On Academics

TEACHING EPIDEMIOLOGY CONCEPTS EXPERIENTIALLY: A "REAL" FOODBORNE OUTBREAK IN THE CLASSROOM

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Active learning methods require students to engage in their own learning process through doing and then reflect on what they have done.[1] Active learning has been shown to result in greater enjoyment for the students and, in some cases, better understanding and recall of the concepts being taught.[2,3] Learning how to conduct outbreak investigations is a basic competency for epidemiology students. Multiple methods are implemented to teach these concepts, including experiential learning through student participation in real outbreak investigations, computer simulation programs, and detailed case studies. While these strategies contribute to student learning, real outbreaks can be unpredictable and may not offer the participant's point of view. In addition, very few case studies move from a tabletop exercise to a full-scale exercise for foodborne outbreaks.

Within the context of a credited course, we have trained graduate public health students to work with state and county health departments during outbreak investigations. This semester-long course includes training sessions at several health departments around the state, as well as didactic lectures, exercises, and experiential participation with infectious diseases outbreaks and public health response.[4] As a supplement to the student participation in the actual county and state outbreak investigations, we designed a classroom exercise to teach basic outbreak investigation concepts through a combination of techniques grounded in experiential and problem-based learning pedagogy. The exercise includes tenets of both pedagogies. Students actively engage in generating their own problem for investigation as direct participants in an "outbreak" that occurs as a result of consuming "contaminated" food during a potluck meal. This hands-on, classroom-based exercise incorporates multiple epidemiologic concepts and, best of all, is fun for the students.

The primary learning objectives of this exercise are to give students a real-world understanding of (*1*) recall bias; (*2*) measuring associations with small sample sizes; (*3*) dealing with raw data; (*4*) interviewing techniques, including what it is like to be interviewed by an epidemiologist; and (*5*) determining the likely etiology of a disease based on symptomology and incubation periods. The exercise is scalable, allowing it to be applied to any setting where food is served to a larger group, such as departmental seminars or even college-wide gatherings.

This article describes each of the steps needed to conduct the exercise, including the roles of the instructor and the students/participants. We have also included some hints that will make the exercise more successful, both logistically and as a learning experience. We outline preparation activities, what to do the day of the event, communication with the students following the potluck, the components of the culminating exercise as they relate to the teaching objectives, and exercise evaluation strategies. Figure 1 outlines the timeline for each step in the process.

This exercise was designed to meet competencies for entry-level epidemiologists working at a government public health agency as described by the Centers for Disease Control and Prevention (CDC) and the Council for State and Territorial Epidemiologists (CSTE).[5] The learning objectives of the exercise link to three of the tier 1 competencies for applied epidemiologists, specifically those for assessment and analysis (skill domain 1).[5] The competencies addressed are listed within the corresponding steps described in the article. Conducting an investigation is itself a sub-competency and is addressed throughout the exercise.

