

Two Worlds Collide, Part 2

Systems of Linear Equations: Substitution and Elimination

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Grade Level	8th – 11th Grade	**Time Frame**	100–150 minutes
Subject	Mathematics	**Duration**	3 class periods
Course	Algebra 1, Algebra 2		

Essential Question

How can systems of equations be used to represent situations and solve problems?

Summary

This lesson focuses on how to analyze and solve systems of linear equations by using the substitution and elimination methods. Students will use their prior knowledge of the components of a system to solve problems algebraically. Students will identify, solve, and write equations using substitution and/or elimination as their tools. This is the second lesson of three in the "Two Worlds Collide" lesson series.

Snapshot

Engage

Students use the Tell Me Everything strategy to activate prior knowledge.

Explore

Students investigate different algebraic methods through an Amplify Classroom activity.

Explain

Students discuss their findings from the Amplify Classroom activity and formalize their understanding of the substitution and elimination methods.

Extend

Students expand their knowledge through a second Amplify Classroom activity, based on a real-world scenario.

Evaluate

Students determine which method works best to solve each given problem and share their reasoning.

Standards

ACT College and Career Readiness Standards - Mathematics (6-12)

A604: Solve systems of two linear equations

Oklahoma Academic Standards Mathematics (Algebra 1)

A1.A.1.3: Analyze, use and apply mathematical models to solve problems involving systems of linear equations with a maximum of two variables by graphing, substitution, and elimination. Graphing calculators or other appropriate technology may be utilized. Interpret the solutions in the original context.

Oklahoma Academic Standards Mathematics (Algebra 1)

A2.A.1.7: Represent and evaluate mathematical models using systems of linear equations with a maximum of three variables. Graphing calculators or other appropriate technology may be used.

Attachments

- Lesson Slides—Two Worlds Collide, Part 2.pptx
- Note Catcher—Two Worlds Collide, Part 2 - Spanish.docx
- Note Catcher—Two Worlds Collide, Part 2 - Spanish.pdf
- Note Catcher—Two Worlds Collide, Part 2.docx
- Note Catcher—Two Worlds Collide, Part 2.pdf
- Which Method—Two Worlds Collide, Part 2 - Spanish.docx
- Which Method—Two Worlds Collide, Part 2 - Spanish.pdf
- Which Method—Two Worlds Collide, Part 2.docx
- Which Method—Two Worlds Collide, Part 2.pdf

Materials

- Lesson Slides (attached)
- Note Catcher handout (attached; one per student; print two-sided)
- Which Method? handout (attached; one per student; print one-sided)
- Paper
- Pencil
- Student device with internet access

5 minutes

Engage

Introduce the lesson using the attached **Lesson Slides**. Display **slide 3** to share the lesson's essential question. Show **slide 4** to go over the lesson's learning objectives. Review these slides with students to the extent you feel necessary.

Display **slide 5** and pass out the attached **Note Catcher** handout to each student.

On the top portion of the handout, have students use the Tell Me Everything strategy to write everything they know about the words *substitution* and *elimination*. Encourage students to write or draw anything that comes to mind, whether it is a definition, an example, a picture, or something else.

Once students have written or drawn something for both words, have students find a partner or assign partners and give pairs time to discuss their responses. Then, invite several pairs to share their responses with the class. Keep in mind this portion of the lesson is just meant to activate students' prior knowledge and get them thinking about the concepts.

30 minutes

Explore

Teacher's Note: Amplify Classroom Activity Preparation

To prepare for the Amplify Classroom activity in this phase of the lesson, go to *Amplify Classroom: Line Zapper*. Sign up to create an account or log in. Select the “Assign” dropdown button, and then select “Create single session code.” Adjust the settings as desired, then select “Create Invite Code.” Prepare this session invitation code to distribute to students during the lesson. For help assigning an Amplify Classroom activity, see k20.ou.edu/AssignActivity.

For more information about getting started with Amplify Classroom, go to k20.ou.edu/StartAmplify.

Display **slide 6** and provide students with your session code. Then have students go to student.amplify.com/join and enter the session code.

Teacher's Note: Sign-in Options

If students sign in with their Google or other account, then their progress automatically saves, and they can resume the activity or view their work later. If students continue without signing in, they can complete the activity, but they must do so in one sitting. It is strongly recommended that students sign in; otherwise, they risk losing their work.

During the activity, students go through nine screens and work in pairs to "zap" different points of intersection based on the equation and/or graph provided. Have students use the “Line Zapper” portion of the Note Catcher (and additional scratch paper, if needed) as a space to investigate the equations and write down their thoughts as they work.

The activity does not specifically tell students how to solve the equations, so they may use any algebraic method they want. This is a time for students to explore their knowledge, figure out a process that works best for them, and reflect with their partners.

25 minutes

Explain

Have each pair join another pair to form a group of four or assign groups of four. Display **slide 7**. In groups, have students unpack the Amplify Classroom activity by discussing the following questions:

- How can you determine the exact solution to a system of equations?
- What did you feel was the hardest part of the activity?
- What became easier as you progressed through the activity?

Ask for volunteers to share their responses with the whole class.

Sample Responses

Students' answers may vary. Some students might not have used substitution or elimination to solve. Instead, they may have looked at the graph and determined where the two lines intersected. Depending on the problem, students likely had an easier time finding the solution graphically. However, most of the problems had two lines but did not show the coordinate plane. To see when the equations had a common point, students may have created a table.

