An Outreach Activity Teaching Cub Scouts About the Human Body

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Abstract
Possessing awareness about the human body is important for the maintenance of good health. To increase such awareness in children's daily lives, we developed and implemented a two-hour activity session for a group of nine Cub Scouts. Three graduate students, one undergraduate student, and one high school student assisted faculty during this session. The children were given a presentation about the human body using an Anatomage Table and models of the heart, lungs, liver, kidney, muscle, and ear. The Cub Scouts were given a brief quiz before and after the session in order to evaluate the impact of the intervention on students' knowledge. The post-test score was 8% higher than the pre-test score ($p<0.05$), suggesting that the introduction to the human body was helpful in enhancing Cub Scouts' learning. This project also allowed high school, undergraduate, and graduate students to communicate anatomy with young children at their level. https://doi.org/10.21692/haps.2020.008

Key words: Cub Scouts, human body, The Anatomage Table

Introduction
Outreach is a meaningful teaching service that benefits the public beyond the academic community (Andrews et al. 2005). Public outreach is a powerful and immediate means of bridging formal and informal science education (Stocklmayer et al. 2010). Science outreach may include tutoring, mentoring, presentations, facilitating inquiry, supporting teachers during school, after school and in summer programs, judging science fairs, and developing resources and curricula. Educational outreach activities for children between the ages of five and 18 years old (K–12) are a direct way of increasing young students' scientific knowledge and skills, and fostering their interest in science. Physiology Understanding (PhUn) Week is an outreach program sponsored by the American Physiological Society (APS) that brings physiologists and K-12 students together to introduce laypersons to concepts related to physiology (Stieben et al. 2017).

Engaging undergraduate, graduate, and high school students in outreach activities helps students develop leadership and communication skills especially in translating difficult scientific concepts into simple terms that the younger learners are able to understand. In addition, presentations regarding technical topics often lead to many questions from students, and having graduate students and research scientists directly involved in K-12 educational programs can help address this issue (Clark et al. 2016).

As an outreach activity to stimulate young minds, this project consisted of two goals. Inspiring students in science was the primary goal. We introduced the details of the human body to the Cub Scouts as a hands-on activity through a number of models as well as using the Anatomage Table, which is a visualization system of radiologic images of human cadavers (Custer and Michael 2015). Pre- and post-tests were used to measure changes in student knowledge. The second purpose of this study was to provide opportunities for older students (one high school, one undergraduate, and three graduates) to utilize their knowledge of the human body to design relevant educational experiences for the youth. Any additional gains from organizing this event by the student volunteers were revealed using a qualitative survey.

Materials and Methods
Recruitment
The Institutional Review Board (IRB) of the Southern Illinois University, Edwardsville (SIUE), approved this project, IRB protocol #172. Youths, ages five to ten years, from a Cub Scout pack in Edwardsville, Illinois were invited to participate in an evening of learning about the human body. Parents or guardians and youth provided consent and assent, respectively.

Event Description
A two-hour session was held at SIUE during PhUn week in 2018. Models of specific organs were displayed, one per table, in a common area and the Anatomage Table was located in the simulation lab. First, the students were given a pre-test followed by hands-on activities and a post-test at the very end of the session. The pre-test consisted of a total of ten questions, nine multiple choice and one true/false question (Figure 6). Once the pre-test was completed, students were put into random groups of two to three participants per group and directed to stations that contained three-dimensional models for specific human organs (the lungs, liver, heart, kidney, ear, and muscle). Each station was staffed by a volunteer (student or faculty) who explained the structure

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***Figure 1**. A Cub Scout Listening to the Stethoscope as the volunteer assisted.*

