**HOW WE TEACH | Generalizable Education Research**

Developing a nationwide K–12 outreach model: Physiology Understanding (PhUn) Week 10 years later

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Stieben M, Halpin PA, Matyas ML. Developing a nationwide K–12 outreach model: Physiology Understanding (PhUn) Week 10 years later. Adv Physiol Educ 41: 357–362, 2017; doi:10.1152/advan.00005.2017.—Since 2005, nearly 600 Physiology Understanding Week (PhUn Week) events have taken place across the U.S., involving American Physiological Society (APS) members in K–12 outreach. The program seeks to build student understanding of physiology and physiology careers, assist teachers in recognizing physiology in their standards-based curriculum, and involve more physiologists in K–12 outreach. Formative goals included program growth (sites, participants, and leaders), diversification of program models, and development of a community of practice of physiologists and trainees involved in outreach. Eleven years of member-provided data indicate that the formative goals are being met. Nearly 100,000 K–12 students have been reached during the last decade as an increasing pool of physiologists took part in a growing number of events, including a number of international events. The number and types of PhUn Week events have steadily increased as a community of practice has formed to support the program. Future program goals include targeting regional areas for PhUn Week participation, establishing research collaboratives to further explore program impacts, and providing on-demand training for physiologists.

K–12 outreach; PhUn Week

Physiologists practice a discipline that many laypersons cannot spell or define. This is incongruous in that the basic physiological principles allow each of us to walk, talk, think, breathe, and carry out all life functions. Fortunately, educators know that, by engaging laypersons with student-centered teaching methods, they can demystify the powerful physiological principles that explain the human body and how it works. For many years, scientists in all fields have been called to help improve laypersons’ understanding of the powerful impacts of science on their everyday lives (13, 14). Science outreach, that is, communicating science with nonscientific audiences (8), has generated a wide variety of programs and initiatives, including scientist-in-the-classroom programs, radio and television productions, blogs, and webinars.

In 2005, the American Physiological Society (APS) piloted a program, Physiology Understanding Week (PhUn Week), which emphasized grassroots outreach by APS member physiologists to K–12 students in their own communities.

The primary goals of PhUn Week were established at that time and have remained consistent throughout the intervening years:

1. Inform and excite students about physiology as a discipline and as a potential career;
2. Increase the awareness and relevance of physiology in students’ daily lives;
3. Assist teachers to recognize physiology in their standards-based curriculum; and
4. Involve more physiologists in outreach to students and teachers in their communities.

In the pilot program, physiologists led hands-on instructional activities in exercise physiology and shared information on physiology careers with students in grades 2–12. The following year, the APS Council approved expanding and continuing the program. The program objectives for PhUn Week in the first decade were primarily formative. We sought to:

1. Steadily increase the number of sites, students, and physiologists involved in the program;
2. Develop a program model and resources that could meet the outreach needs of physiologists, teachers, and students in communities across the country;
3. Promote repeat participation by APS members in the program, that is, build an APS outreach community of practice (24, 25); and
4. Encourage participation of APS member trainees (graduate students and postdoctoral fellows).

*Supporting Physiologists’ Involvement*

Like other scientists, physiologists have many demands on their time. For many, their primary focus is research. For others, teaching of undergraduate, graduate, or professional school students is their primary concern. However, many institutions also expect scientists to perform community service and/or outreach. For those scientists, PhUn Week provides a structured way to engage in community outreach that benefits students and teachers, and also provides opportunities to model professional outreach for their graduate students and postdoctoral trainees. However, it is important to note that many physiologists participate in outreach solely because they want to share their love of science with K–12 students. Many receive little or no recognition at their home institution, and, for some, outreach activities are done “under the radar” because their institution or department does not consider it a valuable use of time.
With this wide variance in the reasons physiologists have for participating, APS felt it was critical to provide flexible formats, resources, training, and recognition for scientists involved in the program. These program supports are described below.

Flexible formats and scheduling. PhUn Week activities vary widely, but nearly all allow K–12 students to:

- Meet visiting physiologists at their schools or local science museums and through visits to physiologists’ laboratories;
- Learn about careers in physiology;
- Perform hands-on physiology activities and experiments; and
- Interact with near-age peer mentors invested in physiology.

