Tips and Tools

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Implementing Online Discussion and Mind Mapping to Investigate a Disease Outbreak

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INTRODUCTION

The abrupt shift to online learning caused by the coronavirus disease 2019 (COVID-19) pandemic has created challenges for maintaining real-time discussions. Instructors often face difficulties in encouraging and assessing student participation and engagement with the course material. Online discussion options may allow for only superficial comments in discussion boards or represent an intimidating atmosphere with too many silent, faceless participants (1–4). Therefore, we implemented an accessible learning activity in our Microbiology for Nursing course to strengthen problem-solving and discussion-based skills.

Mind mapping can be implemented to allow students to visualize relationships between key components of a larger complex issue (5–8). The mind map is a useful educational tool that allows students to better see the big picture when discussing complex etiologies and disease progression. Entire topics can be easily summarized on a single page, and a thorough mind map can effectively illustrate concepts in a hierarchy as students organize fine details about large case studies. When discussing disease outbreak, mind maps are well suited to the disease triangle activity. The disease triangle breaks down an outbreak into three essential components: pathogen, environment, and host. Upon completing their individualized, preassigned reading on either the pathogen, environment, or host (see Appendix S1 and Table S1 in the supplemental material), students can brainstorm together in small groups to generate mind maps on their assigned "corner" of the triangle. The disease triangle further aids in comprehending an epidemic, as each group was responsible for only one corner of the triangle and relied on their peers in other groups to learn about the remaining two corners. A simplistic model of the complex outbreak can illustrate how the pathogen, hosts, and environment all contributed to the further spread of the disease and the associated mortality.

LEARNING OBJECTIVES

By the end of this activity, students will be able to use mind maps and the disease triangle to (i) investigate an outbreak (for example, cholera in Haiti) to understand host-pathogen interactions, (ii) describe the steps in the chain of infection, (iii) explain how characteristics of a given host, pathogen, and environment can influence a disease state, (iv) explain methods that can interrupt the chain of infection, and (v) explain the role of public health agencies.

PROCEDURE

The 2010 cholera outbreak in Haiti presents an excellent use of the disease triangle and mind mapping to connect cause-and-effect relationships from the perspective of the pathogen, environment, and host. Infection with *Vibrio cholerae* leads to massive dehydration from watery diarrhea (9). Since *Vibrio cholerae* is primarily transmitted through contaminated water, the strained Haitian infrastructure following the January 2010 earthquake and Hurricane Tomas provided optimal transmission routes (10). Because cholera had not been prevalent on the island for over a century, there was little to no natural immunity against the pathogen (11). The students will tie together how each corner of the disease triangle contributed to such a severe outbreak. Each student was given a unique news or research article on *Vibrio cholerae*, the geographical and political environment of Haiti, or the physiology and social norms of the Haitian hosts. Each student brought their unique piece of information to their discussion group to aid in the construction of a mind map following the exercise protocol that is provided in Appendix S1. Prior to the learning activity, students were given a brief presentation on the basics of a mind map, using examples of how stress, diet, and infections influence the immune system

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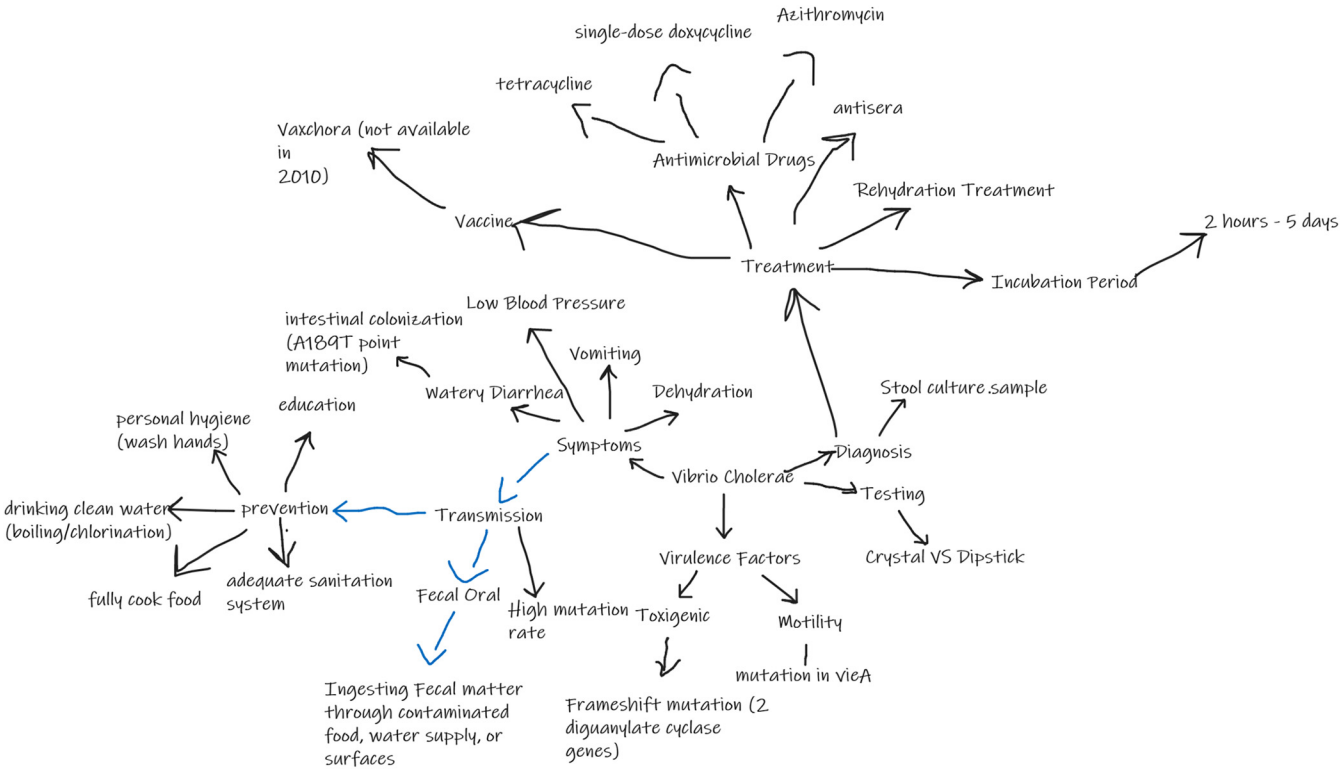

