**Lesson One and Virus Zero Hour**

**Problem statement:** At the start of the 21st century humanity has been brought to the brink. Environmental natural disasters- the symptom of global warming- have created a skeleton of what the world used to be. The last deadly disaster created something even worse than anticipated, a deadly zombie outbreak.

Washington is in a state of emergency. At the epicenter, an unknown virus has spread from Seattle and is quickly moving over land and across the Puget Sound. There are mixed reports about those infected, but no clear cut source for the disease. We are looking for a way to cure and/or eradicate the source of the disease.

Once infected those carriers are able to spread their sickness to other people. We are unsure how the virus is spread, but it appears that air or close personal contact may play a role in becoming infected.

As a result of this disease, physical structures and buildings have been destroyed during the looting and riots that occured after the outbreak. Scattered buildings remain standing but power, water, and sewer remain scarce. There is enough food storage to last for now.

Societal decay is a major problem as the pathogen spreads. How well can your team plan for and react to the collapse. You must work as a team to decide what you will do to deliver a cure. Think about the strategies that will make you successful in avoiding infection and curing those that are infected.

*Luckily, the virus strain is specific to the human race only, leaving animals and plants free.*

*Students are free to ask who the virus affects, something the teacher will disclose to students if not asked by the end of lesson 1.*

(Teacher only)

Clarifying Information : Zombies look for a highly populated area to “POP”. This is a fungal infection, students will learn about this from research (<https://askabiologist.asu.edu/zombie-ants><https://www.sciencedaily.com/releases/2014/08/140825142124.htm><https://www.livescience.com/47751-zombie-fungus-picky-about-ant-brains.html>). At first they may think it is bloodborne due to the fact that our zombies “explode”. But, through their research and further clues they will determine that it is an airborne fungus. Possible cure would be a competing fungus (<https://news.nationalgeographic.com/news/2012/05/120504-zombie-ant-fungus-science-environment-rainforest/> )

It is possible to contain the fungus infected person by containing the head. You can determine they are infected by their bulging eyes, twitching ear lobes and snotty dribble that appears to be a yellowish-greenish grainy mushroom.

**Learning objectives:** Students will be able to (SWBAT) identify theorigin of the pathogen and begin to make sense of the factors that may contribute to the spread of the virus/fungus.

SWBATexplain the spread of the mock disease in terms of “how long” until everyone is infected.

SWBAT describe model of our classroom in terms of the city, state, country, world in considering the spread of a large scale disease.

**Lesson standards (NGSS, CCSS, CTE):**

**MS-LS2-2:** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

**MS-LS3-1:** Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organisms.

**6.RP.3c:** Find percent of a quantity.

**6.SP.2:** Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall.

**Soft skills:**

* Students will work in teams to analyze and describe the spread of the mock disease.
* Students will use critical thinking and problem solving to explain their thinking.

**Locally and/or personally relevant for students:**

Geographically relevant, showing the simulation video of how viruses can spread through the world, starting in a local area as told in the PBL statement. Take a look at local scientists and have them talk. CDC high level personnel that are women or underrepresented minorities.

<https://www.cdc.gov/women/stem/>

**Connections to career and educational pathways:**

CDC career options. Talk about the flu and how disease spreads. Also, how data is mapped, discussed, and presented to solve such problems. Consider the simulation video. Where does such data come from? Government & social services jobs, etc.

**Materials:** Computer (teacher) and projecting device, student notebooks/note taking materials, map(s) or access to google earth/maps, pencils/pens

**Lesson preparation:** Figure out the level of authenticity of your hook lesson (How deep will you go? Are you planning on talking about all the issues with societal decay or focusing on just the surface level: No Internet, No School, No mass transit, etc.). Are you dressing up for lesson one? (teacher dressed as a zombie). Red/Orange/Blue stamps or other identifying marks, or colors for students as they enter.

**Time required:** One 75 minute lesson, or two 45 minute blocks.

**Grouping of students for instruction:**

Groups are encouraged, 4-5 students per group ideal.