While the initial vision of PhUn Week events included an individual physiologist (or a physiologist and his or her trainees) visiting a single classroom, participating physiologists soon expanded this vision to encompass numerous outreach formats at multiple grade levels. Some physiologists have coordinated large-scale events at science museums or in connection with all-school “Physiology Days.” These events often engage parents and preschool age children, as well as K–12 students and teachers. Other physiologists plan weeklong events at schools, visiting a number of classrooms each day, and some coordinate a single visit. A few invite students to their institutions to explore hands-on physiology in their research or teaching laboratories. In addition to the larger events, a new model that is gaining in popularity involves training middle or high school students to present their physiological findings to primary grade students.

While PhUn Week is officially scheduled during the first full week of November, many physiologists find it difficult to schedule events during that week due to teacher and researcher time commitments, tightly-scheduled school standardized curricula, and established standardized testing dates. The program has worked to accommodate these parameters, allowing physiologists to schedule their PhUn Week activities throughout the late fall and into January.

APS has members in many countries around the world. PhUn Week has begun to expand beyond the U.S. to other countries, including Canada and Australia. APS has allocated additional funding for shipping PhUn Week materials overseas.

Structured planning for quality control. APS seeks to provide a level of quality control for the content and structure of each PhUn Week event. With more than 100 events happening each year, this control must take place at the event-planning stages. Fall is a very busy time for all educators, so APS strongly encourages physiologists to contact teachers early, preferably in the spring of the previous year, over the summer, or very early in the fall term. The logistical planning, flexibility, and coordination of schedules by the physiologist and the teacher are instrumental in designing and implementing a successful PhUn Week event (16). Waiting until October makes planning a November or December event very difficult for both teachers and researchers.

Second, the lead physiologist at each PhUn Week site must submit an Event Planner form by early October. This form includes information on event location and date(s), number of planned participants (students, teachers, and physiologists), and a detailed description of the planned activities. The planner is reviewed and approved by APS staff for appropriateness of activities (e.g., age level and safety). The submission and review of the event planner by the due date ensures that the physiologist is planning an APS-approved PhUn Week event.

Materials. APS provides hands-on and print materials for all students participating in PhUn Week. Materials are age appropriate and are designed to engage students in career and physiology exploration:

- Foam “squeezy” hearts (Fig. 1A) are given to all students. They can be used to demonstrate heart rate and function (10, 11).
- PhUn Week “sneaker” bags (Fig. 1B) provide students of all ages with links back to the PhUn Week site and promote participation in sports and other physical activities. The official PhUn Week logo (Fig. 1C) is included on all materials.
- Career trading cards (Fig. 1D) have replaced dated career brochures for middle and high school students. They provide real-life examples of physiologists from diverse groups (race, sex, ethnicity) engaged in a wide variety of physiology careers. They also encourage students to go to the website to answer a quiz about the physiologist to access special cards (2). The card packs also include a career card describing physiology careers and a “physio-facts” card with fun facts about the human body. Teachers

Fig. 1. Take-home materials for students. Materials provided for students attending PhUn Week events include squeezeable foam hearts (A) and sport bags (B). D: career trading cards highlighting APS members from various institutions and research areas, physiology facts, and career information are provided for middle and high school students. E: Phizzy and Phreezy Bear Activity Books include physiology and career information for Grades K–4 students along with teacher and parent resources. C: all materials include the PhUn Week logo/URL or APS logo/URL.
are provided with letter-sized cardstock versions of the cards appropriate for bulletin board use.

- Physiology activity books (Fig. 1E) engage elementary age students in puzzles, coloring, reading, and writing activities about physiology and physiology careers. Activities were developed in consultation with elementary teachers.

To receive these materials for students at their events, physiologists must submit their PhUn Week Event Planner by the October deadline, even if their planned event will not take place until the following spring.

