INQUIRY & INVESTIGATION

Hands-on Research Reaching across Disciplines

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Abstract

We describe an interdisciplinary research project for undergraduate students involving microbiology and public health. Students designed and carried out two research studies on hand hygiene and the use of gloves by mobile food vendors in New York City and in a New Jersey mall. Students received training in aseptic techniques and survey methodology to carry out the multifaceted study. We discuss the importance of interdisciplinary collaboration and research in the context of its value in preparing professionals in the fields of biology and public health.

Key Words: *Microbiology; public health; interdisciplinary research; hand hygiene; aseptic technique; food safety.*

○ Introduction

The value of interdisciplinary approaches to education has been noted for over a century. Many current-day educators have built on earlier work by educational philosophers such as John Dewey who promoted an amalgamation of content in courses of instruction (Fallace, 2016), which is sensible as we live in an interdisciplinary world. Biologists interact with professionals from other disciplines in chemistry, health and medicine, physics, and technology. In higher education, artificial disciplinary walls exist in the forms of departments, and students may wrongly conclude that each discipline is a world unto itself, separate from other disciplines and areas of study. The artificial separation of disciplines in academia makes it critical for interdisciplinary initiatives to be pursued in formal programs (e.g., linked courses and cluster courses) and less formal collaborations. As such, educators have called for a greater emphasis on a Deweyan philosophy in health-related fields such as public health education and practice (Brouse et al., 2005), yet little research exists on the specific ways that collaborations have occurred.

Here, we describe a novel interdisciplinary approach to research. This collaborative project between a biology professor and a professor of public health enabled students to complete research projects straddling both disciplines. The students applied research protocols in biology and public health to document an important health-related issue, namely hand hygiene and the use of disposable gloves by food handlers (Wahrman, 2016). In this vein, we worked to create a learning environment that enables science students to consider complex problems in human health.

○ Research Approach

We designed two studies using public health survey methodology and biology laboratory techniques to study hand hygiene and glove use among street food vendors in New York City and mall food vendors in a suburban New Jersey mall. The aim of these studies was to determine (1) the frequency with which mobile food vendors change gloves after monetary transactions and (2) the level of bacterial contamination on a subset of dollar bills collected from those vendors. College students at William Paterson University were recruited from public health and biology classes to help design and carry out the study. They were engaged for the project by presenting this research as a way to determine the risk of eating at food vendors and to recommend behavioral changes to improve food hygiene. This is important because the proper use of gloves can reduce the risk of transfer of microorganisms from hands to food. The focus on food vendors is of particular importance because handling currency can facilitate transmission of microbes from person to person.

The studies conducted by undergraduate college students involved students observing food vendor behavior at New York City locations near major medical centers (Basch et al., 2016) and at busy New Jersey mall venues during the holiday shopping season (Basch et al., 2018). Students were trained in aseptic technique in the microbiology lab, where they learned how to open and don sterile gloves, handle sterile broth and test tubes, and store dollar bill samples for later processing. They were also trained in observational methodology to study human behavior in the field.

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Seven students participated in various aspects of the studies. These projects were challenging and time intensive for the students who participated. For instance, in the 2018 study, Phase 2 involved a total 17 hours of field observations. Note, however, that the design of the project can be modified to provide opportunities for larger groups of students to be involved, by dividing up the research tasks accordingly. For instance, a class of 24 can be divided into 12 teams of two researchers or eight teams of three researchers. With additional student researchers, time-intensive tasks can be divided up, the number of observations per student team is more manageable, and the project can be conducted as a unit within a formal course. Students can be involved in all aspects of the study or be assigned tasks focusing on fieldwork or lab work. As long as inter-rater reliability is considered, larger numbers of students can conduct fewer or shorter periods of observation. At the end of the study, students can pool their data and work together as a larger group to analyze, discuss, and present the data.

