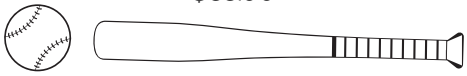
Grade 8 Lesson-Design Sample: Systems of Linear Equations

Preparing for the Lesson: Systems of Linear Equations
Unit: Systems of Linear Equations **Date:** December 6 **Lesson:** This lesson is specifically about how to solve a system of linear equations using substitution. Students have learned how to solve graphically and will discuss how to use elimination in the next lesson.
Essential learning standard: State the big idea content and process standard for the unit addressed during this lesson. • Content— ‣ *I can analyze and solve pairs of simultaneous linear equations.* • Process— ‣ *I can use problem-solving strategies and reasoning skills to solve problems. I can communicate my thinking and explain why my strategy works.*
Learning target: State the specific learning outcome or outcomes for this lesson. Students will be able to solve pairs of simultaneous linear equations using substitution.
Academic language vocabulary: State the academic vocabulary expectations for the lesson. Describe how you will explicitly address any new vocabulary. *Simultaneous* *Solution* *Substitution* *These three vocabulary words have multiple meanings in mathematics and other contexts. As an introduction to the terms, students will first write the meaning of these review words within the context of the lesson and mathematics. We will add these words to students' foldable for the unit.*
Beginning-of-Class Routines
Prior Knowledge: Describe the warm-up activity you will use. How does the warm-up activity connect to students' prior knowledge, connect to an analysis of homework progress, or connect to future learning? *Put the baseball shop math task on the smartboard and have the students explore the task. Tell students that today they will be making connections between the problem-solving strategies used in the baseball shop task and some algebraic strategies that they can use to solve problems involving systems of equations (look for evidence of problem solving and reasoning).* *Task: A baseball souvenir shop is offering the following packages for signed baseballs, hats, and bats.* *Couple's Package* *$46.00*  *Autograph Hunter Package* *$31.00*  *Let's Play Ball Package* *$33.00* 

If the baseball shop sells each item individually, what is the cost of each item?
Students will work in teams of four to come up with a strategy as a team for solving the mathematics task.
Teams will share their strategy for solving the problem and why it works.

(Source for task: Howard County Public Schools Office of Secondary Mathematics Curricular Projects. [2015]. Mathematics 8. *Accessed at https://hcpss.instructure.com/courses/161 on March 3, 2018.)*

Instruction—During-Class Routines

Task 1: Cognitive Demand (Circle one): ☐ or ☐

What are the learning activities to engage students in learning the target? Be sure to list materials you will need.

Introduce the following scenario to students: At a local movie theater, you can buy two large sodas and a box of popcorn for $11.00. If you only want one large soda and a box of popcorn, it will cost $8.00. How much does the box of popcorn cost?

What will the teacher be doing?	
• How will you present and then monitor student response to the task? • How will you expect students to demonstrate proficiency of the learning target during in-class checks for understanding? • How will you scaffold instruction for students who are stuck during the lesson or the lesson tasks (assessing questions)? • How will you further learning for students who are ready to advance beyond the standard during class (advancing questions)?	*Have students think-pair-share to solve the problem.* • *As students work together, they should be discussing different strategies used to solve the problem.* • *How are these strategies similar to the strategies they used in the baseball shop task? (Students should be recognizing that in order to solve the problem, quantities are being substituted into the other scenario to help find a solution. Substitution is a method of replacing quantities with equivalent quantities to help find a solution. Look for evidence of communication about this strategy.)* • *Once students demonstrate and can communicate a strategy that is substitution, they should then work together to write equations to represent the scenario. (Note: This may be the first point in the lesson that variables are introduced, so be sure to have students define the variables they use.)* *Sample assignments are:* *Let x = Cost of a large soda* *Let y = Cost of a box of popcorn* *Ask students to connect the algebraic representation to the strategy they use. For example, if students say, "Since one large soda and a box of popcorn is $8,00 then one additional soda must be $11.00 – $8.00 or $3.00." Then help students understand this is equivalent to:* *Equation 1:* $x + y = 8$ *Equation 2:* $x + x + y = 11$ $x + (x + y) = 11$ $x + 8 = 11$ $-8 = -8$ $x = 3$

	Assessing prompts: • *How are these strategies similar to the strategies we used in the baseball shop task?* • *What information do you know? How can we represent the unknown?* • *What does the intersection of the two lines mean?* *Advancing prompt: Can you come up with other equations that would generate the same solution? Write them in the context of the problem.*
What will the students be doing? • How will students be actively engaged in each part of the lesson? • What type of student discourse does this task require—whole group or small group? • What mathematical thinking (reasoning, problem solving, justification) are students developing during this task?	*After completing the prior knowledge warm-up activity, students will work with a partner to solve task 1. (Use think-pair-share.)* • *As partners decide on a strategy, they will partner with another pair to decide whose strategy is most efficient and decide if the strategies are similar to the baseball shop task.* • *Once they agree on the best strategy, they will work to create equations to represent their strategy.* • *Using a large whiteboard, teams will write their system and solution and prepare to display their response.* • *On command, they will do a "one strays and the rest stay" formative sharing strategy. One member of the team will get up and rotate to a new team presenting that team with his or her team's whiteboard solution and then inviting feedback for correction or advancement. The students then return to their original teams for sharing. (Use teams of four and a whiteboard.)*
Task 2: Cognitive Demand (Circle one): ☐ or ☐ What are the learning activities to engage students in learning the target? Be sure to list materials you will need. *Once the solution is verified with substitution, ask students to examine the same problem using a prior knowledge graphical solution method either by hand and or with a graphing calculator.*	
What will the teacher be doing? • How will you present and then monitor student response to the task? • How will you expect students to demonstrate proficiency of the learning target during in-class checks for understanding? • How will you scaffold instruction for students who are stuck during the lesson or the lesson tasks (assessing questions)? • How will you further learning for students who are ready to advance beyond the standard during class (advancing questions)?	• *Students should be verifying that the solution to the system is the intersection point on the graphs. Have students do this together in groups of four or back in their original think-pair-share groups.* • *As you walk around, look for student sample graphs and equations that could be written or projected onto the front board for whole-class discourse.*