**What is the instruction? Consider the PBL Procedure that is being addressed here:**

**Understanding the Problem**

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| --- | --- |
| **Teacher** | **Student** |
| Teacher will …   * Mark each students hand with a color as they enter the room. Teacher will not say anything about why/what the colors mean yet. Suggested colors and amounts are noted below.   + Infected sick with symptoms - red (~20%)   + Infected carrier - orange (~15%)   + Dead in 5 minutes - black (1-2 students)   + Not sick or carrier - blue (~65%) | Students will…   * Get marked and find their seats. |
| Teacher will ...   * [Simulation video here](https://www.bing.com/videos/search?q=virus+spread+simulator&&view=detail&mid=DFAA88C8E986E633DEFADFAA88C8E986E633DEFA&FORM=VRDGAR). This video is just a visual simulation without explanation.   + Teacher needs to explain how one person coming into contact other people causes the virus to move to other hosts. As other become infected the population of hosts grows at an increasing rate (exponential growth can be mentioned, but is not assessed until 8th grade). * Introducing the problem statement and launch using the video. * Shows the simulation and spread of an infectious disease | Students will…   * Thinking and recording about their noticing and wonderings. *(Recording in their science notebook/journal they will use throughout the unit)*   + *Some examples:*     - *What type of virus caused this pattern?*     - *Why is it spreading so fast?*     - *What makes a virus spread?*     - *I noticed that once it left the city it spread really fast.*     - *I noticed that people died really fast.* * ***This is the first assessment moment. Students will be generating a hypothesis of the reason for the spread (touch, air, fluid, etc.)*** |
| Teacher will …   * Facilitate discussion about the outbreak simulation and focusing in students around the idea of a pandemic. *Possibly defining pandemic: (of a disease) prevalent over a whole country or the world.*   + What do you know about infectious diseases and how they spread?   + What is the difference between a pandemic and an epidemic?   + What do people who are infected look like? *(They can look just like everyone else OR they can look obviously sick)*   + Can it be not obvious? *(Yes)* Can they be infected and not look sick? *(Yes)* * Note: If students or unable to explain the difference between epidemic and pandemic (BK: <https://www.webmd.com/cold-and-flu/what-are-epidemics-pandemics-outbreaks#1> <http://www.who.int/emergencies/diseases/en/>) * Teacher should make sure students understand what a pandemic is and an epidemic is before moving on. | Students will …   * Discuss about their noticings and wonderings from the video.   + What do they know about pandemics?   + What do they know about epidemics? * Take notes and discuss epidemics and pandemics that have occurred in their own lives and in history. (Teacher may introduce the Black Plague, Ebola, Ecoli, Flu data from that year <https://www.cdc.gov/flu/weekly/usmap.htm>) |
| * Introduce patient zero. *(Teacher note: Patient Zero refers to the first known person to be a carrier of a disease).*    + Teacher discretion on how to describe the person. Consider: where was patient zero before the outbreak, what is her/his job, are they married/kids, etc.) - *Suggestions include travel to South America (where the real life zombie ants are found), biologist, single, having traveled or been in an area with a lot of people such an arena or concert venue.* * Direct students to generate 3-4 questions. They will ask only one per group so they must prioritize. * Sharing about the spread of disease within the classroom (introduction about the hand marks and what they mean)   + If you are direct contact (sitting right next to) an red, you are now red. If you were red you are now black.   + If you are sitting in a group with someone orange, you are now orange if you were blue, you remain orange if you are orange.   + Anyone sitting at a group with black mark turns red (unless you are already black). * Explain that each seat change represents 1 day, the incubation period for the virus. It takes another day for symptoms to manifest. * Teacher will randomly draw for new student seating arrangements and explain that the same rules apply regarding spread. *(Teacher should remind the students that while they know who is infected in this activity in the real world it may be unclear that carriers of disease are one of the main causes of epidemics/pandemics)* * Repeat a third different seating plan. *(Likely at this point all students will be infected)* | * Generate 3-4 questions they have about the situation of our patient zero. * Share only one question with the class and cross out repeats. * After recording their initial results from the dots/stamps they will move to new teacher directed seats. * Students will record new results in their journals. * After final move they will write about the spread through the class and what it means on a larger scale.   + Prompt students to consider that if one person is infected then those around them in a concert/sporting event/or other large gathering may also become infected.   + Give the prompt of if each person has a 50% of infection how many interactions would it take to infect 100 people starting with just one person. *(Consider having students actually flip a coin or some other way of randomizing).* |
| Teachers will …   * Create a whole class graph of growth/spread. *(rate will be different given the configuration of students and where the original infected students are located).* * Lead a discussion of the differences and patterns between the different seating arrangements. * The following patterns may emerge from class data: * Below are a few examples of questions a teacher may ask at the end of the lesson:   + How did the rate of infection change as the disease spread?   + How would the distributions change if the initial infection rates were different?   + What would be a way for people to avoid a pandemic level for a virus?   + What would be the difference if the incubation period for the virus was longer/shorter? | Students will …   * Record in their own science journals a copy of the whole class graph. * Compare and contrast the data from the seating arrangements.   + Have students think about what might have changed the distribution. *(Some answers might include: smaller groups, no one sitting next to each other, being able to avoid obviously sick people.)* * *Teacher note: This data will be considered the infection rate/data for lesson 3. Make sure students keep data for comparison.* |