**Training.** As the number of participants in PhUn Week grew, the need grew for professional development and sharing opportunities for both those physiologists who participated annually in the program and those who were new to the program. Initially, the APS Education Office staff provided specific hands-on activities for physiologists to do with K–12 students during PhUn Week events, and, starting in 2007, they organized an annual PhUn Week training session at the APS annual meeting, Experimental Biology (EB). Initially, these sessions were structured as didactic workshops, with one or two presenters describing successful models that physiologists might implement in the coming year. However, by 2011, a strong PhUn Week community of practice was growing among APS members, and training became APS member driven. The workshop was transformed into a highly interactive poster and networking session, highlighting outreach efforts by diverse physiologists working with preschool through 12th grade students and their teachers. Attendees meet PhUn Week participants, learn details about the varied PhUn Week activities held the previous year, ask questions, share best practices, and get advice on their own future PhUn Week activities. To minimize conflicts with EB scientific sessions, the PhUn Week session is held in the early morning. After EB, participants are encouraged to submit their posters and PhUn Week activity instructions to the APS digital library, the Life Science Teaching Resource Community (www.lifesctrc.org). This allows wide distribution of diverse PhUn Week approaches.

**Recognition.** As noted earlier, the value of faculty participation in K–12 outreach varies widely, depending on the specific institution and/or department. However, as a professional society, APS highly values K–12 outreach, recognizing its critical contribution to the future of the field (17a). Toward that end, APS has not only fully-funded PhUn Week for more than 10 yr, but also has established a number of awards that encourage K–12 outreach, including the Dale J. Benos Early Career Professional Service Award, Minority Outreach Fellowship, and Local Science Fair awards. In the same spirit, APS also recognizes those members who lead PhUn Week events in their local communities, presenting special awards to those who have led PhUn Week in their communities for 5 and 10 yr.

**EVALUATION METHODS**

Data for evaluating impacts were provided by several sources. First, the Event Planners provide information on the participating institutions, event leaders, and types of events and activities planned. Following PhUn Week, each event leader is required to submit a student demographic form that reports basic demographics on students who participated in a PhUn Week event. They also provide information on the final numbers of physiologists participating in the event. We also gather information from the posters presented at the EB PhUn Week session on types of activities done and physiology trainees engaged. It should be noted that most PhUn Week activities are carried out as part of normal school activities (classrooms, guest speakers, field trips).

This study meets the requirements for educational exemption for human subjects research (17). Data collected on students are limited to the number of student participants and the general grade level (primary, elementary, middle, and high). Data are anonymous and are not recorded by student name, school name, or teacher name.

As stated earlier, in the first decade, our evaluation focused on four formative goals. Demographic evidence provides support for each of these goals as summarized below.

**Goal 1:** Consistently increase the number of sites, students, and physiologists involved in the program. The program has shown steady and significant growth in terms of number of events, physiologists and trainees engaged, and students reached (Fig. 2). The number of students has increased significantly, more than 30-fold in the first decade, with more than 16,000 participating in the 11th year of the program, and more than 97,000 students total participating over 10 yr (Fig. 2A). Similarly, the number of physiologists and trainees participating has increased significantly, showing a nearly 57-fold increase over 11 yr (Fig. 2B). The number of PhUn Week sites annually has grown significantly, increasing 25-fold to more than 100 sites in its 11th year and nearly 600 events total (Fig. 2C). In this 11-yr span, PhUn Week has been held in 41 states, Puerto Rico, Canada, and Australia. While most of the early PhUn Week events involved middle/high school students, there has been a significant shift toward inclusion of lower grade levels. By 2015, the events had become evenly distributed from preschool through 12th grade (Fig. 3).

**Goal 2:** Develop a program model and resources that could meet the outreach needs of physiologists, teachers, and students in communities across the country. PhUn Week has proven adaptable to a wide range of event models, from single classrooms to large events involving multiple schools. The initial teaching resources and guidelines have proven effective and robust in diverse situations, and the program has fostered the development of many new hands-on activities in multiple languages. The PhUn Week website offers on-demand information and supporting materials. It provides numerous resources for physiologists to use in planning their PhUn Week events, curricular materials for teachers to use in their classroom to expand on the physiologist’s visit, and career planning materials for guidance counselors and teachers to use in guiding future physiologists into the field (4).

