>

8 – ⭐ = 5 Given the wording of the problem, this one will be extremely unusual, but may come up in the discussion as students try to generate more ideas. It is correct.

After the lesson, write and post the original problem situation, along with the many student-generated equations, somewhere in the classroom.

Assign each group or pair one of the forms of equations above to demonstrate using the number balance. Those with addition will likely be able to do this easily. Those with subtraction are likely to have questions. Lead a class discussion about each equation and how it is represented on the number balance. Discuss WHY it is hard to show subtraction using the number balance. Therefore, it is more useful to choose an equation involving addition when using a number balance to solve a problem.

**Note to teacher:** One reason for having students generate many kinds of equivalent equations, some with addition and some with subtraction is that the way they will represent these situations on the balance will be to have the whole on one side and the parts on the other. They will need to be able to recognize and convert subtraction problems into “missing addend” addition problems.

Other situations to use for demonstration if needed:
Jan and Bill earned 23 points together for their class. Jan earned 14 of the points. How many did Bill earn?
Natalie found 5 cans. She put them in the recycling bin. When she counted the cans, she found that there were 17 in the bin. How many were there before she put in those she found?

Give students the student sheet and have them write at least 2 different ways to represent each situation with an equation. Emphasize the point that there are often different ways to write a useful number sentence for any given situation.

Student will write several ways to represent mathematical situations using equations. (See student sheet.)

- *Summary by the Learner:* Have students compare their equations from the student sheet with a partner or small group. They discuss whether all are correct and defend answers as needed.

**Differentiation:**
- **More capable:** Give students a more complex situation and have them write equations to represent it. Example: Margaret, Jill, and Bob read a total of 15 books last month. Margaret read 6. Jill read 4. How many did Bob read? Have students solve the problems in addition to writing the equations.

- **Less capable:** Teacher will use leading questions/prompts to help students generate more possible ways to represent the situation.

**Materials for this Lesson:**
- strips of paper for equations
- class set of student sheet

**Vocabulary for this Lesson:**
- equation
- flexibility
- number sentence
- divergent thinking
Write at least 2 different equations to represent each situation. Be sure to use a variable in your equation. Remember: Think flexibly and write some equations that do more than simply use a different symbol. Try to write your two equations so that

- the variable is on the left side of the equals sign in one and on the right side in the other.
- a different operation is used for each

1) Jose and Sarah scored 10 points together. Sarah scored 4. How many points did Jose score?

2) Karen bought 3 erasers. She put them in her box that had other erasers. When she counted, she found that she had 9 erasers. How many were in the box before she added the new ones?
Name: **KEY**

**Note:** Variables used in key are simply convenient for reference to the problem. **ANY** variable may be substituted for those in key.

Write at least 2 different equations to represent each situation. Be sure to use a variable in your equation. Remember: Think flexibly and write some equations that do more than simply use a different symbol. Try to write your two equations so that
- the variable is on the left side of the equals sign in one and on the right side in the other.
- a different operation is used for each

1) Jose and Sarah scored 10 points together. Sarah scored 4. How many points did Jose score?

- \[ 4 + j = 10 \]
- \[ j + 4 = 10 \]
- \[ 10 = j + 4 \]
- \[ 10 = 4 + j \]
- \[ 10 – 4 = j \]
- \[ 10 – j = 4 \]
- \[ j = 10 – 4 \]
- \[ 4 = 10 – j \]

Note: The above equations fit the situation and include all of the given information. These are more useful.

Note: The above equations fit the situation, but you may want to discuss their usefulness in solving the problem because they are generalized rather than including ALL the information given. A student may understand that the “4” may be substituted for “s”.

2) Karen bought 3 erasers. She put them in her box that had other erasers. When she counted, she found that she had 9 erasers. How many were in the box before she added the new ones?

- \[ x + 3 = 9 \]
- \[ 3 + x = 9 \]
- \[ x = 9 – 3 \]
- \[ 9 – 3 = x \]
- \[ 9 – x = 3 \]
- \[ 3 = 9 – x \]
- \[ 9 = x + 3 \]
- \[ 9 = 3 + x \]