

Teaching about COVID-19: Using a Virtual Epidemic to Contextualize and Problematize Infectious Disease Epidemiology in a High School Class

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Abstract: *SPIKEY-20* is a virtual epidemic within the Whyville.net virtual world that infected over 400 online players during a month-long outbreak. We report on a design study of one high school teacher who used *SPIKEY-20* in a NGSS-aligned curriculum on epidemiology with his AP Biology class during the COVID-19 pandemic. Class observations and teacher interviews illustrated how students' online experiences with the virtual epidemic helped the teacher to contextualize and problematize their understanding of community spread, prevention, and economics with their lived experiences of COVID-19.

Keywords: COVID-19, SPIKEY-20, High school biology, virtual worlds, epidemiology

Overview

As the COVID-19 pandemic impacted schools around the world, much attention has focused on how teachers and students handle the transitions to physically distanced, hybrid, or online learning. However, a paucity of research exists explaining student understanding of infectious disease. The absence of core ideas underpinning topics of epidemiology and disease prevention in the Next Generation Science Standards (NGSS), K-12 science learning standards, highlights the lack of attention on these now critical areas of science education. As students, families, and communities have been dramatically and personally impacted by the COVID-19 pandemic, infectious disease epidemiology is an increasingly relevant subject for science classes (Straif-Bourgeois, Ratard & Kretzschmar, 2014). One critical issue is how to engage students in meaningful learning about relevant aspects of disease transmission and prevention that can promote understanding and impact their behaviors and actions. A participatory epidemic simulation could address this issue by providing a context to model and examine the dynamic interactions of disease vectors while also adding real-time experience to inquiries (Kafai & Dede, 2014).

The SPIKEY-20 virtual epidemic in the Whyville.net online community was launched as a timely opportunity to immerse students in this type of experiential learning about infectious disease outbreaks and their prevention in an safe, free online environment that is accessible from home or school. In this study, the research team developed a NGSS-aligned science curriculum about infectious disease spread and prevention, using the SPIKEY-20 outbreak in Whyville as a testbed for student explorations of epidemiology topics, including community spread, testing and public health prevention practices, and population infection modeling (see Figure 1).

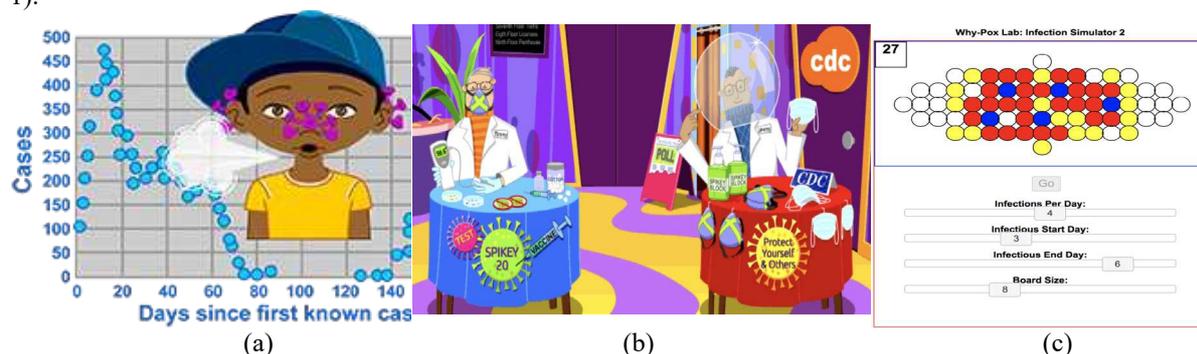


Figure 1. Screenshots from Whyville.net, including (a), a player suffering SPIKEY-20 and a disease rate chart, (b), the Whyville City Hall Lobby, where players can get tested for SPIKEY-20 and purchase PPE, and (c), simulators of infectious disease spread, for students to explore impact of infection duration and population size.

A teacher implemented the curriculum in a high school AP Biology classroom with 18 students in weekly 1-hour lessons during the roughly 4-week outbreak. Lessons consisted of individual computer-based play in Whyville, and a mix of individual, small-group, and large-group off-screen activities designed to support reflection about Whyville observations and experiences. Building on a decade of research on virtual epidemics within Whyville (e.g. Fields et al., 2017; Neulight et al., 2007), SPIKEY-20 seeks to extend this design research

approach, using iterative trial and revision informed by teacher and student feedback to shape the epidemic and curriculum (Edelson, 2002). Our analysis of recordings and transcripts of classroom observations (two off-screen lessons) and teacher interviews (following each lesson) focused on how students connected the real COVID-19 and the virtual SPIKEY-20 epidemic.

Students made connections between the virtual SPIKEY-20 and real COVID-19, that relate to critical aspects of infectious disease epidemiology (Straif-Bourgeois, Ratard & Kretzschmar, 2014): an understanding of (a) biological concepts such as germs and infection, (b) processes such as incubation and immunity within larger ecological contexts and, most importantly, (c) community factors that contribute to or hinder an epidemic outbreak. The curriculum connected the Whyville unit directly to AP biology concepts of cell anatomy and genetics, which led to discussions about how viruses spread by attacking cell organelles to replicate viral DNA.

While students demonstrated a strong grasp of virus anatomy and physiology, they had challenges understanding how these relate to public health behaviors. Students' experiences with the virtual SPIKEY-20 epidemic supported their conceptual understanding of factors that impact spread of COVID-19 in the following ways: (1) *Understanding data visualizations*: Students engaged with data visualizations of the virtual epidemic (see Figure 1a) to track player behaviors and identify disease vectors, interpret population infection rates, and compare to published visualizations about COVID-19; (2) *Examining data inconsistencies*: In tracing SPIKEY-20 infections in their own class, they noticed a counter-intuitive finding about spread (students who visited more places in Whyville were not more likely to become infected, due to infection being algorithmically initiated at login rather than through organic player interactions), leading to discussions about sampling error and experimentation limits in COVID-19 population statistics; (3) *Simulating vectors of epidemic outbreaks*: Students used online simulators to model infection and epidemic spread based on factors like duration and rate of infection, and compared outcomes in relation to public messaging around herd immunity in COVID-19 (see Figure 1c); and (4) *Discussing economic barriers to personal protective equipment*: Students noticed differential access to individual SPIKEY-20 preventive measures in Whyville such as cheap masks and expensive full-body suits (see Figure 1b), and discussed how economic affordance impacts community health.

We found that students' participation in SPIKEY-20 provided an experientially motivating and academically salient context for learning about factors of infection, incubation, and community spread critical to understanding real-world epidemics such as COVID-19. In contrast to traditional epidemiology curricular interventions (e.g. Panou et al., 2013), results also revealed an emotional investment in SPIKEY-20, with students drawing on personal anecdotes, current events, and first-hand experiences contracting COVID-19 to interpret SPIKEY-20 trends. This personal connection inspired students to compare public health attitudes and preventive behaviors observed in Whyville and in their real-life communities, leading some to intensify their SPIKEY experience by logging extra time in Whyville to earn more PPE. We interpret these findings to mean that virtual epidemics can offer students an immersive outlet to explore emotional and epidemiological aspects of the real-life COVID-19 pandemic, yielding heightened awareness of public health prevention measures in everyday life.

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Acknowledgements

This work was supported by a grant (NSF RAPID 2031748) from the National Science Foundation to Yasmin Kafai. Any opinions, findings, and conclusions or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the National Science Foundation or University of Pennsylvania.