hunt for virtual rocks, and test minerals. In a creative-writing assignment, students crafted an autobiography of a "rock person" on the basis of a rock they found and brought to school. Teachers used rubrics to assess student work and issued passport stamps for completed work.

The science content then spiraled upward to a component called How Does It Work? in which students learned about simple and complex machines. Using interactive Web sites, students investigated levers, pulleys, inclined planes, wheel and axles, screws, and wedges. Culminating activities included creating a complex machine and an advertisement promoting the invention.

Later that fall, MCAS data confirmed that the pilot test raised student performance on test items aligned to Saugus Iron Works unit content. Students did better on such technology and engineering questions as, "What other tool beside a sledge hammer should you use to split a log?" or "Identify and sketch four simple machines" (the lever, pulley, inclined plane, wheel and axle, for example).

Engaging students in an exploration of how colonists built and managed the ironworks is the driving force for teaching about the science behind the machinery.

Independent evaluation data revealed that 85 percent of the students involved in the project answered these questions correctly, as opposed to 55 percent in the comparison group. Moreover, statistical groupings taking into account whether students had an Individualized Education Plan or were eligible for free lunch indicated that project-based unit exposure was the major factor in raising student performance. When the project was implemented in all Malden 5th grade classrooms, more than 500 students studied the unit. On the 2005 MCAS science exam, the 5th graders scored significantly higher on items that related to the project-based unit than on nonrelated items. Our data suggest that creating and implementing a project-based learning experience that is technology infused and aligned to district curriculum standards is a model worthy of replication. ▲

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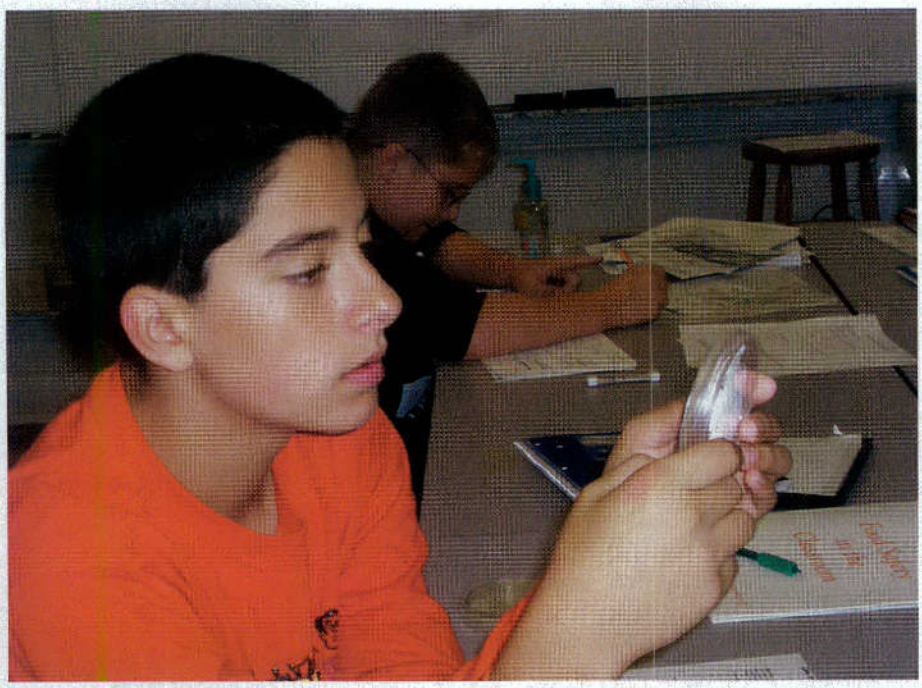
The Science of Salmonella

Jennifer Richards, Gary Skolits, Harry Richards, and F. Ann Draughon

Every year, 76 million Americans contract food-borne illnesses that result in an average of 5,000 deaths annually.[1] To combat this growing problem, the University of Tennessee, funded by a USDA National Integrated Food Safety Initiative (NIFSI) grant, is pilot testing an innovative food safety curriculum targeted at middle school students. The goal of the program is to create an interdisciplinary curriculum focused on food safety concepts that encompasses state content standards in science, math, social studies, and language arts. The cornerstone of the unit is the scientific principle of bacterial growth.

In the science component, students learn that bacteria are microscopic organisms found on most surfaces, including the human body, and that bacteria can be easily transferred to food, resulting in a food-borne illness. Students conduct an experiment comparing the growth of bacteria from unwashed hands, hands washed for 5 seconds in cold water with no soap, hands washed for 20 seconds in warm water with soap, and hands treated with a hand sanitizer. Students construct concept maps to activate prior knowledge; gather new knowledge from a

Students consider whether there is a connection between a country's standard of living and its incident rate of food-borne illnesses.



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Students participating in the food safety program hone their critical-thinking and problem-solving skills as they analyze bacterial growth lab results.

PowerPoint presentation; and then apply their knowledge by creating such products as poems, rap songs, and how-to manuals. Students aggregate the results of the bacterial growth experiment to reflect classroom data, and they isolate and stain colonies from their growth experiment to view under the microscope.

The math component uses the real-world data generated from the bacterial growth experiment to teach basic statistics, such as mean, median, mode, and range. Students also use these data to create graphical representations, such as box-and-whiskers plots, frequency tables, histograms, stem-and-leaf plots, and scatter plots. In addition, students explore the concept of bacterial growth as an example of exponential curves. Using modeling clay, students demonstrate the division of cells and extrapolate growth rates at two, three, and four hours. Students then apply this knowledge to determine whether food is safe to eat by analyzing food-based scenarios that provide the initial load (the number of bacteria present); the generation time (the time it takes a bacteria to divide under optimal conditions); and the amount of time that a food has been sitting out.

Research skills, such as evaluating credible sources and gathering data, are the cornerstones of the social studies component. Students research several common food-borne pathogens and then analyze scenarios to determine the pathogen responsible for the outbreak. Students must locate incidents of Salmonellosis in four different countries during the past five years. For each incident, students record the date, location, number of cases, and suspected source. They then find standard-of-living information for each country in which they located an outbreak. Using the data collected by the class, students consider whether there is a connection between a country's standard of living and its incident rate of food-borne illnesses. To bring the located outbreaks into a spatial context, students create and label outbreak maps.

In the language arts component, students focus on the core concepts of safe food handling: cook, chill, clean, and separate. Students summarize informational text into key points, write press releases educating their community on the potential effects of Salmonellosis, and suggest strategies to avoid the illness. The culminating activity for the food safety unit requires students to demonstrate understanding by assuming the role of food safety experts contracted by the Centers for Disease Control. To help combat a high number of outbreaks in their community, they must create a PowerPoint presentation on safe food handling.

Early feedback from the University of Tennessee's pilot project suggests that the program works. So far, 23 7th grade teachers have been trained to implement the curriculum, which takes one to two weeks to complete. When asked whether the curriculum was useful in their classrooms, most teachers indicated it was excellent, entertaining, and well organized. Most teachers agreed that there was a direct connection between food safety and the disciplines they teach and that it was easy to use food safety concepts to teach the core knowledge and skills that they must cover to prepare students for state accountability tests. ▲

[1] Economic Research Service, U.S. Department of Agriculture. (2002). *Economics of food-borne disease: Food and pathogens*. Washington, DC: Author.

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