



Maria, Eduardo, and Rani embody different approaches to the scientific investigation process. Artwork by Charlie LaGreca, design by Blue Telescope

So You Want to Make a Comic

By Martin Weiss, Geralyn Abinader, and Michaela Labriole

The New York Hall of Science (NYSCI) wanted to help middle school students understand how scientists solve mysteries: the process of creating theories, collecting and analyzing evidence, and understanding what data supports or refutes their hypotheses. Focusing on disease that can be transmitted between humans and other animals (zoonotic diseases), we decided to develop a comic book. We wanted the comic to be fun and to engage the reader in the process of scientific inquiry while closely aligning with the classroom curriculum. We based the comic on events from the summer of 1999 in New York City. And then we took a few liberties, setting our story in the fictional world of Metro City, 2019.

NEW YORK CITY, 1999

During a hot and dry August in 1999 in New York City, crows seemed to be falling from the sky. At the Bronx Zoo, headquarters of the Wildlife Conservation Society, many exotic birds were dying. Dr. Tracey McNamara, a pathologist at the zoo, examined scores of dead crows and exotic birds, trying to discover the cause of their unusual neurological symptoms and deaths. Though able to eliminate some suspects based on her knowledge of pathogens that kill different birds, Dr. McNamara needed help in identifying this particular pathogen. Simultaneously, several elderly patients in Queens had mysteriously fallen ill. They lived near each other and exhibited the same neurological symptoms. Admitted to Flushing Hospital, doctors suspected the patients had contracted viral

encephalitis, a brain infection.

In September, scientists discovered abundant eggs and larvae of *Culex pipiens* mosquitos in stagnant water around the homes of several of the patients. This common household mosquito can transmit several viral diseases. In response, New York City mayor Rudolph Giuliani announced that St. Louis encephalitis had infected a number of elderly people in Queens and several had died. Dr. McNamara immediately realized that the sick patients and her birds had the same symptoms and strongly suspected the same virus had infected her birds and the patients in Queens. The problem was that the St. Louis encephalitis virus rarely kills birds. Dr. McNamara was convinced the city had made a mistake. She sent the birds' blood samples to some national laboratories for further analysis. Results proved that her birds were infected by West Nile virus. This virus, new to the Western Hemisphere, was known to be fatal to humans as well as birds.

Dr. McNamara's work illustrates science inquiry at work: hypothesis, testing, and evidence. Her work played an instrumental role in solving this medical mystery.



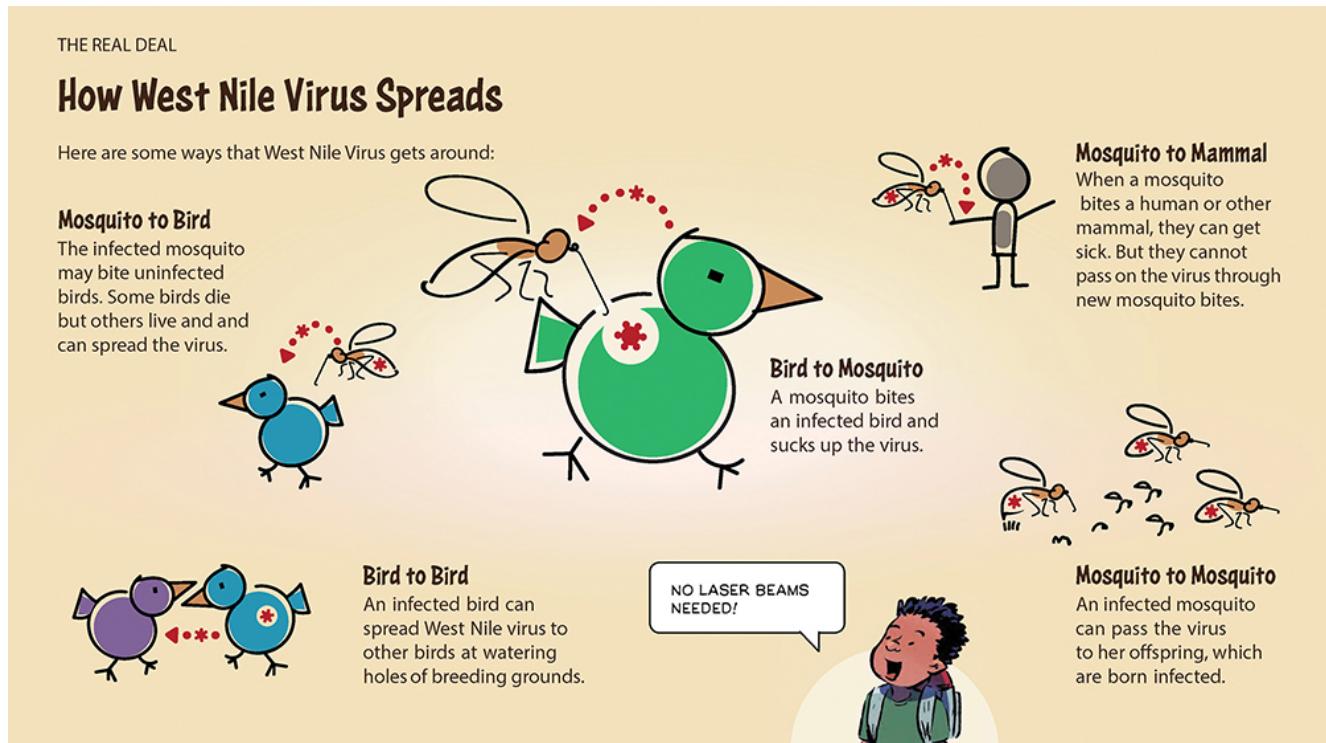
Photo blog. Artwork by Charlie LaGreca, design by Blue Telescope

