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LESSON

Slowing the Spread

Using the engineering design process, students research solutions for stopping the spread of germs, discuss barriers to these solutions, and consider how to overcome these problems. They simulate the spread of germs, model how soap kills germs, and observe high-touch areas. In groups, students pick a problem to solve, explore existing solutions, and brainstorm solutions.

GRADES

1, 2

SUBJECTS

Biology, Health, Engineering

CONTENTS

3 Activities

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ACTIVITY 1: INVISIBLE VILLAINS | 45 MINS

DIRECTIONS

This activity is part of the Germ Problem-Solvers: Using Engineering to Develop Solutions unit.

1. **Introduce the activity by connecting the engineering design process to the final product of the unit project.**

- Remind students that even though we can't see germs with our naked eyes (without a microscope), they are all around us (microbes can be found in the air, water, soil, trees,

animals, humans, etc).

- Tell students: *Today we will be considering problems that we face as we try to stop the invisible villains (or germs) from spreading, so we can stay healthy.* Remind students of the final product of the unit project.
- Tell students they will be using a process called the engineering design process to do this work. Show them the full process using the *Engineering Design Process Cycle Graphic.*
- Introduce the first part of the engineering design process—ask to identify the need. Read the description from the *Engineering Design Process Cycle Graphic* aloud to the class. Let students know that before we can design a way to stop the "big problem" of slowing the spread of germs that make us sick, we have to ask questions to figure out the smaller problems we are trying to solve.
- Ask students to work in small groups to brainstorm ways that they think germs spread. Have them share their ideas with the whole class. Record students' ideas publicly on the whiteboard or chart paper.
- (Students may say: sharing food, utensils, or drinks; coughing or sneezing; not washing hands before eating; touching germy surfaces; or just by being around someone who is sick.)

2. **Lead students in a simulation that will help them see how sneezing spreads germs.**

- Building on their ideas from the previous step, tell students that you will show them one way to see how germs travel if we don't cover our coughs and sneezes.
- Simulate a sneeze with spray bottles filled with water and food coloring. Students should know that this is a model of what happens when we sneeze. Students should pretend that the spray bottle represents our mouths and nose, and the water represents germ-filled droplets that get forced out in a sneeze.
- Have students predict how far they think the droplets will fly before they land.
- Before spraying, put down white butcher paper or other light-colored surface so students can see how far those water droplets travel.
- Ask for a volunteer to help you measure the length the droplets travel.
- Simulate a sneeze with the spray bottle, repeating a few different times. See how close students were in their predictions.
- Ask students what problem this presents with the spreading of germs (as engineers always have to figure out what problem they are solving first), guiding them to the idea that sneezes and coughs cause germs to travel a long distance around us.

3. **Support students as they identify conditions that increase the spread of germs, and ask questions that help clarify the unit problem.**

- Reinforce the idea that germs, both good and bad, are everywhere on various surfaces (including our skin and bodies). Fun fact - microbes can also be found in trees/wood and this is why campsites prefer one buys wood from their area instead of bringing wood from other locations to avoid the spread of foreign germs that may be harmful to the local flora. Ask students to think of times when they might be spreading germs or picking up germs and not even know it.
- Distribute the *Spreading Germs Snapshots* handout. Explain that students will use it to represent moments throughout the school day when germs might spread. After students have considered three moments throughout the day when germs may have spread, have them share their thoughts with a partner, then record their pictures and labels on the handout.
- Next, remind students that in this activity, they are working on the first step of the engineering design process—ask to identify the need—so their focus is on what specific problems we need to solve that will help stop bad germs from spreading. The big problem is slowing the spread of germs that make us sick, but what are smaller problems that contribute to the spread of germs?
- Guide students through the next step on the *Spreading Germs Snapshots* handout: "Review your three snapshots. Now think about the problem that needs to be solved for each one. Write the problems in the spaces below."
- If time allows, ask students to share with the class some of the problems they identified. Explain that in the next activity, *Getting Rid of Gross Germs,* they will be researching solutions that will help solve the big problem: slowing the spread of germs that make us sick.

Tip

Step 3: You may want to work through a document panel from the *Spreading Germs Snapshots* handout with students as an example, adding a picture, the description, and the problem that needs solving.

Step 3: Consider pre-selecting locations and providing images with descriptions in the *Spreading Germs Snapshots* handout. You could provide images of the cafeteria, playground, bus, library, art/PE/music class, or hallway interactions as places for students to start.

Informal Assessment

Class Discussion: Use class discussions to assess students' ability to identify ways that germs can spread, as well as their ability to participate in collaborative conversations.