The PhUn Week training session has shown steady and significant growth, as well. In 2016, 34 posters were presented (Fig. 4), more than double the number in 2011. The 2016 session attracted more than 125 attendees. Many presenters share their posters through APS’ digital library, the Life Science Teaching Resource Community (LifeSciTRC) (3). There also are several PhUn Week blog entries on the LifeSciTRC (19, 20). In addition, APS published Three Easy Steps to Participate in PhUn Week, a simple guide for getting started in outreach (21).

**Goal 3:** Promote repeat participation by APS members in the program, that is, build an APS outreach community of practice. PhUn Week is designed to be scientist driven, with events organized at the grassroots level with standards set by the professional society. To achieve a strong, growing program, repeat involvement by physiologists is essential. We have two strong indicators that PhUn Week is achieving this goal. First, many PhUn Week leaders participate regularly. One APS member has led PhUn Week in her local community for all 10 yr of the program. In addition, 24 persons have led PhUn Week events for at least 5 yr, and 116 APS members have led a PhUn Week event more than one time (26% of total leaders). Second, scientists and trainees engaged in PhUn Week outreach have developed into an active community of practice. They share their
successes and failures through the EB poster session and workshop (5–7), blog entries (19, 20), Facebook and Twitter posts (1), and journal articles (9, 15, 16, 22).

Goal 4. Encourage participation of APS member trainees (graduate students and postdoctoral fellows).

Data regarding trainee participation in PhUn Week events were first collected in 2006. Only one of the six events (16%) that year included trainee participation (Fig. 2D). Trainee participation has significantly increased with 59% of the 2015 events, including trainees in planning events as well as participating in them. Involving trainees provides important training in K–12 outreach that can be continued into their formal careers. It also helps trainees gain physiology teaching skills applicable at any level.

DISCUSSION

Science outreach is a win-win-win for the students, teachers, and scientists involved. Students are engaged in the scientific process, gain insights into science careers and the lives of scientists, and increase their understanding of science concepts and how they relate to everyday life (8). Researchers and trainees gain presentation skills, confidence, emotional rewards, understanding of K–12 education issues, and credit for community service (12, 23). K–12 teachers benefit from professional development and long-term connections with science experts (12, 23).

Science outreach seeks to engage the nonacademic audience (13) to increase public awareness and understanding of science and its benefits (23). Building connections between physiologists and local schools can enhance scientific interest and promote understanding of physiology for both students and teachers. In turn, having a scientifically literate public can further increase public support for government funding of research as well, leading to further degrees of knowledge (8, 18).

Fig. 2. PhUn Week events and participants, 2005–2015. Annual participant statistics were provided via post-PhUn Week reports by APS member PhUn Week Event Leaders. The no. of participating K–12 students (A) and physiologists (B) increased annually; increases were significant for both students ($r = 0.97, P < 0.0001$) and physiologists ($r = 0.94, P < 0.0001$). The no. of PhUn Week events (C) increased annually as well ($r = 0.97, P < 0.0001$). D: the no. of PhUn Week events by year that involved physiology trainees (graduate students and/or postdoctoral fellows); this increased annually ($r = 0.90, P = 0.0002$).

Fig. 3. Student participants by grade level, 2005 and 2015. In 2005, the vast majority of students participating in PhUn Week were middle (grades 6–8) or high school (grades 9–12) students. By 2015, participants were more evenly distributed across K–12 grade levels, including primary grades (grades K–2) and elementary (grades 3–5), representing a significant change in the distribution of participants by grade level ($\chi^2 = 54.24$, degrees of freedom = 3, $P < 0.0001$).

Fig. 4. Posters presented at EB PhUn Week training sessions, 2011–2016. The no. of PhUn Week posters presented during the annual EB PhUn Week Training session has steadily increased since the poster format was instituted in 2011 ($r = 0.95, P = 0.0021$).
PhUn Week was established to engage all three groups, students, teachers, and scientists, and data indicate that the formative evaluation goals for PhUn Week are being accomplished. The program has grown in size, models, and resources and is engaging both physiologists and trainees with K–12 students nationwide. In the coming years, we anticipate continued growth of PhUn Week, especially as the number of APS members involved in undergraduate education increases and the connections between APS members and local schools strengthen. However, there are a number of issues that will need to be addressed as the program matures.

