

Outbreak! An Online Board Game That Fosters Collaborative Learning of Viral Diseases

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Remote education has become necessary to resume teaching activities during the pandemic. Most educators were not prepared for this type of teaching or did not have access to the resources required for online classes. Taking advantage of the sudden interest in the microbial world, we developed Outbreak!, a board game that can be used to support hybrid teaching, focusing on transmission and symptoms caused by viral diseases. We used the engaging potential of cooperative board games to provoke an enriching debate about the roles of both researchers and health workers during an outbreak. Educators in developing countries are in desperate need of creative and accessible tools during this unprecedented crisis. We believe Outbreak! can be a useful and fun tool.

INTRODUCTION

In addition to the serious consequences for public health, social life, and the economy, the SARS-CoV-2 pandemic has brought about an additional challenge for educators: remote teaching. Instructors at schools and universities are having a difficult time providing quality education to their students during this prolonged period of confinement. The coronavirus pandemic has accelerated unexpected instant transitions from regular to remote learning across the world, resulting in an urgent need for online education. The most obvious strategy was to hold online meetings at the same time as regular classes, trying to replicate the experience in virtual rooms. It has been much debated that traditional lectures might not be the best way to teach, and the online environment makes this even more evident. At home, students are much more prone to distractions. Also, some students do not even have access to the Internet. On the other hand, the pandemic has sparked worldwide interest in the microbial world: What are the symptoms of the disease? How does the virus spread? How do we flatten the curve? Why do physicians and scientists have to cooperate to come up with the best solution?

This pandemic has imposed a common characteristic of remote and online teaching: the lack of interaction between teacher and student, or among classmates (1). Also, due to physical distancing, collaborative learning and a sense of community were replaced by individual learning and loneliness, and strategies developed to target these two characteristics of the education process can be a game changer. Unlike traditional lectures, classes that include games can potentially increase engagement and improve learning (2). The majority of teaching resources for online education involve student–computer interaction, but a board game could favor peer learning by facilitating student–student interaction (3). Peer learning is effective in promoting microbiology learning because it allows problem-solving and predicts better learning outcomes (4).

Indeed, several studies have shown that board games are effective resources to improve microbiology learning by increasing knowledge gain (5–7), exam performance (8), and long-term knowledge retention (9). Furthermore, using board games for microbiology education is well appreciated and preferred by both students and instructors (5, 10). Most experimentally validated microbiology board games are quiz-based, but there are different gaming mechanics that are likely to promote similar results, such as simulations and strategic games (11). Among the strategic games for microbiology education, the classic cornerstone mechanics encompasses pathogen attack, host defense, and territory occupancy. These mechanisms are proposed in *Pandemic*, *Microbe Combat*, *The Great Flu* (10), and *The Survivor: Pathogen Island* (8). However, while some microbiology board games require decision making, most are not collab-

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orative, do not address real diseases of specific locations, were not designed for an online environment and are not free, which creates a barrier for low-income public schools in developing countries.

To overcome the challenge of keeping students engaged in an online environment while making the most of the sudden interest in viruses, we developed an online board game to support hybrid learning. The game was initially developed to cover subjects such as the transmission and symptoms of diseases caused by Brazil's most prevalent viruses, such as Dengue virus. The game was also developed to be a physical board game but, considering the pandemic, we were able to adapt it to Tabletopia (www.tabletopia.com), a free online portal where users can play and create virtual tabletop games.

PROCEDURES

The activity was designed to be carried out in two 40-minute classes with up to four students and one instructor (teacher or teacher assistants). The instructor will play the role of the virus and conduct discussions. Background knowledge in microbiology, epidemiology, or any similar field is not required.

Creating an account and log in for Tabletopia

Instructions for creating a Tabletopia account and starting the game are in Appendix 1.

Goals

Scientific Team: Medic and Researcher. The Scientific Team must contain the outbreak. Each character on the scientific team has their own specific abilities and skills, which increase the group's chances of success. Working together is essential to contain the outbreak. This can be done by: 1) removing all Infection Markers (I.M.) from the map and 2) uncovering all the symptoms and how the virus is transmitted.

Virus. The virus wins the game when 20 different territories have at least one I.M. on them.

Starting the game

Figure 1 shows an overview of the board and the location of each element.

Virus. The virus player (usually the instructor) rolls the four-sided dice to select the region in which the outbreak will start. The player can choose any territory in that region



FIGURE 1. Board overview. 1) Four-sided die, 2) Virus card, 3) Infection Markers, 4) Medic card, 5) Basic Research cards, 6) Researcher card, 7) Institution cards, 8) Transmission cards, 9) Symptom cards, 10) Infected territories counter, 11) Symptom Almanac, 12) Transmission Almanac, 13) Almanac of the virus in play.

and place 2 I.M. in the chosen location. In the following turns, the virus will always roll the dice to find out how many I.M. they can play. By placing four I.M. in a single territory, the virus player may cause an outbreak and infect neighboring territories. For each territory infected with at least one I.M., the player advances 1 point on the Infected Territories scoreboard. If scientists eliminate all I.M.s in a territory, the virus player goes back 1 point on the Infected Territories scoreboard.

