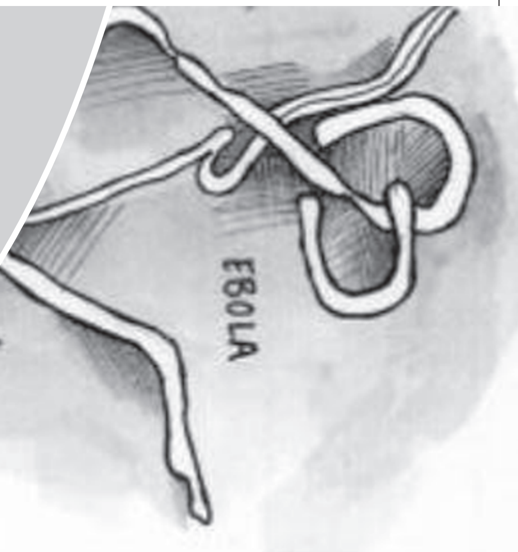
FEATURE ARTICLE



Ebola Epidemic: Using Current Events to Teach Authentic Inquiry Science

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Abstract

First reported in March 2014, the Ebola virus disease (EVD) outbreak in West Africa has now claimed more lives than all other known EVD outbreaks combined, making it the deadliest occurrence of the disease since it was first discovered nearly 40 years ago. In hopes of turning the outbreak into something positive from an educational standpoint, a module was developed focusing on EVD, infectious disease, and epidemiology. The module engages students in a series of inquiry-based lessons, providing accurate and up-to-date information on the current outbreak of EVD in West Africa. The lessons also serve to correct popular misconceptions about the disease. The lessons include a jigsaw WebQuest using resources from the Centers for Disease Control and Prevention, a simulation based on fluid exchange to model the spread of an outbreak of infectious disease, and a "disease detective"–style mapping activity based on published data outlining the start of the current EVD outbreak in Guinea.

Key Words: *Ebola; infectious disease; outbreak; epidemiology; inquiry; authentic science; mapping; NGSS.*

○ Introduction

First reported in March 2014, the Ebola virus disease (EVD) outbreak in West Africa has now claimed more lives than all other known EVD outbreaks combined, making it the deadliest occurrence of the disease since it was first described nearly 40 years ago. According to the Centers for Disease Control and Prevention (CDC), as of December 15, 2015, there have been 28,640 cases and a total of 11,315 deaths in six countries: Guinea, Liberia, Sierra Leone, Nigeria, the United States, and Mali. However, it is important to note that both the CDC and the World Health Organization (WHO) agree that these are likely underestimates given the difficulty in collecting data.

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Sensationalist reporting of the epidemic in the media has been nearly as controversial as the disease itself (Salles, 2014). Fortunately, the lack of new cases in the United States, along with an apparent stem in the flow of new cases in West Africa, has slowed down the wall-to-wall coverage. The last confirmed case of EVD in West Africa occurred in late November 2015; however, although there have been no new reported cases since then, the first confirmed case of sexual transmission was reported in October 2015, and this along with additional studies published in the New England Journal of Medicine have raised concerns that sexual transmission of the virus might cause flare-ups in the region after it has been declared Ebola-free.

In order to promote accurate understanding of the outbreak from an educational standpoint, a three-lesson module was developed focusing on EVD, infectious diseases, and epidemiological practices. Many lessons already exist to aid in teaching about infectious diseases and epidemiology individually, but few combine both topics in a single module – and even fewer, if any, are based on published data related to a current event that students will have experienced in their lifetime. Perhaps the most recent comparable scenario would be the earthquake in Haiti in 2010, which led to a massive outbreak of cholera. Furthermore, beyond correcting any scientific or public health misinformation on EVD, the goal was to introduce students to social and cultural practices in West Africa and how they have contributed to the transmission of the disease.

Perhaps the most important facet of the unit described here is the authenticity of the scientific tasks, particularly in the third lesson. On the continuing spectrum of educational reform in science, the two key tenets of effective science teaching that have emerged are inquiry-based science instruction (Abrams et al., 2007; Blanchard et al., 2008) and nature-of-science instruction (Lederman, 2007). However, it has been noted in the

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literature that many of the inquiry activities used in science classrooms do not really serve to guide students toward a greater understanding of the cognitive processes of authentic science (Chinn & Malhotra, 2002; Abrams et al., 2007; Blanchard, 2008). Despite the difficulty of including activities designed to replicate authentic scientific reasoning, it is essential that students be involved in labs and activities that bring together scientific content, scientific thought processes, and skills that support scientific investigation (Chinn & Malhotra, 2002).

