Understanding preservice teacher beliefs about vaccination while using and modifying group-based computational simulations

Anthony J. Petrosino[1], Maximilan K. Sherard[1], and Jason R. Harron[1]
STEM Education in the Department of Curriculum and Instruction
The University of Texas at Austin

The University of Texas at Austin
College of Education

Introduction

National concern over infectious disease is sweeping the nation as epidemics such as the measles reach record numbers since 1994 [1]. A primary concern for public health officials is the rising tide of distrust in vaccination recommendations from organizations like the Centers for Diseases Control. For example, a Southwestern school district has only 1.07% of students unvaccinated for measles, but individual school sites range from 100% to less than 50% of students vaccinated [2][3]. Teachers are a demographic that are not often considered when thinking about how to engage parents in scientific and social discussion about the importance of vaccinating children who attend schools. Moreover, systemic reasoning about disease transmission and vaccination can be supported by creating, using, or evaluating computer models; however, this type of engagement is infrequent in elementary pre-service teacher programs [4]. This work in progress is part of a larger design-based research project to implement computational modeling of complex phenomena in STEM education. In this single-implementation case study, the authors use computational simulations to engage preservice teachers in a locally relevant issue of vaccination in K-12 schooling.

Research Goals

The researchers designed, built, and used simulations of disease transmission and engaged teachers in a 3- hour lesson to determine:

1. what beliefs pre-service teachers hold about requiring vaccinations in schools before and after engaging with the simulations; and
2. how these beliefs emerge when pre-service teachers attempt to re-design a computational model to represent three schools with unique social and economic conditions.

Methods

Participants and Participant-Observers
Participants were 33 pre-service elementary education teachers enrolled in an elementary science methods course enrolled in a classic teacher preparation program, two course instructors, and a graduate student researcher.

The Lesson
This case study took place over the course of two lessons and were both led by the graduate student researcher with the course instructors present. Lesson one used half of the class time (1 hour and 15 minutes) and introduced students to model-based teaching practices. Lesson two used the entire class time (2 hours and 45 minutes) and focused on the vaccination models. Participants used the model to identify optimal vaccination levels in a homogenous population, then read about the true nature of vaccination in schools and were tasked with re-designing the model to represent three school sites with varying vaccination rates.

Data Analysis
Pre- and post-beliefs surveys were collected, counted, and qualitatively coded for themes. Participant modified model drawings were collected and analyzed for common themes or patterns in construction.

Beliefs about Vaccination Before and After Modeling

The GbCC Vaccination Model
The Vaccine model (a re-creation of a NetLogo Web herd immunity model) allows users to manipulate the number of people in the space, set the percentage of which are vaccinated, and change variables related to the virulence of the disease (Figure 1). A graph displays the total population, the number of sick individuals, and the number of healthy individuals.

The Model Re-Design Task
Imagine thinking of three separate schools. One school is a large public school located in a part of the city characterized as high SES. The second school also a large public school but is located in a part of the city typically characterized as lower SES. The third school is a much smaller private school, also located in a high SES part of the city. Redesign a model that would show what these three schools would look like in a city. Think about how and why the vaccination rates at each school would be different.

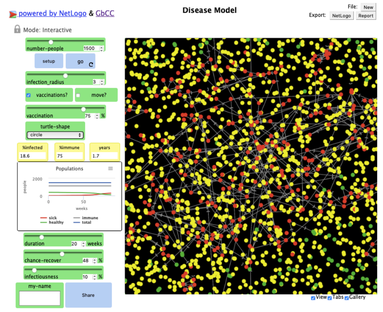

Figure 1. The GbCC Disease Model, created by Kalpana Vaidya and Jason Harron.

Research Goal One: Preservice Teacher Beliefs about Required Vaccination

Before and after teachers worked with and modified the models, they were given an infographic from the CDC about vaccinations recommended for entrance into Kindergarten, as well as the State's policy for exemption by conscientious objection. Teachers were then asked whether they believed all vaccines should be required, some should be required, or no vaccines should be required (Table 1). Teachers were then asked to explain their answers (Table 2)

Table 1.
Number of participants classified as having Pro- and Anti-Vaccination beliefs for students entering Kindergarten.

Participants (n = 31)	Pro-Vaccination Beliefs		Anti-Vaccination Beliefs			
	All Vaccines Required		*Some Vaccines Required*		*No Vaccines Required*	
	Pre	Post	Pre	Post	Pre	Post
	18	20	11	10	3	2

Table 2.
Codes for participants reasons why they support all, some, or no required vaccines for students entering kindergarten.

