Cholera and the Science of Medicine: Instructor Guide

Title

Cholera and the Science of Medicine

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Discipline

Science Education

Target Audience

Introductory, non-majors

Keywords

John Snow, cholera, disease, inquiry, medicine, nature of science

Length of Time/Staging

Five stages, three or four class periods, with opportunity for individual research.

Abstract

Students explore the essential nature of science processes of evidence, explanation, prediction, experimentation, and communication and how they are used by scientists. The London cholera

epidemic of 1854 is explored as an early application of the processes of science to the understanding of a disease.

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Format of Delivery

The problem is presented in five stages and can be accomplished in three to five class periods with intermediate student research.

Student Learning Objectives

1. Discuss and write about science as reflecting the cultural context in which it operates.
2. Discuss and write about evidence and what constitutes the evidence collected and developed by John Snow as compared and contrasted to that used by some others.
3. Discuss and write about the relationship between evidence and explanation—both evidence used in the development of explanation and then the use of that explanation to infer, design tests, and the collection and evaluation of new evidence.
4. Write about the how John Snow used both collaboration and communication in his work on cholera.
5. Collaborate with other students in the development of products related to the problem.

Student Resources

Allen, G., and Baker, J. (2001). Chapter 3. In *Biology: Scientific process and social issues.* Hoboken, N.J.: Wiley and Sons.
- Provides a concise account of the epidemics and John Snow's role.

Benedictow, O.J. (2004). *The Black Death, 1346-1353: The complete history.* Rochester, NY: Boydell Press.

Frerichs, R. R. *John Snow.* (Site maintained by the UCLA Department of Epidemiology) Accessed 20 June 2007. URL: www.ph.ucla.edu/epi/snow.html.
- Tremendous resources, complex and interesting site.

Johnson, S. (2006). *The ghost map: The story of London's most terrifying epidemic and how it changed science, cities, and the modern world.* London: Penguin Books.
- A good read, with an interesting presentation of the appalling conditions that characterized London at the time of John Snow and the impact of the work of Snow and others to make cities livable places.

Johnson, S. Video presentation of the cholera story, part of the TED series of talks: www.youtube.com/watch?v=KvHL0dHj3RM. Accessed 24 July 2009.

Snow, J. (1855). *On the mode of communication of cholera.* London: John Churchill. (Complete text online at UCLA site above.)
- Snow's classic work, with many data tables.

Vinten-Johansen, P., Brody, H., Paneth, N., Rachman, S., and Rip, M. (2003). *Cholera, chloroform, and the science of medicine. A life of John Snow.* Oxford: Oxford University Press.
- Recent scholarly presentation of the accumulation of Snow's life work, including his work with chloroform. Sets the context for public health and political/social contexts in the mid-19th Century.

Instructor Resources

McComas, W. F. *The principal elements of the nature of science: Dispelling the myths.* Available at: http://earthweb.ess.washington.edu/roe/Knowability_590/Week2/Myths%20of%20Science.pdf. Accessed 22 June 2007.
- Good presentation of the student misconceptions about the nature of science.

Selby, C.C. *What makes it science? A modern look at scientific inquiry.* J. College Science Teaching, July/Aug. 2006. p. 8-11.
- A thoughtful discussion of some of the cultural issues that have contributed to the lack of adequate science literacy.

Author's Teaching Notes

General Comments:

While scientists are comfortable with the question about what science is and what it is not, there is ample evidence that non-scientists are sometimes willing to consider that the domains of science, religion, humanities and art may overlap and even merge with one another to a significant degree. Thus, the current debate about teaching Intelligent Design in the science classroom suggests that in the interest of "fairness" or "examining the controversy," the public is willing to revise the meaning of science and thereby abridge its usefulness. The essential relationships between evidence, explanation, and prediction are important and it is important that citizens understand the issues related to the nature of science raised by some of these suggestions and the power and the limits of science as a human endeavor.

This problem has been used in a course titled Scientific Inquiry and Quantitative Literacy for class of middle school mathematics and science teachers. Goals for the course included: 1) to encourage the participants to reflect deeply on the nature of science and how it reflects society and culture, how it affects society; 2) the necessity for evidence and how evidence, explanation and prediction are linked; 3) how science is both robust and tentative; 4) the importance of communication by scientists.

Although other figures from history might have been chosen, John Snow was an early practitioner of medicine as science and is at the center of an interesting story. He is regarded as a pioneer in the fields of epidemiology, anesthesiology, and the sub-discipline of medical cartography. A reading of his work during the 1854 cholera outbreak in London reveals a classic case study of what scientists do when they do science.

Briefly stated, the processes used by Snow are:

- The use of historical and empirical evidence as opposed to the supernatural or suppositional statements;
- Explanations constructed on evidence and also explanations open to revision in the light of new evidence;
- The importance and use of predictions (based on the explanations).
- Communication of the results to the appropriate audience.

Stage Specific Notes:

The stages of the problem were delivered with opportunity for individuals and groups to prepare responses to the end of stage questions. Usually, the questions were discussed during the class by small groups of students and they prepared their individual answers to the questions for submission at the next class. The end of stage questions were read and returned with comments.

Part 1.

1 - 3. Group discussion is often improved by having the students think and write individually first. Student prior knowledge of plagues, epidemics, development of germ theory, etc., is generally limited.

Part 2.

1 - 2. Some students may suggest that the societal context was important and that when authorities began to collect epidemiological data, they were responding to societal imperative as well as a medical mystery. The collection of data on elevation, the sources of water, and the relative incidences of cholera suggested authorities thought that those variables were in some way inter-related.

3. Learning issues that students may identify: general information about cholera, including how is cholera transmitted? What about "germ theory in the context of understanding cholera? Parts 1 and 2 may be delivered within the first day of the problem, and these questions may serve as learning issues for discussion when the problem is resumed.

Part 3.

Students should recognize that evidence and explanation and explanation and prediction are tightly linked, and that linkage was what motivated John Snow to collect the data that he did: a very detailed representation of the geographical relationship of choler and the water supply. Students may find John Snow's famous map centered on the Broad Street pump, which tallies the deaths from cholera with respect to the pump, and can see the connection between this observational evidence and his explanation for the cause of the disease. This contrasts with the kinds of anecdotal "evidence" that was suggested by the writer of the letter.

After Part 3, groups are asked to prepare a concept map of the Nature of Science. That map should include the terms evidence, explanation, prediction, communication, society, questions, theories, and laws, plus any other concepts that they deemed important. At the end of the problem, the groups return to the concept map to update it and provide additional examples from the cholera problem or from other class activities. Although the primary benefit of the concept map is to motivate student discussion around the concepts, I was able to evaluate the concept map using a simple assessment rubric. This rubric was created, with input from the students, prior to the groups beginning work on the map itself. Each concept was to be clearly connected to other concepts, supported by propositional statements and accompanied by examples from the problem, including their research.

Part 4.

The data in Table 2 are not easily dissected into a clearly supportive framework for the water theory of transmission. However, there does appear to be a benefit of having the Lambeth Company as the water source, and along with the text statements that suggest that the two companies' water pipes were intermingled, they should suggest that a detailed canvassing of the districts should result in a pattern of almost all of the cholera deaths as a result of obtaining water from the Southwark & Vauxhall Company.

Part 5.

Students should predict the pattern of data represented in Table 3. They may also recognize that the final piece of the puzzle would require that the sources of the water be different for the two different water companies.