	• *During the whole-group discourse, create class definitions of the vocabulary words for the day, specifically focusing on substitution. Also, connect the different problem-solving strategies to the different algebraic representations to help students make connections between different models.* • *Throughout the task, look for evidence of problem solving and reasoning.* *Assessing prompts:* • *How do you verify a solution with graphing?* • *How are these strategies similar to the strategies we used in the baseball shop task?* • *What information do you know? How can we represent the unknown?* • *What does the intersection of the two lines mean?* *Advancing prompt: Can you come up with another equation that would generate the same solution? Write them in the context of the problem.*
What will the students be doing? • How will students be actively engaged in each part of the lesson? • What type of student discourse does this task require—whole group or small group? • What mathematical thinking (reasoning, problem solving, justification) are students developing during this task?	*Students will then use the graphing calculator to verify their solution, by looking at the intersection point of the two graphs.* *Students then discuss with their partner or group members and participate in whole-class discourse.*

Task 3: Cognitive Demand (Circle one): ☐ or ☐

What are the learning activities to engage students in learning the target? Be sure to list materials you will need.

Ask students to complete the additional mathematical task and understanding prompt as part of in-class guided practice. Students can complete the activity in stations around the room or in groups with an assigned task for each group using a jigsaw to discuss the different problems with other classmates.

- *If you order a Big Mac and medium fries from McDonald's, the meal will be 920 calories. A Big Mac has 160 more calories than the medium fries. How many calories are in each item? [Solution: A Big Mac has 540 calories and the medium fries has 380 calories.]*
- *Consider the system of equations:*

$$3x + y = -3$$
$$-2x + y = 7$$

Explain how you can solve this system of equations by substitution. How will you decide which variable to solve for first? If the variables represented a real-world situation such as the number of months and cost, why must the values of the variables be greater than or equal to zero?

- *High-speed internet provider SOHO has a $100 setup fee and costs $70 per month. High-speed internet provider TELE has a setup fee of $30 and charges $70 per month. In how many months will both providers cost the same? What will the total cost be? [Answer: 14 months and a total cost of $1,010]*

What will the teacher be doing? • How will you present and then monitor student response to the task? • How will you expect students to demonstrate proficiency of the learning target during in-class checks for understanding? • How will you scaffold instruction for students who are stuck during the lesson or the lesson tasks (assessing questions)? • How will you further learning for students who are ready to advance beyond the standard during class (advancing questions)?	*I will look for evidence of problem solving and reasoning.* *Assessing prompts:* • *How are these strategies similar to the strategies we used in the baseball shop task?* • *What information do you know? How can we represent the unknown?* • *What does the intersection of the two lines mean?* *Advancing prompts:* • *Can you come up with another equation that would generate the same solution? Write it in in context of the problem.* • *In the internet provider task, explain what your answers to the two questions represent graphically.*
What will the students be doing? • How will students be actively engaged in each part of the lesson? • What type of student discourse does this task require—whole group or small group? • What mathematical thinking (reasoning, problem solving, justification) are students developing during this task?	*Students will be working in small groups as they rotate through the scenarios at each station around the room.*

End-of-Class Routines

Common homework: Describe the independent practice teachers will assign when the lesson is complete.
Have students create their own scenario that would require substitution to solve. Students should also show work to solve the scenario.

Lesson closure for evidence of learning: How will lesson closure include a student-led summary? By the end of the lesson, how will the lesson measure student proficiency and that students develop a deepened (and conceptual) understanding of the learning target or targets for the lesson?
Ask students to share solutions and discuss closure questions.
- *Why can you use the substitution strategy to solve a scenario involving a system of equations?*
- *How does the substitution strategy relate to representing a system algebraically?*

Students will complete a quick write on the two closure questions and then share their responses with their team.

Teacher end-of-lesson reflection: Which aspects of the lesson (tasks or teacher or student actions) led to student understanding of the learning target? What were common misconceptions or challenges with understanding, if any? How should you address these in the next lessons?
The baseball shop task worked well to prepare students for the lesson of the day. By the end of the lesson, most students were able to demonstrate understanding of the substitution strategy as a way to solve a system of equations. There were a few students who struggled in the beginning, but by the end of the sample problems, all students seemed to have an understanding of substitution and how to use it within the context of the problem given.