Tech for Global Good Wastewater Data Challenge

Grade Levels: 7-12

Duration: 105 minutes

In this lesson, learners work in teams to examine wastewater data for a local region. Then they use this data to make recommendations which address the public health concerns of their area.

Outline

Frame the Challenge	**25 min**
Introduce The Tech for Global Good	15 min
Introduce the Challenge	10 min
Wastewater Data Challenge	**80 min**
Analyze the Data	30 min
Taking Action Based on Data	10 min
Design Sprint	15 min
Share Ideas for Action	15 min
Debrief	10 min

Grade Levels: 7-12

Duration: 105 minutes

Concepts/Skills

Data analysis, data literacy, public health

Objectives

Students will:

- Analyze graphs of data gathered from wastewater testing.
- Compare data across regions and areas.
- Identify questions which arise during data analysis.
- Make recommendations for actions that can be taken based on data.
- Share their analysis with others and receive feedback.

Materials and Preparation

Materials

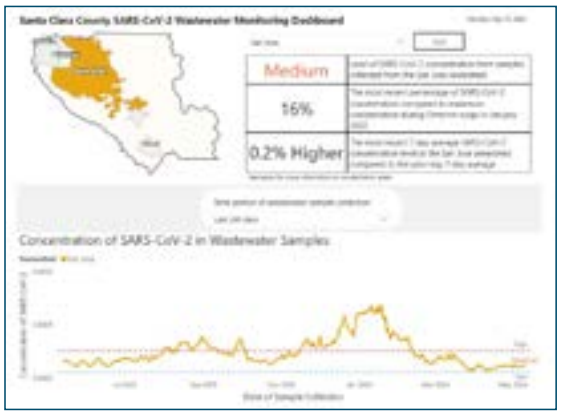
Handouts *(per student)*	Materials *(per team of 3-6 learners)*	The Tech for Global Good videos
• **Project Guide** (1 per student) • Graphs of COVID Wastewater Data (2 graphs of data for their assigned city. See **Data Sources** and **Preparation** below for more details.)	• Devices on which learners can watch videos • Sticky notes (1 set of 3 colors) • Chart paper (1 or 2 sheets) • Markers, pen/pencil, and other writing utensils (sets of multiple colors) • *Optional:* large dry erase boards (1 per team) • *Optional:* Masking tape	4 videos based on the 2022 The Tech for Global Good laureate BioBot Analytics • **The Problem** *(1:30 min)* • **The Innovators** *(2:57 min)* • **The Solution** *(1:39 min)* • **The Impact** *(2:20 min)*

*All resources connected to this lesson can be found at The Tech for Global Good: Wastewater Data Challenge webpage.

Data Sources

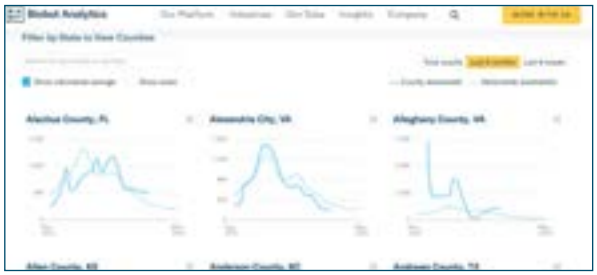
The examples in this lesson are based on Santa Clara County's Covid Wastewater monitoring of four cities:
• San Jose • Palo Alto • Sunnyvale • Gilroy

COVID wastewater monitoring data, Santa Clara County website: **https://covid19.sccgov.org/dashboard-wastewater**



For those from other areas, choose regions local to your area to strengthen connection to the content.

Wastewater data by state and county can be found on Biobot Analytics's website: **https://biobot.io/data/**



Wastewater data for other factors can also be found on the WastewaterSCAN Dashboard **https://data.wastewaterscan.org**

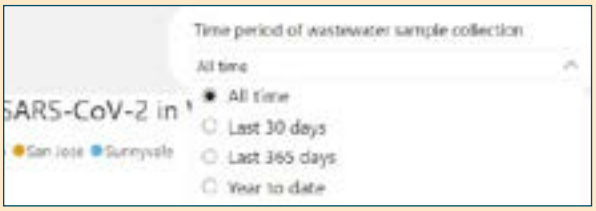
Additional sources for wastewater data include:
- **https://covid.cdc.gov/covid-data-tracker/#wastewater-surveillance**(US/National Data)
- **COVIDPoops19 Dashboard** University of California MERCED website. (Global Data)