Show **slide 8**. Inform students they are going to use the 3-2-1 strategy to complete the "Substitution: 3-2-1" portion of the Note Catcher as they watch the video on the following slide.

Go to **slide 9** and play Khan Academy's *The Substitution Method* video, which demonstrates how to solve systems of equations with the substitution method.

Embedded video

https://youtube.com/watch?v=uzyd_mIJaoc

After the video, move to **slide 10** and ask for volunteers to share their answers to the questions on the handout:

- What are three things you learned?
- What are two questions you still have?
- What is one thing you found interesting?

Depending on students' questions and feedback, you may have to solve another problem using substitution as a class until all misconceptions are cleared up. This may vary from class to class.

Repeat the same process for the elimination method by transitioning through **slides 11–13**. Have students complete the "Elimination: 3-2-1" portion of the Note Catcher as they watch Khan Academy's *Solving Systems With Elimination* video.

Embedded video

https://youtube.com/watch?v=NPXTkj75-AM

Similarly, depending on students' questions and feedback, you may have to solve another problem using elimination as a class until all misconceptions are cleared up. This may vary from class to class.

Teacher's Note: Guiding the Activity

Students often develop a preference for one method over the other. Remind students that, while both methods always work, one method may be easier to use on certain problems. Knowing how to use both methods and being able to recognize when a particular method is more efficient are important skills for students to have going forward as they encounter more difficult problems.

30 minutes

Extend

Teacher's Note: Amplify Classroom Activity Preparation

To prepare for the Amplify Classroom activity in this phase of the lesson, go to *Amplify Classroom: Wafers and Crème*. Sign up to create an account or log in. Select the "Assign" dropdown button, and then select "Create single session code." Adjust the settings as desired, then select "Create Invite Code." Prepare this session invitation code to distribute to students during the lesson. For help assigning an Amplify Classroom activity, see k20.ou.edu/AssignActivity.

For more information about getting started with Amplify Classroom, go to k20.ou.edu/StartAmplify.

Display **slide 14**. Provide students with your session code. Then have students go to student.amplify.com/join and enter the session code.

During the activity, students apply their knowledge of substitution and/or elimination to a real-world scenario to determine the number of calories in a pack of triple-crème cookies. Have students use the "Wafers and Crème" portion of the Note Catcher (and additional scratch paper, if needed) as a space to solve the system of equations.

Teacher's Note: Guiding the Activity—Screen 4

On **screen 4** of the Amplify Classroom activity, students need to use the given information about the single-crème and double-crème packs of cookies to find the number of calories per wafer and per layer of crème and then apply that information to the triple-crème pack of cookies.

If students struggle on this screen, encourage them to think of what they would need to know to determine the total calories (in each wafer and in each layer of crème) for a cookie pack of any size. If students are unsure, without directly giving them the answer, ask them what stays the same in each pack of cookies and what is different in each pack. This should help them more easily decide what they need to define as unknown variables to write a system of equations.

Consider also reminding students to clearly label what their variables represent. If a student chooses to use the letter "c," for example, it will be unclear whether "c" represents the number of calories per wafer, the number of calories per layer of crème, the total number of calories in a single crème cookie, or the total number of cookies.

To help students check their expressions, prompt them to use the sliders to adjust the number of cookies and layers of crème to recreate the cookie packs shown on previous screens. When a student selects six cookies with single crème filling, for example, the screen will show the number of calories their expression would yield, which should be 320 calories if their expression is correct.

Have students recreate all three packs of cookies to check their work.

Teacher's Note: Guiding the Activity—Screen 7

The variable ***m*** represents the number of whole cookies (2 wafers + crème), and the variable ***n*** represents the number of layers of crème (a single crème cookie means that ***n = 1***, a double crème cookie means that ***n = 2***, etc.).

If students struggle with **screen 7**, encourage them to use their equations from the previous screens to write a verbal model. Then, they can use this model as a starting point to help them write an expression with the given variables.

10 minutes

Evaluate

Display **slide 15** and pass out the attached **Which Method?** handout to each student.

For each problem, ask students to decide if they should use substitution or elimination to solve it. Have students write their thoughts on the handout. Remind students that, while both methods always work, one method may be easier to use on certain problems.

Optional Slides

If students are struggling to understand which method to choose, consider unhiding and transitioning through **slides 16–17** to review the sample responses as a class.

Students continue to apply what they have learned in this series' final lesson: Two Worlds Collide, Part 3.

Resources

- Desmos Classroom. (n.d.). *Line zapper* [Interactive activity]. Amplify Classroom. https://classroom.amplify.com/activity/6835bf2a06c057e7a4ccbec5?collections=5da6485a83c0877d4b5708dd
- Desmos Classroom. (n.d.). *Wafers and crème* [Interactive activity]. Amplify Classroom. https://classroom.amplify.com/activity/56d74abe3df0d04006f0cb97?collections=5da6485a83c0877d4b5708dd
- K20 Center. (n.d.). 3-2-1. Strategies. https://learn.k20center.ou.edu/strategy/117
- K20 Center. (n.d.). Amplify Classroom. Tech tools. https://learn.k20center.ou.edu/tech-tool/1081
- K20 Center. (n.d.). Tell me everything. Strategies. https://learn.k20center.ou.edu/strategy/107
- Khan Academy. (2016, October 28). *Solving system with elimination* [Video]. YouTube. https://www.youtube.com/watch?v=NPXTkj75-AM
- Khan Academy. (2011, March 10). *The substitution method* [Video]. YouTube. https://www.youtube.com/watch?v=uzyd_mIJaoc