**Assessment:**

Formative

* Observational
* Exit tickets

**References/Resources:**

**Lesson Two and Separating Healthy Cells**

**Problem statement:** Washington is in a state of emergency. At the epicenter, an unknown virus has spread from Seattle and is quickly moving over land and across the Puget Sound. There are mixed reports about those infected, but no clear cut source for the disease. We are looking for a way to cure and/or eradicate the source of the disease.

Societal decay is a major problem as the pathogen spreads. How well can your team plan for and react to the collapse. You must work as a team to decide what you will do to deliver a cure. Think about the strategies that will make you successful in avoiding infection and curing those that are infected.

**Learning objectives:** Students Will Be Able To (SWBAT) use the engineering design process to develop a tool to successfully separate healthy and infected cells (Skittles/M&Ms) from each other given a set of constraints.

SWBAT explain the distribution of success data from the engineering design challenge in terms of real world application (being able to work toward a cure by finding disease resistant/immune cells).

SWBAT use a box-and-whisker plot (or other graphical representation) to compare and contrast their change in efficacy over time. *(Data uses all class groups success for Trial 1, Trial 2 and Trial 3 respectively).*

**Lesson standards (NGSS, CCSS, CTE):**

**MS-LS1-2** (Structure and Function): Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships between its parts.

**MS-LS2-2:** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

**MS-LS3-1:** Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organisms.

**6.SP.2:** Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall.

**Soft skills:**

* Students will work in teams to analyze and describe the spread of the mock disease.
* Students will use critical thinking and problem solving to explain their thinking.

**Locally and/or personally relevant for students:**

Geographically relevant, showing the simulation video of how viruses can spread through the world, starting in a local area as told in the PBL statement. Take a look at local scientists and have them talk. CDC high level personnel that are women or underrepresented minorities.

<https://www.cdc.gov/women/stem/>

**Connections to career and educational pathways:**

CDC career options. Talk about the flu and how disease spreads. Also, how data is mapped, discussed, and presented to solve such problems. Consider the simulation video. Where does such data come from? Government & social services jobs, etc.

**Materials:** Computer (teacher) and projecting device, student notebooks/note taking materials, pencils/pens, M&Ms or Skittles (colored candy appropriate to the dietary restrictions of the classroom), bowls (1 per group to house candy to start), frosting (or other adhesive food), chopsticks (one set per group), note cards, graph paper, loose leaf paper, tape, other student generated materials (consider opening up to students items around the room that they may want to use).