There are many ways in which to add authenticity to science labs and activities. This module does so by (1) addressing real-world problems faced by scientists (Edelson et al., 1999); (2) asking students to address a problem relevant to their own lives (Barron et al., 1998); (3) linking students and scientists through data sharing, critiquing, or direct communication (Pea, 1994); and (4) addressing what scientists do to reach common understanding (Bell & Linn, 2000).

○ Overview

The module consists of three hands-on, inquiry-based lessons: (1) a jigsaw activity using resources from the CDC; (2) a simulation based on fluid exchange to model the spread of an outbreak of infectious disease; and (3) a "disease detective"–style mapping activity based on a journal article from *The New England Journal of Medicine* (Baize et al., 2014), which outlines the start of the current EVD outbreak in Guinea. Implementing the entire lesson in class requires two 50-minute periods; however, there are multiple ways to implement this module, and examples are given in the context of each lesson described below. Furthermore, existing lessons on related topics provide ample opportunity for extension activities related to other subjects, such as math, reading, and history (see Additional Resources). The overall learning goals for the module are

1. Describe the following for EVD: symptoms; sources and risk factors; diagnosis and detection; treatment; prevention and control.
2. Simulate the spread of an infectious disease.
3. Analyze and graph data, determining dependent and independent variables.
4. Describe the "epidemiological triangle": agent, host, and environment.
5. Describe how epidemiologists think about the origins and spread of infectious disease.

○ Connections to the *Framework & Next Generation Science Standards*

This module was designed on the basis of the "three dimensions" put forward by the National Research Council's *Framework for K–12 Science Education*, a new vision of scientific proficiency which serves as the foundation for the *Next Generation Science Standards* (NGSS). The NGSS provide performance expectations that incorporate the three dimensions described in the *Framework*: disciplinary core ideas, scientific practices, and crosscutting concepts. The combination of these three dimensions to frame science instruction is meant to encourage more robust and significant learning of science and the scientific process, continually expanding, refining, and revising knowledge. Incorporation of the NGSS into classroom instruction has become increasingly important as more and more states adopt the new standards. Table 1 outlines the disciplinary core ideas, scientific practices, and crosscutting concepts addressed by the three lessons in the unit.

The objectives put forth by the NGSS for both content and process stem from an inquiry-learning model, which utilizes activities that incorporate authentic scientific inquiry in order to help students develop deep, interconnected content knowledge and inquiry skills (Edelson et al., 1999). The lessons contained in the module described here embody this inquiry-based pedagogy.

○ Lesson Descriptions

1. Ebola Jigsaw

The first lesson takes the form of a WebQuest to utilize the vast store of online information about EVD. Because students are likely to have varying degrees of knowledge on EVD and the current outbreak, it can be helpful to precede this lesson with a diagnostic activity to determine whether they already hold any of the common misconceptions. This can take the form of a class discussion, or even a formal pretest with questions based on the information to be gleaned from the WebQuest; clickers can also be used if the technology is available, allowing for rapid assessment of prior knowledge. The results from this assessment can be used to drive discussion later in the lesson, and even later in the module.

In order to complete the first lesson, students are divided into six groups and assigned one of six topics (A–F; Table 2) related to the current outbreak. Students have ~15 minutes to collect this information, using the CDC or WHO websites (see References) or other relevant websites (students must list their resources). Once the groups have gathered the relevant information, students count off within their group, 1 to 4, and new groups are formed by number, each of which which should have (at least) one person from each of the topic groups (A–F). Each student takes 1–2 minutes to share about their topic, allowing the group to answer the assigned questions shown in Figure 1. In the event that computers are not available, the related information from the CDC's website is provided as a packet that can be distributed to students by the teacher. For the sake of time, this lesson can also be given to the class as a homework assignment prior to completion of the remaining two lessons.