Codes	Example from Participant Answers
Prevention (P)	
(1) prevents illness	[Vaccines] prevents more sickness from spreading!
(2) prevents stress	[Vaccines] make sure you won't have to deal with the complications of [being sick]: physically, money-wise, and stress-wise.
(3) herd-immunity	Even though vaccines are great, they only work extremely well if everyone has it.
Risk (R)	
(1) Decreases risk of infection	[Your] Chances of you getting sick are lower.
(2) Children are higher risk	Because children are more susceptible to illnesses
(3) Immune-compromised individuals	All should be required because if a student isn't able to get a vaccine b/c of immune deficiencies
(4) Depends on the risk of the disease	*It should be based on how much a disease can be cured.*
Economic (E)	
(1) Cost of vaccines	*I know that vaccines can be expensive, and some families might not believe in them*
(2) Saves money	make sure you won't have to deal with the complications of [being sick]: physically, money-wise, and stress-wise
Rights and Responsibilities (RR)	
(1) Parents right to choose	*I don't think anything should be required because I think everything should be up to the parent.*
(2) Responsibility to community	I feel that it is your job as a citizen to keep you and the people around you safe
Personal Experience (PE)	
(1) Relating to anti-vaxxers	*I'm staying the same because I know there are people who feel strongly against vaccinations for some reason*
(2) Family history of not using vaccines	*I've never gotten a flu shot nor has many people in my family*
(3) Getting sick after vaccination	*I have seen people get the flu after getting the flu shot*
Unsure (U)	
(1) Not *enough* information	*To preface, I feel like I don't know enough about each of these vaccines*

**Italicized codes were elicited by students who held anti-vaccination beliefs*

Modeling Re-Design Task

Participants worked in groups of 4 to re-design the disease models according to the design task. Video data with teacher models is still being analyzed, however, two strategies stood out to the researchers for how participants modified the model.

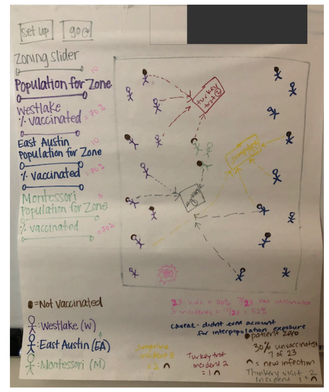

Figure 2. This spatial strategy highlights how disease transmission is a factor of the spaces people interact within.

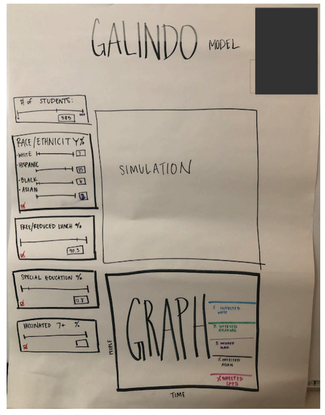

Figure 3. The socioeconomic modeling strategy doesn't allow users to set the vaccination level, but rather the vaccination level is determined by social and economic factors.

Spatial Modeling Strategy
The most used modeling strategy to represent three school types with varying social, economic, and vaccination conditions is displayed below (Figure 2). Termed the spatial strategy, this method places three types of agents to represent students from each of the three school types in the same interacting simulation space. A slider for each student type controls each the level of vaccination for each agent class. The agents in the model are geographically distributed and *come together* at certain points on the simulation space to interact. This demonstrates that preservice teachers were attending to: (a) the differing vaccination rates they would expect to see in across the three school types; and (b) the spaces in which contact might occur outside of isolated school sites.

Socioeconomic Modeling Strategy
Perhaps a more sophisticated model (Figure 2), participants in this group chose to think about the vaccination as the product of other social and economic variables interacting. This modeling strategy did not explicitly show the agents on the simulation space interacting, but rather displayed sliders that could be set to varying levels which control the rate of vaccination among a population. A graphic was inserted at the bottom to show the varying infection rates among different racial or ethnic communities in the simulation space.

Acknowledgements and References

Thank you to the preservice teachers who took the time to participate in this study. Also, special thanks to the teachers who took these models back to their placement classes to work with elementary students.

Group-based Cloud Computing (GbCC) for STEM Education project is funded by the National Science Foundation (NSF) grant number DRL 1615207.

[1] Measles | Cases and Outbreaks | CDC. (2019, May 24). Retrieved May 28, 2019, from https://www.cdc.gov/measles/cases-outbreaks.html
[2] J. Hellerstedt, "Annual report of immunization status of students. DSHS Immunization unit," Texas Department of State Health Services. [Online]. Available: https://www.dshs.texas.gov/uploadedFiles/Content/Prevention_and_Preparedness/immunize/coverage/schools/11-14849%20Annual%20Report%20of%20Immunization%20Status%20of%20Students_06-2018.pdf. [Accessed Oct. 14, 2018].
[3] A. Kata, "A postmodern pandora's box: Anti-vaccination misinformation on the internet," *Vaccine*, vol. 28, no. 7, 2010, pp. 1709-1716. doi: 10.1016/j.vaccine.2009.12.022.
[4] C. V. Schwarz, "Developing preservice elementary teachers' knowledge and practices through modeling-centered scientific inquiry," *Science Education*, vol. 93, no. 4, pp. 720–744, July, 2009. doi:10.1002/sce.20324.