Developing a Public Health Web Game to Complement Traditional Education Methods in the Classroom

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ABSTRACT

Infectious disease outbreaks, whether natural or deliberate, constitute a growing health concern. The impending reality of this situation is indicative of the exigency in which the government recently created the Canadian Public Health Agency. As with other countries, Canada is committed to enhance its capacity to respond to emergencies through increased investment in the interdisciplinary training of medical and public health professionals. This article describes our initiative to create an innovative scenario-based web game of an infectious disease outbreak to be used in medical and public health university-level courses. By providing real-life, concrete examples of health crisis situations, students will develop strong critical-thinking skills while examining the cause and effect relationship of actions. Ultimately, our goal is to transfer current knowledge on best practices in emergency preparedness to university-level students.

KEYWORDS: Emergency management, epidemics, goal-based scenarios, infectious disease, public health, simulation, game, students, training, online education.

INTRODUCTION

Infectious disease outbreaks, whether natural or deliberate, constitute a growing health concern. Recent terrorist attacks in London and Madrid, or the natural disasters in Peru, the Hurricane Katrina in the US Golf Coast, the Tsunami in Indonesia, or disease outbreaks like the 2003 SARS outbreak in Toronto, all highlight the need for better training, communication, integration and improved emergency responsiveness. Health care workers, researchers, and policy advisors recognize the need for enhanced collaborative and coordinated communications and training for healthcare workers as 'first responders'. There is also a need to establish better training guidelines and raise public awareness of how to manage and contain infectious diseases. Thus, the genesis of this project stems from the need to engage and train future healthcare workers, health policy analysts and first responders to respond to an infectious disease outbreak. Our public health scenario-based game, *OUTBREAK*! serves to fill this gap by offering students the chance to role play and test their abilities in understanding, mitigating and managing an infectious disease outbreak in a large urban city. This paper discusses the developmental stage of developing the game prototype for *OUTBREAK!* Future phases in this game development include the testing, evaluation and subsequent revision of the prototype once it has been tested in a computer-equipped undergraduate health sciences lab classroom.

Design Strategy

Training health care specialists through e-learning strategies and role-playing games has proven to be widely successful. As Garris, Ahlers and Driskell (2002) contend, these games are both engaging and instructive in their design, with students demonstrating a high retention of new material acquired. In the Canadian context, there are few public health web-based scenario games developed, thereby providing a substantial niche for our scenario-based game.

As an interactive and visual tool, *OUTBREAK!* is designed to engage students whose learning styles are best served though the use of concrete examples and role playing experiences (Garris et al., 2002). The game is intended for small groups to play in order to emphasize a team-based approach, and to draw on the range of student's different areas of knowledge and expertise. Development of an effective, interactive game required two phases. Phase I focused on the characterization of educational objectives to ensure that the game would sufficiently address disciplinary content, provide for consequential decision-making and enable students to learn through success and failures. This phase consisted of setting learning objectives, (disciplinary expertise and necessary preparation required to play the game), the target audience (identification of game end-users), and characterization of the infectious disease underlying the game. Phase II consisted of determining the conceptual framework including the game design, objectives, scenario design (setting, context, roles and responsibilities of key decision-makers), consequential decision-making and learning uptake (identification of parameters for success and failure, debriefing and learning assessment). The scenario development design was facilitated by a rigorous consultative process with experts in infectious disease management, public safety, computer software design, e-learning, education curriculum design and/or effective classroom teaching. As undergraduate students are the end-users of this game, it will be essential to incorporate student participation and feedback during the design phases of the scenario.

Infectious Disease Agent

A critical first step in design development was to determine the nature of the health emergency. To ensure an integrated co-operative response from various sectors (health care, government, public health agency), we selected an infectious disease agent that could rapidly be transmitted from person to person, with marked symptoms and complications including mortality. Literature reviews were conducted to identify the most appropriate infectious disease agent and best practices for diagnosis, treatment and public response.