**Lesson preparation:** Figure out the level of authenticity of your lesson. Do you want to show DNA/Virus information to provide context for the lesson (<https://ed.ted.com/lessons/cell-vs-virus-a-battle-for-health-shannon-stiles>). Students will be separating the candies into different groups. They need to generate a tool for “safe” and effective separation of the cells that are infected and healthy. Consider allergies and food sensitivities for the class when providing candy. If you want to provide candy for students to eat at the end of the lesson be sure to have extra that is clean. **Remind students NOT to eat the candy they are using for the activity.**

**Time required:** Two 60 minute lesson, or three 40 minute lessons

**Grouping of students for instruction:**

Groups are necessary, 3-4 students per group ideal.

**What is the instruction? Consider the PBL Procedure that is being addressed here:**

Teacher will provide the constraints of separating out healthy and unhealthy cells in the mock laboratory. They must remain 15+ inches away from the cells (candy) during their lab. Students will need to move the candies into three groups: infected cells (brown, green, purple), healthy cells (yellow and orange), fighter blood cells (red). After separation they will need to use frosting or other adhesive to connect healthy cells with fighter blood cells. One pair per cell combination (yellow+red or orange+red).

**Understanding the Problem**

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| **Teacher** | **Student** |
| Teacher will ...   * Address the candy in the room *(Some students may be extremely excited or interested in the candy. It is important to address this or the students may be distracted by the inclusion of candy in the lesson)* * Discuss the task at hand. Reintroduce the problem statement and launch the challenge. (see above). | Students will… |
| * Explain that the man/woman from the launch (patient zero) has been at the hospital for two days now. *(Remind students that the incubation period of the virus is one day and another day for symptoms to manifest).* * On day two; the nurse and doctor treating the man are starting to show symptoms similar to patient zero. * CDC called in to investigate.   + *(Teacher Note: Consider explaining at this point about quarantine. Explain that the transmission of the virus is still unknown, but narrowed down to close proximity and that safety precaution would be used to avoid any potential contact with disease carrying materials, fluids, or persons)* | * Ask questions * Take notes about the “facts” of the story.   + Students can choose their preferred method to record their thoughts. *(Teacher note: graphic organizer is encouraged, but not necessary. Use best practice in your classroom to support your population).* |
| * [Simulation video of viral infection here](https://ed.ted.com/lessons/cell-vs-virus-a-battle-for-health-shannon-stiles) | * Thinking and recording about their noticing and wonderings about viral infection. *(Recording in their science notebook/journal they will use throughout the unit)* |
| * Video debrief   + What are their takeaways?   + Talk about content specific vocabulary (mitochondria, cell walls, antibodies, etc.) Give sentence stem: Antibodies \_\_\_\_\_\_\_\_\_\_ for the body. | * Write 1-2 takeaways from the video.   + Isabelle’s journal example * Complete the mini-assessment (Sentence stem). |
| * Talk up the reason for skittles not to contaminate the “lab environment”. * Explain lab environment   + Show Monster’s Inc. clip of contamination. <https://www.youtube.com/watch?v=NSAXkp9cqbk>   + Show real life CDC contamination suit picture.   + <http://www.lamsys.com/gallery/exhibitions/30032017> * What questions do you have about this? | * Write 1-2 questions (curiosity moment). * Share out their questions one per group. |
| * Introduce/Reintroduce Engineering Design protocol   + Engineering Design Protocol graphic <http://clickmakana.com/wp-content/uploads/2016/04/design-process.png> | * Fill out a graphic organizer as a group (one per group) explaining what they know/remember about the engineering design process. |
| * Allow for priority questions (one per group) | * Generate 2-3 questions. They will ask one per group. Cross out repeat questions. |
| * Facilitate discussion about the challenge of separation of healthy cells from infected cells. * Engineering planning facilitation   + What kinds of safety protocols might be needed to ensure 15+ inches away from the cells.   + What type of tool do they need to move the cells?     - Allows for free movement of the skittles. | * Work in teams to plan and create tool(s) to successfully separate the cells and adhere the healthy cells together.   + Develop a materials list   + Draw a model of their “tool” and check that it meets the requirements.     - Minimum of 15” away |
