



Two Worlds Collide, Part 2

Systems of Linear Equations: Substitution and Elimination



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Grade Level	9th – 11th Grade	Time Frame	115-150 minutes
Subject	Mathematics	Duration	2-3 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 a Desmos "Line Zapper" activity.

Explain

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

Extend

Students expand their knowledge through a second Desmos activity, "Wafers and Crème," based on a real-world scenario.

Evaluate

Students determine which method works best to solve a given problem and share their reasoning. Students reflect on their confidence in using the two algebraic methods.

Standards

Oklahoma Academic Standards for Mathematics (Grades 9, 10, 11, 12)

A1.A.1.3: Analyze and solve real-world and mathematical problems involving systems of linear equations with a maximum of two variables by graphing (may include graphing calculator or other appropriate technology), substitution, and elimination. Interpret the solutions in the original context.

A2.A.1.8: Represent real-world or mathematical problems using systems of linear equations with a maximum of three variables and solve using various methods that may include substitution, elimination, and graphing (may include graphing calculators or other appropriate technology).

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; printed front/back)
- Which Method handout (attached; one per student; printed front only)
- Paper
- Pencil
- Laptop or tablet with internet access

5 minutes

Engage

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

Assign student pairs or have each student find a partner. Go to **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's a definition, an example, a picture, or something else.

Once students have written or drawn something for both words, give students time to discuss in pairs. Then, invite several pairs to share out. 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: Desmos Activity Preparation

To use this [Desmos Classroom](#) activity, select the following link: "[Line Zapper](#)." Create an account or sign in under the "Activity Sessions" heading. After you log in, the green "Assign" dropdown button will be active. Click the arrow next to the word "Assign," then select "Single Session Code." After making some setting selections, select "Create Invitation Code" and give the session code to students. For more information about previewing and assigning a Desmos Classroom activity, go to <https://k20center.ou.edu/externalapps/using-activities/>.

For more detailed information about Desmos features and how-to tips, go to <https://k20center.ou.edu/externalapps/desmos-home-page/>.

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

Teacher's Note: Sign-in Options

If students sign in with their Google or Desmos accounts, then their progress is saved, 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 Desmos: 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 student pair join another pair to form a group of four or assign groups of four. Display **slide 7**. In groups, have students unpack the Desmos 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. They may instead 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.

Go to **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 following video.

Go to **slide 9** and play Khan Academy's video, "[The Substitution Method](#)," which demonstrates how to solve systems of equations with the substitution method:

Embedded video

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

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: Desmos Activity Preparation

To use this [Desmos Classroom](#) activity, select the following link: "[Wafers and Crème](#)." Create an account or sign in under the "Activity Sessions" heading. After you log in, the green "Assign" dropdown button will be active. Click the arrow next to the word "Assign," then select "Single Session Code." After making some setting selections, select "Create Invitation Code" and give the session code to students. For more information about previewing and assigning a Desmos Classroom activity, go to <https://k20center.ou.edu/externalapps/using-activities/>.

For more detailed information about Desmos features and how-to tips, go to <https://k20center.ou.edu/externalapps/desmos-home-page/>.

Display **slide 14**. Provide students with your session code. Then, have students go to student.desmos.com 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 Desmos: 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—Desmos Screen 4

On screen 4 of the Desmos 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—Desmos 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

Go to **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, you may unhide and transition 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]. Desmos.
<https://teacher.desmos.com/activitybuilder/custom/5df166d1fa83ee79c328d37d?collections=5da6485a83c0877d4b5708dd>

Desmos Classroom. (n.d.). Wafers and Crème [Interactive activity]. Desmos.
<https://teacher.desmos.com/activitybuilder/custom/56d74abe3df0d04006f0cb97?collections=5da6485a83c0877d4b5708dd>

Khan Academy. (2011, March 10). The substitution method [Video]. YouTube. https://youtu.be/uzyd_mljaoc

Khan Academy. (2016, October 28). Solving system with elimination [Video]. YouTube.
<https://youtu.be/NPXTkj75-AM>

K20 Center. (n.d.). Desmos 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>

K20 Center. (n.d.). 3-2-1. Strategies. <https://learn.k20center.ou.edu/strategy/117>