Preparation

1. Divide students into teams of 3-6 and assign each team one of four areas.
   - *Example*: We have chosen to focus on four cities local to The Tech Interactive in California: San Jose, Palo Alto, Sunnyvale, and Gilroy.
   - If possible, have at least two teams working on each of the areas.
2. Access recent wastewater data for the areas you chose and prepare 2 sets of graphs for each area. Each student will need access to the graphs for their area.
   - *Example*: One graph of the last 30 days and one graph showing data in that area for all time. (Make sure learners can clearly see the date range.)
   - Options for providing student access to the graphs include:
     - Printing the graphs.
     - Providing links and directions for students to look up the data themselves.

Tip: For those using data from **"COVID wastewater monitoring data,"** Santa Clara County website.

- Use the dropdown to choose the time period.



- Use the arrows to change the view from all cities to just one.

Optional: Prepare sets of comparison data as well so students can see all four cities in one graph when they share during **Analyze Data: Part 3**.

3. Watch and review all of the resources to become familiar with the material.
   - **Project Guides**
   - 4 Biobot Analytics videos (approximately 9 minutes total)
4. Set up and organize materials for student brainstorming and share-outs.

Adaptations for Distance Learning

- Have learners review The Tech for Global Good videos asynchronously.
- Have teams or learners conduct their data analysis asynchronously and come back together for sharing.
- Use an online collaborative tool for brainstorming and design sprints (i.e., Slides, Padlet, Seesaw, etc.).
- Invite special guests to a virtual presentation and celebration. For more tips on adapting Design Challenges to a virtual setting, see our **"Tips for Remote STEM Learning,"** The Tech Interactive website.

Background Information

Tech for Global Good

The Tech for Global Good is an initiative that prepares the next generation of innovators to tackle the toughest challenges facing our planet. Every year, The Tech recognizes innovators who use technology to improve lives. Their stories are the inspiration for The Tech for Global Good Design Challenges. These design challenges engage learners in taking a systematic and empathetic approach to addressing social and engineering problems faced around the world. This lesson profiles an organization using data to advance their work improving the health of communities.

- **Biobot Analytics** monitors wastewater to detect viruses, high-risk substances, and other risks to community health. Their technology provides early warnings, enabling communities to take action and prevent health threats from turning into major crises.

Systems Design Challenges

Systems Design Challenges present learners with a real-world problem that is part of a complex system. Learners examine the intricate parts of that problem as they design potential solutions. By the end of a systems design challenge, learners will be able to articulate a potential solution, the real-world problem it addresses, and the effects their idea might have on other components of that larger system. Systems Design Challenges use the Innovation Design Process and Innovator Mindsets. This focus on the process builds learners' problem-solving capacity and self-confidence, preparing them for careers of the future, and empowering them to create change in the world.

Data Science

Data is everywhere. Large datasets are used in everything from journalism to public health, and the ability to navigate and understand data is becoming increasingly important. Data science involves humans and computers collecting, processing, analyzing, and utilizing data to understand and solve problems. This lesson provides students with the opportunity to build skills in data literacy and data analysis.

Frame the Challenge

Introduce The Tech for Global Good *(15 min)*

1. Before introducing The Tech for Global Good program, activate student's prior knowledge about the field of **public health** and some of the issues public health officials deal with.
   - *What is public health?*
   - *What do you know about the work of public health officials?*
2. Let learners know they are going to be watching a series of short videos that explore an important public health issue — collecting data to learn about the health of a community.
   - Introduce **The Tech for Global Good program** and the laureates who are using data to solve complex problems.
3. Play the first three videos about the 2022 The Tech for Global Good laureate BioBot Analytics:
   - **"Biobot: The Problem,"** The Tech Interactive, YouTube (1:30 min)
   - **"Biobot: The Innovators,"** The Tech Interactive, YouTube (2:57 min)
   - **"Biobot: The Solution,"** The Tech Interactive, YouTube (1:39 min)

