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| **TEAM Lesson Plan Template** |
| Teacher: Dr. James Smart |
| Subject/Grade: Epidemiology / Grade 6 (or 7) |
| Lesson Title: Epidemiology 1 hour  |
| **STANDARDS** | **Identify what you intend to teach.** State, Common Core, ACT College Readiness Standards and/or State Competencies; Enduring Understandings and Essential Questions. |
| Caution: This activity has students use sodium hydroxide. Wear goggles and gloves. **6.LS2.1** Evaluate and communicate the impact of environmental variables on population size.**6.LS2.2** Determine the impact of competitive, symbiotic, and predatory interactions in an ecosystem.**7.ETS2.1** Examine a problem from the medical field pertaining to biomaterials and design a solution taking into consideration the criteria, constraints, and relevant scientific principles of the problem that may limit possible solutions.Crosscutting Concepts: Cause and effect relationships that can be explained through a mechanism, Stability and change of systemsSEPs: Planning and carrying out controlled investigations; Constructing explanations and designing solutions to explain phenomena or solve problems. Note the connection to Tennessee Social Studies Standard 7.36 Describe the economic and social effects of the spread of the Black Death (i.e., Bubonic Plague) from Central Asia to China, the Middle East, and Europe, and its impact on the global population.  |
| **OBJECTIVE(s)/Sub-Objectives** | **Connect prior learning to new learning.** Clear, Specific, Observable, Demanding, High Quality, Measurable, Aligned to Standard(s), and Integrated with other subjects, build on prior student knowledgeStudent-Friendly (I Can Statement) |
| I can model the spread of a contagious disease in a population I can use data about disease spread to determine patient zero in a populationI can calculate the rate of spread of a disease (R0 value) |
| **MATERIALS AND RESOURCES**  | **Content-related:** Clearly supports lesson objective(s); rigorous & relevant; Incorporates multimedia & resources beyond the textbook.  |
| **Resources**This activity requires that students move around. Each student will need a “home station” such as a desk, but students also need to move around and interact in pairs multiple times. Plan for this movement. Ensure that students stay on the same step of the experiment as everyone else. **Materials** Whiteboard, markers, and eraser.A music source (optional). Epidemiology Notes (attached). 3oz paper (Dixie®) cups, a total of 5 per student. If there are an odd number of students, use 5 more for the teacher to ensure that there is an even number of participants. There also need to be at least 16 participants. Four cups per student will begin empty and will be handed to the students. The teacher will prepare one cup per student as described in the instructional procedures below. Approximately 1 oz sodium hydroxide (NaOH) 1 molar solutionPhenolphthalein in a dropper bottleSharpie® markers, about 1 four every 4 or 5 students. For each student: Worksheet, Dropper pipette, pen or pencil, pair of gloves, pair of goggles**Routine for distributing materials:** Before the activity, prepare an even number (one per student, + 1 for the teacher if the number of students is odd) of cups. Number these cups 1, 2, 3, . . . . Fill all but one cup ¼ full with water. Paying attention to which it is, fill one cup ¼ full with 1M NaOH solution. In a different location, lay a pipette, a pair of goggles, a pair of gloves, and four cups on a worksheet for each student. They should pass a Sharpie® down a row of students for each one to use in turn. After labeling their cups and pipettes, the students should put on their gloves and goggles. After donning the safety equipment, they should move to get a cup with liquid.  |
| **ACCOMMODATIONS/ADAPTATIONS** | **Learning styles and interests.** Anticipate learning difficulties, regularly incorporate student interests & cultural heritage; differentiate instructional methods. |
| **Modifications/Plans for Diverse Learners** **Differentiation****\_\_x\_\_ Product** R0 values can be averaged by hand or collected in a spreadsheet to calculate the average value. **\_\_x\_\_ Content** If a student has mobility issues, let that student remain stationary while other students move to him or her for mixing encounters.  **\_\_x\_\_ Process** 1)Some students may need help choosing the appropriate column and reading the cell entries in the second table on the worksheet. It may be appropriate to x-out the columns they are not to use, and it may be appropriate to help them read their partner’s chart to get the correct value of magenta or clear. 2) The teacher can collect R0 values and average them or the teacher can designate a student to do this. **Accommodations*****To be created for particular students*** |

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| **MOTIVATING STUDENTS/ANTICIPATORY SET** | **“Hook”: Engage students’ attention and focus on learning.** Personally meaningful and relevant. |
| Describe transmissible diseases from real life, such as one of these:Black Death <https://www.britannica.com/event/Black-Death> Ebola <https://www.cdc.gov/vhf/ebola/history/chronology.html> The common cold <https://www.cdc.gov/dotw/common-cold/index.html> Zika <https://www.who.int/emergencies/situations/zika-virus-outbreak> Monkeypox <https://www.cdc.gov/poxvirus/monkeypox/outbreak/us-outbreaks.html> COVID-19 <https://globalepidemics.org/key-metrics-for-covid-suppression/>These diseases affect our health, our economy, and have changed the course of history. They spread in slightly different ways. We will model transmission from one person to another, the way colds and COVID-19 spread.   |