| Teacher will …   * ***Optional***   Provide Pugh Chart criteria   * + - (++ Much better, + Better, S Same or Zero, - Worse, -- Much Worse)     - Uses least amount of materials     - Uses least amount of money (example of costs: $100 for chopstick set, $20 notecards, $10 loose leaf paper)     - Keeps lab techs safe (15+ inches)     - Is possible to be used by only one lab tech * Monitor student collaboration. Use Collaboration Rubric for PBL for baseline measurement of students.   **Break here for 2nd day if doing over two days** | Students will …   * Teams will create the tools trying to balance cost against benefits - use Pugh Chart (competition aspect and could be linked to other aspects of the PBL such as balancing out cost of cure and delivery system within a finite budget). * Students self assess after activity using Collaboration Rubric for PBL for baseline measurement. |
| Teachers will …   * Provide candy in bowls to groups (presort candy to have at least 10 red candies and 10 orange plus 10+ brown/green/purple candies).   + *(Teacher Note: Take yellow out as the “antibody” cells. Choose one color to be the “helper blood cells” (suggested red).* * Remind students about the constraints and expectation.   + Bowl remains flat (no tipping) *Teacher note: tape the bowl down to make it ‘easier’ on students.*   + 15+ inches away from the cells   + Cells remain within the bounds of the “sterile” area and the area may not be moved or altered (no making it bigger). * Time students for 1 minute. * Time for 2 minutes. * Reset candies * Time students for 1 minute * Time students for 2 minutes * Reset candies * Time students for 1 minute. * Lead students in a discussion comparing the data between trials.   + Facilitate share out of data.   + Make a class model using Trial 1 of a box and whisker (or other graphical representation) | Students will …   * Separate candies on graph/grid paper keeping at least 3 squares between healthy and unhealthy cells. * Collect data on the number of cells successfully separated during the first time period. * Revise original tool to improve the successful separation. * Collect data on the number of cells successfully separated during the second time period. * Revise new tool to improve the successful separation. * Collect data on the number of cells successfully separated during the third time period. * Within each group one student completes one box and whisker on a shared paper. They compare the data within their group and prepare to share with the class. * Make a box and whisker (or other graphical representation) of Trials 1-3 |
| * Engineering planning facilitation   + What kinds of safety protocols might be needed to ensure 15+ inches away from the cells.   + What type of tool might they need to adhere the cells together? |  |
| Teachers will …   * Provide adhesive materials after students complete separation of cells. Gives new tool materials as needed. * Time students for 1 minute. * Time for 2 minutes. * Reset candies * Time students for 1 minute * Time students for 2 minutes * Reset candies * Time students for 1 minute. * Time for 2 minutes. * Reset candies * Time students for 1 minute * Lead students in a discussion comparing the data between trials. | Students will …   * Combine healthy cells and fighter blood cells using adhesive materials and newly developed tool. * Collect data on the number of cells successfully combined during the first time period. * Revise original tool to improve the successful separation. * Collect data on the number of cells successfully combined during the second time period. * Revise new tool to improve the successful separation. * Collect data on the number of cells successfully combined during the third time period. * Revise new tool to improve the successful separation. * Collect data on the number of cells successfully combined during the fourth time period. * Compare the data using a quad box-and-whisker plot or other data comparison tool. *Teacher note: This data will be used/referred to in lesson 3 as the ‘cure data’.* |
| Teacher will …   * Provide exit slip criteria * Explain next lesson (proportion and growth/scale) connection to activity. | Students will …   * Write on an exit slip about their experiences collaborating. Reflect using Collaborative Rubric. (Link to rubric in resources) * Write about process their group went through to create their tool and ***Optional***explain the reason/cost benefit that you used for Pugh Chart [Link](http://thequalityportal.com/pugh.xls) |

**Assessment:**

Collaboration Quiz (Rubric)

Formative

* Observational
* Exit tickets

**References/Resources:**

Collaboration rubric

<http://www.bie.org/object/document/6_12_collaboration_rubric_ccss_aligned>

Pugh Chart information

<http://www.weighteddecision.com/>

**Lesson Three and Proportions (Grouping of Infected/Non-Infected)**

**Problem statement:** Washington is in a state of emergency. At the epicenter, an unknown virus has spread from Seattle and is quickly moving over land and across the Puget Sound. There are mixed reports about those infected, but no clear cut source for the disease. We are looking for a way to cure and/or eradicate the source of the disease.