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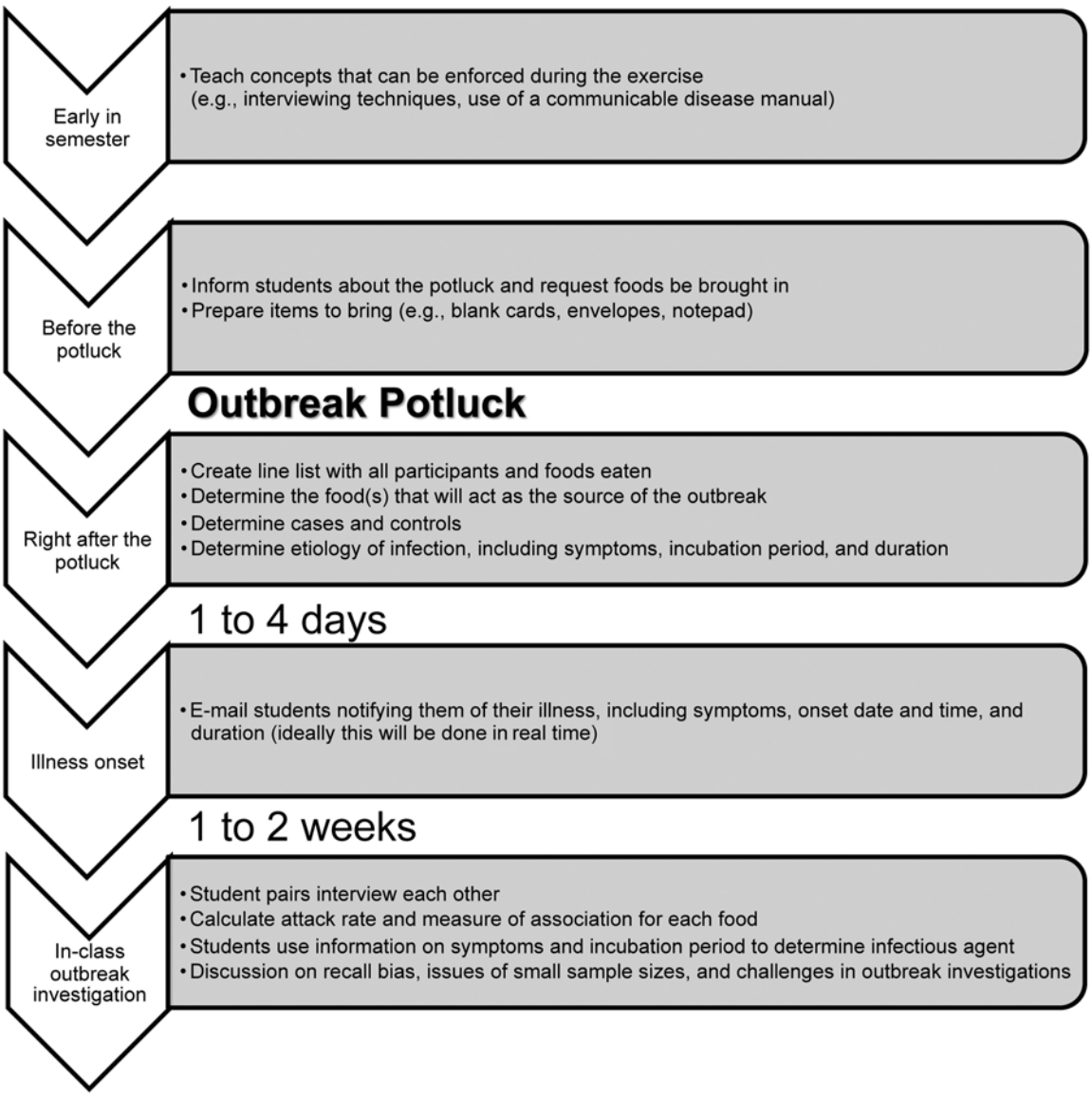
Figure 1. Timeline of events to plan and execute Outbreak Potluck Exercise



STEP 1: SETTING THE STAGE FOR THE OUTBREAK

Instructor's role

Identify a setting in which you have sufficient time to have a meal for students and other potential attendees. For example, you could conduct the exercise toward the end of the class term, at a weekly seminar where food is provided, an existing departmental potluck, or even a college-level picnic. Be sure to schedule the event early enough in the term so there is at least one subsequent meeting time scheduled for the students. Prior to the event, create sets of cards with a unique number for each of the dishes that will be brought, plus a few extra sets for unexpected dishes. Each set should have at least as many cards as the number of students participating.

Alternatives. Instructors may also collect information on the food being brought ahead of time and make cards with each food type being brought. This step requires extra preparation but may reduce confusion in identifying which card number is matched with which dish.

Students'/participants' role

Prepare or buy food to bring to the potluck.

Hints

To give students the best perspective of what it is like to be a part of an outbreak, it is important that they do not realize the true purpose of the potluck or know as few details as possible. Selecting a theme (e.g., brunch for a morning class) or type of food (e.g., Mexican or Italian) as a class can also simplify event planning and add a little cohesiveness to the menu.

STEP 2: THE DAY OF THE POTLUCK

Instructor's role

The potluck can be held as an end-of-the-semester activity (as long as there will be one class period following the potluck) or in conjunction with other activities, such as student class presentations. Before foods are set out, create a codebook to assign a specific dish to each number. Stacks of numbered cards should be arranged next to their corresponding dishes.

Students' role

Students are invited to eat whatever they wish, but for each food they select, they must pick up a card associated with that food. Students are given envelopes to collect the cards, which will later be used to represent each student's actual menu. If the person takes a second helping of a dish, he or she should pick up a second card and place it in the envelope. Following the meal, students are asked to seal their envelope, write their name and e-mail addresses on it, and return it to the instructor.