In the first study (Basch et al., 2016), students completed field observations at 25 street food vendors in close proximity to five major medical centers in New York City, designated locations A–E (see Table 1). Food vendors near hospitals were chosen for this study because such vendors are typically patronized by hospital workers and visitors who bring food into the hospital, as well as by outpatients with compromised immunity, who may be particularly vulnerable to foodborne illness. The data collection process included documenting the number of monetary transactions and the number of subsequent glove changes following a monetary transaction.

The first step of each contact with a vendor was to collect a dollar bill for testing. Students worked in pairs, and while one student made a purchase with a higher-denomination bill ($5, $10, or $20), the second student donned individually wrapped, single-use sterile examination gloves. The gloved student received the change, extracting a single dollar bill, which was immediately placed inside a sterile tube containing 40 mL of sterile tryptic soy broth. In order to maintain the best practice of aseptic technique possible in a public setting, the ungloved student handled and opened each tube only long enough for the gloved student to insert the sample. Samples were stored on ice in an ice chest for transport to the laboratory where they were tested for bacterial contamination. The process of collection of currency was repeated using a fresh pair of sterile gloves for each dollar bill sample collected, for a total of 25 separate transactions (25 dollar bill samples) from five vendors.

In the lab, a 100 µL sample was removed from each test tube, plated on tryptic soy agar, and incubated at 37°C overnight, or at 35°C for up to four days. Further dilutions of samples were prepared and plated as necessary to facilitate colony counting.

Table 1 summarizes the data, showing that in 495 observed monetary transactions a mere seven glove changes were completed by food workers. Note that 11 of 34 food workers wore no gloves at all while handling money and food (Basch et al., 2016). Nineteen of the 25 bills collected (76%) generated bacterial colonies, with from 400 to 42,000 colony-forming units (CFUs) of varied morphology and size. Thirteen of the samples with the highest CFUs were chosen for coliform bacteria testing using the Colilert test (Idexx Laboratories, n.d.), and 10 of those samples tested positive for coliform bacteria.

It should be noted that in another study (Basch et al., 2015), observations of food vendor behavior alone were conducted in a similar fashion, but that study lacked the important element of a microbial analysis. Hence, we were only able to tell part of an important story. In other words, we observed that gloves were not often changed by food vendors after collecting money, but the fact that money can carry microbes, which could be transferred to the customer, was not documented. The addition of microbiological analysis to this project enabled our students to appreciate the link between disciplines, and it made the conclusions of the study more compelling – that food vendors potentially endanger customers when they ignore health codes for food handling.

The second interdisciplinary study (Basch et al., 2018) focused on 17 mall food vendors in New Jersey. This study involved two phases: Phase 1, which consisted of 10-minute observation periods capped off by a transaction and collection of dollar bills; and Phase 2, which involved 60-minute observation periods. Table 2 shows that in 175 transactions observed in Phase 1 there were four glove changes (2.3%). In 1193 transactions observed in Phase 2 there were 40 glove changes (3.35%). Seventeen dollar bill samples were collected from the 17 vendors in Phase 1, and all the samples generated bacterial CFUs. Six of the 17 samples (35.3%) were coliform positive.

The Institutional Review Board/Human Subjects Committees at William Paterson University and Teachers College, Columbia

Table 1. New York City mobile food vendors study: summary of food cart data and biological testing by hospital location.[a]

NYC hospital location/no. of food vendors obs.	Total no. of customers served during the observation period	Total no. of times food vendors exchanged money	Total no. of times the food vendors changed their gloves	Percent of samples that grew CFUs (colony-forming units)	Range of CFUs	Percent of tested samples that were positive for coliform bacteria
A/5	120	115	0	100%	400–13,600	100%, 4 of 4
B/5	130	126	4	100%	800–42,400	25%, 1 of 4
C/5	113	112	0	40%	0–2000	100%, 1 of 1
D/5	122	94	3	60%	0–2400	100%, 1 of 1
E/5	49	48	0	80%	0–22,400	100%, 3 of 3
Total	534	495	7		0–42,400	

[a]From Basch et al. (2016); reprinted with permission.