The questions to be answered are relatively straightforward but provide the opportunity to correct two misconceptions about EVD, namely (1) that it is an airborne disease and (2) that the virus can be spread by an individual not showing any signs or symptoms. In addressing the first misconception, it is important to emphasize the distinction between droplet transmission and airborne transmission. Some diseases, such as EVD or measles, can be transferred by infectious droplets contacting the surfaces of the eyes, nose, or mouth. These droplets may be created when an infected person talks, coughs, or sneezes, or even during certain medical procedures. Droplets quickly settle out of the air because they are too large to remain airborne for very long (Wells, 1955). "Airborne transmission," however, refers to the process by which pathogens enter the upper and lower respiratory tracts, usually via dust

Table 1. Connections of this module to the "three dimensions" described in *A Framework for K–12 Science Education* (National Research Council, 2012).

Disciplinary Core Ideas	Scientific Practices	Crosscutting Concepts
ESS3.B: Natural Hazards Natural hazards and other geological events have shaped the course of human history at local, regional, and global scales. **LS2.A: Interdependent Relationships in Ecosystems** Ecosystems have carrying capacities resulting from biotic and abiotic factors. The fundamental tension between resource availability and organism populations affects the abundance of species in any given ecosystem. **LS2.C: Ecosystem dynamics, functioning, and resilience** If a biological or physical disturbance to an ecosystem occurs, including one induced by human activity, the ecosystem may return to its more or less original state or become a very different ecosystem, depending on the complex set of interactions within the ecosystem. **LS4.D: Biodiversity and humans** Biodiversity is increased by formation of new species and reduced by extinction. Humans depend on biodiversity but also have adverse impacts on it. Sustaining biodiversity is essential to supporting life on Earth.	**Developing and Using Models** Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems. **Analyzing and Interpreting Data** Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine optimal design solution. Evaluate the impact of new data on a working explanation and/or model of a proposed process or system. **Constructing Explanations and Designing Solutions** Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve problems. Design, evaluate, and/or refine a solution to a complex real-world problem based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. **Obtaining, Evaluating, and Communicating Information** Compare, integrate, and evaluate sources of information presented in different formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or problem. Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally graphically, textually, or mathematically).	**Patterns** Observe patterns in systems at different scales as empirical evidence for causality in supporting explanations of phenomena. **Cause and Effect** Suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. Recognize changes in systems may have various causes that may not have equal effects. **Scale, Proportion, and Quantity** Use algebraic thinking to examine scientific data and predict the effect of a change in one variable or another (e.g., linear growth vs. exponential growth). **Systems and system models** Investigate and/or analyze a system by defining its boundaries and initial conditions, as well as inputs and outputs. **Stability and Change** Constructing explanations of how things change and how they remain stable. Quantify and model changes in systems over very short or very long periods of time.

Table 2. Group topics for the Ebola jigsaw WebQuest.

Group	Topic
A	General information
B	Illness and symptoms
C	Sources of infection and risk factors
D	Diagnosis and detection
E	Treatment
F	Prevention and control

1. Is Ebola a bacteria or a virus?
2. How many species of Ebola are there? Do all of the species cause disease in humans?
3. What is the natural host of Ebola virus?
4. List five symptoms of Ebola.
5. How long after exposure to the virus do symptoms appear?
6. Can the virus be spread by someone who is not showing any signs or symptoms?
7. What tools are used to diagnose Ebola?
8. How is the disease transmitted?
9. Is the Ebola virus airborne?
10. How can the spread of Ebola be prevented?
11. Which strain of Ebola is responsible for the current outbreak in West Africa?
12. What countries in West Africa have been affected by the 2014 outbreak?
13. How many total cases of Ebola have been reported in the 2014 outbreak? How many deaths?
14. What sources did you use to obtain your information?

Figure 1. Questions for the Ebola jigsaw WebQuest.

particles or droplet nuclei (residue remaining from droplets that have dried out), which remain suspended in the air for long periods. Only a limited number of diseases, such as tuberculosis and chickenpox, can be transferred via the airborne route, because the pathogen must be capable of surviving outside of the body for long periods and must be resistant to drying (Wells, 1955).

2. Modeling an Epidemic

The second lesson utilizes a well-known activity to study the spread of infectious disease, as seen in the National Institutes of Health's (n.d.) "Science and Society: Preventing the Spread of Disease" lesson and in Project Learning Tree's (2014) "Biotechnology and Human Health" activity, among many other sources. In this lesson, students conduct a fluid exchange activity that models the spread of an infectious disease, while the summary questions and discussion aid students in applying their understanding of how an infectious disease might be spread.