| **INSTRUCTIONAL PROCEDURES** | **Step-by-Step Procedures-Lesson Sequence: Basic to Complex.** Lesson includes visuals, modeling, logical sequencing and segmenting (beginning, middle, ending); essential information; concise communication; grouping strategies; differentiated instructional strategies to provide intervention & extension; seamless routines; varied instructional strategies; key concepts & ideas highlighted regularly. |
| ***Introductio*n**With the whole group’s attention, explain what is going to happen. The cups are going to represent people. One cup represents a person infected with an illness, but we do not know which cup. ( The teacher knows. Making sure to avoid that cup with NaOH), demonstrate mixing liquid from cup to cup, returning half the liquid to each cup, sampling the liquid with a pipette, and placing the sample in a lettered cup. Explain to students that they will be using sodium hydroxide. If they spill some on themselves, then they need to let the teacher know and rinse the affected area. It is not incredibly dangerous, but they need to be careful. We are going to have the cups interact, a pair at a time, and sample the population after each interaction. Make sure that students all remain on the same step as the experiment proceeds. Have students move to a central location to get a worksheet, pipette, pair of gloves, and goggles, and 4 cups each. Pass a Sharpie® to students and have them label their cups. Label each cup with the students’ name and one of the letters A, B, C or D. Each student should also label the students’ pipette with the student’s name or initials. Have students put on their goggles and gloves, then go get a cup. Have students record their names and their cup numbers on their worksheets. Emphasize that they must keep their own cup and only use their own pipette throughout the simulation. **Middle**Cup A: Sample: Using their **own** pipettes, take a 1 mL or 2 mL sample of the liquid from their numbered cup and place it in their **own** named cup A. Announce that the simulation is about to begin. Let students know a signal for stopping, and tell them to wander around with their pens, worksheets, and cups until the signal (Suggestion: play some music. When the music stops, then they should stop wandering). Cup B: Mix: Have the students begin to wander around. Signal them to stop. Students should form pairs with nearby students. Have them record the number of their partners’ cup on their worksheets in row B, then have them mix their liquids. They should finish by dividing the mixed solution as evenly as possible between the two partners’ numbered cups. Sample: Have students return to their own desk (wherever they left their lettered cups). Using their **own** pipettes, take a 1 to 2 mL sample of the liquid from their numbered cup and place it in cup B. Cup C: Mix: Make sure students understand that they have to have a new partner this time. Have the students begin to wander around. Signal them to stop. Students should form pairs with nearby students, but no pair should be the same as during the previous mixing step. Have them record the number of their partners’ cup on their worksheets in row C, then have them mix their liquids. They should finish by dividing the mixed solution as evenly as possible between the two partners’ numbered cups. Sample: Have students return to their own desk (wherever they left their lettered cups). Using their **own** pipettes, take a 1 to 2 mL sample of the liquid from their numbered cup and place it in cup C. Cup D: Mix: Make sure students understand that they have to have a new partner this time. Have the students begin to wander around. Signal them to stop. Students should form pairs with nearby students, but no pair should be the same as during the previous mixing step. Have them record the number of their partners’ cup on their worksheets in row D, then have them mix their liquids. They should finish by dividing the mixed solution as evenly as possible between the two partners’ numbered cups. Sample: Have students return to their own desk (wherever they left their lettered cups). Using their **own** pipettes, take a 1 to 2 mL sample of the liquid from their numbered cup and place it in cup C. Final Mix: Mix: Make sure students understand that they have to have a new partner this time. They should try to find a partner near their desk. One or two students may have to move, and if so, have them do so. Students should form pairs with nearby students, but no pair should be the same as during the previous mixing step. Have them record the number of their partners’ cup on their worksheet in row “final”, then have them mix their liquids. They should finish by dividing the mixed solution as evenly as possible between the two partners’ numbered cups. Announce that this cup with no letter is now the “final” cup for sampling purposes, even though it was also their first cup. If a students had to move, then those students should return to their desks (wherever they left their cups). The teacher should appoint a student helper or two and give each a pipette with phenolphthalein. The teacher and the helper(s) should take part of the class each. Place a drop or two of phenolphthalein in each cup. Once every cup has phenolphthalein, some of the cups will turn magenta (purplish-red or reddish-purple). Have students look at their cup labels. On each row of the first table on their worksheets they should circle “magenta” or “clear” corresponding to the appearance of the liquid in their corresponding cup. Ask students to identify the first row on which they circled “magenta.” Tell them that this is the column that they will use in the second table. Each student may cross out the other columns of Table 2. If the first row on which a student