The biological agent responsible for our simulated infectious disease outbreak is modeled after a norovirus. Norwalk-like viruses or 'nor viruses' are a leading cause of acute gastroenteritis epidemics in industrialized countries (Moe, Christmas, Echols and Miller, 2001). Norovirus outbreaks are characterized by symptoms of severe vomiting, watery diarrhea, nausea, abdominal cramps, fever and general malaise. Onset of symptoms is generally 15-48 hours after exposure with illness lasting 12-60 hours (Hutson, Atma and Estes, 2004). Noroviruses are the cause of acute gastroenteritis in people of all ages with documented transmission following direct person-to-person contact, consumption of contaminated food, namely raw oysters, bakery products, fresh fruit and vegetables, (Berg, Kohn, Farley and McFarland, 2000; Long, Adak, O'Brien and Gillespie, 2002;) water (ice, well or bottled water, and during swimming, (Cannon et al., 1991; Pedalino et al., 2003;) and following exposure to contaminated environmental surfaces and to airborne droplets containing the virus (Marks et al., 2003). Noroviruses are transmitted very easily due in part to their low infectious dose with less than 10 virions sufficient to infect a healthy adult (Moe et al., 2004). In our web game *OUTBREAK!,* contamination of a fictitious brand of bottled spring water (*Corneil's Best*) with a variant strain of Norwalk virus was selected as the source of the foodborne/waterborne outbreak.

Learning Objectives and Pedogogical Approach

Learning objectives were identified in five major categories (Table 1):

1. Observation and analysis: The first learning objective requires users to analyze descriptive health sciences scenarios, comprised of both text and graphics. Information provided early in the learning exercise must be retained for successful problem assessment and derivation of solutions throughout the game (Schank, Fano, Bell and Jona, 1993).

2. Knowledge application - Learning through failure and success: Users must use knowledge acquired through a wide range of courses to understand scenario descriptions that include use of medical terminology, scientific language and scientific approaches (Schank et al., 1993).
3. Health science expertise - Problem-based learning: As this scenario-based game was designed for interdisciplinary health sciences programs, it was essential for the game to provide a greater understanding of health sciences theory and approaches, particularly in the fields of anatomy, physiology, epidemiology and public health. (Schank et al.).
4. Risk communication- reflection opportunities: An integral part of any organizational response to public health crises is effective and timely risk communication. Decisions regarding when to release information on sensitive public health and safety issues, how to select the individual delivering the messages and when to involve the media are complex and critical management skills that will be addressed in the game design (Schank et al.).
5. Crisis-management, consequential decision-making, goal based scenario: Consequences of decisions regarding the triage of emergency room patients, communications with public health authorities, strategic deployment of emergency personnel and resources will illustrate the complex and dynamic interrelationships between emergency personnel, their communications and access to specialized equipment and protection (Schank et al.).

Table 1. Learning objectives and pedagogical approach used to develop scenario-based game design.

Learning Objectives	**Pedagogical Approach** (Shank, 1993)
Observation and analysis	Assessment through replaying events
Knowledge application	Learning through failure and success
Health sciences expertise	Problem-based learning
Risk communication	Reflection opportunities
Crisis management, consequential decision-making	Goal based scenarios

Game Objective

The objective of this public health scenario-based game, *OUTBREAK!,* is to successfully mitigate and manage the infectious disease outbreak. Containment of the outbreak will be measured by the absence of new cases of infection, and minimal number of casualties. Effective management of the outbreak will be measured by minimal disruption in the operation of the game city services including maintaining a strong economy, tourism and special events.

Game Framework and Design

The fundamental objective of *OUTBREAK!* is to enable students to make informed decisions within the context of an infectious disease health emergency. Decisions will be required at three levels or 'lenses': *1. Municipal government, 2. Public health* and *3. Health care* (Figure 1). The game requires players to make a series of decisions based on six situations that occur within the linear timescale of an infectious disease outbreak (Figure 2). *OUTBREAK!* is divided into six levels, each level requiring students to answer four questions within one of the three lenses (municipal government, public health, healthcare; Figure 1). By dividing the game into different levels, players are required to demonstrate a level of expertise within each lens in order to progress to the next level. This will further the educational objectives by ensuring that all students gain exposure to each of the three lenses.

A decision-matrix (Table 2) will be used to stream students through to the next situation on the subsequent level. For each situation, players must make decisions for four scenarios. Each scenario presents the players with four possible options (Table 3) representing one Good decision, two Neutral decisions and one Bad decision. Each question will depict an event during the timeline of an infectious disease outbreak (scenario). Scenarios will be introduced in a Scenario Context page which will provide the setting of the event, the decision-maker's profile and information necessary to provide context to the event. Finally, a Scenario Feedback page will provide the player with specific feedback regarding the decision selected (Figure 3). Players that consistently select Good decisions are directed through the decision tree thereby maximizing total score (Figure 2). The rationale underlying this strategy is twofold. First, pedagogically, it was important to design a decision tree that would enable players to overcome bad decisions by making good decisions in subsequent situations. Second, as individuals often make decisions that are not intrinsically harmful or disadvantageous, it was decided that 50% of the options would represent neutral decisions. These neutral decisions would require players to make sound decisions that would fall within the limits of best practice. The decision score matrix (Table 3) is used to determine how each decision cluster (representing a single level) contributes to the decision path for the next scenario situation.