Each student is given a test tube containing ~2 mL of a sample fluid, and students are told that one person in the class has the "infected" sample, although the students do not know who that is. Students exchange their fluid with three other classmates, taking care to record who they exchanged with. Once all three exchanges are complete, the students are asked to assay their sample to determine

Instructions for Testing Samples

1. Hold the dipstick by the white plastic and dip the orange end into the sample for 2 seconds.
2. Remove the dipstick and read the results immediately.
3. If the results show a green square at the end of the dipstick, this is a negative result – sample is not infected.
4. If the results show a dark blue square at the end of the dipstick, this is a positive result – the sample is infected.

Figure 2. Modeling an epidemic using the pH indicator stick test.

whether it is infected. This lesson is different from the traditional assay, in that it uses a pH indicator dipstick test – instructions are given to the students on how to read the dipstick (Figure 2).

Any basic solution can be used as the contaminant solution, and options are provided for the instructor within the lesson to vary the difficulty of the experiment, depending on their individual needs. Positive and negative control samples should be used, and this can be done by the teacher with the whole class for the sake of time. Depending on time availability, the instructor can have the students repeat the experiment, varying the number of exchanges (e.g., they can compare the change in results if they exchange fluid with only one other person). If repetition is not an option, this can be a point of discussion at the end of the lesson.

Each student should receive a Fluid Exchange Record Sheet, adapted from Project Learning Tree (2014). In addition to recording their results from the fluid exchange experiment, students are given a dataset from a similar experiment and asked to graph the results, labeling the axes with the dependent and independent variables in the experiment (number of infections and number of exchanges, respectively). If done correctly, the outcome should be an S-shaped curve (logistic growth curve), characterized by an exponential middle phase and leveling off at the end. This "leveling off" refers to reaching carrying capacity in the experiment, because only a finite number of students in the class can become infected.

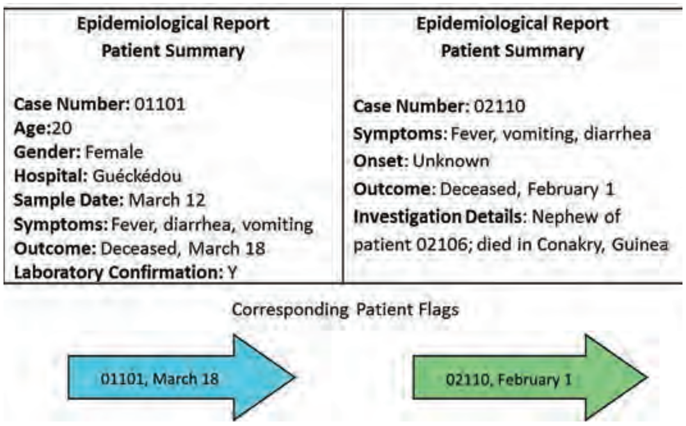
As a point of discussion, the teacher can also ask the class to describe how the spread of disease in real life may differ from what they have just experienced. Possible answers can include susceptibility of certain populations (e.g., older, younger, immunocompromised), differences in transmission (e.g., airborne contamination), or preventative measures (e.g., washing hands, covering mouths). This also serves as an opportunity to talk about the use of biotechnology and other assays used to detect disease, such as the enzyme-linked immunosorbent assay (ELISA), which is touched upon briefly in the first lesson as a method for detecting EVD in patients. For those looking to delve more deeply into the biotechnology component, a separate lesson covering the use of ELISA to detect Ebola virus as a simulation is also available (see Additional Resources).

3. Tracking an Epidemic

The third and final lesson in the module is the most novel. It is based on the article "Emergence of Zaire Ebola Virus Disease in Guinea" (Baize et al., 2014), which details the findings of an epidemiological investigation linking laboratory-confirmed cases of EVD with the presumed first fatality of the outbreak that occurred in December 2013.

This activity is designed to be done in pairs or small groups. The students are briefly introduced to epidemiology and the model known as the "epidemiological triangle," which details the disease agent, host, and environment (or the who, what, and where). The mission of an epidemiologist is to break at least one side of the triangle, disrupting the connection between the three vertices and stopping the spread of the disease.