circled “magenta” is the final row, then they do not need Table 2 at all. That student did not infect anyone. For the next few steps, have students watch for and record the number of the student who circled “magenta” in row A of Table 1. Have students whose first “magenta” row corresponds to cup D complete column D of Table 2. They should move to meet with their partner from the row “final” mix. (If the partner is using Table 2, then the partner may also fill out row 4 of the partner’s Table 2). In Table 2 of the student’s own worksheet, the student should record the partners’ cup number. The student should look at row D of the partner’s Table 1 to see the color circled there. In Table 2 of the student’s **own** worksheet the student should record the color circled in Table 1 on the **partner’s** worksheet. Students should return to their seats. Have students whose first “magenta” row corresponds to cup C complete column C of Table 2. Their fourth row should be complete from the previous step. They should move to meet with their partner from the row D mix. In Table 2 of their own worksheet, they should record the partners’ cup number. They should look at row C of the partner’s Table 1 to see the color circled there. In Table 2 of their **own** worksheet, they should record the color circled in Table 1 on the **partner’s** worksheet. They should return to their seats. Have students whose first “magenta” row corresponds to cup B complete column B of Table 2. Their third and fourth rows should be complete. They should move to meet with their partner from the row C mix. In Table 2 of their own worksheet, they should record the partners’ cup number. They should look at row B of the partner’s Table 1 to see the color circled there. In Table 2 of their **own** worksheet, they should record the color circled in Table 1 on the **partner’s** worksheet. They should return to their seats. Have students whose first “magenta” row corresponds to cup A complete column A of Table 2. Their second, third and fourth rows should be complete. They should move to meet with their partner from the row B mix. In Table 2 of their own worksheet, they should record the partners’ cup number. They should look at row A of the partner’s Table 1 to see the color circled there. In Table 2 of their **own** worksheet, they should record the color circled in Table 1 on the **partner’s** worksheet. They should return to their seats. Have all students complete Table 2 by counting the number of times that they circled “clear.” Have a spreadsheet ready. Have students report their numbers. Find the average of these numbers and display it for the class. **End/Closure**: Ask students to explain what has happened. Ask students to identify patient zero, the first person to be infected. Define R0 for students. This is a measure of how many new incidents of disease each infected person causes. Explain the significance of whether this number is less than 1 ( total number of cases is decreasing) or is greater than 1 (total number of cases is increasing). Ask students how this simulated infection compares with some other diseases ((Measles: 18, Mumps 10, Covid-19: 5.7, H1N1 Influenza: 1.5 )Ask students how they might have prevented the spread of the “infection.” If everyone had stayed at their desks originally, would the disease have spread? What if we had added the phenolphthalein at the beginning, testing and identifying patient zero. If just patient zero stayed put and everyone else mixed, would anyone have gotten sick? What if a student had added some acid to his or her cup, neutralizing the sodium hydroxide? Would the liquid have turned magenta? [Short answer: No. Longer answer: This depends on the concentration of the acid & relative amounts. A similar amount of 1M HCl would neutralize the 1M NaOH and give a colorless result].Have students pour out their solution, dispose of their cups, pipettes, and gloves. Have them return their goggles to a central location. Clean up any spills. **Motivating Students** \_x\_ Relate to Real World 2020s middle school students are well aware of modern pandemics. Seventh grade students also study the Black Death from the Middle Ages \_x\_ Verbal Reinforcement The teacher will monitor students’ work throughout the activity to provide reinforcement. **Presenting Instructional Content** \_x\_ Hands on Students will label, mix, and sample solutions by hand\_x\_ Lecture: After conducting the simulation, the whole group will discuss what the simulation shows about the spread of disease. \_x\_ Modeling The teacher will demonstrate how to mix solutions and sample solutions***Instructional strategies:*****Modeling and Guided Practice *–*** The teacher will demonstrate comparison and measurement. The teacher will monitor students’ work and ask questions to prompt them if they are stuck.  **Check for Understanding (CFU) –** ***What am I doing for students that progress at different rates?*** During the mixing and sampling, it is critical that students stay on the same step as everyone else. Students should mix, then return to their desk AND STAY THERE until it is time for all students to mix again. Partners will help each other through most of the activity so that it will be hard for students to get too far ahead or behind. During sampling, if a student is having difficulty, it is also acceptable for a partner to help, MAKING SURE NOT TO SWAP PIPETTES. Each student’s cup gets sampled with that student’s own pipette. ***What do I do if they get it?*** Discuss other diseases and prevention steps. (Hand washing, staying home if you are sick, covering a cough). How do these prevention measures work? (It is OK to discuss vaccines, but this simulation did not have a vaccine analogue). ***What do I do if they don’t get it?*** Try the Scratch epidemic simulator at <https://scratch.mit.edu/projects/376656449/> Run the simulation several times as students watch. The disease spreads through interactions. If fewer dots interact, then fewer people get sick, and certainly, there are not as many people sick at one time. With fewer people sick at one time, doctors and nurses are better able to treat those who are sick.   |
