STAYING CURRENT | K–12 Outreach

Developing a science outreach program and promoting “PhUn” all year with rural K–12 students

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Hendrickson JL, Bye TK, Cockfield BA, Carter KR, Elmer SJ. Developing a science outreach program and promoting “PhUn” all year with rural K–12 students. Adv Physiol Educ 44: 212–216, 2020; doi:10.1152/advan.00196.2019.—Demonstrating how science relates to human health is an important step for generating K–12 student interest in health-related careers. Science outreach is often performed in urban areas; however, ~20% of K–12 schools are in rural areas. Michigan Technological University is located in Michigan’s upper peninsula, which accounts for 30% of the state’s land mass but only 3% of the total population. Our goal was to create a science outreach program for reaching K–12 students in our rural region. We assembled a team of undergraduate and graduate students, staff, and faculty to implement science outreach with K–12 students. Specifically, we leveraged existing national and international science outreach events [Physiology Friday, Physiology Understanding (PhUn) Week, National Biomechanics Day] to offer hands-on physiology and biomechanics activities during the year. Between 2016 and 2019, we connected with 31 K–12 schools and impacted 327 elementary (19%), 351 middle school (21%), and 1,018 high school (60%) students (total impact 1,696). Over 90% of the outreach visits took place at the K–12 schools. The hands-on activities were delivered by more than 85 undergraduate and graduate students and 10 faculty. Together, the supportive culture and resources within the department (e.g., outreach coordinator, participation from students and faculty, grant funding) were key to developing the program. We recommend starting with a single outreach event, working as a team, and being flexible with K–12 schools. The program also provided service-learning and professional development opportunities for undergraduate and graduate students and faculty. Our robust science outreach program promoted “PhUn” all year-round with rural K–12 students.

biomechanics; K–12; outreach; PhUn week; physiology education

INTRODUCTION

Educational outreach aims to enhance public awareness and understanding of science (20, 28). Some of the benefits of science outreach include building relationships between researchers and kindergarten through 12th grade (K–12) teachers (6, 8, 9, 23), increasing K–12 student interest in science (5, 6), and providing undergraduate and graduate students with professional development opportunities (1, 13, 26, 27). Implementation of science outreach activities with K–12 students is supported and promoted by federal organizations, such as the National Science Foundation (16) and National Aeronautics and Space Administration (NASA) (14), so that a diverse future workforce is ultimately developed. With the global health workforce shortage projected to reach 15 million by 2030 (12), it is imperative that health science-based outreach be implemented to inspire K–12 students to pursue careers broadly related to human health.

University-driven science outreach is often performed in urban areas. However, nearly 20% of K–12 public schools in the United States are classified as rural (17). Rural K–12 students may have, for example, reduced access to technology, advanced courses, and extracurricular opportunities. Accordingly, these students may not be exposed to the breadth of career possibilities in Science, Technology, Engineering, and Mathematics (STEM) and health sciences. Furthermore, due to several constraints (e.g., cost, time, transportation), it can be difficult for rural K–12 students to participate in university-sponsored science outreach programs and events. Similarly, faculty may be unable to step away from teaching and research responsibilities and visit rural K–12 schools. To broaden rural student participation in STEM, United States legislation recently proposed to increase support for education and workforce development research in rural areas (24). Thus future work will need to implement science outreach programs for underrepresented rural K–12 students.

Physiology Understanding (PhUn) Week is a popular science outreach event sponsored by the American Physiological Society (22, 23). The goals of this event are to increase student interest and understanding of physiology in their lives, introduce students to physiology as a possible career, and involve more physiologists in science outreach with K–12 students and teachers in their communities. Since 2005, PhUn Week has been celebrated annually in the first week of November and, to date, has engaged over 100,000 K–12 students (23). For example, VanRyn and colleagues (25) have hosted an annual large scale PhUn Week event at a science center for the past 6 yr. With assistance from undergraduate student volunteers, the event has impacted ~1,000 individuals each year. This work is admirable and exemplifies why PhUn Week is a great tool for enhancing public knowledge of physiology and related topics while providing service-learning opportunities for undergraduate students. It is important to also identify other possible science outreach events, as many departments include faculty with expertise, not only in physiology, but also in biology,
kinesiology, and/or exercise science. Including a range of science outreach events and activities would develop a stronger critical mass of college students and faculty that could impact more K–12 students throughout the year.