Students' Handouts: Use students' *Spreading Germs Snapshots* handouts to assess their ability to identify situations when germs spread and identify problems that need to be solved.

Extending the Learning

Show the video *How Germs Spread* (2:04) from Cincinnati Children's Hospital Medical Center.

OBJECTIVES

Subjects & Disciplines

Biology
- Health
- Engineering

Teaching Approach

- Project-based learning

Teaching Methods

- Brainstorming
- Discussions
- Simulations and games

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Creativity and Innovation
    - Critical Thinking and Problem Solving
- 21st Century Themes
  - Health Literacy
- Critical Thinking Skills
  - Applying
  - Understanding
- Science and Engineering Practices
  - Asking questions (for science) and defining problems (for engineering)
  - Developing and using models

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.SL.9-10.1:**
Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
• **Speaking and Listening Standards K-5:**
Presentation of Knowledge and Ideas, SL.1.6
• **Speaking and Listening Standards K-5:**
Presentation of Knowledge and Ideas, SL.2.6

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 2:**
Cause and effect: Mechanism and prediction
• **Crosscutting Concept 3:**
Scale, proportion, and quantity
• **Engineering Design:**

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

- **Science and Engineering Practice 1:**

Asking questions and defining problems

Preparation

BACKGROUND & VOCABULARY

Background Information

The engineering design process is a series of steps that engineers go through to solve a problem. The first step—ask—requires students to ask questions to figure out what problem they are trying to solve, what the goal is, and what the limitations are. In this activity, students consider specific problems that lead to the spreading of germs. Germs are everywhere on various surfaces. Viruses, in particular, can live longer on stainless steel, plastic, and other hard surfaces than on soft materials, and uncovered coughing and sneezing can spread germs. They can live for several hours or up to a few days. For example, an uncovered sneeze can travel as far as 27 feet. As students explore the content about the spread of germs, they will be better able to complete the final product of the unit project of designing a tool or product that helps keep germs from spreading so that they can keep themselves and others healthy.

Prior Knowledge

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Recommended Prior Activities

- Feeling Yucky
- Getting to Know Germs

Vocabulary

Term	Part of Speech	Definition

Term	Part of Speech	Definition
engineering design process	*noun*	series of steps that guides engineers as they solve problems.
germ	*noun*	disease-producing microbe.
model	*noun*	image or impression of an object used to represent the object or system.

ACTIVITY 2: GETTING RID OF GROSS GERMS | 45 MINS

DIRECTIONS

This activity is part of the *Germ Problem-Solvers: Using Engineering to Develop Solutions* unit.

1. **Lead a discussion about how we keep germs from spreading and read a text called *Germs vs. Soap* to help students understand how handwashing slows the spread of germs.**

- Remind students of the specific problem(s) they are trying to solve in the unit, leveraging their ideas from the *Spreading Germs Snapshots* handout from the *Invisible Villains* activity. Relate their work to the driving question of the lesson (How do germs spread, and how can we keep them from spreading?) and the final product for the unit project (to design a tool or product that helps keep germs from spreading so that they can keep themselves and others healthy).
- Ask students to brainstorm ways to keep germs from spreading. Keep track of their ideas in a place the class can see. (Students may respond: washing hands, using hand sanitizer, covering coughs and sneezes, giving other people personal space, washing hands if we share items, staying home when we are sick, wearing masks, and not touching our faces.)
- Read a children's book that explains how soap gets rid of germs to the class, such as *Germs vs. Soap* by Didi Dragon. Or show the video, *Germs vs. Soap - Read Aloud* (8:10), of the book being read aloud. Discuss how germs get into our bodies and how soap helps get rid of germs. Write the questions below on the whiteboard or chart paper, to guide students as they listen:

  - How do germs get into our bodies? (Germs enter through the eyes, noses, and mouths – especially when we have open cuts through which they can get directly into the bloodstream)
  - What do germs want from people? (Germs want "energy cupcakes" or a safe place to make more of themselves or an easy way to spread around so they can reproduce more

easily.)
- Where can germs "hide" on our hands? (Germs hide between fingers and under fingernails.)
- What does soap do to germs? (Handwashing works by binding to the oils on our hands, and then mixing with the water to suspend and wash the germs away.)

2. Model how soap works through a hands-on simulation so students can understand how soap works and begin to make connections to the project.

