Mathematics: The Language of STEM

Systems of Equations - 8..AF.8 & AI.SEI.1

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CONTENT AND TASK DECISIONS

Grade Level:
8th Grade or Algebra

Description of the Task:
Students will use their knowledge of writing and graphing linear functions to write and graph systems of equations from a real-world problem. Students will create their own real-world examples from a system of equations.

Indiana Mathematics Content Standards:
8.AF.8 Understand that solutions to a system of two linear equations correspond to points of intersection of their graphs because points of intersection satisfy both equations simultaneously. Approximate the solution of a system of equations by graphing and interpreting the reasonableness of the approximation.
AI.SEI.1: Understand the relationship between a solution of a pair of linear equations in two variables and the graphs of the corresponding lines. Solve pairs of linear equations in two variables by graphing; approximate solutions when the coordinates of the solution are non-integer numbers.

Indiana Mathematics Process Standards:
Practice 1: Make sense of problems and persevere with solving them
Practice 2: Reason abstractly and quantitatively
Practice 4: Model with mathematics
Practice 5: Use appropriate tools strategically
Practice 6: Attend to precision
Practice 7: Look for and make sure of structure

Mathematics Content Goals:
Students will be able to write equations from a real-world problem.
Students will be able to convert equations into slope-intercept form.
Students will be able to graph systems of equations.
Students will be able to determine the solution of a system of equation by identifying the point of intersection.
Students will be able to interpret the point of intersection as it related to the real-world example.

Language Objectives:
Systems of Equations - a set of equations
Picture or other explanation: Draw a picture of two linear functions on a coordinate plane and put a star where the two systems intersect

Solution of a System of Equation - an ordered pair that makes each equation valid or true

Picture or other explanation: Draw an arrow to the star in the above picture and label this as the “Solution”

Materials:
Quadrant I Coordinate Plane Graph Paper
Ruler
Colored Blocks

THE LESSON

Before:

Comment [1]: This phase of the lesson should be designed to get students ready for problem solving. It also provides an opportunity for you to find out what they already know about the topic. Describe how you will accomplish each of the following in this phase of the lesson:
· Activate prior knowledge (including the specific questions you will ask to raise students' curiosity and activate or determine their prior knowledge),
· Be sure the problem is understood, and
· Establish clear expectations (including the specific expectations you have for students to record their mathematical thinking in writing or drawing).

Provide the students with graph paper and two equations written in slope intercept form.
Ask the students to graph these equations.
(Ex: $y = \frac{1}{2}x + 4$ and $y = -3x + 2$)

Activate prior knowledge

What do we remember about slope-intercept form?
What does slope-intercept form look like?
Where is the slope in slope-intercept form?
Where is the y-intercept in slope-intercept form?
How do we graph equations in slope-intercept form?
How do we graph the y-intercept?
How do we graph the slope?
What are important characteristics of the graph of an equation?

Provide the students with graph paper and an equation.
Ask the students to write the equations in slope-intercept form and graph the equation.
(Ex: $4x + 2y = 12$)

Activate prior knowledge

How do you change equations into slope-intercept form?
What are some challenges while changing equations into slope-intercept form?
What are some common mistakes we make while changing equations into slope-intercept form?

Present the students with the following situation:

(8.AF.8) *A movie rental store offers customers two choices. Customers can pay a yearly membership of $45 and then rent each movie for $2 or they can choose not to pay the membership fee and rent each movie for $3.50.*

(AI.SEI.1) Steve bought dinner for some friends. Steve spent $11 on four tacos and two burritos. Joe bought dinner for some friends. Joe spent $17 on three tacos and five burritos.

Given the following information, have the students brainstorm different questions they might have for this problem.

What questions do you have for this situation?

What do you notice?
What are you wondering?
What could you find out from this problem?
Is any more information needed? If so, what information is needed?

Then present something along the lines of the following question:

(8.AF.8) *Determine the number of rentals needed to give the same price between the two payment options.*

(AI.SEI.1) *Determine the cost of one taco and one burrito.*

Put the students in equal ability groups to discuss this problem.

During:

During the lesson, each group of students will explore systems of equations. Students will determine a system of equations. Students may use the graph paper, pictures, or colored cubes to solve the problem. If a group solves the system of equations ask them to check their answer for accuracy. If a group thinks they have found the solution have them try to find the solution using a different method.

As the facilitator, consider the different methods students are using to solve this problem. Make note of the different methods and begin to pair groups together to discuss their findings.
Some students may use pictures, tables, equations, or graphs.
Students will be recording their findings on the back of their coordinate plane paper.

Support Questions:

What are we talking about in this problem?
What variables can we use to represent the different items in this situation?
Did you define your variables?
What do your variables represent?
How could you use an equation to represent this situation?
How do you know which number goes at the end of the equals sign?
How did you write your equations?
How did you solve your equations?
When you solve your equations, what are you finding?
What is the intersection point of the system of equations?
What does the intersection point of the system of equation represent in the context of this situation?
How do we know which number goes with which variable?
What details do we need when presenting our solution?
Which label do we use for which number? How do you know?
Why does the solution have two numbers instead of one?