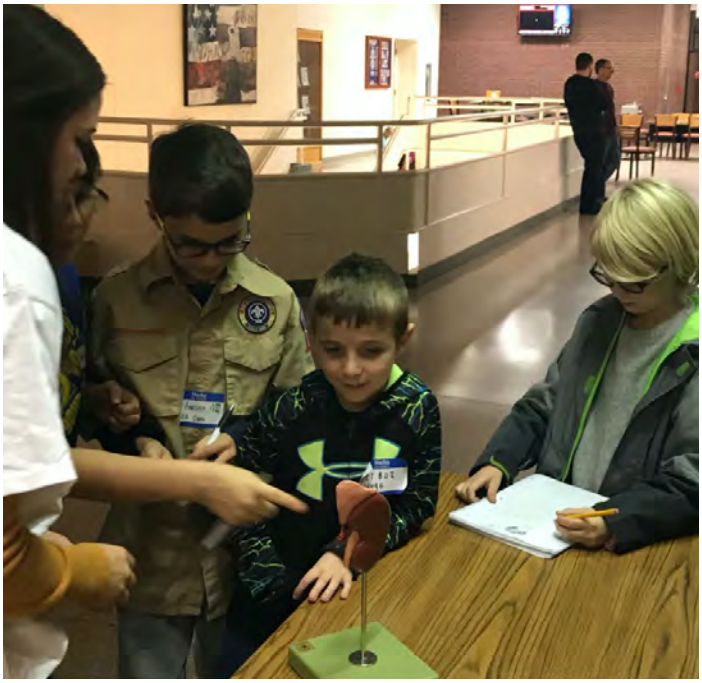

***Figure 2**. Cub Scouts Exploring the Kidney Model. A volunteer is explaining details of where urine is made and how it travels within the kidney and then into the ureter.*

***Figure 3**. Cub Scouts Exploring the Muscle Model with the assistance of a volunteer. The muscles could be taken apart and reassembled. A volunteer assisted participants to name a few muscles and explained the functions of muscles in general.*

***Figure 4**. Cub Scouts Exploring the Lungs Model. A volunteer helped the group learn about the lobes of the lungs, bronchial tree and the functions of the lungs.*

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Figure 5. *Cub Scouts Exploring the Liver Model. The functions of the liver, the lobes of the liver and the gallbladder were discussed at this station.*

and function(s) of the organ in very simple terms, appropriate for the ages of the Scouts, who ranged in age from five to ten years. The volunteers also explained the locations of these organs within the body as well as their relationships to the overall body function. Examples, analogies, and disease states were used to explain the concepts.

Hands on activities included the opportunity for the Cub Scouts to listen to their own heart sounds using a stethoscope (Figure 1). The Scouts spent approximately ten minutes at each station, allowing ample time to interact with the models, including dismantling and rebuilding them, as well as asking questions. After each Scout visited all stations, student volunteers provided an interactive presentation using the Anatomage Table. They were able to touch the Anatomage screen to point to the organs that were displayed. After studying each model and the Anatomage Table, the Scouts completed the post-test, which was the same as the pre-test so that learning gains could be assessed.

Volunteers

The volunteers consisted of a high school student, an undergraduate student, and three graduate students as well as two faculty members. The students were teaching and research assistants with the two faculty mentors involved in the PhUn project. All of the volunteers were familiar with the human body since they had completed advanced placement Biology (high school student) or Anatomy and Physiology courses (undergraduate and graduate students). Each volunteer assumed responsibilities in one or more activities such as composing the questionnaire and the answer key, demonstrating body parts using the Anatomage Table, proctoring pre- and post-tests, setting up and staffing of the tables with models, and interacting with groups of Scouts as they visited each table. Volunteers practiced the presentation of details pertaining to each model with at least one faculty member prior to the event and revised their scripts as needed.