The Department of Kinesiology and Integrative Physiology at Michigan Technological University did not have a formal science outreach program. Accordingly, a strategic department goal was to create a health science-focused outreach program for reaching K–12 students. It is important to point out that Michigan Technological University is geographically isolated, as it is located in Michigan’s upper peninsula, which accounts for 30% of the state’s land mass but only 3% of the total population. Moreover, every county in the upper peninsula currently has multiple federal designations for health professional shortages, and thus there is a strong need for local students to pursue health-based careers. For our science outreach program, we linked together existing professionally sponsored science outreach events in physiology and biomechanics to promote a culture of having “PhUn” all year-round.

In this paper, we describe the steps we took to develop a science outreach team and major outreach events in which we participated. We also discuss the program impact, sustainability, and lessons learned.

METHODS

Team. The first step we took in launching our science outreach program was to invite a physiologist with extensive outreach experience (25–27) to our university. The invited speaker carefully explained the goals of science outreach, shared examples, and offered advice on how to get started with an event such as PhUn Week. This served as an immediate way to educate and excite our students and faculty about the benefits of participating in science outreach. Subsequently, we formed a team consisting of a department outreach coordinator, undergraduate and graduate students, and faculty to implement our science outreach events (Fig. 1). Briefly, the outreach coordinator was a staff member who was responsible for establishing lines of communication with K–12 science teachers, organizing visits with schools, recruiting undergraduate and graduate students and faculty to contribute, and overseeing event coordination. Undergraduate students helped develop and present hands-on activities broadly related to human health as part of science outreach assignments for select freshman and sophomore courses in kinesiology. Graduate students also assisted with outreach as part of their career development, which is in line with the expected competencies for graduate physiology education (e.g., communication, teaching and mentoring, professional development skills) (4). Finally, faculty were encouraged to develop a science outreach activity and often trained undergraduate and graduate students to carry out the activities.

Outreach events. As a diverse department housing students and faculty with expertise in kinesiology, physiology, molecular and cell biology, and biomechanics, we targeted three major national and international science outreach events throughout the year (Fig. 2). Specifically, we participated in the following: 1) Physiology Friday (October), 2) PhUn Week (November), and 3) National Biomechanics Day (April). First, Physiology Friday, sponsored by The Physiological Society, is celebrated on the second Friday in October (18) and is part of International Biology Week (19). The primary aims of this event are to increase communication skills, break down barriers between...
scientists and the public, and make science more fun and accessible. Second, PhUn Week is celebrated in November through the American Physiological Society, and, as stated previously, the purpose of this event is to expand student understanding of physiology and physiology careers, assist educators in recognizing physiology in their curriculum, and include more physiologists in outreach (22, 23). Finally, National Biomechanics Day is celebrated in April and is sponsored by the American Society of Biomechanics (2, 8). The objectives of National Biomechanics Day are to teach students and teachers about biomechanics, create jobs in biomechanics, and improve societal understanding and appreciation for biomechanics. Since 2016, National Biomechanics Day has impacted over 28,000 high school students (2) and expanded to other countries across the world (21). Moreover, a long-term event goal is to incorporate biomechanics into high school science curricula. In addition to these major established outreach events, we also participated in smaller local and regional science outreach events (e.g., day of science, science fairs).

For the science outreach events, we hosted K–12 schools at Michigan Technological University and also traveled to visit the schools. When hosting events on campus, K–12 schools provided their own transportation to and from the event. Additionally, for outreach events that took place on or close to campus (<30 miles), an outreach team consisting of 4–10 people (undergraduate students, graduate students, faculty) implemented the hands-on activities. Events that took place at K–12 schools farther from campus (>30 miles) were led by a smaller outreach team consisting of the outreach coordinator, faculty member, and/or a doctoral student. For these long-distance trips, multiple schools were usually visited during the same day.