Scientific team

Each member of the Scientific Team chooses an institution card. There are four different institution cards. For example, if a player draws the orange institution card, they start the game in one of the two black dots in that region. After the Medic and the Researcher set their initial location in this way, they can perform the actions listed below:

- Move
- Heal
- Research

Players can perform up to two actions each turn. Collecting Basic Research (BR) cards by doing Research and taking I.M.s by using the Heal power from the board are only possible in territories infected with at least 1 I.M. The number of BR cards collected equals the Research Focus power of a character. The number of I.M.s collected from a location equals the Medical Care power of a character. Scientists can exchange the I.M. and the BR cards for Symptom cards (3 BR cards or 4 I.M.) or Transmission cards (4 BR cards or 6 I.M.). Some of these cards increase the scientist's power.

We recorded a full game match to show the rules and dynamics of the game. The video can be accessed through the link <https://youtu.be/fgyAnUlxRqM>. It is in Portuguese, but it is possible to activate subtitles and translate them into any language on YouTube.

Safety issues

None.

CONCLUSION

Strengths and limitations

By playing *Outbreak!*, students will probably overcome at least one of the barriers of reduced social interaction in educational settings during remote learning. Similarly, collaborative learning gains yet another tool in microbiology courses. Because the game conclusion depends on the decisions made by the students and observation of the cards, the students will be exposed directly and indirectly to several scientific concepts that can be learned, such

as: virus transmission, spread prevention, prevalence, and disease symptoms. The mechanics of the game facilitate the inclusion of *Outbreak!* as a didactic strategy during synchronous teaching but can be used asynchronously as a postclass activity or homework. Indeed, using the game in synchronous classes is preferable because it guarantees the presence of an expert to address questions about the game.

Although acquisition of microbiology knowledge by the players is yet to be confirmed, the board game is likely to improve awareness of transmission and symptoms of viral diseases. Moreover, the game's storytelling will help players understand the dynamics of research and medical care in the containment of infectious diseases. And finally, the game shows that scientific knowledge is built on investigation. As previously reported in the introduction of this article, playing a board game can significantly improve the learning of microbiology concepts. According to Bochennek *et al.* (11), the simple fact of playing the Black Death Game, in which players have the goal of damming up a spreading disease in Europe, is enough to transfer knowledge. Because *Outbreak!* was developed to foster collaborative learning, skills such as peer communication, social interaction, and decision-making might be improved, as it was observed in students exposed to the board game antimicroGAME (9). Game boards developed for microbiology education can increase learning even when students have no prior knowledge or background in microbiology (6).

Most educational resources found in online platforms are available for English-speaking nations and prioritize global diseases. *Outbreak!* is based on viral diseases that impact tropical countries, like Brazil. We hope that it can be useful to support learning in developing countries, in Africa, Southeast Asia, and parts of Oceania, which often lack educational materials specific to their reality. *Outbreak!* was developed so as not to generate cognitive overload in the players, because the rules are simple and intuitive. Additionally, game moves and sounds call for engagement and fun. It is both educational and entertaining and, we hope, a useful online tool. In Appendix 2 there are images representing different moments of the game.

There are several games on the theme of pandemics and the spread of diseases in humans. For example, *Plague Inc*, *Infection: Humanity's Last Gasp*, *Viral*, and *Herbalism*. Our game shares similarities with all of them, like the mechanics of movement, cards, and characters. The main difference with our game is that we use symptoms and transmission characteristics of real viruses that are prevalent in Brazil. We also explore the scientific method and scientists' behavior during a pandemic, highlighting how they make observations, raise hypotheses, and develop experiments. The instructor role can be played by any player, as long as they understand the rules and mechanics of the game. Students' prior knowledge of microbiology and viruses does not interfere with gameplay, since no one knows which virus is causing the outbreak and the goal is collaborative learning. Any student who watches the video can play the role of the instructor.

Each game is different because they are all based on the decisions made during the game. If the room has a large number of students, teachers and/or teaching assistants could act as consultants. In preliminary tests carried out with teaching assistants, four players were considered to be the best number, taking into account the time consumed by decision-making processes, but it is possible to include more players, as long as the instructor controls the time. To implement the game with a large number of students, it would be helpful to get instructors in breakout rooms, with smaller groups of students. Instructors can even be experienced students who are already familiar with the game, or interns. At the end of all parallel games, the teacher can gather all students back for a whole-group discussion.

From our own experience as players, the biggest challenge is still how to get everyone connected to the match without spending a lot of time in the process. It is essential that the teacher become familiar with the platform and send the right links so that students can easily enter the room. The game interface is friendly, and younger students tend to master game controls very easily, given that these are generic controls used by many games and current apps. Some students tend to lose interest if the game lingers on for too long, so the teacher's ability to turn the game into an immersive setting will determine whether students achieve an epic win or whether they are just moving the pieces randomly across the board.

One of the major limitations is the mandatory Internet access. Although Internet access is not a reality for 29% of public schools in Brazil, a survey estimated that three out of four Brazilians used the Internet between October 2019 and March 2020. Of these, 41% did school-related research, 40% studied on the Internet on their own and 12% took online courses (12). It is not the perfect scenario, but it shows that it is possible to play the game in a digital environment for emergency teaching during this pandemic. When schools return to normal activity, the physical version of the game will be ready, updated, and available free of charge to public schools in Brazil.

SUPPLEMENTAL MATERIALS

Appendix 1: Creating an account and logging in to Tabletopia

Appendix 2: Images of the game at different stages of play

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