- Ask students why they think soap gets rid of germs. Some students may say that soap kills germs, but soap just binds to the oils on our hands, and then mixes with the water to wash the germs away.
- Model how soap works to get germs off our hands. You can do this as a demonstration yourself or with a student volunteer, or it can be a hands-on activity for students.
- For each pair or small group, provide a bowl or tub with oil, big enough for hands to fit into. They should also have a sink available for washing their hands.
- Add 2-3 tablespoons of cocoa powder, cinnamon, chalk dust, or pepper to each container of oil. Ask: *What do you think the material in the oil represents?* (Germs.) Have students place their hands in the oil and mix the two together. Ask: *What do you think the oil represents?* (The oil represents the natural oils from our hands.) Make sure they rub lots of the cocoa powder, cinnamon, chalk dust, or pepper into their hands.
- Have students attempt to wash their hands in the water without soap. Ask: *What do you notice about your hands?* (The oil and spices or chalk are still on our hands.)
- Ask students to use soap to wash their hands for at least 20 seconds. Then have them rinse with the water. Ask: *Are there any "germs" left?* (They should have been able to wash all or most of the "germs" off their hands.)
- You might say: *What would happen with the spread of germs if you had germs on your hands—like the spices or chalk dust—and didn't wash with soap?*
- Ensure that students understand how soap works. How germs get into our bodies, where they can "hide," and what they want from people may be somewhat clear from the text, but ensure that students understand the importance of using soap and how soap gets rid of germs.
- Ask: *How does this activity help you think about solving a problem or finding a solution to a real-world problem about the spread of germs?* (Students may make connections to

problems with hand washing in their context. They may report a lack of soap in restrooms, a lack of time to wash thoroughly, or a lack of knowledge in themselves, their classroom, or community about how to wash thoroughly. This may bring up other questions about when or how often to wash their hands.)

3. Introduce the second part of the engineering cycle, research, so that students can begin researching solutions to the spread of germs.

- Show students the *Engineering Design Process Cycle Graphic* again. Point them to the research step. Let students know that the research component can include talking to people who can share solutions that exist or what solutions could be adapted to fit their needs. Explain for the purposes of this unit, solutions include promoting behaviors that can stop or slow the spread of germs, as well as designed objects, such as masks, face shields, gloves, or other devices.
- Introduce the *Getting Rid of Gross Germs Research Notes* handout to collect their research and review the directions with students. Have students choose a solution they want to learn more about. Organize the groups based on students' preferences.
- Distribute the *Getting Rid of Gross Germs Resources* handout. Have students complete their research in like-groups reading about the same topics.
- Come back together as a class and discuss barriers to these solutions in your context and how these problems could be overcome. You might ask:
    - *What could keep people from using that solution?*
    - *How could we make it work?*
    - *If ____ is hard to do, how could we fix that problem?*
- Ensure that students document other groups' findings and barriers so they can reference these in the next activity as they brainstorm solutions.
- Let students know that in the next activity, *Sick Solutions*, they will be working on developing solutions.

Informal Assessment

Class Discussion: Use class discussions to assess students' ability to explain why washing with soap is necessary to get rid of germs and dirt, as well as their ability to participate in collaborative conversations.

Class Discussion: Use a class discussion to assess students' ability to discuss barriers to solutions in your context and how these problems could be overcome.

Research Notes: Use the *Getting Rid of Gross Germs Research Notes* handout to evaluate students' ability to gather information from provided sources to answer a question.

Extending the Learning

Take a "brain break" at some point in the activity and have students learn the song *Wash Your Hands* (0:47) from the World Health Organization and Disney Junior's Doc McStuffins.

You may decide to have the school nurse or a medical professional talk to the class about ways to keep germs from spreading.

Some teachers prefer using Glo Germ gel and UV light for a visualization of germs' persistence on our hands and to show the importance of proper handwashing. You can learn more about Glo Germ procedures by viewing the resource, *Handwashing Training*.

OBJECTIVES

Subjects & Disciplines

Biology

- Health

- Engineering

Teaching Approach

- Project-based learning

Teaching Methods

- Demonstrations
- Reading
- Research

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Critical Thinking and Problem Solving
- 21st Century Themes
  - Health Literacy
- Critical Thinking Skills
  - Applying
  - Understanding
- Science and Engineering Practices
  - Constructing explanations (for science) and designing solutions (for engineering)
  - Developing and using models
  - Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.SL.9-10.1:**
Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
• **Speaking and Listening Standards K-5:**
Comprehension and Collaboration, SL.1.1
• **Speaking and Listening Standards K-5:**
Presentation of Knowledge and Ideas, SL.1.6
• **Speaking and Listening Standards K-5:**
Comprehension and Collaboration, SL.2.1
• **Speaking and Listening Standards K-5:**
Presentation of Knowledge and Ideas, SL.2.6

Preparation

Background Information

The engineering design process is a series of steps that engineers go through to solve a problem. The second step—research the problem—includes talking to experts and practitioners to assist with researching what products or solutions already exist. In this activity, students research several solutions for how to stop the spread of germs. One specific solution students investigate is washing their hands. Hand washing works by binding to the oils on our hands, and then mixing with the water to wash the germs away. Think of oil and water: if you add both of them to a clear container, they won't mix and will form separate layers. The process in which soap works leverages this chemistry to wash away germs from our hands. It separates the germs from our skin. This is why it's important to form a soapy lather when washing our hands.