METRO CITY, 2019

On a hot August day, Maria, Rani, and Eduardo head out on one last summer excursion. While walking through the park, they stumble across a dead crow. Maria whips out her cell phone and takes some shots; Rani carefully examines the crow carcass to find signs of trauma; while Eduardo, after getting totally grossed out, figures space aliens killed the bird. As more dead crows start appearing and neighbors contract a mysterious illness, the trio embarks on an adventure to find out what's plaguing their neighborhood. Aided by a veterinary pathologist and an entomologist, they gather evidence about the dead birds, disease transmission, and biology in an effort to identify the mysterious illness. *Transmissions: Gone Viral*, a digital, interactive comic follows the story of these three childhood friends as they set out on a great scientific adventure.

How did we get from 1999 to 2019? Three kids? Cell phones? At NYSCI, our research has shown that active engagement in science increases learning and understanding, and that you can have

fun while you're learning. We reviewed many existing educational comics and found they were well executed but static. We wanted to create another kind of experience.



An infographic shows how West Nile virus spreads. Artwork by Danny Loi, text by Karen de Seve

First, we updated the story to the present, with relatable characters who reflect the diverse Queens community where NYSCI is located. Technology like cell phones, laptops, and interactive whiteboards made it possible to share real microscopic and MRI images, illustrate scientific principles effectively, and explain concepts in a dynamic way that fits the storyline.

We wanted our audience to actively participate in the science. Going digital enabled us to include interactives where readers could join the investigation. These activities, designed to help youth develop science inquiry skills, included sorting and analyzing the evidence, comparing skeletons and dissections, and studying microscopic images. Infographic pop-ups dove more deeply into scientific concepts and highlighted some of the people and evidence involved in solving the mystery behind the 1999 epidemic. To ensure that the comic was broadly accessible, we developed it as a web-based version that could be read on any device with a web browser.

THE REAL DEAL

Dr. Tracey McNamara

When Dr. Tracey McNamara became a veterinarian, she didn't know she would help solve one of the biggest medical mysteries ever to hit New York City. In 1999, birds began mysteriously dying at the Bronx Zoo, where she was the Senior Zoo Pathologist. Meanwhile, people were also dying of a mystery disease in the city's hospitals.



*Wildlife World Conservation
Society's Wildlife Health
Center, New York City, 1999*



Government officials said the cause was St. Louis encephalitis. But Dr. McNamara knew that her evidence pointed to something different—something new to New York City. She didn't give up investigating until she found the truth.

The sickness was caused by West Nile virus. This was the first time it appeared in North America. Dr. McNamara is a science hero! Her work helped protect millions of people and animals in New York City and beyond.

THIS SUPER SCIENCE SLEUTH CRACKED THE WEST NILE VIRUS CASE!