Anatomage Table and the Models

The Anatomage Table is an advanced anatomy visualization system that is built utilizing radiographic images of cadavers. It allows dissection of the human body in any angle. It is an excellent device for hands-on and interactive methods to understand cross- sectional anatomy of body parts and adjacent structures associated in an integrative approach. It also allows the visualization of blood vessel arrangements, lymphatics, and nerve supply to the selected body parts. The three-dimensional models for specific human organs (the lungs, liver, heart, kidney, ear, and muscle) can be disassembled to explore deeper parts. The ability to remove and rearrange the parts of each model itself can intrigue users to engage with the body parts (Figures 2 to 5). Having an opportunity to touch and view the organs on the Anatomage Table screen in detail was another interactive mode for students to learn about the body parts.

Assessment

The pre- and post-tests consisted of the same ten questions and assessed Scouts' knowledge of body structures and functions (Figure 6). Use of the same questions for the pre-test and post-test allowed for assessment of how the learning activities enhanced the Scouts' knowledge on general anatomy and physiology topics.

Nine of the Cub Scouts were accompanied by their parents. The Scouts completed the pre-test, some receiving help from their parents to read the questions. In the case of a word/words that a Scout did not understand, a brief explanation was provided. Parents were asked not to provide any hints or reveal answers while reading questions. After both tests were completed, student volunteers graded the Scouts' pre-test and post-tests. Leadership experience by the student volunteers were assessed through virtual individual interviews following the event.

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Statistical Analysis

A paired Student t-test was used to analyze the data from both the pre-test and the post-test using the *Graphpad Prism* program. Student volunteer survey responses were analyzed qualitatively as described below.

Results

Results are summarized in Figures 7, 8, and 9. As shown in Figure 7, there was an average of 8% increase in knowledge from the pre-test to the post-test ($p<0.05$), which signifies an overall improvement due to a variety of learning activities. Figure 8 shows that, although not statistically significant, all the Scouts except for Scout 2 had improved in comparison to their pre-test results. As displayed in Figure 9, though not statistically significant, the Scouts had the most improvement in knowledge related to the liver. Figure 9 also shows that while, again not statistically significant, the Scouts' knowledge was reduced in post-test questions related to the heart and lungs.

1. What is the Heart made up of?
   1. Muscle
   2. Bones
   3. Cartilage
   4. Skin
2. How many bones are in your ear?
   1. 1
   2. 2
   3. 3
   4. 4
3. The lungs help to add _____ to the blood
   1. Air
   2. Oxygen
   3. Carbon Dioxide
   4. Nitrogen
4. What is one function of the liver?
   1. Supplies blood throughout the body
   2. Helps absorb energy from the body
   3. Helps detoxify the blood
   4. Circulates vitamins in the body
5. What is a byproduct of the kidney?
   1. Blood
   2. Urine
   3. Protein
   4. Fat
6. If you do not use your muscles, what happens to them?
   1. They strengthen
   2. Nothing
   3. They weaken
   4. They will grow
7. Eating a lot of salty foods will not affect your heart
   1. True
   2. False
8. How can one survive without any kidneys?
   1. They can't
   2. A Dialysis machine
   3. Eating less food
   4. Drinking only water
9. What is a lung made up of?
   1. Neurons
   2. Bronchioles
   3. Capillaries
   4. Rods and Cones
10. Which one these is **not** a type of muscle?
    1. Smooth Muscle
    2. Straight Muscle
    3. Skeletal Muscle
    4. Cardiac Muscle

Figure 6. *Questionnaire Used as Pre-Test/Post-Test. There were 10 questions in total, 9 multiple choice and one true-false. The same questions were used in both pre-and post-tests.*

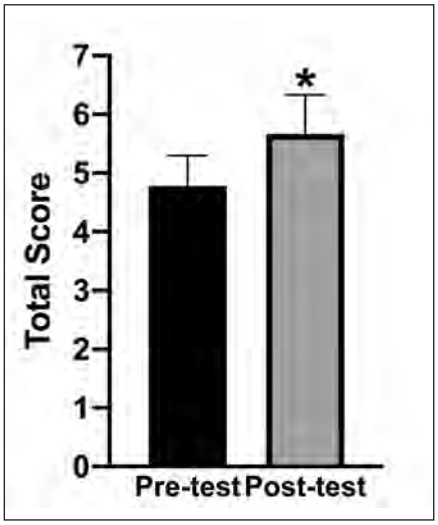

Figure 7*. Mean scores of Pre-test and Post-test of the Cub Scout Group *P<0.05 (N=9).*