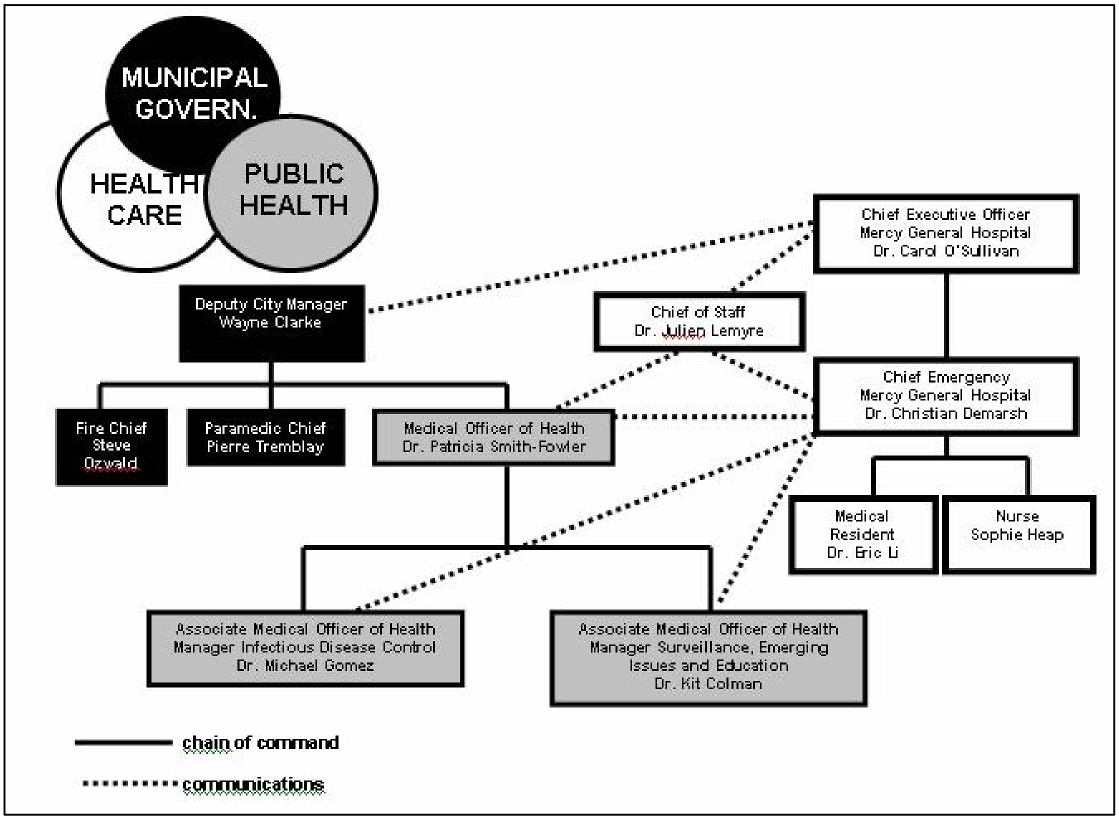

Figure 1. Decision-Makers Map.