Each group is asked to act as disease detectives. Using summaries of patient epidemiological reports provided by health care workers active on the scene in West Africa, students are challenged to track the current outbreak of EVD in Guinea to its origin. The summaries were created from details documented about the patients by Baize et al. (2014). Each patient is given a case number that starts with 01 or 02; those beginning with 01 are laboratory-confirmed cases, and those beginning with 02 are suspected cases of EVD. The same basic information is provided for each patient, with some variation (for examples of patient summaries, see Figure 3).


Epidemiological Report
Patient Summary

Case Number: 01101
Age:20
Gender: Female
Hospital: Guéckédou
Sample Date: March 12
Symptoms: Fever, diarrhea, vomiting
Outcome: Deceased, March 18
Laboratory Confirmation: Y

Epidemiological Report
Patient Summary

Case Number: 02110
Symptoms: Fever, vomiting, diarrhea
Onset: Unknown
Outcome: Deceased, February 1
Investigation Details: Nephew of patient 02106; died in Conakry, Guinea

Corresponding Patient Flags

01101, March 18

02110, February 1

Figure 3. Epidemiological report summaries and patient flags.

The summary cards span a period of about four months, from December 2013 to March 2014. Each group receives two to four summary cards (depending on the number of groups), and students are asked to create a flag for each patient. For each patient, the colored flag will vary and is based on the date of disease onset (e.g., December patients are given a red flag, yellow for January, green for February, and blue for March; see Figure 3). In cases for which the date of onset is not available, students should be instructed to use the date of death. Each flag is then placed on a large wall map of Guinea, marking the city where the patient died (alternatively, the instructor can project the map on a wall or other large surface). If the student card indicates that the patient survived or the outcome is unknown, the flag should be placed at the very bottom of the map. It is important to instruct students to place their flags near but not on the names of cities, so that the latter are not covered up.

Once all of the flags have been placed (Figure 4), patterns will emerge, allowing students to determine the location of origin and chronology for the outbreak, the patients responsible for transmission from village to village (and to other countries), and the identity of "Patient Zero." For example, the earliest reported dates of onset are indicated by the red and yellow flags, which should be placed around the village of Guéckédou. Of the red flags, the flag with the earliest date of onset would correspond to Patient Zero.

As documented by Baize et al. (2014), the outbreak began in early December 2013, in the village of Guéckédou. Patient Zero is thought to be a two-year-old boy, confirmed by laboratory testing to have EVD, who spread the disease to his immediate family and then through the village. Analysis of the investigation details will lead students along the path of transmission from Guéckédou to nearby Macenta and Kissidougou, to regional capital Nzérékoré,