Societal decay is a major problem as the pathogen spreads. How well can your team plan for and react to the collapse. You must work as a team to decide what you will do to deliver a cure. Think about the strategies that will make you successful in avoiding infection and curing those that are infected.

**Learning objectives:** Students Will Be Able To (SWBAT) use the sample data from lesson one to predict the growth and scale for a larger population (city, state, etc.).

SWBAT use data collected lesson two to predict success for cure development and delivery within the given constraints.

**Lesson standards (NGSS, CCSS, CTE):**

**MS-LS1-2** (Developing and Using Models): Develop and use a model to describe a phenomena.

**6.RP.3** .Use ratio and rate reasoning to solve real-world and mathematical problems. Find a percent of a quantity.

**7.SP.1** Understand that statistics can be used to gain information about a population by examining a sample of the population

**Soft skill** Students will work in teams to analyze and describe the spread of the mock disease.

* Students will use critical thinking and problem solving to explain their thinking.

**Locally and/or personally relevant for students:**

Geographically relevant, showing the simulation video of how viruses can spread through the world, starting in a local area as told in the PBL statement. Take a look at local scientists and have them talk. CDC high level personnel that are women or underrepresented minorities.

<https://www.cdc.gov/women/stem/>

**Connections to career and educational pathways:**

CDC career options. Talk about the flu and how disease spreads. Also, how data is mapped, discussed, and presented to solve such problems. Consider the simulation video. Where does such data come from? Government & social services jobs, etc.

***Teacher Suggestion: Link to CDC Skype Classroom***

**Materials:** Computer (teacher) and projecting device, student notebooks/note taking materials, pencils/pens, flair pens (or other non-bleeding pens), graph paper (if notebook is non-grid)

**Lesson preparation:** Figure out the level of authenticity of your lesson. Consider bringing in actual disease spread information from CDC site.

[**https://www.cdc.gov/nchs/fastats/default.htm**](https://www.cdc.gov/nchs/fastats/default.htm)

[**https://www.cdc.gov/flu/index.htm**](https://www.cdc.gov/flu/index.htm)

[**https://www.cdc.gov/flu/weekly/usmap.htm**](https://www.cdc.gov/flu/weekly/usmap.htm)

**Time required:** One 60 minute lesson, or two 40 minute lessons

**Grouping of students for instruction:**

Groups are necessary, 3-4 students per group ideal.

**What is the instruction? Consider the PBL Procedure that is being addressed here:**

The teacher will draw upon data collected in lesson one and lesson two. They will have students apply their small sample size to larger population simulations and make predictions about the spread and cure rate.

**Understanding the Problem**

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| **Teacher** | **Student** |
| Teacher will ...   * Reintroduce the problem statement and launch the challenge. (see above) * Prompt students with the questions to get them thinking about precautionary measures used to avoid infection. | Students will…   * Record their thoughts and questions about the spread of a disease and how it impacts their lives.   + Prompt: *“How might the spread of a disease impact your life? What precautions do you take to keep yourself healthy?”* |
| Teacher will …   * Have students share their collected data from lessons one and two. * Ask students to take their data and scale them proportionally to city (Everett 109,043 in 2016), state (Washington 7,405,743 in 2017) and country (US 325,719,178 in 2018) data. ***Students can use resources at bottom to do research or teacher can provide the population data.*** | Students will…   * Use the virus spread data to predict the number of individuals infected on a larger scale.   + Infection percent x population = total number infected (at each population level). * Use the ‘cure data’ to predict the number of individuals “saved” through successful “vaccination” during the lesson two.   + Successful percent cured x population infected = total number of infected cured (at each population level). |
| Teacher will …   * Prompt students to consider the best delivery method for spreading the cure (prep for lesson 4). * *Teacher note: Students should be told to consider the effectiveness (percent) of the cure when determining if a focused (more concentrated cure) is necessary. The more effective the less concentrated the vaccine delivery needed.* | Students will…   * Use the data calculated for the “cure” to determine the best method for spreading their vaccine. * Begin to plan for the final lesson (engineering design process) cure delivery. |

