INTRODUCTION

Scientists are increasingly present on a variety of social media platforms which provide opportunities to communicate science, build an online scientific community, and exchange professional opportunities (e.g., share job advertisements or solicit presenters or advice). Scientists can also build relationships with journalists on social media, particularly on Twitter (1, 2), who can provide them with a platform to reach a wider audience. This audience includes educators and students, who can leverage this connection with research scientists to inspire experiments and provide early mentoring for aspiring young scientists. Our experience with a Twitter outreach project, dubbed #FungalPeeps, exemplifies this emerging educational model that has enormous potential to enrich research programs and classroom curricula alike. In this article, we will discuss the progression of this project from the initial hashtag to a high school laboratory across the country, and we will draw from this experience some best practices that may help facilitate similar future connections.

Germination of a relatable outreach project

On March 25, 2019, Dr. Kasson (@kasson_wvu) posted a tweet with marshmallow Peeps inoculated with one of a dozen or so fungi he had available in his lab, including several well-known food spoilage fungi (Rhizopus, Aspergillus, and Penicillium species) (Fig. 1). At the time of his tweet, Dr. Kasson had ~3,500 followers generating around 200,000 impressions across 100 to 150 tweets per month, mostly about fungi and science. This tweet illustrated a lighthearted visual experiment involving this popular holiday treat. The goal was to see if any fungi could colonize these marshmallow bunnies and to provide captivating photographic documentation of the process. Two days later, even before any results were in, the tweet had amassed thousands of likes, hundreds of retweets, and had garnered an interview with the New York Times. Predicting virality for a social media post is a fickle endeavor, but this simple outreach experiment asked a straightforward question about a candy most people recognize. The response, like most viral tweets, was exciting but unexpected. To ensure these new followers (the experiment attracted some 1,000 new followers) had some results to follow, additional marshmallows were treated with some modifications (e.g., presoaked in water), as the original inoculated marshmallows were already proving difficult to colonize.

Interest in the project grew with the publication of the New York Times article (3), and the memorable hashtag
#FungalPeeps made the experiment easy to follow and engage with. The profile of this project became large enough that the Peeps brand later recognized it on social media, possibly due to Dr. Kasson tagging them, trading their own hashtag (#Peepsonality) in a light-hearted positive response that reinforced their welcoming social media presence (Fig. 1). At the same time, another Peeps-themed hashtag (#PeepYourScience), championed by The Open Notebook, was gaining traction, encouraging people to submit science-themed Peeps dioramas as part of an online competition. #PeepYourScience proved to be a huge hit, showcasing the talents of students and professionals alike with awards for categories such as “Most Accurate Representation of Sciences” and “Best Use of Peeps” (4). The simultaneous trending of these hashtags revealed what many have known for a long time: these seemingly indestructible marshmallow treats are incredibly popular, for better or worse, and have long served as a muse for kitchen counter and backyard science experiments.

Despite their national popularity, the scientific literature on Peeps is quite sparse. Perhaps the most elaborate was a 2018 article describing a microbiology teaching lab using bacteria with gelatinase to degrade marshmallow Peeps (5). Another relevant study by Perez and colleagues (6) discussed the use of consumer products to culture fungi; this article directly referenced the New York Times piece on #FungalPeeps. Another Peeps-centric project that received considerable enthusiasm was the voyage of the “Peep-o-nauts,” for which NASA sent two teams of Peeps to the stratosphere in weather balloons to measure the effects of an Easter geomagnetic storm on Earth’s upper atmosphere (7). The Perez example highlights how the popular media coverage of the #FungalPeeps experiment allowed it to reach beyond the confines of a social media feed from a laboratory at West Virginia University and into academic literature a year later. This amplification also allowed the project—and enthusiasm for fungi in general—to reach a wider audience, including younger readers not yet practicing science. This coverage was particularly inspiring because newsworthy fungi tend to be pathogens, such as drug-resistant Candida auris (8) or amphibian-killing chytrids (9), which are aptly portrayed in a negative light.