Hints

Be sure to tape the corresponding number to each of the dishes so there is no confusion as to which number to draw for each food item. Bring extra blank cards to be filled out in case of any last-minute changes to the menu.

STEP 3: FOOD HISTORY AND DISEASE SELECTION

Instructor's role

Create a line list that includes every person exposed, using foods consumed based on the cards submitted at the end of the class. The line list should include all the foods available at the potluck. Code the foods as either eaten (1) or not eaten (0) for each student to determine the number of people that actually ate each food. Reviewing this information, the instructor must choose a particular food to be the cause of the outbreak. It is important to pick a food that not everyone ate so there will be some controls in the analysis. For example, if there are 20 students in the class, choose a food that 10–15 students ate.

The agent of infection should be selected based on (*1*) the type of food chosen as the vehicle of infection, (*2*) student knowledge and prior information distributed on specific agents, and (*3*) the length of the incubation period as it fits into the course schedule. Completion of the exercise is likely to occur within one to two weeks of the potluck, so agents with incubation periods ranging from two to four days are best suited for the time frame (Figure 2).

Once you have selected the vehicle of infection and infectious agent, you should determine the attack rate (i.e., the number of people ill/total number of people who ate that food). This rate can be determined arbitrarily or based on the likely rates for the chosen agent. However, for the purposes of the exercise, the rate should be greater than 50% (ideally, 60%–80%) so that the food responsible for the outbreak will be obvious to the students (although it should be pointed out that this is often not the case). An attack rate of 100% should not be used because (*1*) it is rare in any real foodborne outbreak that everyone who ate the food in question will become ill, for a variety of reasons, including dose received and immune status; and (*2*) it would make the analyses too easy for the students.

For a challenge, two foods that are often eaten together can be linked to demonstrate confounding. If, for example, strawberries and whipped cream are both options and the strawberries are the chosen culprits, the measure of association for whipped cream will also likely be high because the two foods are often eaten together. Students must then find out if anyone at one of the suspected foods without the other, as well as their knowledge of the foods and potential agents, to determine the true cause of the outbreak.

STEP 4: DISEASE ONSET, SYMPTOMS, AND DURATION

Instructor's role

Based on the normal distribution of the incubation period, assign each participant an "illness history" (i.e., symptoms and duration of illness). During actual outbreaks, people do not all have the same universal set of symptoms, incubation period, or length of illness, so it is a good idea to vary the experiences for the students slightly. For each case, add to the line list (*1*) an incubation period (distribute students over the known time range), (*2*) a set of symptoms (some mild cases, others more severe), and (*3*) duration of illness.

Hint

Graph the illness onset from the mock data to ensure the epidemic curve fits the agent and describes a point-source outbreak.

Figure 2. Incubation periods and symptoms of common foodborne diseases appropriate for use in the Outbreak Potluck Exercise[a,b]

Agent	*Incubation period*	*Common symptoms*
Bacillus cereus	1–24 hours	Vomiting, abdominal cramps, diarrhea, nausea
Campylobacter	1–10 days (usually 2–5 days)	Diarrhea (frequently bloody), cramps, fever, vomiting
Clostridium perfringens	2–36 hours (usually 6–12 hours)	Vomiting, abdominal cramps, putrefactive diarrhea, nausea
Escherichia coli O157H7	1–10 days (usually 3–4 days)	Severe (frequently bloody) diarrhea, abdominal pain, vomiting; can lead to kidney failure
Nontyphoidal *Salmonella*	6 hours–10 days (usually 6–48 hours)	Abdominal cramps, diarrhea, vomiting, fever, chills, malaise, nausea, headache
Salmonella typhi	3–60 days (usually 7–14 days)	Malaise, headache, fever, cough, nausea, vomiting, constipation, abdominal pain, chills, rose spots, bloody stools
Shigella species	12 hours–6 days (usually 2–4 days)	Abdominal cramps, diarrhea, vomiting, fever, chills, malaise, nausea, headache
Staphylococcus aureus	30 minutes–8 hours (usually 2–4 hours)	Nausea, vomiting, retching, diarrhea, abdominal pain, prostration
Vibrio parahaemolyticus	4–30 hours	Abdominal cramps, diarrhea, vomiting, fever, chills, malaise, nausea, headache
Norovirus	15–77 hours (usually 24–48 hours)	Diarrhea, fever, vomiting, abdominal pain

[a]Council to Improve Foodborne Outbreak Response. Guidelines for foodborne disease outbreak response. Atlanta: Council of State and Territorial Epidemiologists; 2009.