**Assessment:**

Rate/Growth/Proportion quiz with example populations and disease spread stats

Formative

* Observational
* Exit tickets

**References/Resources:**

<https://www.cdc.gov/>

<https://data.cdc.gov/browse?category=NCHS>

<https://www.census.gov/>

Population for City of Everett, WA:

<https://www.census.gov/quickfacts/fact/table/everettcitywashington/PST045217>

Population of WA State:

<https://www.census.gov/quickfacts/fact/table/WA/AFN120212>

**Quick Quiz**

1. **With a rate of 1 out of every 3 people being infected every day, about how long would it take a population of 100 people to all be infected (use normal rounding rules)?**

***Example Answer: About 10 or 11 days***

1. **If I have a cure that work 70% of the time and there are 58 people vaccinated, about how many people will be saved by the cure?**

***Example Answer: About 40 or 41 people***

1. **If you have an infected sample population of 25 out of 30 people, about how many people are infected in a population of 42,000?**

***Example Answer: 35,000 people infected***

**Lesson Four Engineering Design (Cure Delivery)**

**Problem statement:** Washington is in a state of emergency. At the epicenter, an unknown virus has spread from Seattle and is quickly moving over land and across the Puget Sound. There are mixed reports about those infected, but no clear cut source for the disease. We are looking for a way to cure and/or eradicate the source of the disease.

Societal decay is a major problem as the pathogen spreads. How well can your team plan for and react to the collapse. You must work as a team to decide what you will do to deliver a cure. Think about the strategies that will make you successful in avoiding infection and curing those that are infected.

**Learning objectives:** Students Will Be Able To (SWBAT) use the calculations from lesson 3 to make a determination for the best method for delivery of the cure payload.

SWBAT use the engineering design process to develop, test and refine a tool to administer a cure without risk of infection.

**Lesson standards (NGSS, CCSS, CTE):**

**MS-ETS1-1: (**DCI and SEP only) Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution.

**MS-ETS1-2:** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

**Soft skill** Students will work in teams to analyze and describe the spread of the mock disease.

* Students will use critical thinking and problem solving to explain their thinking.

**Locally and/or personally relevant for students:**

Geographically relevant, showing the simulation video of how viruses can spread through the world, starting in a local area as told in the PBL statement. Take a look at local scientists and have them talk. CDC high level personnel that are women or underrepresented minorities.

<https://www.cdc.gov/women/stem/>

**Connections to career and educational pathways:**

CDC career options. Talk about the flu and how disease spreads. Also, how data is mapped, discussed, and presented to solve such problems. Consider the simulation video. Where does such data come from? Government & social services jobs, etc.

**Materials:** Computer (teacher) and projecting device, student notebooks/note taking materials, pencils/pens, flair pens (or other non-bleeding pens), graph paper (if notebook is non-grid), popsicle sticks, tape, straws, scissors, glue, other student generated tools/materials, “cure” from lesson 2, extra frosting.

**Lesson preparation:** Figure out the level of authenticity of your lesson. Consider showing actual disease prevention tools (masks, needles, medicines, etc.).

**Time required:** One 60 minute lesson, or two 40 minute lessons

**Grouping of students for instruction:**

Groups are necessary, 3-4 students per group ideal.

**What is the instruction? Consider the PBL Procedure that is being addressed here:**

The teacher will draw upon data calculated in lesson three. They will also draw upon the review of the engineering design process from lesson two to refresh students’ memories on how to develop tools using the process.