Extension Questions:

What would happen if you solved your equations for the other variable? Try it!
Now that you believe you have an answer, how could you use this answer to write your own system of equations involving tacos and burritos?

Comment [2]: This phase of the lesson should be designed for students to explore the focus task. Describe specifically what the students will be doing in this phase. Include a description of how the students will record their mathematical thinking in writing or drawing throughout the investigation. Describe how you will accomplish each of the following in this phase of the lesson:

- Let go,
- Listen actively,
- Provide appropriate support (including the specific questions you will ask to focus students' thinking on the critical features of the task or to help students who are stuck), and
- Provide worthwhile extensions.

Was your solution a whole number?
What do we do if our solution to our system is not a whole number?
Does it make sense for the solution of this system to have a decimal?
When would it NOT make sense for the solution to be a decimal?
Could you write this decimal answer in a different form?

After:

Have each group determine a team leader. Pair each group with another group that use a different method or different approach to solve the problem.
Encourage students to ask their peers questions about their method and to compare the numbers in their method to the numbers in the other group's solution.
Encourage students to explain how they "knew" their answer was correct. What did they do to check their work?
Encourage students to use correct terminology. (variables, equation slope-intercept form, system of equations, solution)
After 10 minutes of explanations, discussions, and questioning, ask for volunteers for some examples to be projected in front of the class. Be sure to include multiple representations - tables, pictures, graphs.
Students should come up with the following solutions:
(8.AF.8) 30 movie rentals or (30 movies, $105)
(AI.SEI.1) One taco costs $1.50 and one burrito costs $2.50 or ($1.50, $2.50) or ($2.50, $1.50) depending on this variable they solved for

As students work with other groups and hear new methods to solve the same problem, ask the students if they see a method that is most efficient to solve this problem.

Do certain methods lend themselves better to certain types of questions?

(Smaller numbers → pictures/tables, Larger numbers → graphs)

What tools can we use to help us determine solutions to systems of equations?

ASSESSMENT

Now that students have explored different methods in solving systems of equations, use SeeSaw as an opportunity for students to create their own real-world problem. In their groups, have students refer to the problem they just solved - think of the question asked the the process to get to the solution - to come up with their own system of equations problem.
Groups will first type their problem in Notability and then screenshot their real-world problem to post in SeeSaw. Be sure to number each group and remind all groups to include their group number in the title of their post. Each group should use Notability to create an "answer key" for their problem. Encourage groups to use their resources.

What situations would lend themselves to systems of equations?

(Think of restaurants, grocery shopping, car repair shops, gas stations, sports)

Comment [3]: In this portion of the lesson, students should work as a community of learners, discussing, justifying, and challenging various solutions to the problem all have just worked on. Here is where much of the learning will occur. It is critical to plan sufficient time for a discussion and make sure the During portion does not go on for too long. Describe how you will accomplish each of the following:

- Promote a mathematical community of learners (Describe how the students will present their solution strategies. How will you organize the discussion to accomplish the mathematical goals? Which solutions will be shared and in what order?)
- Listen actively without evaluation (How will you respond to students' presentations of their solutions?)
- Make connections (What questions will you ask to help students make sense of the mathematics, make connections, see patterns, and make generalizations?)
- Summarize main ideas (How will you formalize the main ideas of the lesson? How will you reinforce appropriate terminology, definitions, or symbols?)

Comment [4]: Observe: Describe how you will observe students to gather evidence about what they are learning, and describe the specific evidence of mathematical understanding that you will look for in your observations.

Ask: List the specific questions you will ask students to assess their learning.

If a student is stuck on creating their own example, ask them questions about things that interest them.

What sports do you play?
What restaurant do you like?
What things might you buy at a gas station?
What stores do you like to shop at?

Encourage groups to check their system by substituting and to also check their system by graphing.

What resource can we use to make checking our answer by graphing quicker? (Graphing calculators, Desmos, etc)

Once each group has submitted a problem in SeeSaw, individually have them choose another group's problem. Each student will click on a peer's real-world problem and take a screenshot. Students can either work through the problem in Notability and then explain their thinking in a SeeSaw video or import the picture into a new SeeSaw post and then record themselves while solving the problem. The students may first want to put their screenshot in Notability and then put a large coordinate plane on their note to make graphing in SeeSaw easier.
Once each student has created a video of their solution to a peer's system of equation problem, have them post it to the SeeSaw page. Then each student needs to comment their answer under the problem they decided to solve.

Explore the comments under each post.
Did some students get different answers for the same problems?
Did students represent their solution in different ways? (Ex: ½ and 0.5)
Did students represent their answer as an ordered pair?
Did students label their answers appropriately?