ABSTRACT
Infectious diseases are a major threat to humans, and finding sources of infection is therefore an important task. We designed a website to help teachers communicate the relevant principles of infectious diseases, deepen students’ understanding of disease transmission, and equip students with the ability to trace the origin of infections caused by microorganisms. The website enables multi-person online use, with real-time recording of the exchange process and real-time viewing of infection results. Additionally, the website is able to preserve data permanently by setting multiple infection sources, providing a better simulation of real-world scenarios. Test use of the website by 120 students demonstrated that it has no significant bugs.

Key Words: infection; finding the source of infection; Python; Django; website.

O Introduction
Infectious disease occurs when pathogenic organisms spread among humans, among other animal species, or between animals and humans. Epidemics can be both covert and sudden (Anderson & May, 1992). Acute and chronic infectious diseases have often been disastrous for human health, causing great losses of life and impeding social and economic development (Binder et al., 1999; Daszak et al., 2000; Smolinski et al., 2003; Morens et al., 2004; Jones et al., 2008). There are many recent examples. The 2003 outbreak of severe acute respiratory syndrome (SARS) represented a heavy blow to China’s society and economy (Li et al., 2005). West Nile virus (Lanciotti et al., 1999), an arthropod virus (or arbovirus), is transmitted to humans mainly through mosquito bites and has caused thousands of deaths so far (the first documented mortality in the United States occurred in 1999). And in Africa, the Zika, Ebola, and Chikungunya viruses have caused considerable social and economic losses amid surging morbidity and mortality (Anderson & May, 1992; Metsky et al., 2017). A crucial step in preventing and controlling all these diseases is to find the sources of infection, and this article introduces a website designed to help students properly understand this process.

The website, called “Find the Source of Infection,” is based on the principle that if A and B are in contact, the infection status code of A will become AB; the code of B will become BA; and both contacts will copy all their code to each other. The website is easily accessible on mobile phones, computers, and other devices. It is completely free of charge and allows 100 people online at the same time. More functions will probably be added in the future. To access the website, please contact the authors to obtain the URL, an account number, and a password.

O Methods
Website Structure & Navigation
The website was built using Python 3.5, Django 2.0.4, and SQLite 3. Its overall structure is shown in Figure 1. The home page is “Input Code” (Figure 2A), which will go to the “Input Code Successful” page (Figure 2E) if the input is valid. Administrators can set on/off inputs (Figure 3F). When the switch is set to on, participants can start to enter exchange information. When the switch is set to off, information can no longer be entered. Inputs will be saved in the “Exchange Record” table (Figure 3D) first, and then loaded to the “Blog Post” table (Figure 3C) after being processed. After all data are collected, all exchange (Figure 2B) and infection records (Figure 2C) will be displayed. An error page (Figure 2F) appears if the “Exchange Record” page (Figure 2B) is visited without submitting any records (the “Exchange Record” page can be viewed at any time in the process). “Exchange Record” data can be searched simply (Figure 3D). Infection results are also readily available (Figure 3E). Administrators can log in (Figure 3A) for “backstage” data management; from the “Administration” page (Figure 3B), click “view site” to jump to the “Input Code” page. Finally, the “About” page (Figure 2D) provides information about our lab.
Access each other by clicking the button at the top of the page

**Input Code**

- Is the input legal?
  - N
  - Y
    - Successfully submit page

- Write the submitted data to the exchange record table

**Exchange Record**

- Is there a query?
  - N
  - Y
    - Updated page

- Query the database

**Results**

- Is there a query?
  - N
  - Y
    - Updated page

- Return all exchange records

**Exchange record table**

**Exchange record table**

**Codes table**

**Administrators can view and modify all information**

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**Figure 1.** Overall structure of the website. The flowchart demonstrates the relationship between three main pages and the control panel. The “Input Code” page is for recording input and saving the data to the database. The “Exchange Record” page is for reading all the exchange records from the database. The “Results” page is for reading all the infection status codes from the database and correctly calculating and displaying the infection results.

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**How to Simulate Inference of the Source of an Infection**

The website is relatively straightforward to use (Figure 4), as it requires only a few simple steps.

*If you are a teacher:*

1. Log in and empty all databases, such as blog posts, exchange records, infection sources, and on/off inputs.

2.1 Set up one or more infection sources. An initial infection source is necessary (it can be modified later on).

2.2 Set up the input switch to get the website to work. Exactly one number is required to activate the page (otherwise it will report an error).

3.1 It is necessary to determine in advance what each person’s ID is. Each user has to have his or her own ID, which can be a student ID, name (no repetition), a favorite animal, or any other, but this ID must be unique.