Infographic: Dr. Tracey McNamara. Artwork by Danny Loi, text by Karen de Seve

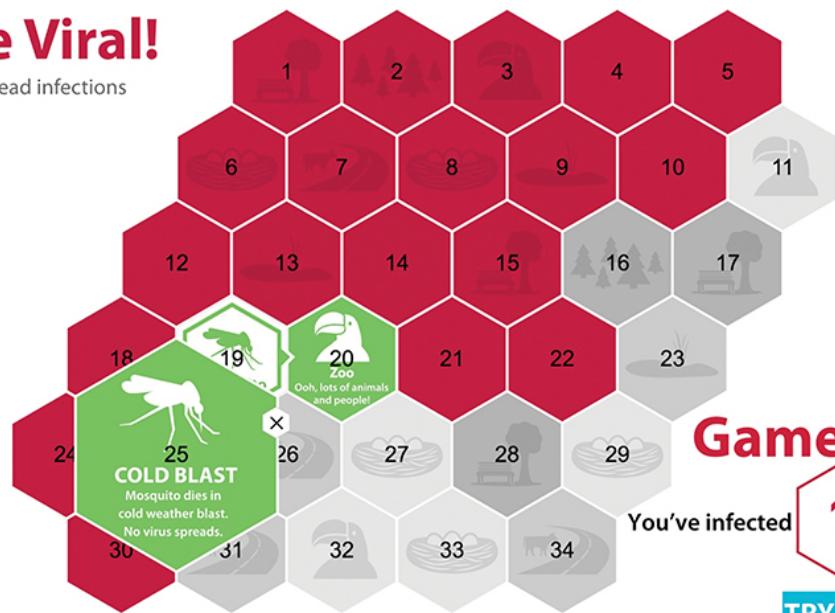
And finally, the story structure itself modeled the science inquiry process. Our three protagonists approach the investigation in ways that reflect different inquiry skills: Rani collects and studies specimens, Maria documents and maps evidence, and Eduardo creates hypotheses. The trio's scientific mentors, a pathologist and an entomologist, guide them through the laboratory process and they discover the new virus.

We worked with New York City-based developer Blue Telescope, who creates interactives and online tools for museums and corporations. Blue Telescope's producer and self-proclaimed comic nerd, Brad Barton, introduced us to a wonderful comic artist, Charlie LaGreca, who has worked on many educational comics. Our writer, Karen de Seve, has written for many educational publications and animated series and has a long history as a content developer for science museums. They all worked seamlessly with our team of educators, scientists, creators, and researchers at NYSCI.

From the early concept stages through the development of the final comic and interactives, we iteratively tested the concept, book design, and instructional guide to ensure the resources were useful for educators, while also engaging youth ages 10 to 14 from a variety of backgrounds. The research aided in creating an engrossing and educational story.

Gone Viral!