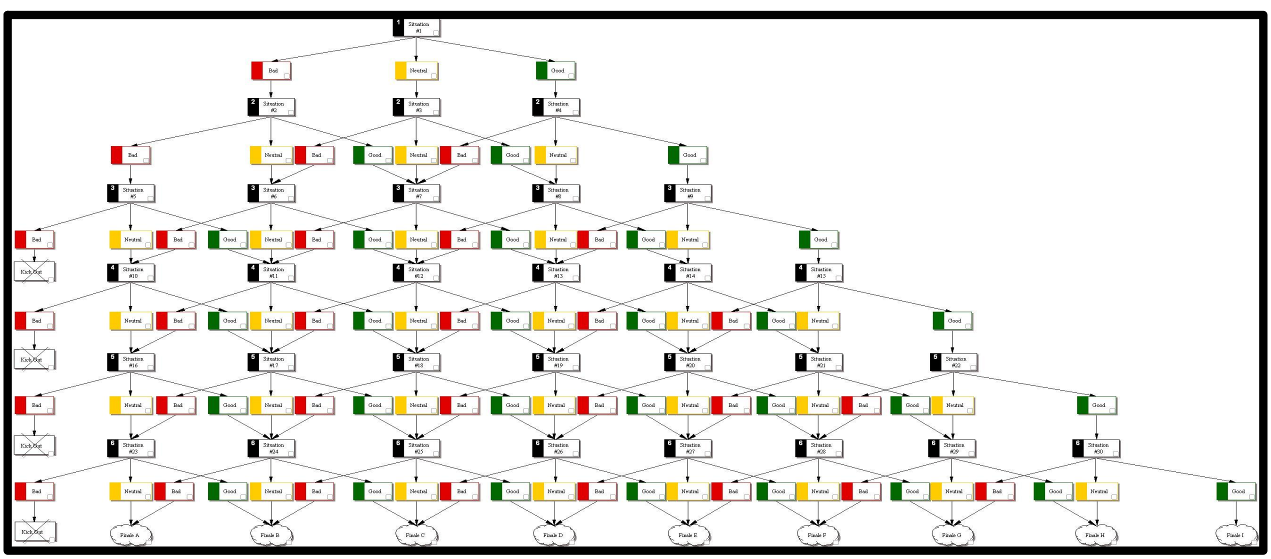

Figure 2A. Full decision making tree. See Fig. 2B for details.

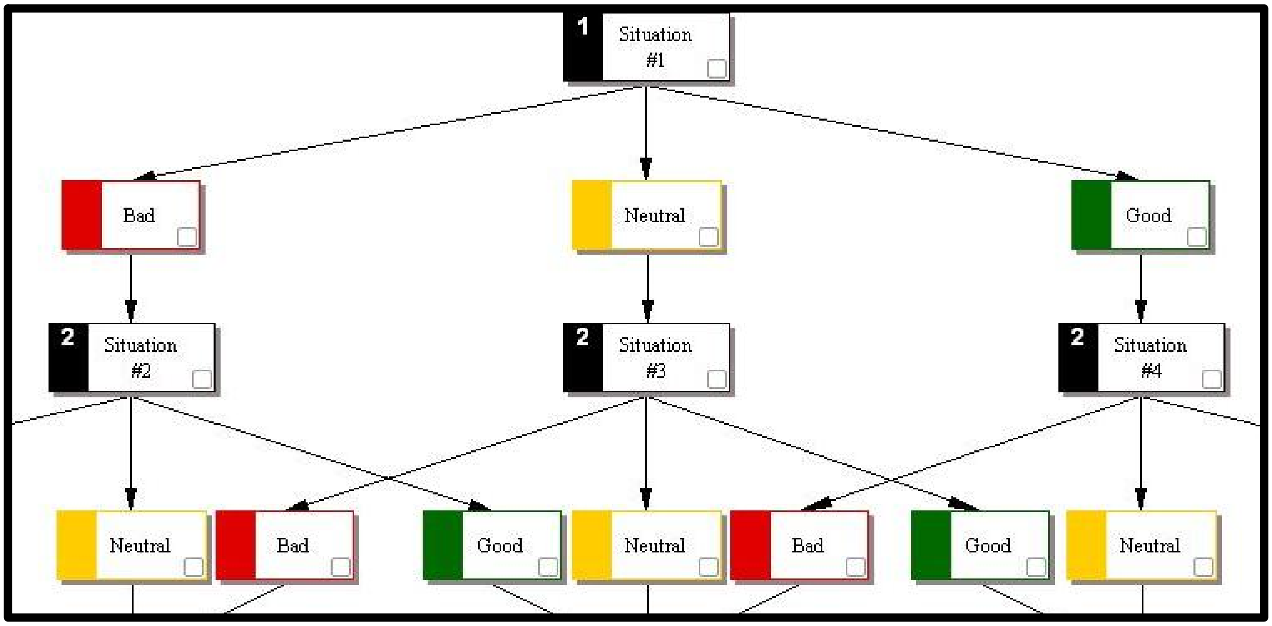

Figure 2B. Decision Tree details.

Figure 3. Scenario Design.

Table 2. Decision Score Matrix.

Choices	Weighting	Sample	Score	Feedback
Decision 1A	2		2	Good answer
Decision 1B	1			
Decision 1C	1			
Decision 1D	0			
Decision 2A	0			
Decision 2B	1		1	Neutral answer
Decision 2C	2			
Decision 2D	1			
Decision 3A	1			
Decision 3B	1		1	Neutral answer
Decision 3C	2			
Decision 3D	0			
Decision 4A	0			
Decision 4B	1			
Decision 4C	1			
Decision 4D	2		2	Good answer

Table 3. Pedagogical Impact of Decision Score Matrix.