[b]Heymann DL, editor. Control of communicable diseases manual. 19th ed. Washington: American Public Health Association; 2008.

STEP 5: CASE SELECTION

Instructor's role

Once you have determined the food vehicle, agent, and attack rate, you will need to identify which students will be the cases and controls. Consider a class of 20 students where 15 students ate the contaminated food. For an attack rate of 60%, nine of those students would be considered cases, and six would not (Figure 3). A random number generator can be used to assign case and control status. For the students who did not eat the contaminated food, select about 10%–20% to be cases as well and use this number/percentage to discuss issues of cross-contamination. For the purposes of this example, this would result in one additional case.

STEP 6: THE OUTBREAK BEGINS

Instructor's role

The outbreak can begin as soon as the minimum incubation period assigned has been attained. Each case receives an e-mail notification of the development and duration of his/her symptoms. The notification includes the time in which the symptoms started (ideally, this is the same time the e-mail is sent out), the list of symptoms they are experiencing, and the time in which their illness will resolve. One example is:

Dear Student,

I regret to inform you that, at 4 p.m. on Sunday, you began experiencing vomiting, diarrhea, and abdominal pains. These symptoms will last for the next 36 hours. Feel better soon.

It is important to only e-mail students who are cases, and not the controls. Doing so will help to demonstrate recall bias and determine if students who became "ill" remember the foods they ate differently than students who were not cases.

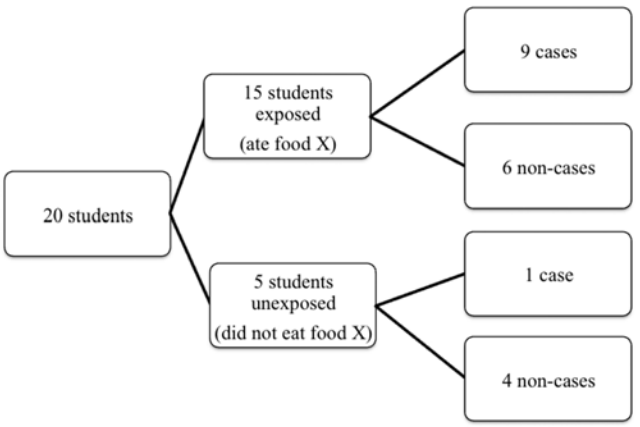
STEP 7: PREPARING FOR THE INVESTIGATION

Instructor's role

Creating the questionnaire. Develop a succinct questionnaire for use in the class session focused on the outbreak. Survey design is beyond the scope of this described exercise but could be incorporated as a teaching point. To more closely follow what students would use in a real outbreak setting, you may want to contact local health departments requesting they share their questionnaire. You can then modify it to fit the scenario, reflecting dates of exposure, list of food, and setting.

Completing the line list. Create a blank line list for a select number of students that can be completed following

Figure 3. Example of student breakdown into cases and controls based on foods consumed and attack rates: Outbreak Potluck Exercise



the interview process (i.e., completion of the questionnaires). Be sure to include at least three controls and three cases to determine if there is a difference in recall between the two groups.

Contacting students. E-mail all students, reminding them to print and bring to class the e-mail they received if they were identified as a case. In addition, students should bring laptops to class to access online programs such as Open Epi[6] and Epi Info™.[7]

Determining the measures of association. If time permits, you can create a database for students to aggregate their data and calculate the rate ratio and odds ratios. If classroom time is short (i.e., less than two hours), you can prepare the measures of association ahead of time for interpretation by the class. Analyses can be presented for both a cohort study design, as this is a defined population with known exposures, and a case-control study, as this design is more commonly used in outbreak investigations. Comparison of the two designs and differences in results can be talking points for discussion. This discussion may also present an opportunity for students to be exposed to Open Epi[6] or Epi Info[7] to calculate the measures of association and confidence intervals. If students will be completing analyses by hand in the classroom, it may be useful to create some sample two-by-two tables and leave several blank for student completion.

STEP 8: IN-CLASS INVESTIGATION

Instructor's role

Bring the following items to the class: questionnaires, communicable disease manual, and each student's packet of food cards for comparison.