Your goal: spread infections far and wide

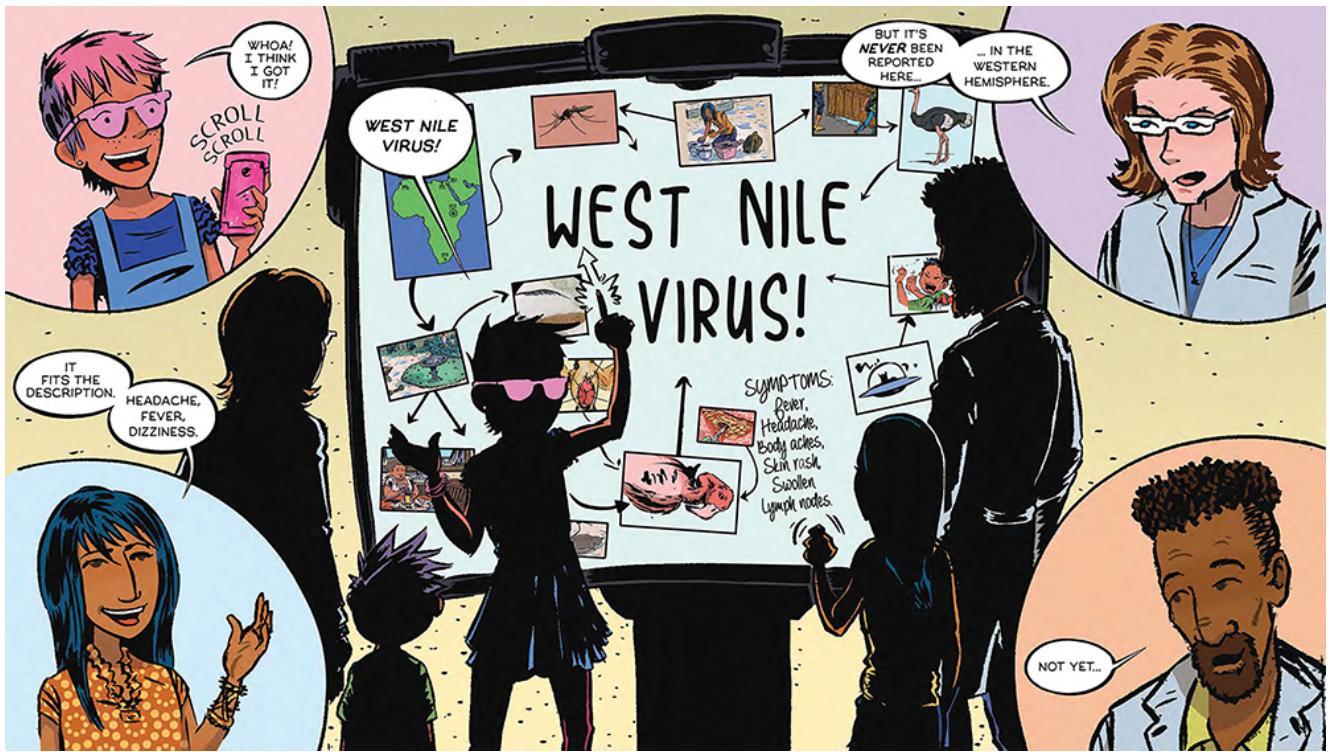


Game Over!

You've infected **19** places

TRY AGAIN

Virus game (panel): You are a virus trying to spread far and wide using hosts to move around the world. Design by Blue Telescope, text by Karen de Seve