4. Have students take notes on the Reflection Questions in their **Wastewater Challenge Project Guide**:
   - *What problem is Biobot Analytics trying to address?*
   - *What data did they collect?*
   - *How did they use that data?*
5. Following the videos, lead the class in a brief discussion about the laureates and the role of data in communities and public health.
   - *What are some other examples of data that is collected anonymously about your community?*
   - *What are some of the ways that collecting or using data can be potentiallyintrusive?*
   - *How have you seen large data sets used by cities or governments?*
   - *What are some other ways you have heard of data being used to benefit the community?*
6. During the discussion students may mention:
   - Additional public health data around hospitalization rates or diseases.
   - Government data like the census, political polling, graduation rates, and unemployment history.
   - Environmental data about regions such as pollution levels, temperatures or weather.
   - They may also note data that can be tracked via cell phone and app usage.

Note: If students need prompting, encourage them to consider the Five Ws of the data they saw in the video (who, what, when, where, why, how).

Introduce the Wastewater Data Challenge *(10 min)*

1. Let learners know that during this lesson they will have a chance to see how the anonymous data collected on wastewater can be used to inform the actions of a community.
2. Introduce the **design scenario:**

You and your team work for the public health department of your city. You want to ensure that your community is safe and healthy. As part of your duties, you monitor and analyze data about the wastewater within your city to detect viruses, high-risk substances, and other risks to community health.

- *First, you will examine the latest reports to look for trends and patterns in the data.*
- *Then you will make recommendations of actions that will prevent health threats from turning into major crises.*
  - *Make sure you consider what data you will base these decisions on.*
- *Once you have some ideas for action, you will present them to the city planners for your region. They will listen to your ideas and give you feedback.*

3. Divide students into teams.
4. Their first task will be to analyze data from the most recent time period.
   - Distribute the data for the first graph that students will examine. See **Preparation** for directions on preparing that information.

Career Connection: Public Health

Interested in a career in healthcare and helping others? Public health is the science of protecting and improving the health of people and their communities. It differs from other health careers as it focuses on protecting and promoting the health of the public rather than treating patients. The public health field sees inequity as the root cause of health disparities in our world. Addressing inequities is essential for disease prevention. This can take on many forms, including detecting and responding to outbreaks of illness, research working toward the prevention of disease and injury, and promoting a healthy lifestyle. Professionals in public health come from various fields of study, including but not limited to epidemiology, behavioral science, environmental health, and health policy and management.

To learn more about career path options for public health, check out the **"CDC Nerd Academy,"** Playlist, Centers for Disease Control and Prevention, YouTube:

- **Meet the Experts:** Not sure what kind of public health work you want to pursue? Check out the Public Health Careers videos, which feature professionals from a variety of public health fields describing their work.
- **Research:** Learn more about the basics of public health work with the Student Quick Learn videos. These animated videos explore concepts essential to the field, such as **"Why is contact tracing so important?"** Centers for Disease Control and Prevention website, YouTube (12:29 min) and **"How is an outbreak investigated?"** Centers for Disease Control and Prevention website, YouTube (12:43 min)

Analyze the Data *(30 min)*

Part 1: Recent Data *(5 min)*

1. Begin the challenge with a short **Data Talk**. `
2. For this Data Talk, have each team look at the graph which shows them the most recent set of information for their area, (e.g., the last 30 days of data).
3. Ask teams to discuss and take notes on the data.
   - *What do you notice?*
   - *What do you wonder?*
4. The open-ended nature of this analysis is designed to empower students to use their own words and to make observations.
   - Students may notice:
     - The labels of the axes on the graph.
     - High and low points in the data.
     - Patterns in the data over time (upward or downward trends).
   - Encourage students to use the Five W structure to develop their questions about the data:
     - *Where did the data come from?*
     - *How was the data collected?*
5. If students are familiar with them, encourage them to use key statistics and mathematical vocabulary and concepts as they discuss (e.g., range, distribution, mean).

Data Talks

Data Talks encourage students to consider the story that the graph is telling as they look at how the information is represented, the data itself, and what it means. (See "**Pick + Chews Data Talk**," on The Tech Interactive website, for another example of a Data Talk.)