**Understanding the Problem**

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| --- | --- |
| **Teacher** | **Student** |
| Teacher will ...   * Reintroduce the problem statement and launch the challenge. (see above) * Prompt students with the idea that in order to have a successful return from a global pandemic we need to be able to deliver the cure we’ve created to those infected and vaccinate those not yet infected against future infection. | Students will…   * Record their thoughts and questions about how we currently deal with diseases in their experience and what ways we administer medicine to cure and prevent illness.   + Prompt: *“How does disease and illness affect you personally? What precautions do you take to keep yourself from getting diseases? How do others also avoid major illness?”* |
| Teacher will …   * Have students share their thoughts on common delivery systems for vaccines (if none are presented or the ones presented include delivery from a distance remind students that proximity is dangerous with this illness). * Set parameters for successful delivery of a “cure.”   + A minimum of 2 feet from the victim   + Must “hit” the victim within a small area.   + Must remain in contact with the victim’s “skin” for a minimum of 10 seconds.   + Must use the “cure” developed in lesson two. * *(For the purpose of the tests students will be trying to get their delivery tool to attach to a piece of paper with a 2 inch by 2 inch square in the center of it. The paper will be on a slope.)* | Students will…   * Use peer ideas to generate a possible tool that can successfully deliver a “cure” without risk of infection. * Draw/design a tool to deliver the cure within the constraints.   + Include materials needed   + Dimensions of the tool   + Way to manipulate/use the tool * Build the tool * Test the tool * Repeat the engineering design process at least three times   *Note: Students should refine their drawing/schematic before redesigning their tool. They should also be sure to document any modifications they make during the testing of their tool (if any).* |
| Teacher will …   * Have the students calculate their final success rate using the number of cell binding from lesson 2 and 3’s calculations and their percent success with their tool in this lesson (lesson 4). | Students will…   * Find their final percent cured with the data from lesson 3 and the success percent of their tool.   + *Teacher note: Students will be calculating a compounded percent in this lesson. For example if the cure is 80% effective and they are successful 50% of the time delivering it then they have a 40% cure rate.*   + *To be considered successful the “cure” must remain intact. (i.e. The candy/frosting can’t fall apart on impact.)* |
| Teacher will …   * Prompt students to consider what made their tool successful or not. | Students will…   * Write a reflection about the engineering design process.   + How many modifications did you make?   + What was the most successful part of the process in your group?   + Why did some ideas not get tried? OR If all ideas were tried, why was it possible for all ideas to be tested in your group?   + What did you learn about the requirements for a tool to be accurate at a distance?   + What did you learn about the materials necessary to meet the contact requirements? |

**Assessment:**

* Observational
* Exit tickets

**References/Resources:**

**Summative Assessment**

**Question 1:**

In a sample population of 50 people, 32 of them are sick with an infectious disease. How many people in the total population of 28,000 would you expect to be infected?

*Example Answer: 17,920 will be infected*

**Question 2:**

You are developing a solution to the problem of delivering a cure to people who are highly contagious. After you try a method out and are unsuccessful what part of the engineering design process would you move on to and why?

*Example Answer: If the method we tried was unsuccessful then we would evaluate using the plan and/or improve step in the engineering design process. We would use the plan step to make a plan to address the part(s) of the tool that failed. We would use the improve step to add or subtract parts to the tool to improve the performance of the tool.*

**Question 3:**

If the percent accuracy of a cure delivery method is 85% and the rate of success for a vaccine is 75%, what is the expected percent of people saved by this combination of cure and delivery?

*Example Answer: About 64% OR 63.75%*

**Question 4:**

Describe the skills necessary to work successfully in a group to develop a tool. Why are those skills important? Include at least two examples from your work in this unit.

*Example Answer: The 21st skills necessary to work in a group successfully are communication, collaboration and citizenship. The reason communication is important is because if we did not talk well as a group then it would have been really hard to share ideas and come to an agreement on what we should do. The reason that collaboration is important is if we didn’t work together then everyone in our group would be doing different things. The first round we all tried to make a tool and so we weren’t very successful at first. The reason that citizenship is important is because if we aren’t good citizens then people might get angry or hurt by each other’s comments.*