Decision 1	Decision 2	Decision 3	Decision 4	Sum (Score%)	Path
Good (2)	Good (2)	Good (2)	Good (2)	8 (100%)	GOOD
Good (2)	Good (2)	Good (2)	Neutral (1)	7 (87.5%)	GOOD
Good (2)	Good (2)	Neutral (1)	Neutral (1)	6 (75%)	GOOD
Good (2)	Good (2)	Good (2)	Bad (0)	6 (75%)	GOOD
Good (2)	Neutral (1)	Neutral (1)	Neutral (1)	5 (62.5%)	NEUTRAL
Good (2)	Good (2)	Neutral (1)	Bad (0)	5 (62.5%)	NEUTRAL
Good (2)	Good (2)	Bad (0)	Bad (0)	4 (50%)	NEUTRAL
Good (2)	Neutral (1)	Neutral (1)	Bad (0)	4 (50%)	NEUTRAL
Neutral (1)	Neutral (1)	Neutral (1)	Neutral (1)	4 (50%)	NEUTRAL
Good (2)	Neutral (1)	Bad (0)	Bad (0)	3 (37.5%)	NEUTRAL
Neutral (1)	Neutral (1)	Neutral (1)	Bad (0)	3 (37.5%)	NEUTRAL
Good (2)	Bad (0)	Bad (0)	Bad (0)	2 (25%)	BAD
Neutral (1)	Neutral (1)	Bad (0)	Bad (0)	2 (25%)	BAD
Neutral (1)	Bad (0)	Bad (0)	Bad (0)	1 (12.5%)	BAD
Bad (0)	Bad (0)	Bad (0)	Bad (0)	0	BAD

Learning Assessment

By limiting the game design to pre-determined options, this educational tool will emphasize decision-making approaches guided by consequences, penalties and rewards. The individual weighting of each decision ensures that game remains strategic, with only 27% of possible options leading to the Good Path, 47% options leading to the Neutral Path and 27% options leading to the Bad Path. The strategic weighting of each decision ensures that approximately 73% of possible answers will propel the student through the game. If a student makes a series of consecutive Bad decisions, the game is over (Figure 2).

Performance in the game will be measured through a morbidity/mortality score, which will be correlated to a 'public health expert scale' (Table 4) ascertained using a disease algorithm based on the amount of time the user takes to complete decisions. Time penalties will be awarded when players make Bad or Neutral decisions. Strategic application of time penalties may also be imposed for decisions that are considered critical for successful resolution of the outbreak.

Table 4. Performance: Level of Public Health Expertise.

Level 1	Public Health Expert (case range x-xx)
Level 2	Public Health Associate (case range xx-xxx)
Level 3	Public Health Novice (case range xxx-xxxx)
Level 4	The Contaminator (case range >xxxx)

Conclusion

The potential for *OUTBREAK!* to contribute to public health education and training is significant. The selection of a waterborne illness as the infectious disease agent engages Canadian students with the parallels to the 2000 Walkerton, Ontario outbreak, which produced serious illness in an estimated 2,300 people following exposure to E. coli O157:H7- contaminated drinking water (Schuster et al., 2005). Since waterborne disease agents are responsible for some of the largest disease outbreaks and public health emergencies, inquiries into the cause of these outbreaks have led to changes in public policy, and increased awareness of the importance of interagency/intragovernmental communication and cooperation. Hence, creating a game around the premise of a waterborne infectious disease outbreak complements traditional teaching methods in emergency preparedness by providing an excellent case study for students to learn more about healthcare response, health policy, and disease management in emergency situations.

ACKNOWLEDGEMENTS:

We wish to thank the anonymous reviewers and the journal editors for their excellent comments and suggestions. We would like to recognize the financial support from the Institute of Population Health, and the Center for University Teaching at the University of Ottawa for grants which permitted the development of this game prototype. We also thank several scientists at the Institute of Population Health, including Wayne Corneil, Dr. Carol Amaratunga and Dr. Louise Lemyre; the Center for E-learning, TLSS, at the University of Ottawa, including Richard Pinet, André Seguin, Rémi Rousseau and Nicolas Hessler, and to our excellent student research assistants, Hany Rizk, Naim R. El-Far, Alex deMarsh and Zainab Khan.

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Manuscript received 14 May 2007; revision received 14 Aug 2007.