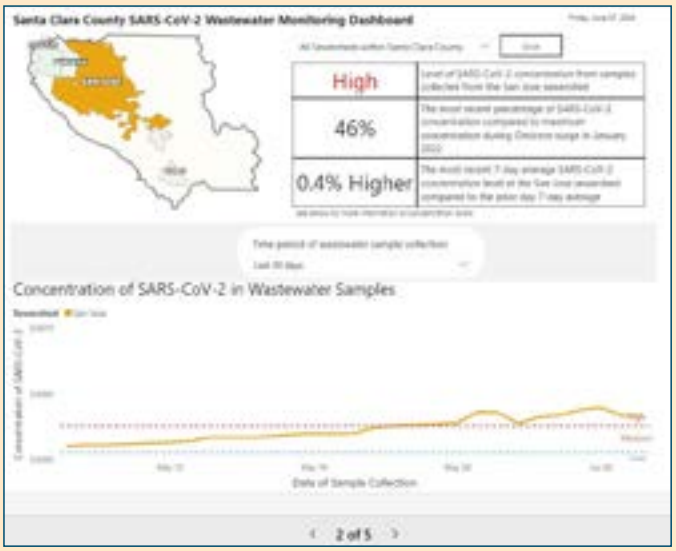
Example of Data Analysis for San Jose

Students may notice:

- The y-axis measures the concentration of SARS-CoV-2.
- The x-axis indicates the date of the sample collection.
- The data was captured on June 7, 2024 and shows the past 30 days.
- The line moves steadily from low to high over the 30 day period.

Students may wonder:

- *What does high mean?*
- *How was the data collected?*



Part 2: Data over Time *(10 min)*

1. After about five minutes, have the teams look at the next graph showing the longer term data for their area.
   Example: All time data for San Jose (since Oct 2020).
2. As they analyze this data, encourage them to see if they notice any patterns.
   - *How has the data changed over time?*
   - *What are some of the highest and lowest points on the graphs?*
   - *Where do you see patterns or trends in the data?*
   - *What other questions do you have? What other information would you want?*
3. Have each team take notes and prepare to share one thing they noticed and one thing they wondered about their own cities' data.
   Example:
   - We noticed that the rates for COVID in our city went up every winter from September to January.
   - We wonder if this coincides with flu and other respiratory illnesses.

Note: Focus on the patterns you notice and the questions they raise, not proving the cause of those patterns.

Pattern Recognition

While students are analyzing graphs, encourage them to use pattern recognition to identify patterns and determine if there are sequences.

In addition to being a core skill in data science and computational thinking, pattern recognition can also be seen in sports and games.

See our **"Tech Tip: Computational Thinking,"** on The Tech Interactive website, to learn more.

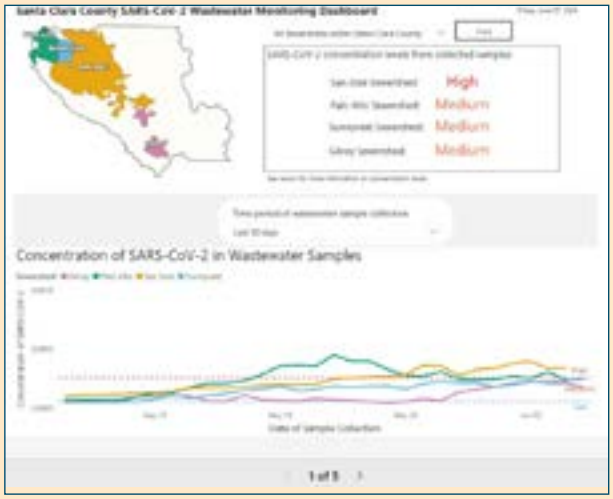
Part 3: Share out and Compare *(15 min)*

1. Next, have each team take turns sharing their city's data along with their observations and questions.
   - Make sure the other teams have access to view each area's data while teams are sharing.
   - *Tip*: If possible, share a new graph which plots all four areas together.
2. Have students compare the data for all of their cities.
   - *Where do you notice similarities in the data for all of the areas?*
   - *Where are the trends different in different cities?*
   - *What other issues might be related to this data?*
   - *What factors do you speculate might be affecting some of these patterns?*
   - *What questions do you have about policies and practices that might be different between the cities?*
   - *What public health concerns do you notice for the region based on the data?*
   - *What would this data look like in an ideal world?*

Example of Data Analysis Comparing San Jose, Palo Alto, Sunnyvale, and Gilroy

Students may notice:
- All four cities seem to start at a similar concentration.
- San Jose has the highest concentration at the end of the month.