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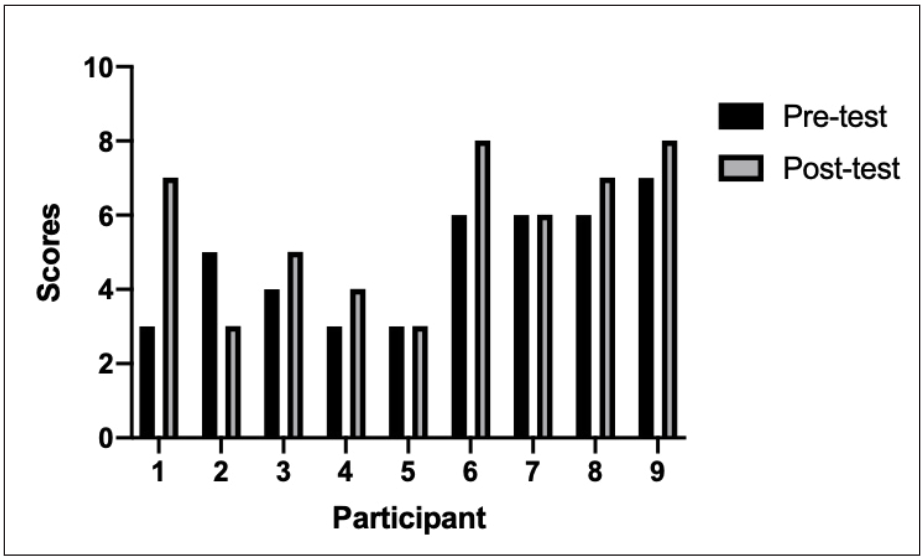

Figure 8. *Comparison of Pre- and Post-test Scores of Individual Participants (N=9).*

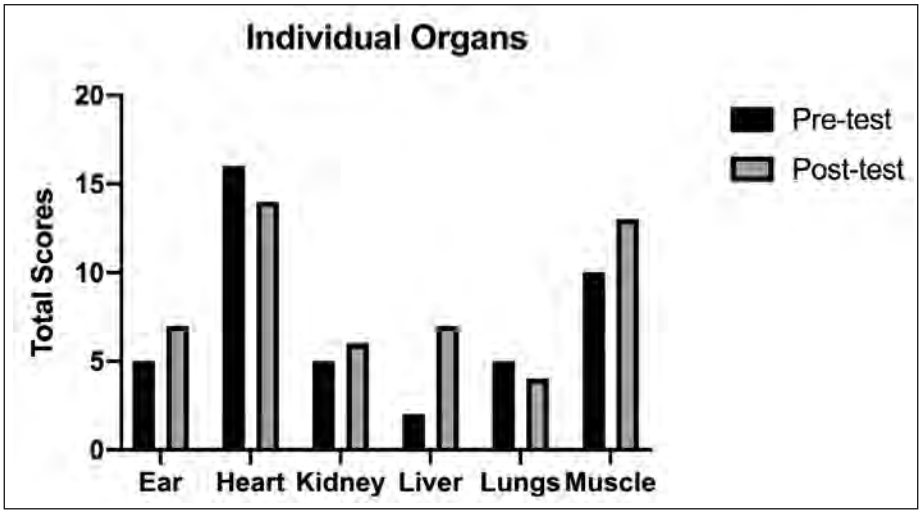

Figure 9. *Comparison of Pre- and Post-test Scores by Individual Organs (N=9).*

Another outcome assessed in this study was the benefit student volunteers experienced from participating in the project. Five student volunteers participated in this project, four of which submitted survey responses following the event. Based on their responses, the leadership roles can be broken down into two categories: 1) tasks or roles assigned as part of the project, and 2) serving as an effective teacher for the Scouts.