Activities. The science outreach team worked together to build a collection of hands-on demonstrations and lessons. Many of these activities were taken from the Physiology Friday (18), PhUn Week (22), and National Biomechanics Day (2) websites. Other helpful resources for developing hands-on activities included the Life Science Teaching Resource Community (11), NASA’s “train like an astronaut” website (15), and published K–12 science outreach literature (e.g., Refs. 3, 7, 9). Undergraduate and graduate students and faculty also developed their own activities as well. Some examples of the activities implemented include the following: 1) recording heart rate at rest and after exercise to learn about the heart and cardiovascular system; 2) measuring body temperature before and after jumping jacks to appreciate thermoregulation; 3) constructing a human elbow joint using rulers, nuts, bolts, and string to visualize the concept of biomechanical leverage and muscular torque in the body; 4) simulating how quickly a disease can spread by tracing the presence of baking soda in drinking water to learn about epidemiology; 5) maneuvering through a slalom course to understand the physics of turning and how it impacts sport performance and predator/prey interactions; and 6) celebrating the 50th year anniversary of the Apollo 11 moon landing to discuss the musculoskeletal and cardiovascular challenges faced by astronauts in microgravity. Many of the activities also introduced students to aspects of the scientific method. Taken together, these activities covered broad topics in physiology, biomechanics, exercise science, and public health, which allowed for them to be used for multiple science outreach events. Furthermore, the overlap of physiology and biomechanics topics between science outreach events enabled undergraduate and graduate student and faculty presenters to scale the difficulty and depth of lessons appropriate for each student audience.

Funding. To further support our science outreach program, we applied for and received small science outreach grants from professional organizations and state agencies (e.g., The Physiological Society, Michigan Space Grant Consortium). These awards provided funds to purchase supplies, cover travel costs to visit schools, and compensate select undergraduate and graduate student volunteers. Importantly, these resources enabled us to sustain our local outreach efforts and expand our science outreach program to target K–12 schools further from our university.

Evaluation. To initially assess our science outreach program, we recorded the total number of K–12 students and schools reached. In addition, we also tracked the number of undergraduate students, graduate students, and faculty involved with implementing the science outreach activities. These assessments were performed between 2016 and 2019, which encompassed seven academic semesters.

RESULTS

Over the past 3 yr, we implemented, on average, five science outreach events per yr. We connected with 28 public K–12 schools (elementary, middle, high) located in 7 of the 14 counties in Michigan’s upper peninsula. We also connected with three public high schools in northern Wisconsin that border Michigan’s upper peninsula. These science outreach efforts impacted a total of 1,696 K–12 students. Specifically, 327 elementary (19%), 351 middle school (21%), and 1,018 high school (60%) students were reached. Of the 24 public high schools in Michigan’s upper peninsula that were within an approximate 100-mile radius of Michigan Technological University, we conducted science outreach activities with 17 of them. All of these schools served rural students, and four schools also served a significant number of Native American students.

A total of 59 undergraduate and 29 graduate students assisted with delivering outreach activities over the three-year period. The majority of undergraduate students were exercise science and sport and fitness management majors in the Departments of Kinesiology and Integrative Physiology. Additional undergraduate students from the Department of Biology and Department of Biomedical Engineering also contributed. Most of the graduate students were in the kinesiology master’s degree and integrative physiology doctoral programs. Several graduate students from the Department of Physical Therapy contributed as well. Ten different faculty members worked with these students to carry out the science outreach events and activities.

In general, K–12 teachers were receptive to participating in an outreach event. More than 90% of the science outreach events took place at the K–12 schools (range of 1–150 miles from Michigan Technological University). The hands-on activities were enthusiastically received by K–12 students and provided a source of scientific inquiry and sometimes even entertainment.

DISCUSSION

Main findings. Our goal was to create a science outreach program for reaching K–12 students in Michigan’s remote upper peninsula. We assembled a team of students, staff, and faculty to implement science outreach with K–12 students in the surrounding schools. Specifically, we linked together existing national and international science outreach events (Physiology Friday, PhUn Week, National Biomechanics Day) to offer hands-on physiology and biomechanics activities. The science outreach program impacted more than 1,600 K–12 students across 31 schools. The close-knit department culture and enthusiasm were key to developing a sustainable science outreach program. Importantly, the program provided numerous service-learning and professional development opportunities for undergraduate and graduate students and faculty.
Building and sustaining an outreach program. An important first step was to designate a staff member to serve as the outreach coordinator. The staff member was the existing academic advisor, and each week this individual had time allocated to focus on science outreach-related initiatives. Another important step was to incorporate science outreach as a component of our undergraduate and graduate curricula, similar to that described by previous authors (6, 13, 26). For example, in select courses, undergraduate students were required to contribute to science outreach as part of service-learning assignments. Graduate students were also expected to participate in at least one science outreach event per semester. After the science outreach program was established, we trained a graduate student to take over as the outreach coordinator. We also secured grant funding to purchase supplies, cover travel costs, and compensate select student volunteers. These resources helped sustain our local outreach efforts and expand the program to target additional K–12 schools. To date, we have implemented science outreach activities with 70% of the K–12 high schools within ~100-mile radius of our university. Thus the science outreach program aligned well with our university mission to sustain our local outreach efforts and expand the program to target additional K–12 schools participating. Additionally, more undergraduate and graduate students volunteered to help, including students from outside our department (biology, biomedical engineering, physical therapy). Most faculty were receptive to engaging with science outreach as they were asked to contribute to one outreach event per year. Select faculty also worked with the department outreach coordinator to secure funding and disseminate outreach program results through conference presentations and publications (3, 10). Collectively, these expectations and opportunities for students, staff, and faculty created an enthusiastic culture of science outreach.