Students may wonder:
- *What does medium mean?*
- *What are each city's policies regarding vaccination?*
- *How does the city inform residents of outbreaks?*



Addressing Assumptions

During comparison and sharing, have students reflect on how comparing areas might lead to assumptions. Point out that data is often only part of the story. As they evaluate the data, they will be looking to ask questions and find out more.

- As students speculate, remind them that the the datasets they are examining do not include the policies or events that may have led to the data.
  - Remind students they do not have enough information to prove the cause of the patterns they notice.
- Have students refer back to the data and facts in front of them.
  - When using prior knowledge, have them acknowledge this as well.
- Make space for students to ask questions so they feel like their voice and opinion matters.
  - Note issues as they arise and fold their concerns into the conversation and the data challenge.
- Encourage them to consider what additional data might help them get a better picture of the issue.
  - *How could they learn more about the public health policies that may have shaped this data?*

Taking Action Based on Data *(10 min)*

1. Now that students have had a chance to examine the type of data that can be collected from wastewater, they will take a look at how wastewater data can be used to take action.
2. Play the final video about the 2022 The Tech for Global Good laureate BioBot Analytics:
   - **"Biobot: The Impact,"** The Tech Interactive, YouTube *(2:20 min)*
3. Have students take notes on the Reflection Questions in their **Project Guide**:
   - *What problem is Biobot Analytics trying to address?*
   - *What data did they collect?*
   - *How did they use that data?*
4. Following the video, lead the class in a brief discussion about how data can inform the actions of individuals or a community.
   - *How did data help the communities Biobot Analytics worked with to create change?*
   - *What actions did you see cities and communities taking based on the data? How was data important to their solution?*
   - *How could individuals take action based on the data collected?*
   - *What actions have you seen your community take based on data?*

Design Sprint *(15 min)*

1. Next, each team will brainstorm their own ideas for responding to the data for their city and consider actions that could be taken to address the situation in their city.
2. Review the next step in the **design scenario:**

You and your team work for the public health department of your city. You want to ensure that your community is safe and healthy. As part of your duties, you monitor and analyze data about the wastewater within your city to detect viruses, high-risk substances, and other risks to community health.

- *First, you will examine the latest reports to look for trends and patterns in the data.*
- *Then you will make recommendations of actions that will prevent health threats from turning into major crises.*
  - *Make sure you consider what data you will base these decisions on.*
- *Once you have some ideas for action, you will present them to the city planners for your region. They will listen to your ideas and give you feedback.*

3. Provide each team with brainstorming materials (e.g., chart paper, sticky notes, etc.).
4. For this design sprint brainstorm, encourage them to include all ideas without judgment.
   - Their goal is to think of as many actions that their city could take as possible.
5. After seven minutes, have teams focus on narrowing in on two of their favorite ideas to share with the other cities.

Brainstorming Tech Tip

Remind teams to encourage anything and everything during brainstorming.

- Think of wild ideas.
- Go for quantity over quality.
- Be creative!

It may be useful for students to create a mindmap to visually break down some of the aspects of the problem first, and then add as many related actions as they can.

For strategies on leading a mindmap brainstorm and structuring a design sprint see our **Tech Tip: Brainstorming**

Share Ideas for Action *(15 min)*

1. Have the teams pair up to take turns sharing their favorite ideas for action for the final step in the challenge.

Now that you have some ideas for action, it is time to present them to the city planners for your region. They will listen to your ideas and give you feedback.

2. Share the process. (See page 3 in the **Project Guide**.)
   - Act as timekeeper for the class. After the first team has presented, teams should change roles and repeat the process.

	Presenters (Public Health Officials)	Audience (City Planners)
1 min	**Present their ideas.**	Silently listen. Take notes.
4 min	**Respond to questions.**	**Ask questions and give feedback.**
	Switch roles	

3. Possible **Sharing Questions** could include:
   - *What actions did your city decide to focus on?*
   - *What data did you base these decisions on?*
4. Encourage learners to focus on both strengths and next steps in their feedback. If using simple sentence frames, introduce them at this time. *Example*: "I like..." or "I wonder..."