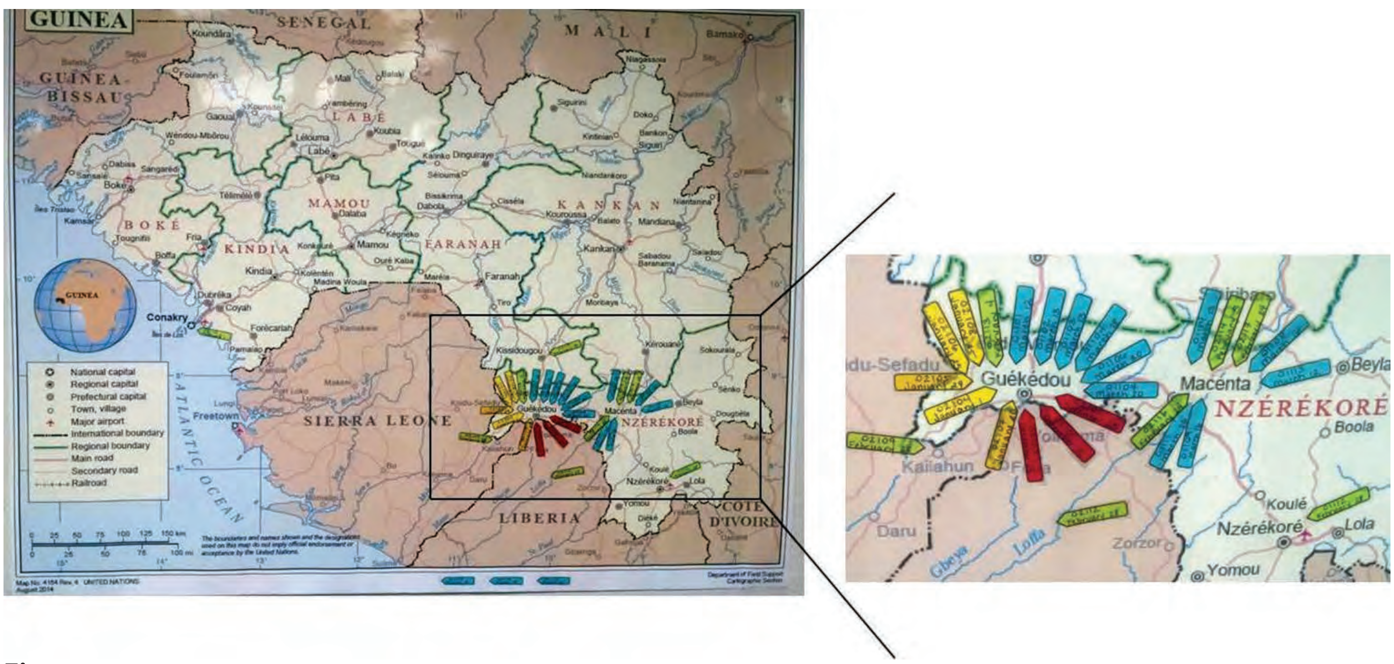


Figure 4. Wall map of Guinea with patient flags.

across the country to Conakry (Guinea's capital city), and finally across Guinea's borders to Sierra Leone and Liberia.

The questions accompanying this section (Figure 5) will require students to pull information from the previous lessons and are designed to be discussed in class as a group, because the students all have different patient information. Depending on the level of the students, some answers may not be obvious at first (especially for questions 5 and 6). For example, with regard to question 5, it may need to be drawn to the students' attention that there is only one main road through the entire country, and that this main road sits in line with the country's capital city (Conakry), airports, and railroad. Students also may not be able to answer question 6 without prompting, but it provides an opportunity for the teacher to highlight the cultural influence on disease spread, especially with regard to funeral and burial practices in West Africa and how they differ from those in the Western world. For example, the bodies of the deceased are prepared for burial by their families, and many rituals require direct contact with the corpse. Muslim tradition, for instance, requires that family members of the same gender should wash the body themselves before burial. This proves to be particularly problematic, because victims of EVD are most contagious just after they have died. A combination of inadequate infrastructure, logistical issues, conflicts with Western health care workers, and burial traditions are the major factors that have contributed to widespread difficulties in containing the spread of the disease, particularly among mourners and those caring for the dead. In fact, a study put forward by Ebola researchers at the Yale School of Public Health in the journal *Science* found that the greatest impact in curbing the spread of the disease would come from ensuring safe burials for victims (Pandey et al., 2014). However, despite the risk posed to family members burying their loved ones, it is difficult for public health officials and authorities to interfere with established cultural customs. Furthermore, public health education initiatives are suppressed in an environment where fear, distrust, and social stigmatization have become the norm (Davtyan et al., 2014).

1. Based on the placement and color of the flags, where did the outbreak begin?
2. Can we determine Patient Zero of the outbreak? Suggest at least one way this patient could have gotten infected.
3. Using the investigation details provided on the epidemiological reports, identify which patients are likely to have aided in the spread of the outbreak from city to city.
4. Briefly outline the spread of the outbreak through Guinea (and beyond).
5. Looking at the map and using the legend, what other factors may have contributed to the spread of EVD?
6. Can you think of any social or cultural practices popular in this geographical area that may have contributed to the spread of EVD?
7. Fill in the epidemiological triangle for EVD based on the information you've collected.
8. As an epidemiologist trying to curb the outbreak, which side(s) of the triangle would you target? Suggest potential strategies to prevent the spread of EVD based on the vertex of the triangle you selected.

Figure 5. "Tracking an epidemic" assessment questions.

While the questions that accompany this lesson provide a way to assess student understanding, using the epidemiological triangle model to determine methods by which to solve the complex

Table 3. Extension activities for the Ebola virus disease (EVD) epidemic module.