3.2 When inputting, each student will need to enter his or her own ID and that of the other student(s) that he or she will exchange with. Here, sequential order does not matter as long
Figure 2. Introduction to the website. (A) “Input Code” page provides input interface. (B) “Exchange Record” page shows all exchange records. (C) “Results” page shows all infection results. (D) “About” page shows information about our lab. (E) “Input Code Successful” page. (F) Error page: no exchange records have been entered. All the screenshots are from RED MI NOTE 5 Phone and Baidu Browser (Android 10.7.0.10).
Figure 3. Introduction to the control panel and database. (A) Login. (B) "Administration" page. (C) "Blog Post" table. (D) "Exchange Record" table. (E) "Infection Source" table. (F) "On/off Input" table. All the screenshots are from RED MI NOTE 5 Phone and Baidu Browser (Android 10.7.0.10).
as there is a space between the two IDs; they will copy each other and save as infection status codes. Self-exchange records will not be stored.

3.3 All valid inputs are safely stored in the Exchange Record table to serve as evidence for determining the source of infection.

3.4 Infection results are displayed in the "Infection Source" table. The infection status of each submitted student number is dynamically refreshed as new exchanges occur.

3.5 If one source of infection does not meet the educator's requirements, multiple sources of infection can be set (which will be much more challenging).

4. Wait until all exchanges are completed before proceeding. It is recommended to have sufficient exchanges in order to avoid an unchallenging search for the source of infection. If the source of infection is exchanged with only a few people, it will be very easy to find when searching the results.

5. To secure the results of the experiment from malicious modification, the value of "on/off" should be reentered as any number other than 1 (on), thus shutting down the submission path.

6. Tell students that they need to infer the number and names of infection sources by analyzing the exchange records and the infection results. If they have difficulty with this, hints can be conveyed, such as the number of infection sources.

**Example Results**

In a test run of the website, nine students exchanged records. Their IDs were A, B, C, D, E, F, G, H, and I. If A and B are exchanged, then A becomes A(B) and B becomes B(A); after that, if A is exchanged with D, then A becomes A(BD) and D becomes D(AB). Thus, after exchanges in the order AB, AD, CD, EF, BE, FH, BI, and DG, we get the results A(BD), B(AEF), C(DABHFE), D(ABC), E(BFA), F(EH), G(DABC), H(FECDAB), and I(BAEF). Given the specified source of infection, the system will show that A, C, D, G, and H are all infected at this time. Students can then exchange notes with each other and infer from the uninfected B and F that A, B, E, F, H, and I are not the source of infection; the source of infection is thus either C, D, or G. Finding that there is no G in the exchange record of the infected H, the students deduce that G is not the source of infection. A is infected and did not exchange with G or C, so it can be concluded that D is the source of infection.

**Discussion**

This website allows students to learn about the spread of infectious diseases and the search for sources of infection in the form of a game. When there are many students in the experiment and/or more than one source of infection, the large amount of data necessitates that students use teamwork. For example, some students might sort out the dates of infection while others sort out the uninfected codes from the infected, exclude non-sources of infection, or summarize the results. It is proverbial that teamwork skills are essential to students (Gurt & Tallada, 2017), and collaborative learning can improve students' achievement (Kurucay & Inan, 2017). Thanks to the flexibility of the inference process, students are able to develop their cooperative spirit through teamwork and strengthen their understanding of infectious diseases by engaging in independent deduction.

Although the website is fully functional, a few imperfections have been discovered during test runs with 120 students. First, the site is not able to detect when someone randomly inputs an ID from...
the record table exchanging with his or her ID, which will result in disorganization between experiments and records. However, this does not affect students’ inference because students ultimately determine their results on input records; as long as records are valid, this information can be stored. Second, only one teacher at a time can use the website; functionality for performing multiple experiments at the same time has not been implemented yet, but this will be considered in the future. Third, security verification is not advanced enough to stop malicious attacks. Fourth, exporting results in Excel or TXT formats is not yet possible. Fifth, the website is currently unable to simulate a common real-world situation in which an infected person may not recall everyone with whom they have been in contact. Under general circumstances, people’s memories can make mistakes, but the records in this exercise are 100% accurate, which leads to complete accuracy of the inference. This could be taken into account by adding an appropriate mutation probability in the future, whereby the infection status code may not be recorded or an incorrect result may be recorded.

Although the website is not yet perfect, overall its basic functions are fully operable and can provide teachers with a good method for teaching how sources of infection are tracked down in real-world disease outbreaks. Again, to access the website, please contact the authors to obtain the URL, an account number, and a password.

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