How a viral tweet migrated into the classroom

Two months after the initial tweet, Jocelyn Swift, a student at Notre Dame High School in San Jose, California, reached out to Dr. Kasson via e-mail after reading the write-up in the New York Times to design a similar experiment for her local science fair. She was a sophomore taking an independent research class that provided students with supplies, instructor support, and a lab space for conducting research projects. Under Dr. Kasson’s guidance and after reading available academic papers on fungal growth in baked goods, Jocelyn set out to examine how the concentration of potassium sorbate (the main food preservative in Peeps)
affected fungal growth. To keep the experiment manageable while she attended classes full time, her experiment examined only one fungus (Rhizopus stolonifer) from the original Peeps experiment; this organism was chosen for its ability to rapidly degrade the marshmallow treat. Dr. Kasson provided the fungal strain—a common bread mold fungus he had cultured in his own lab—that Jocelyn needed to complete the experiment. To increase the visibility of the fungi for observation and simplify the number of variables in her experiment, she chose potato dextrose agar as a growth medium, instead of Peeps. After 2 weeks of observing growth rates across concentrations of potassium sorbate, she mounted these fungi onto a microscope slide to further observe sporangia and sporangiospores. As the COVID-19 pandemic imposed shutdowns, all school-related activities ceased. Fortunately, Jocelyn and the rest of her peers were still able to present their research via videoconference as the 2020 Synopsys Santa Clara County Science Fair went virtual. Jocelyn's results aligned with current guidelines on inhibitory concentrations in food. Namely, a 1% concentration of potassium sorbate is sufficient to reduce the growth of the black bread mold R. stolonifer. Her results are summarized in Figure 2.

Social media as a conduit between scientists and K–12 students

The virality of the tweet and the coverage by a national outlet were certainly serendipitous. However, while serendipity played a role in forming these connections, our experience can serve as a guide to understanding how connections between labs and students are formed in general. It was fortunate that Jocelyn noticed the article and had the time, confidence, and support of teachers to reach out to a professor states away to initiate her research project. Considering how rewarding this experience can be for everyone involved, how can we ensure these connections are not left up to chance or lost in the spam folder? The opportunities for scientists to engage K–12 educators and students on scientific dialogue are boundless on social media. Our experience has demonstrated the efficacy of this model by accident, but many more student projects could be initiated if the amplification by popular media and resulting connections between scientists and classrooms were intentional. This could be facilitated by strengthening the connections among scientists, the media, and educators.

Fostering these relationships would benefit everyone

FIGURE 2. Data and images generated from the investigation of R. stolonifer. (A) Average colony width measurements on PDA supplemented with 1 to 10% potassium sorbate, with no potassium sorbate as a control. Error bars indicate standard errors. Lettering indicates groups with significant differences (p<0.05; Student’s t-test), comparing individuals (n=3), and the pink dashed line indicates the maximum width of the plate (6.25 cm). (B) Final observation of an R. stolonifer sample grown with a 1% potassium sorbate treatment for 2 weeks. (C) Representative photograph of microscopic features (sporangia and sporangiospores) applicable for identifying R. stolonifer.
involved. Researchers could expand the scope of their research and mentoring by pitching their work to science journalists. This would allow science journalists to stay more up-to-date with current research and build their portfolio of experts to consult for their stories. Decentralized platforms like national print media or social media allow researchers to reach not only students nearby but also across the nation. When news outlets cover science with the potential to cross over into the classroom, it provides an enormous benefit to K–12 educators and their students. In fact, the #FungalPeeps story was covered in a section called “Trelobites,” which explicitly intends to provide a “treasure trove” of stories with narratives and multimedia fit for the science classroom (10). By creating this section, the New York Times is directly acknowledging the value of such articles to educators as an audience. Furthermore, the New York Times also creates resources for educators to use such content in the classroom via the Learning Network. San Jose’s Notre Dame High School and other schools across the country pay for a school-wide subscription, which provides teachers with training on how to use the Learning Network resources. The value to students is perhaps most tangible. Early training in science is a huge asset for college applications: the ability to engage in independent research and provide a letter of recommendation from a college professor provides a clear advantage for prospective undergraduates. This early training effectively welcomes an innovative cohort of young scientists into research. This initiative can further encourage students to step up to the bench and enter STEM career majors while broadening the scope and productivity of research. In these ways, this model for research scientists to reach students (and vice versa) through social and popular media would enrich education and the scientific enterprise.