Prior Knowledge

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Recommended Prior Activities

- Feeling Yucky
- Getting to Know Germs
- Invisible Villains

Vocabulary

Term	Part of Speech	Definition
barrier	*noun*	obstacle or object that prevents movement.
disinfect	*verb*	to clean and remove harmful microorganisms.
engineering design process	*noun*	series of steps that guides engineers as they solve problems.
model	*noun*	image or impression of an object used to represent the object or system.
research	*noun*	scientific observations and investigation into a subject, usually following the scientific method: observation, hypothesis, prediction, experimentation, analysis, and conclusion.

Term	Part of Speech	Definition
solution	*noun*	an answer to a problem.

ACTIVITY 3: SICK SOLUTIONS | 1 HR 15 MINS

DIRECTIONS

This activity is part of the *Germ Problem-Solvers: Using Engineering to Develop Solutions* unit.

1. Lead students in observing high-touch areas so they can use data to inform their solutions.

- Provide students with a list of the contexts and problems discussed in the *Invisible Villains* activity, compiled from their *Spreading Germs Snapshots* handout. Have students pick a context or specific problem to solve. Organize students in project groups of three or four based on the problem or context they are interested in working on. Students will work in these teams to design a collaborative solution as the final product for the unit project.
    - Contexts could include: times of day, situations, or locations when germs are spread (e.g., riding the bus, lunchtime, recess, etc.)
- Problems could be specific issues in their context that need to be solved (i.e., the restrooms are out of soap, friends don't cover their coughs, friends share drinks at lunch, some people come to school when they are sick, etc.).
- Point students to the preliminary predictions they made about high-touch, germy areas after watching the video *Growing Bacteria* (2:11) by Sick Science!, in the activity *Getting to Know Germs.*
- Let students know that in this lesson, they will carry out some observations of those high-touch areas to see if their predictions are correct.
- Using their list of high-touch areas as a starting point, narrow the areas down to three or four locations that could be observed easily in five to ten minutes.
    - For example, a water fountain, the doorknob to the restroom, a highly-trafficked railing on the way to lunch or activity, your desk, etc.
    - Distribute the *Observing Germy Places* handout and model for students how to use tally marks to keep track of how often a surface is touched in the determined time frame.

- Observe each location as a class or, if you have other adults to help, divide the class into three or four groups to carry out the observations. Regroup to share and discuss the class findings; direct students to record the findings from other groups on their data table and determine which location was touched the most.
- Assist students as they write a claim on their handout. Explain to students that a *claim* is a statement you make based on evidence that answers a question. Share the question we are answering with this activity: *Which area in our school is the most germy?*
- Have students work in their project groups to use evidence from their observation to make a claim about which location is the most "germy" and what behaviors cause that location to have a lot of germs. (Sample student response: For our solution, we will focus on the walls along the hallway to the lunchroom. We observed 11 out of 19 children running their hands along the walls. They were on their way to lunch. This makes this location very germy. Now they are eating with germy hands! They could get sick!)

2. Introduce the next step of the engineering design process—imagine possible solutions—as well as example solutions to prepare students for brainstorming.

- Remind students of the driving question of the lesson (How do we keep germs from spreading?), the final product of the unit project (to design a tool or product that helps keep germs from spreading), and the problem(s) they are trying to solve.
- Introduce the next step of the engineering design process using the *Engineering Design Process Cycle Graphic*—imagine possible solutions.
- Before students begin brainstorming, show existing examples of designs or products that are intended to slow the spread of germs that make us sick. Some examples include:

    - Sink-urinal
    - Door handle for your feet: *FootPull*, *Toepener*, or *StepNpull*
    - Cleaning the most highly-trafficked/germy spots in the classroom
    - Doing a better job of washing hands
    - Signage to remind students to keep hands off of faces, stop the spread of germs, wash hands, etc.

3. Lead students in brainstorming solutions to germ-spreading problems they identified in previous activities so that they can make progress on their final product.

- Introduce guidelines for collaborative brainstorming, such as:

    - Everyone gets a turn to share

    - Record all ideas
    - Build off of each other's ideas
    - Encourage wild ideas and spontaneity
    - There are no wrong ideas
    - No talking over each other
    - Respect each other's ideas
    - Stay focused on the topic and keep the problem in mind
    - Develop as many ideas as you can

- Distribute and introduce the *Brainstorming Solutions* handout they will use to collect their ideas.