Table 2. New Jersey mall study: summary of total transactions, glove changing, and biological testing during Phase 1 and Phase 2 observations.[a]

		Phase 1 observations			Phase 2 observations			Phase 1 lab testing	
Vendor	Food type	Number of transactions	Number of workers wearing gloves[b]	Number of glove changes	Number of transactions	Number of workers wearing gloves[b]	Number of glove changes	Colony-forming units	Coliform bacteria
Total		175	7	4	1193	6	40		6
1	Lunch/ Dinner	13	0	–	100	1	0	1.18×10^7	–
2	Lunch/ Dinner	8	0	–	76	0	–	1.03×10^{10}	+
3	Lunch/ Dinner	14	0	–	113	0	–	3.06×10^7	–
4	Lunch/ Dinner	8	0	–	47	0	–	4.72×10^7	–
5	All	10	0	–	84	0	–	1.13×10^8	–
6	All	7	0	–	89	0	–	2.42×10^8	+
7	All	12	0	–	106	0	–	3.16×10^8	+
8	All	5	1	0	38	1	0	5.34×10^8	+
9	All	18	0	–	60	1	20	2.79×10^8	–
10	All	9	1	0	80	0	–	9.10×10^7	–
11	All	5	2	1	68	1	0	2.89×10^8	–
12	All	16	0	–	121	0	–	1.33×10^8	–
13	Snack	4	1	2	20	1	20	2.74×10^7	–
14	Snack	10	0	–	45	0	–	6.60×10^7	+
15	Snack	21	1	0	40	0	–	2.96×10^7	–
16	Snack	6	0	–	49	0	–	1.30×10^9	+
17	Snack	9	1	1	57	1	0	4.40×10^7	–
C1	Positive control							*E. coli TSB culture*	+
C2	Negative control							0.0 CFUs	–

[a]From Basch et al. (2018); reprinted with permission.
[b]Of the two workers observed.

University, approved these studies. Data were recorded in Excel, and SPSS version 23 was used to perform chi-square tests of association to assess various factors related to glove-changing behavior. Cohen's kappa was calculated to determine inter-rater reliability.

○ Recommendations

We emphasized the importance of collaboration between professions and disciplines, as well as of teamwork. The field of public health focuses on human behavior and how it can influence human health. Biology addresses the physical world, in this case the presence of microbes and how they may increase the risk of disease. Students conducted observations of human behavior and learned aseptic technique and how to test for bacterial contamination. They were also exposed to elements of study design and statistical analysis in both public health and biological sciences.

For biology students, this type of collaboration and interdisciplinary study helps students understand how science affects human lives. For public health students, this study helps students learn laboratory techniques, practice quantitative methods, and make links to the science behind the health issues. All students involved

in such a study are motivated by the goals of the study, to improve health and reduce the risk of disease by revealing behavior patterns that can put people in the general population at risk.

These studies were of particular relevance not only to students who worked on the project, but to those who heard about this in their classes. New Jersey students can relate to purchasing food in shopping malls. All students can appreciate the issues of foodborne illness, food safety among street food vendors, and the particular risks of exposure of health-care workers and vulnerable patients.

There was a critical connection made in these projects between the lack of compliance with the health code and bacterial contamination of the money that food workers handle while providing food. The studies concluded that there is a need for strategies to monitor and increase glove-changing habits of mobile food vendors in an attempt to reduce the risk of foodborne illness.

The hands-on projects completed by the students bring the concepts taught in courses outside of the classroom and into the field and the laboratory. The research design is flexible and can be modified to involve larger numbers of students in a formal class or workshop setting. These projects can motivate students to see connections and to wonder about what is going on in the real world and how we can intervene to improve health and well-being. We encourage science instructors to team up with educators in health and other disciplines, to enable students to see the links and influences of disciplines in our complex world.

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