Debrief *(10 min)*

1. After students share their solutions, bring the conversation back to the concepts and what they learned.
2. Lead a short debrief with some of these questions.
3. Possible **Debrief Questions** include:
   - *What did you discover about the different patterns that the teams identified?*
   - *What did you observe about how teams were planning to use data to affect change?*
   - *Are there any considerations you would need to make when collecting the data or making decisions, especially around consent and privacy?*
   - *How could this process be used to analyze other data?*
     - *What other information could cities check in our wastewater?*
   - *What systems and structures need to be in place to make this kind of work possible in a city?*
   - *How has your understanding of data in your own life changed after this activity?*

Extensions

This data lesson can be the starting point of a longer term project.

Developing Ideas

- Students choose one of their action ideas and develop it further.
  - *Example*: Creating a poster, designing a social media campaign, producing a video, writing a proposal.
- If possible, teams could try to implement their idea within their city:
  - Putting up the posters.
  - Sending the social media messages out.
  - Sending a letter to the city council.
- After implementing their solutions, students could observe and analyze the effects.
- Teams could present their results and lessons learned to the class or a group of community stakeholders and local public health officials.

Digging Deeper into Data

- If students are passionate about creating change in their own communities, use the **Data Challenge** to guide them in creating a plan for collecting and using data to address a problem.

Standards Connections

Next Generation Science Standards

Grades	Standard	Description
6-8	MS-ETS1-4.	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
9-12	HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Common Core State Standards: English Language Arts

Grades	Standard	Description
6-12	CCSS. ELALITERACY. SL.6-12.5	Using visual/digital presentations to support claims and add interest: Ex: (11-12) Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Vocabulary

- **Anonymous data:** Data that does not include identifiable information about individuals as a way of protecting privacy. Since it is not treated as personal data, user consent is not required.
- **Data:** Information that can be collected, analyzed, and used to inform decisions.
- **Data literacy:** The ability to interpret, understand, and utilize data. At the heart of data literacy is the ability to identify patterns and discrepancies and draw conclusions.
- **Data science:** A field that focuses on collecting, processing, analyzing, and utilizing data to understand and solve problems, with both humans and automated computers performing the analysis.
- **Public health:** The science of protecting and improving the health of people and their communities.
- **Qualitative data:** Is descriptive. It can be observed or collected in a survey or interview. *Example*: I love pepperoni and mushroom pizza. No one else in my family likes mushrooms.
- **Quantitative data:** Can be measured numerically. Example: I ate pizza seven times last month. My family ordered 21 pizzas last month.
- **Wastewater:** Water that has been used in the home, in a business, or as part of an industrial process.

Wastewater Data Challenge
Project Guide

Names: **Date:**

The Tech for Global Good is an initiative to create the next generation of innovators ready to tackle the toughest challenges facing our planet. From 2023-24, the program honored BioBot Analytics for their use of technology and data to significantly advance health equity and improve lives.

BioBot Analytics monitors wastewater to detect viruses, high-risk substances, and other risks to community health. Their technology provides early warnings, enabling communities to take action and prevent health threats from turning into major crises.

As you watch the videos, consider:

What problems are they trying to address?	
What data did they collect?	
How did they use that data?	
Other notes	

Wastewater Data Challenge Scenario:

You and your team work for the public health department of your city. You want to ensure that your community is safe and healthy. As part of your duties, you monitor and analyze data about the wastewater within your city to detect viruses, high-risk substances, and other risks to community health.

- First, you will examine the latest reports to look for trends and patterns in the data.
- Then you will make recommendations of actions that will prevent health threats from turning into major crises.
  - Make sure you consider what data you will base these decisions on.
- Once you have some ideas for action, you will present them to the city planners for your region. They will listen to your ideas and give you feedback.

Analyze the Data

As you examine the data sets about your city, use this space to take notes.

What do you notice?	*What do you wonder?*

Take notes on some of the things you notice and questions you have as you compare data across the different areas.

Design Sprint

Brainstorm some of the actions that could prevent health threats from turning into major crises in your city.

- **Consider the data you will base these decisions on.**

Share Ideas

	Presenters (Public Health Officials)	Audience (City Planners)
1 min	**Present their ideas.**	Silently listen. Take notes.
4 min	**Respond to questions.**	**Ask questions and give feedback.**
	Switch roles.	

Feedback from the other team	Notes for the other team