**Conduct impact evaluation.** Evaluating K–12 informal science programs and nationally disseminated programs is complicated. Combining these factors, informal science at more than 100 locations, is especially problematic. Although school systems welcome presentations and interactive science activities by local scientists, collecting and releasing data on under-age students takes extraordinary effort. Due to these factors, we have not tried to directly evaluate the impact of PhUn Week activities on students and have, instead, relied on general observations by researchers and/or teachers. In the coming decade, however, we hope to build a collaborative research network of local PhUn Week sites that can work with their local school systems to collect, analyze, and publish student data on PhUn Week impacts. This would allow multisite assessment of impacts on student understanding of physiology concepts and careers, and interest in science careers. It also would allow analysis of impacts of different PhUn Week models (e.g., single classroom visit, large museum event, laboratory visit). A collaborative also would allow us to work with a group of researchers on how to structure educational research projects, analyze informal science data, and develop educational research manuscripts.

**Provide online, on-demand training.** We plan to offer additional PhUn Week training options, including online webinars on how to plan events and work with students of different age groups. Another option is to add a new APS Professional Skills Training course on K–12 outreach. A pilot course is being tested with APS Minority Outreach Fellows in 2016 and, if successful, could be offered to both trainees and established scientists in coming years. The APS is committed to supporting and growing trainee participation in K–12 outreach programs that expose children and teens to the excitement of the physiological sciences. The future of PhUn Week successes will depend on APS trainee members who are willing and capable of making meaningful impact on K–12 students’ interests in science throughout their careers.

**Expand the outreach.** The number of PhUn Week activities in each state is significantly correlated with the number of APS members in that state (Fig. 5). While PhUn Week events have taken place in 82% of U.S. states, there are still several states and many communities where there are strong communities of APS members but no PhUn Week events. In coming years, we will work with the Association of Chairs of Departments of Physiology and APS regional/state chapters to encourage the continued growth of the PhUn Week program. Retired physiologists are another potential target audience to engage in the PhUn Week program. While in some areas it may be difficult for physiologists to make the initial connection with a teacher, we recommend several strategies to get engaged with local schools:

- Offering to judge a local science fair in order to meet science teachers;
- Recruiting local teachers for APS regional and national teacher professional development programs;
- Contacting a local or regional science center or museum to identify local school contacts; and
- Asking friends or colleagues who have school-aged children for help in connecting with a K–12 teacher.

**Summary.** The APS PhUn Week program contributes to scientific literacy by partnering scientists with their local schools to enhance teacher and student understanding of physiology concepts and careers and to promote student-centered learning. When a physiologist visits a local school, the students are given what, for many, will be their first opportunity to actually interact with a scientist. The structure for meaningful outreach provided by PhUn Week allows physiologists to talk about physiology as a discipline and a career, to perform experiments with students, and to become role models. During the first decade of this organized outreach initiative, nearly 100,000 students have had the opportunity to meet a physiologist, have been engaged in hands-on physiology activities, have gained insights into science careers, and have increased their understanding of physiology and how it impacts their health and everyday life, fulfilling the initial PhUn Week objectives. While much has been accomplished, there is still additional work to be done in gathering data on student impact, providing additional online training, and continued support of member-teacher contact opportunities.

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**Fig. 5.** PhUn Week events in state 2005–2015 by APS membership, 2016. The correlation between the total no. of PhUn Week events (2005–2015) in each state and the total no. of APS members in the state was significant ($r = 0.49$, $P = 0.0002$).
DISCLOSURES
M. L. Matyas and M. Stieben are employees of the American Physiological Society.

AUTHOR CONTRIBUTIONS
M.E.S. and M.L.M. conceived and designed research; M.E.S. and M.L.M. performed experiments; M.E.S. and M.L.M. analyzed data; M.E.S., P.A.H., and M.L.M. interpreted results of experiments; M.E.S. prepared figures; M.E.S. and P.A.H. drafted manuscript; M.E.S., P.A.H., and M.L.M. edited and revised manuscript; M.E.S., P.A.H., and M.L.M. approved final version of manuscript.

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