    - Be sure that students also have access to their *Getting Rid of Gross Germs Research Notes* handout and *Spreading Germs Snapshots* handout.

- Remind students of the driving question for the unit and of the limits to solutions they discussed in the *Getting Rid of Gross Germs* activity and recorded in the *Getting Rid of Gross Germs Research Notes* handout.
- Ask students to identify the specifics about the problem they are solving (who/what/where/when/why) on their *Brainstorming Solutions* handout.
- Ask students to brainstorm and record as many solutions as possible in their small group for their assigned/chosen context or problem.

    - Explain that the purpose of this step is to come up with solutions to the limits students described in the last question of the *Getting Rid of Gross Germs* Research Notes handout and solutions to the problems pinpointed in the *Spreading Germs Snapshots* handout.

- Remind students where they are headed in the unit. They are brainstorming ideas today, and they will choose one of these solutions and design it later. Therefore, they should not get too bogged down in considering materials or constraints in this brainstorming session.
- After 10-15 minutes, come back together as a whole class to discuss the process. Prompt students to reflect on the challenges and benefits of their group's brainstorming process.
- If time allows, prompt students to share some of their initial ideas with the whole class.
- Let students know that in the next activity, *Developing Our Germ-Stopping Solution*, they will be working on selecting promising solutions.

Informal Assessment

Class Discussion: Use class discussions to assess students' ability to participate in collaborative conversations and understanding of how to identify specific problems and solutions.

Brainstorming Solutions: Use the brainstorming solutions handout/brainstorming discussions in small groups to evaluate students' ability to follow agreed-upon rules for discussions and build on others' talk in conversations as part of the engineering process.

Extending the Learning

If you want to spend more time discussing and modeling the brainstorming process, use this PBS Kids resource, *Brainstorm*.

OBJECTIVES

Subjects & Disciplines

- **Biology**
  - Health
- Engineering

Teaching Approach

- Project-based learning

Teaching Methods

- Brainstorming
- Discussions
- Inquiry

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills

    - Communication and Collaboration
    - Creativity and Innovation
    - Critical Thinking and Problem Solving
  - Life and Career Skills
    - Social and Cross-Cultural Skills
- 21st Century Themes
  - Health Literacy
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Creating
  - Evaluating
- Science and Engineering Practices
  - Constructing explanations (for science) and designing solutions (for engineering)
  - Obtaining, evaluating, and communicating information
  - Planning and carrying out investigations

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.SL.1.1.A:**
Follow agreed-upon rules for discussions (e.g., listening to others with care, speaking one at a time about the topics and texts under discussion).
• **CCSS.ELA-LITERACY.SL.2.1.A:**
Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).
• **CCSS.ELA-LITERACY.SL.2.1.B:**
Build on others' talk in conversations by linking their comments to the remarks of other's.
• **Speaking and Listening Standards K-5:**
Comprehension and Collaboration, SL.1.1
• **Speaking and Listening Standards K-5:**
Comprehension and Collaboration, SL.2.1

Preparation

Background Information

The engineering design process is a series of steps that engineers go through to solve a problem. The third step—imagine possible solutions—includes brainstorming ideas with a group. In this activity, students collaboratively brainstorm several solutions for how to stop the spread of germs to solve a specific problem for a specific context. Undertaking authentic professional practices in the science classroom (such as the engineering design cycle in this activity and throughout the *Germ Problem Solvers* unit) are crucial ways in which students can develop a broadened sense of what it means to be a scientist or engineer. Explicitly highlighting how students' classroom activities are the same as professional practices can foster their identification with science and engineering, leading to students' ability to "see themselves" as scientists or engineers, and even increase their desire to pursue STEM disciplines in college or career pathways. Further, encouraging students to bring in their ideas about how they use science and engineering in their everyday lives provides the final link to holistically expand their sense of these subjects as taking place in many different contexts, not just in the classroom.

Prior Knowledge

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Recommended Prior Activities

- Feeling Yucky
- Getting Rid of Gross Germs
- Getting to Know Germs
- Invisible Villains

Vocabulary

Term	Part of Speech	Definition
brainstorm	*verb*	to discuss a problem and suggest solutions or ideas
context	*noun*	set of facts having to do with a specific event or situation.

Term	Part of Speech	Definition
engineering design process	*noun*	series of steps that guides engineers as they solve problems.
solution	*noun*	an answer to a problem.
tally	*noun*	a recorded number of items.