Topic Area of Lesson Extension	Description	Source
Biotechnology	Additional information can be provided on assays such as ELISA and polymerase chain reaction (PCR), which are often used to diagnose infectious diseases. A stand-alone lesson on EVD takes students through the steps of an ELISA using storyboards, and then has the students perform a simulated test to determine which patients are positive for EVD.	Available for download along with the full module at http://www.cpet.ufl.edu/?p=25386
Mathematics	"Analyzing the Data" worksheet. In this activity, students learn more about the patterns in the outbreaks and better understand the spread of the Ebola virus in its human hosts by analyzing data gathered by the WHO on EVD outbreaks since 1976. Students are given the data in multiple formats and asked to explain which format does a better job of conveying the information.	Provided as part of the "Ebola Outbreak Lesson" published by PBS NewsHour at http://newshour-tc.pbs.org/newshour/extra/wp-content/uploads/sites/2/2014/09/Ebola-outbreak-analyzing-the-data-worksheet.pdf
Reading (General Audiences)	An excerpt from the book *The Hot Zone* by Richard Preston. Here students learn about the devastating symptoms experienced by those infected with Ebola. However, although the	The excerpt from *The Hot Zone* is provided as part of the "Ebola Outbreak Lesson" published by PBS NewsHour at http://newshour-tc.pbs.org/newshour/extra/wp-content/uploads/sites/2/2014/

Table 3. continued

Topic Area of Lesson Extension	Description	Source
	book is presented as a true story, the descriptions of the disease symptoms have been admittedly exaggerated by the author, and therefore the instructor should be prepared to address any misconceptions. These have been conveniently outlined in a referenced blog post by epidemiologist Tara Smith, a professor of infectious disease epidemiology at Kent State University, titled "How *The Hot Zone* Created the Worst Myths about Ebola."	09/Excerpt-from-The-Hot-Zone-for-PBS-NewsHour-Education-Random-House-Publisher.pdf Smith's blog post is at http://thinkprogress.org/health/2014/10/07/3576799/ebola-cable-news-coverage
Reading (Advanced – Journal Article)	The *New Enland Journal of Medicine* article (Baize et al., 2014) used in lesson 3 of the module can also be used as an introduction to primary literature. Links are provided within the module for ready-to-use guides on how to read and understand a scientific paper.	Baize et al. (2014) is provided as part of the module resources at http://www.cpet.ufl.edu/?p=25386
Documentary	An excellent hook into the story is provided by "Ebola Outbreak," a 27-minute episode of the documentary series *Frontline* that brings the viewer into the center of the health crisis burning through West Africa. The story follows the lives of the patients, doctors, and volunteer workers joined together by the worst recorded outbreak of EVD in history.	The documentary can be viewed online at http://www.pbs.org/wgbh/pages/frontline/ebola-outbreak/
Ethics, Law, & Policy in Public Health	The story of Kaci Hickox, the nurse who publicly fought the (admittedly controversial) quarantine policy for health workers returning to the United States, provides fodder for discussion of health care policies and the difference in mandates put forth by health organizations (such as the CDC) versus those put forth by lawmakers not versed in science (in this case governors Chris Christie of New Jersey and Paul LePage of Maine), as well as discussion of bioethics as it pertains to health care professionals.	http://www.theguardian.com/commentisfree/2014/nov/17/stop-calling-me-ebola-nurse-kaci-hickox
News & Social Media	Many articles and videos are available online that demonstrate the spread of misinformation. Once the module has been completed, the teacher may choose to have students analyze an article or video in order identify the misinformation and correct it.	A good example is a video of journalist George Will incorrectly claiming EVD is airborne, confusing droplet and airborne transmission: https://www.youtube.com/watch?v=aY-hgjmCMEE

problem of disease outbreak offers an opportunity for the students to get creative in presenting their solutions. Students can work individually or in small groups to demonstrate their ideas for tackling the problem, and these can be presented to the class in the form of posters that can be viewed in a gallery walk, short videos or podcasts, oral presentations, and so on. In addition, students can be asked to address a misconception about EVD covered in the lesson (or any others they may have caught) and use one of the above techniques to try and dispel the myth. Students could also be asked to address these issues for different audiences (i.e., the general public of Eastern or Western audiences versus public health workers and scientists).

○ Additional Resources

The full modules can be accessed at http://www.cpet.ufl.edu/?p=25386. Depending on the time available and the interests of the teacher and/or class, multiple extension activities are available to supplement topics discussed in the module, as outlined in Table 3. Barber and Stark (2015) also provide an excellent list of online resources for analyzing outbreaks and learning about infectious diseases, including additional information on pathogen biology as well as vaccines.

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