An online model for enriching science curricula

While many high schools support some form of student research and science fair participation, resources and support for students vary widely from school to school. At Notre Dame High School, Jocelyn is among 20 students whose research is supported by a co-curricular independent science research class that meets once or twice monthly and provides after-school lab support. Her biology teachers, like many great high school science educators, go beyond what is expected of them for this course and devote a considerable amount of time to helping their students complete their projects, including support on experimental design, microscopy, data analysis, writing, and figure preparation. Student projects are overseen by mentors (Dr. Chris Kollerman and Ms. Chelsey Beck) and funded by the school, with lab space, supplies, and equipment provided. Without these, Jocelyn would not have had the capacity to initiate this work. In most cases, students seek ideas for projects in primary literature; however, Jocelyn’s interaction with Dr. Kasson can serve as a model for other students and mentors to better motivate and inspire their independent experimentation. Reading and understanding a peer-reviewed scientific study can be a difficult task for many at the high school level. If these scientists are directly accessible to students via social media platforms, this may foster an effective type of science communication that high school students can participate in as a resource to inspire their development as young scientists.

Already, programs like Skype-a-Scientist (an educational nonprofit organization) are succeeding at bridging the gap between scientists and K–12 classrooms. Our experience illustrates another, as-yet less formal, avenue where scientists and students can build relationships and advance science through both mentorship of young scientists and by doing primary research. Although Notre Dame High School is equipped with progressive science funding and opportunities not available at most high schools across the country, scientists and educators could certainly collaborate on research experiences that are low-cost and do not require equipment or a formal lab environment. These connections could be facilitated with a general or concerted hashtag where media and educators can turn for classroom-friendly science content (e.g., #STEMentors and #ScientistsForSchools).

This model has been effective for scientists in different fields to engage with the general public, such as #BugID or @BugQuestions for entomology and #ActualPlantPathologist for plant pathology, and new initiatives may galvanize more such connections in the future. An initial hurdle to making these connections is that scientists have formed communities on a variety of social media platforms (e.g., Instagram and Twitter), and high school students and educators may not occupy these same spaces. For example, TikTok has made significant inroads to teaching Generation Z about science. Darrion Nguyen, a popular TikTok science communicator, has risen to fame for his @labshenanigans TikTok channel, which focuses on biochemistry comedy sketches. Yet, many millennials and Gen X-ers do not occupy this space. However, concerted initiatives, for example partnering with existing networks such as Skype-a-Scientist (11), to build longer-term mentorship opportunities with individual schools and classrooms could encourage these groups to broaden their horizons and welcome educators and students into the scientific communities that already exist online (12). Recent social media initiatives (e.g., #BlackInMicro) are also strengthening community among underrepresented scientists, providing explicit role models to inspire and support young scientists from minoritized groups. Such initiatives would require time and effort on the part of scientists, but participation in community education is exactly the kind of broader impact that our society expects scientists to provide and that granting agencies require for funding (e.g., the National Science Foundation’s Broader Impacts).

As these modern educational models gain momentum, these contributions should increasingly be valued by research institutions and funding bodies alike with direct incentives and recognition. Additionally, the opportunity to turn a
community education initiative into a talk or paper creates publicity and publications that are already valued by research institutions, universities, and funding bodies. The University Marketing and Communications (UMC) of Illinois State University hosts the #RedbirdProud Social Media Awards and Workshop event annually, recognizing the best uses of social media across Illinois State University’s campus (13). At its best, technology can break down barriers and connect people in new and powerful ways, and our experience with the viral #FungalPeeps posts and resultant media coverage has unpredictably fostered a mutually beneficial relationship among us. In describing this process, we hope to facilitate more such intentional connections to bring social media outreach into high school classrooms across the country.

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