| **QUESTIONING/THINKING/PROBLEM SOLVING (embedded throughout)** | **Balanced mix of question types.** Utilizes Blooms Taxonomy/Webb’s Depth of Knowledge; high frequency; purposeful & coherent; require active responses; balance based on volunteers/non-volunteers, ability, & gender; lead to further inquiry & self-directed learning.  **Implement four types of thinking (Analytical, Practical, Creative, & Research-based) & Teach/Reinforce problem-solving types**. Provide opportunities for students to generate ideas & alternatives; analyze, evaluate & explain information from multiple perspectives& viewpoints. |
| **Questioning** These questions will occur throughout the activity as prompts based on groups’ or individual students’ progress. **Knowledge:**What does R0 mean? [The average number of people that an infected person directly passes the disease to] What was R0  in this simulation? What is a disease with a large R0 value? [measles is an example]**Comprehension:** If R0 is less than 1, what is happening? [the number of new cases is decreasing ] If R0 is greater than 1, what is happening? [the number of new cases is growing ]If R0 is equal to 1, what is happening? [Some people are getting sick, and some people are getting well, but the number of sick people is staying about the same]  **Application:**What are some steps we can take to limit the spread of disease? [avoid each other, social distancing, hand washing, covering coughs, vaccines] If we can test to see if someone has a disease, can that help control the spread of the disease? If we know that someone has an “infected” cup, what can we do with that information? [ask the person to stay at his or her desk; ask the person who he or she interacted with before and ask those people to stay at their desks. (contact tracing) ] Could we reduce the total number of infected cups if we made half the class not interact during a mixing step? Could that variable affect the size of the population of the virus? **Analysis:** Is it practical for everyone to avoid everyone else for weeks or months at a time? In our simulation, we insisted that each pairing be with a new partner. Is that realistic? That is, is it possible that in real life we interact with the same person several times before interacting with a new person? Consider the interaction of the “disease” with the cups. Is the interaction competitive, symbiotic, or predatory? Is this analogous for actual viral infections affecting humans? **Synthesis:** Why did we insist that there be a new partner at each mixing step of this simulation? [ To avoid the opposite problem, that middle school students would just pick one partner and stick with that person. It is easier just to mix with the person sitting beside you]. Can you design a solution to the spread of NaOH in this simulation? [Possible: acid “vaccination,” a larger cup to catch liquid from one cup when students try to mix the liquids in their cups (analogous to a mask)] **Evaluation:** **Thinking**  \_x\_ **Practical** – Disease prevention is a practical goal \_x\_ **Creative**– Students choose how to label their pipettes \_x\_ **Analytical** – Students must determine patient zero and calculate the number of cups infected by their cup. \_x\_ **Research-based** – This activity is a simulation where students model the spread of disease. The outcome is not pre-determined. **Problem Solving** **\_x\_\_** **Observing and Experimenting**. Students conduct an experiment. **\_x\_\_ Abstraction** Students are simulating disease spread, not actually spreading disease. **\_x\_\_ Improving solutions** Students must describe ways to reduce the spread of disease.  |

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| **GROUPING** | **Maximize student understanding & learning** Varied group composition (race, gender, ability, & age); clearly understood roles, responsibilities & group work expectations; accountability for group & individual work; student opportunities for goal setting, reflection & evaluation of learning. |
| * Students work in multiple pairings followed by whole-group discussion. Following each pairing, students work individually for a brief sampling phase.
* Students will wander about until a signal to stop. They will pair with someone close by after stopping.
* Product. Students complete individual worksheets.
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| **ASSESSMENT** | **Formative and/or summative assessment.** A variety of assessments, including rubrics, measure achievement of objectives and informs instruction.  |
| **\_\_x\_ Observation** The teacher will directly observe if students understand and are contributing to the discussion **\_\_x\_ Teacher made test** A future exam may include questions such as “What are some steps we can take to spread disease? What is an R0 value? When a disease is spreading, If R0 is less than 1, what is happening? |
| **CLOSURE** | **Reflection/Wrap Up.** Summarizing, reminding, reflecting, restarting, connecting. |
| After students have cleaned up, ask them how many cups were infected at the beginning. [1 cup ]. Ask them to raise their hands if they had a magenta cup (or several magenta cups) at the end. Ask “did the simulated disease spread?” [yes]. ***Reflection: You must reflect on every lesson you teach.*** |

**NOTES:**

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