FIG 1. Sample mind map illustrated by the pathogen group.

(Appendix S2). The disease triangle activity ideally requires at least an hour and a half of active learning time. We began the activity in Microsoft Teams with a brief introduction and reminder of their tasks before dismissing the students into their preassigned virtual breakout rooms to discuss and create their mind maps following the guiding questions in their handouts (60 min). The students were accompanied by teaching assistants to help get them started using the Whiteboard function. The learning session concluded with a 30-minute discussion, which allowed the entire class to share and explain their mind maps. The students received detailed instructions on how to log into Microsoft Teams and operate it for this exercise (Appendix S3). The instructors created a list of articles to read prior to the activity (Appendix S1; Table S1). It was an efficient practice to upload or email each article to provide ease of access and prevent paywalls or dead Web links. While we randomly selected which student received which article, the instructor may choose to assign the more challenging articles to more ambitious students.

Instructors may wish to include grading criteria based on the quality and completeness of their group's mind map as well as credit for participation and discussion. An example of a virtual mind map generated by the pathogen group is presented in Fig. 1. The students were assessed on their understanding of the material by completing the study questions at the end of the protocol handout (Appendix S1) following the activity. Responses were graded on the ability of the student to think critically and apply what they learned to the Haitian cholera outbreak as well as the COVID-19 pandemic. A sample set of study questions submitted by a student that received a top score and another set with instructor feedback are provided in Appendix S4. To provide ease in evaluating student success in this learning activity, the students were assessed only on the study questions. Although we did not directly assess our students' mind maps for credit, instructors may wish to include grading criteria based on the quality and completeness of their group's mind map, as well as credit for participation and discussion.

Instructors will need to augment the disease triangle to best fit the overall objective of the course. For example, the activity could be tailored to specific microbiology topics such as biofilms, with each point of the triangle representing quorum sensing, virulence factors, and nutrient availability/environment. Additionally, the disease triangle activity could continue with new groups consisting of students representing the pathogen, host, and environment in which new mind maps could be created to connect all three topics. This would be a full "jigsaw" or "divide and conquer" activity, in which each student would bring the discussion from their previous group to their new group (12). If time permits, implementing the jigsaw component would help further fuel cooperative learning and accountability for the exercise content. Finally, the activity could be conducted asynchronously if needed; such a modification may require each student to upload written or verbal summaries of their assigned readings and to work on the mind map through virtual workspace platforms before an assigned due date.

Safety issues

We do not anticipate any safety issues.

DISCUSSION

We previously conducted the disease triangle activity twice in a high school and three times in a community college setting. We have also implemented the activity three times during in-person laboratory sections for nursing majors. The in-person experience was well received, as noted by the engaging discussions and their thoughtful and thorough mind maps. At the end of course evaluations, the cohort composed entirely of online students also requested more real-time discussions, highlighting the success of the disease triangle and mind mapping activity. The students were primarily sophomore nursing majors, and each section consisted of 25 to 30 students.

The discussions the students had were on topic and strongly reflected a deep understanding of the required reading and integration with other students' contributions. The students' grades for the associated written assignment reflect sufficient understanding of the learning objectives. The average grade was 96.5% (standard deviation [SD], 7.3%), as there were several high values and a strong left skewness.

The abrupt shift to online learning in 2020 disrupted many conventional formats for real-time discussions. Online learning in some capacity is here to stay, and breaking larger class sizes into smaller groups to approach complex issues was shown to be an effective learning exercise for group discussions. The 2010 cholera outbreak in Haiti presented an exceptional opportunity to apply the disease triangle and mind mapping. Each student was able to bring unique information to the discussion from their individually assigned article on the pathogen, environment, or host. This activity received positive feedback from the students, reflected deep understanding of the material, and can be adopted in physical and virtual learning spaces. Furthermore, the context of the disease triangle activity was invaluable for connecting to the COVID-19 pandemic, as evident from relevant comments and questions during the end-of-activity discussion. For example, students discussed how people from different regions of the United States may be more hesitant to receive a vaccine for the virus based on their culture and personal beliefs. This learning activity is a novel approach to better preparing future health care professionals to apply critical thinking skills in real-world situations by combining mind mapping and the disease triangle in a virtual learning modality.

SUPPLEMENTAL MATERIAL

Supplemental material is available online only.

SUPPLEMENTAL FILE 1, PDF file, 0.2 MB.

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