Lessons learned. We followed the recommendations described by the American Physiological Society (23) for making initial connections with K–12 schools. Specifically, we relied on students, staff, faculty, and friends who already had existing contacts with a school. We also recruited K–12 teachers by hosting educational workshops at our annual Michigan Physiological Society meeting. After visiting K–12 schools, many teachers enthusiastically offered contact information for science teachers at nearby schools. It is important to acknowledge that some K–12 schools offered no response to our outreach inquiries, which is not uncommon (9), and thus persistence was key. We also started small by first participating in PhUn Week and then included additional events over time. We also emphasized a team-based approach, so not to overburden students and faculty. The online resources, information presented at regional and national meetings, and K–12 outreach literature offered excellent resources to get started. Another resource for generating ideas was the PhUn Week poster session, which is held annually at the Experimental Biology conference. We also learned to be flexible as schools were sometimes unable to participate on the formally designated science outreach event day and/or had to reschedule. Accordingly, we made every effort to work around these scheduling constraints. Based on these experiences, we recommend being persistent, starting small, working as a team, and having flexibility.

Professional development. For undergraduate and graduate students, science outreach was promoted as an opportunity to develop and practice skills, such as information refinement, communication, and public speaking (1, 13, 26, 27). Moreover, several local undergraduate and graduate students returned to their alma maters to engage in science outreach and give back to their schools. This was a “win-win” scenario (23, 26), which supported the development of current and future students, department science outreach program, and community. A few students emerged as outreach team leaders and presented the program results at professional conferences (e.g., Michigan Physiological Society, Experimental Biology). Participation in science outreach also helped these students strengthen their applications for internships, graduate programs, and research fellowships. For faculty, science outreach participation complemented their classroom teaching, refined their ability to communicate with public audiences, and helped to form relationships with K–12 teachers. It also provided a starting point to discuss long-term goals, such as incorporating biomechanics into high school curricula (2, 8). Accordingly, performing outreach was a rewarding and educational experience for both students and faculty.

Limitations. It is important to acknowledge that science outreach programs can be effective in generating short-term interest in science-related content (5, 6); however, these outcomes do not necessarily translate to long-term interest in science-based careers (5). A limitation of the current science outreach program is that we did not directly evaluate program effectiveness. Evaluation of science outreach is complicated. Clarke and colleagues (5) suggested that future science outreach programs focus on increasing long-term interest in science-based careers and include clearly defined goals and evaluation metrics. Moving forward, an important modification we can make is to better connect our hands-on activities to the specific job experiences of a scientist.

Summary. We developed a science outreach program that impacted more than 1,600 K–12 students in our rural region. Specifically, we used a team-based approach and leveraged existing outreach events to offer hands-on physiology and biomechanics activities throughout the year. Over time, these outreach efforts transitioned into a robust program that encouraged “PhUn” all year round!

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DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

J.L.H., T.K.B., B.A.C., K.R.C., and S.J.E. conceived and designed research; J.L.H., T.K.B., B.A.C., K.R.C., and S.J.E. performed experiments; J.L.H., T.K.B., B.A.C., K.R.C., and S.J.E. analyzed results of experiments; J.L.H. and S.J.E. interpreted data; J.L.H. and S.J.E. wrote the paper; J.L.H., T.K.B., B.A.C., K.R.C., and S.J.E. edited and revised manuscript; J.L.H., T.K.B., B.A.C., K.R.C., and S.J.E. approved final version of manuscript.

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