The roles and responsibilities for each student volunteer were slightly different, partially due to their educational level and work experience. For instance, the graduate students held more responsibility in the event than the undergraduate and high school students. Each student volunteer held a leadership role in that they were each responsible for teaching about a particular organ. Additionally, the graduate students were responsible for creating the lesson plan, preparing and introducing "…the Anatomage table teaching components...", and developing the pre- and post-tests.

The student volunteers felt that they were able to effectively teach about their assigned organ in layman terms, particularly in terms that young children could understand. Each student volunteer prepared for the event in their own way, from "… researching and reading over the importance…" of the organ they were responsible for teaching about, to relying on "…my prior physiology knowledge from an AP Biology class…." The

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two graduate students both had previous work experience in clinical pediatric settings and so, were especially familiar with effective ways to convey complex health information in understandable terms. Techniques described included analogies, "…open ended questions to get a baseline knowledge level," and stopping "…to ensure that the students [understood] the general idea of what I was saying" prior to providing additional explanations. Further, the student volunteers found that as the event went on, they became progressively better and improved "…their own skills about explaining complex information clearly and in simple words and phrase."

Discussion

Our study to engage Cub Scouts using hands-on activities was successful as evidenced by a significant increase in their post-test performance. The improvement of scores with the liver questions was greater than with most other organs. This is possibly due to the students' very little knowledge about the liver prior to attending this session. These results also suggest that the student volunteers were able to communicate with the Scouts effectively which helped the young learners have a positive experience. Besides staffing the table with models, student volunteers also were able to help plan the entire event, demonstrating an important aspect in leadership skills. The student volunteers set up a station for each model, created pre- and the post-tests, proctored the assessments, explained the details of the models at the most basic level possible, and demonstrated the body parts using the Anatomage Table while also asking and answering questions from the Scouts.

One of the constraints of the study was that the assessment was limited to pre- and post-tests of a multiple-choice test style. The questions seemed appropriate to us as college students and researchers, but it would have been helpful to evaluate the literacy level. The Scouts ranged in age from five to ten years, which challenged the student volunteers and faculty members to be very sure that every participant understood the questions and the details of the organs that were discussed. This aspect was addressed by using many examples and analogies to explain and describe the organs. Another constraint was the small sample size consisting of only nine Scouts from one Cub Scout Pack. This was partly due to the busy schedules of many parents and the Cub Scouts themselves. It was difficult to find additional Packs that had enough time to participate in this study.

Student volunteers not only led the activities successfully, but also were able to explain complex details in simplified terms to the younger audience. A short survey conducted to gain insight into the student volunteers' experience suggested that they enjoyed being part of this event as it provided them an opportunity to interact with the young Cub Scouts and share knowledge with them.

Based on the limitations, there are many adjustments that might be made in the future that could be helpful. For example, a discussion format could be implemented for the pre-test and the post-test in order to allow for a better understanding of what children learned from the activities. Parents and guardians could be involved as well in order to help the youth participants understand the questions in the discussion. In addition, a follow-up test a few months after the study could be added to the protocol in order to determine any long-term knowledge that the youth retained from the study. Plans are under way to assess the long-term benefit of the learning activities to the students and to determine if a decline in knowledge occurred over time.

Conclusions

In our present study, providing students with an opportunity to learn about the human body in an interactive manner enhanced learning about the subject. Most of the Cub Scouts were very engaged and proactive in the discussions throughout the activities (Figures 1-5). Learning about the human body by using models and the Anatomage Table may help encourage youth to pursue careers in areas of health sciences. At the same time, this program provided a structure for graduate, undergraduate, and high school student volunteers to gain experience in interacting and explaining complex topics clearly to their community. One of the benefits of this program is the minimal time investment required from both the participants and the volunteers in order to yield very positive results.

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