Sorting evidence. Artwork by Charlie LaGreca, design by Blue Telescope

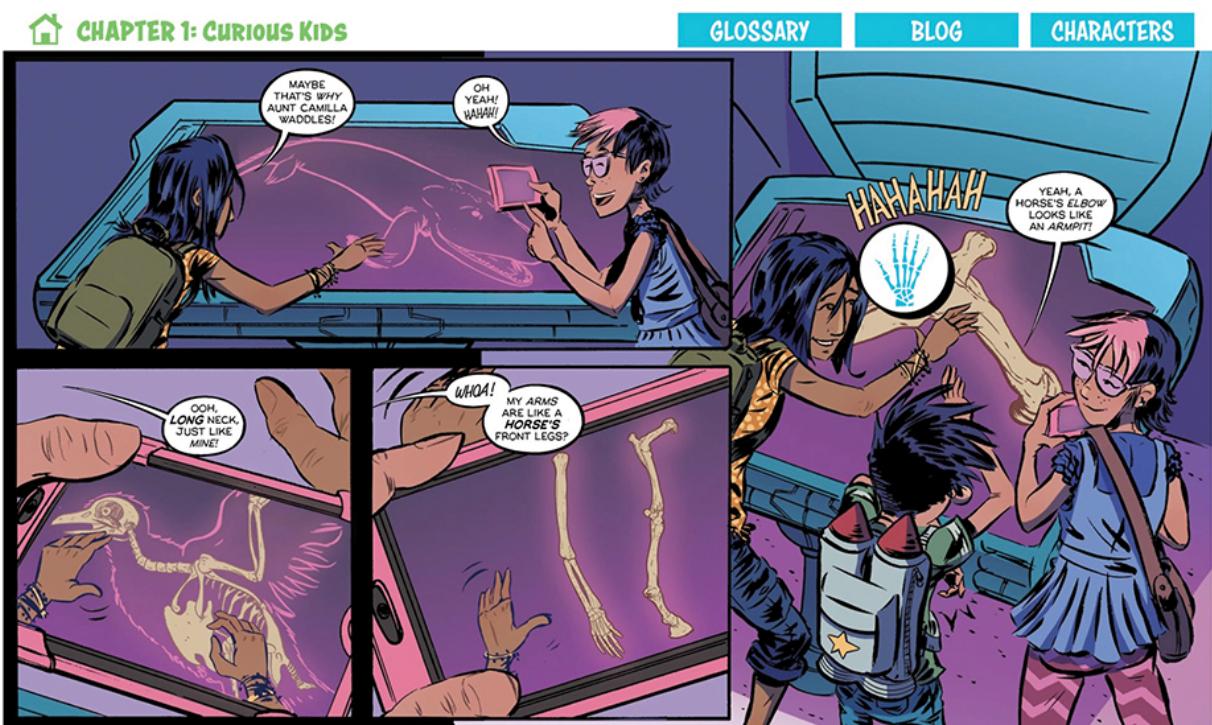
RESEARCH

In our approach, we utilized formative testing (Haertel and Means, 2003) and clinical interviewing (Ginsburg, 1997) to invite producers, developers, educators, and youth to provide insights on key content and design concepts, including

- participants' understanding of disease transmission and human-animal relationships
 - participants' interest and experience with comics

- type and style of comic book
- visual and personality characteristics of the main characters
- digital components such as interactives and infographics.

The research process included 1) challenging producers, developers, and educators to think through learning goals and design; 2) prototyping comic book elements with museum visitors from our target audience; and 3) providing formative feedback on prior knowledge, narratives, and theories participants used to make sense of the comic book elements.



Transmissions: Gone Viral chapter opener. Artwork by Charlie LaGreca

KEY TAKEAWAYS & RECOMMENDATIONS

We found that participants understood that humans are related to animals and can share diseases. They struggled with the differences between viruses and other pathogens and with how viruses are transmitted and infect bodies. They also struggled with concrete roles of evidence and counterevidence in real-life scenarios. We designed interactives in the comic to address these concerns: a virus game focusing on transmission of a vector-borne disease, a build-a-body interactive exploring homologous structures among animals, infographics illustrating the science behind vector-borne diseases, and an evidence-mapping interactive.

Participants were enthusiastic about comic books and graphic novels and felt colorful artwork, entertaining origin stories, and complex plots made comics interesting. We developed detailed, action-packed artwork, relatable characters, and a realistic scientific problem for the characters to investigate. Participants' insights into the visual and personality characteristics contributed greatly to the main characters' development.



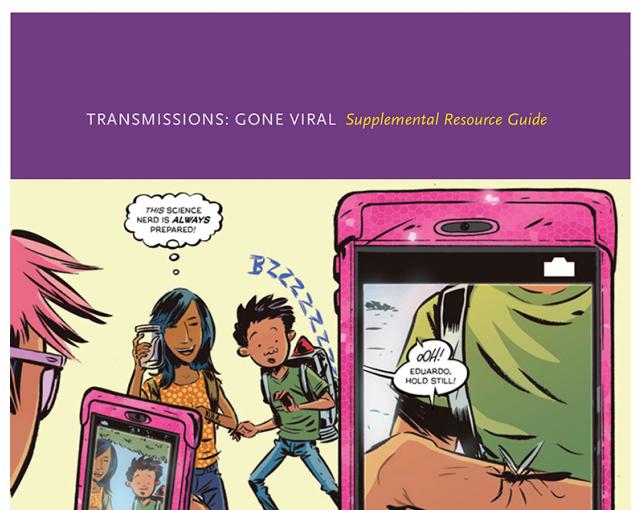
Transmissions: Gone Viral cover. Artwork by Charlie LaGreca

CONCLUSION

Together, researchers, producers, educators, and scientists contributed to the conceptual design of a comic, interactive elements, and supplemental resources. The research informed how to support the developmental appropriateness of the scientific content, characters that spark empathy and represent different roles within the scientific process, and interactive elements that offer deeper exploration of the narrative and concepts. The next step is an ongoing study testing the effectiveness of the comic book and our supplemental resource guide in informal settings.

EDUCATIONAL SUPPLEMENTAL MATERIALS

Six local middle school educators served on the Transmissions Teacher Design Team. Due to the interdisciplinary nature of the project, we recruited educators who taught a variety of subjects, including science, health, and English language arts. They represented diverse student populations, including English-language learners and students with special needs. From March



DIMENSIONS November • December 2019