Students' role

On the day of the in-class investigation, randomly pair students and hand out the questionnaires. Students will take turns interviewing each other. It is important to remind students to use the information on the e-mail for their illness history. To make interviewing more realistic, you can assign students personalities to use during their interviews that are based on real-life interview experiences (Figure 4). This personality assignment challenges students' interviewing techniques and ability to deal with a wide range of people and can add to the fun of the exercise.

Following the interviews, the empty database can be presented to the group on a screen or on paper if that is not possible. Ask the interviewers of at least five cases and five controls to populate the database with the information from their interview. If time permits, this can be done for everyone in the class. Once all the information is made available to the students (either from the interviews or from a spreadsheet already completed by the instructor), the students are asked to determine the attack rate and measure of association for each food (this can be done quickly by assigning a specific food to each student to calculate). It is possible for students to also determine the confidence intervals surrounding the measure of association to find out if the relationship is statistically significant.

A measure of agreement (kappa) can be calculated for the control and case interviews for several foods to test the data for recall bias. The kappa statistic can be calculated for both the overall population, comparing the interview data with the true exposure data (i.e., food cards collected in envelopes), and by case and

Figure 4. Potential interview personalities to be used by students participating in the Outbreak Potluck Exercise

Options for interview personalities[a]
Cases
• Very talkative about symptoms and entire medical history
• Wants to sue whoever is responsible for making the dish that made them ill
Controls
• Suspicious as to how the health department got their information
• Keeps repeating they did not become ill and the interview isn't necessary
Cases or controls
• Convinced of a conspiracy theory involving the government, the school, the food industry, etc.
• Very concerned about their information remaining private

[a]Personalities are based on actual people and events.

control states, to determine if there are differences. As students do not actually experience symptoms, the degree of potential recall bias may be minimized.

Hint
If time is short, collect the first set of interview forms and enter data from the interviews into the blank line list while the second student is conducting his/her interview.

Tier 1 competencies addressed
This step of the exercise addresses the following tier 1 competencies: organize data from surveillance, investigations, or other sources; and analyze data from an epidemiologic investigation or study.[5]

STEP 9: IN-CLASS TEACHING AND DISCUSSION POINTS

Several learning objectives related to outbreak epidemiology are addressed in this exercise (Figure 5). Methods presented include creation of a line list, calculating an attack rate, and determining measures of associations. Study design and recall bias are also addressed.

Another important task in any outbreak investigation is to determine the causative agent of the disease. While most modern outbreak investigations rely on laboratory confirmation of the agent, the interpretation of an epidemic curve and other key information can also be useful. Students can use the data to create an epidemic curve as well as determine the set of symptoms and range of the duration of disease to determine what may have caused the outbreak. Instructors may also inject information such as laboratory results into the discussion to assist students in making this determination. Students should be reminded to bring a communicable disease manual to class the day of the exercise to help in this process.

Figure 5. Outbreak epidemiology concepts covered in the Outbreak Potluck Exercise

Outbreak epidemiology concepts covered

- Recall bias
- Interviewing techniques
- Attack rate
- Line lists
- 2 × 2 tables
- Cohort vs. case control
- Use of a rate ratio or odds ratio
- Incubation periods and symptomology
- Use of communicable disease manual to determine etiology of disease
- Confounding

Tier 1 competencies addressed
This step of the exercise addresses the following tier 1 competency: summarize results of the analysis and draw conclusions.[5]

EVALUATION

After each year's implementation of the exercise, the instructor evaluated the process and made improvements. These steps resulted in the notes and tips provided in this article. As part of a larger course, evaluation of this exercise has been included in the university course evaluation, where in-class activities historically receive a high rating (average of 4.7 out of 5.0). In addition, students have often mentioned this exercise as one of the strengths of the course in the optional comments section of the course evaluation. Some students have indicated that it allowed them to apply what they had learned in a more realistic setting. The fact that students mention it in their general comments about the course overall implies that it is very well regarded by the students.

To specifically evaluate the strength of this exercise, an evaluation plan including a pre- and post- knowledge-based exam and a self-assessment of core competencies gained can be utilized. The pretest should be administered one week following a didactic lecture on the topic to determine the ability of the exercise to enhance the learning concepts beyond a formal presentation. This pretest will also determine the level of retention following the lecture. The evaluation should involve case studies that present an outbreak scenario and data as opposed to direct questions about the content they learned. The case studies should be a foodborne outbreak with parallel, but not identical, processes. Scenarios should be point source outbreaks, such as an outbreak at a wedding, cruise, or banquet. The pre- and posttests should include not only task-oriented questions, but also self-assessment and concept-ranking questions (Figure 6). Ideally, the posttest would be given a week after the exercise, to match the amount of time following the didactic lecture preceding the pretest. Both tests can be given as online or in-class assignments. For the self-assessment of the core competencies, students would be asked to rate their level of understanding using the CDC/CSTE Epidemiology Competency Assessment Form for Tier 1 Epidemiologists (http://www.cdc.gov/AppliedEpiCompetencies/downloads/AEC_Assessment_Tier1.pdf). Finally, instructors should review all of the evaluation data following the exercise and make modifications where students did not feel competencies were well addressed.

Figure 6. Model evaluation questions for pre- and posttests: Outbreak Potluck Exercise

Mock scenario: Following a wedding, the bride calls the public health authorities indicating that a large number of guests have fallen ill after the reception. Investigations identify 25 cases of gastroenteritis out of 146 guests. It is now two weeks since the wedding.

1. Calculate the attack rate.
2. Calculate the odds ratios for five foods.
3. Rate your comfort level in performing the above tasks:
   - Simple: I did not need to use another resource to determine how to calculate.
   - Moderate: I can do this comfortably but with an outside resource.
   - Difficult: I had difficulty completing this task even with an outside resource.
4. To what degree do you think recall bias can impact the results of your study of a foodborne outbreak?
   - Recall bias is of minimal importance.
   - Recall bias is somewhat important.
   - Recall bias is a major concern.
5. To what extent do you agree with the following statements?[a]
   - People can accurately recall the food they have eaten. 1 2 3 4 5
   - All gastrointestinal illnesses have very similar symptoms and incubation periods. 1 2 3 4 5

[a]On a scale of 1 to 5 where 1 = strongly agree and 5 = strongly disagree

SUMMARY

While an in-class exercise will never replace the experience of investigating a real outbreak (and all of the issues that may arise, such as incomplete data or people refusing to give a stool), an outbreak potluck provides the students some direct involvement in the concepts behind the investigation. This exercise is meant to engage students while teaching them a variety of epidemiology concepts, as well as to have fun. In keeping with experiential and problem-based learning, this exercise requires that students become actively involved in the experience, participate in group discussion and reflection of the experience, and utilize the data generated from their active participation to practice analytical techniques developed previously. Students can then take the knowledge acquired during the exercise and apply it to real-world outbreaks they participate in as members of the outbreak response team.

For public health professionals in the field, outbreak investigations challenge their skills and require fast-paced decision-making. Having students conduct and complete questionnaires, enter and analyze data, and make a final determination of the causes of the outbreak (both food and agent) in a short time frame reminds students that outbreak investigations are often done under tight time constraints; as such, it is important to gather data quickly and accurately to make any ultimate public health decisions.

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REFERENCES

1. Bonwell CC, Eison JA. Active learning: creating excitement in the classroom. Association for the Study of Higher Education-Education Resources Information Center Higher Education Report No. 1, p. 33-52. Washington: The George Washington University; 1991.
2. Thornton RK, Sokoloff DR. Assessing student learning of Newton's laws: the force and motion conceptual evaluation and the evaluation of active learning laboratory and lecture curricula. Am J Phys 1998;66:338-52.
3. Humair JP, Cornuz J. A new curriculum using active learning methods and standardized patients to train residents in smoking cessation. J Gen Intern Med 2003;18:1023-7.
4. Pogreba-Brown K, Harris RB, Stewart J, Anderson S, Erhart LM, England B. Outbreak investigation partnerships: utilizing a student response team in public health responses. Public Health Rep 2010;125:916-22.
5. Centers for Disease Control and Prevention (US). Competencies for applied epidemiologists in governmental public health agencies [cited 2012 Feb 2]. Available from: URL: http://www.cdc.gov/AppliedEpiCompetencies/#4
6. Dean AG, Sullivan KM, Soe MM. OpenEpi: Open Source Epidemiologic Statistics for Public Health: Version 2.3.1 [cited 2011 Jul 29]. Available from: URL: http://www.openepi.com/OE2.3/Menu/OpenEpiMenu.htm
7. Centers for Disease Control and Prevention (US). Epi Info™: Version 3.5.3. Atlanta: CDC; 2011.