Outreach Activity Report

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1. Overview

The outreach activity took place April 18-20th at Engineering Expo 2013 in the BMES room on the 2nd floor of Engineering Hall in Madison, Wisconsin at the College of Engineering at the University of Wisconsin-Madison. With over 8,000 children attending Expo this year, it is estimated that approximately 1,000 young learners, ranging in age from 5 to 18 years old, participated in our scientific outreach activity over the three days of Expo. The activity was open from 9am to 4pm on April 18th and 19th and from 9am to 2pm on April 20th.

This activity did not include a PowerPoint presentation; however, it did include a poster for which aided members of the team in explaining the objective of the activity, how the surgical robot functions, and for which surgical applications it is used. Members of the presenting team challenged students to think about advantages and disadvantages of robotics as applied to surgical applications in medicine. Therefore, the majority of the time spent with each student was spent on a hands-on activity and kinesthetic learning. While the event did not include a PowerPoint presentation, the major constraint on the presentation was the mass numbers of students and therefore a limited amount of time presenting to those waiting to participate in the activity.

For the outreach requirement, an activity in the BMES room at Engineering Expo 2013 was developed. The team developed an activity with a robot used in surgeries and implemented it in a way that would be engaging and interactive for students in elementary school and up to high school. The surgical robot was set up with a bowl of small chocolate candy bars underneath each arm and the task was to manipulate the arm using a joystick to move the arm side to side and a foot pedal to move the arm down toward the bowl of candy. From the student's perspective, the goal was to manipulate the surgical robot arm in order to pick up a piece of candy from the bowl and place it on the table next to the bowl. The students could not directly see the candy bowl and the position of the surgical arm so they relied on the camera feed on a monitor in front of them in order to simulate an actual surgical robotics set up.

The intended audience enjoyed the opportunity to work with the surgical robot and was eager to learn more information about how the surgical robot works and how it is utilized in various surgeries. Many older students asked in depth questions about the electronic components and programming of the robot. The older students seemed to appreciate the challenge of considering the advantages and disadvantages of using robots in surgery. Overall, positive feedback was received from teachers and chaperones about the activity which likely indicates an equally positive reaction from the intended audience. Since the activity resembled an activity the kids would play in an arcade, it was easy for students of all ages to relate to the activity.

While some of the content of the activity was difficult for elementary students to understand, the presenters focused on highlighting the main points of the application so the younger audience would retain the important details and not lose interest in the activity. Additionally, using the joystick to control the robot was challenging for some elementary school students as their motor skills are still developing. The monitor used didn't include adequate depth perception since a camera with only one lens was used rather than one with two lenses, which are typically used today with current surgical robot models. This made the task more difficult but was supplemented by verbal coaching. The team members presenting helped the students out so they could successfully manipulate the device and receive a piece of candy. Overall, given their excitement and numerous questions asked, the elementary students appeared to have a lot of fun with the activity.

In order to improve the activity, more than one activity could be performed so that students could participate in an activity that is more similar to what the surgical robot would be used for. A mannequin could be used as the subject and students could use the surgical arm to cut strings which would be hanging across the abdominal cavity. An activity similar to the activity mentioned would help students to grasp the concept of the surgical robot and better understand the various surgical applications. Additionally, a kid-friendly handout with the main points of the presentation or some sort of take-away would improve retention of the information after the day of the presentation. A final improvement would be talking more about biomedical engineering as a whole when introducing the activity instead of discussing the impacts of biology and engineering at the end of the activity.

2. Presentation

When a student or group of students entered the BMES room, they had the opportunity to complete various activities including the surgical robot activity. For the surgical robot activity, presenters first explained what the surgical robot is and what it is used for. The presenter asked the students to brainstorm examples of surgical procedures, who performs the surgeries, where the surgeries take place, and other general information. The presenter supplemented any student answers and added relevant information about surgeries. Next, the presenter asked the students what types of surgeries use surgical robots. The students produced a wide range of answers and the presenters explained that surgical robots can be used in minimally invasive surgeries (the presenter defined this term and described it further depending on the age of the student) and open surgeries.

Next, the presenters explained how the surgical robot works and information about programming the robot. The amount of detail varied depending on the age of the audience. The presenters explained the components of the surgical robot system including the camera, the robotic arm, the monitor, the controls and the computer program. During this part of the presentation, presenters showed students how to use the controls and what is seen on the monitor.

After explaining the robot, the presenters defined the objective of the activity and explained how to complete the activity. After the activity was complete, the students were asked if the activity was easier or harder than they expected. Students, from middle school age and on, were asked what they thought some advantages of using a robot in surgery would be. Presenters added to their answers. Next, they were asked about some disadvantages of using a robot instead of a human, even if the robot is used as a supplement for the surgeon during the surgery.

After students were able to try manipulating the robotic arm using the hand and foot controls and received their candy, the presenters talked about how this application of surgical technology relates to biomedical engineering and further discussed the field of biomedical engineering as a whole. The presenters described the various tracks within the field – including instrumentation, materials, and imaging – and challenged students to come up with other biomedical engineering applications and devices. The presenters did this by asking students of middle school age or older what they thought biomedical engineering is. The presenters added to their answers and asked if the students had any questions after the presentation about the surgical robot or other displays and activities in the BMES room.

The total time of each presentation varied depending on the age level and group size but was approximately 15 minutes per presentation. However, students spent more time participating in other activities in the BMES room relating to other biomedical engineering applications. For Engineering Expo, time was a constraint and the presentation could not be longer because of logistical constraints, as described in the first section of the report.

Gabe Bautista and Kim Maciolek were mainly in charge of getting the robot ready for the presentation and developing the activity. Jay Kler, Kevin Beene and Hope Marshall developed a list of various thought-provoking questions, as described in the above paragraphs, to ask the students during the presentation so that the activity would provide the students with thorough information about the influence of engineering in the medical field. All members participated in the presentation and demonstration of the activity at various points during Engineering Expo 2013. Kim Maciolek, Gabe Bautista and Jay Kler spent the most time presenting the activity during the days of Expo. Documentation of the activity and setup are shown in Appendix A.

3. Description of Demonstrations or Hands-on Activities

Professor Thomas Yen and Gabe Bautista were the main contacts for obtaining the following materials and props:

- Surgical robot and robotic arm (ZUES Robotic Surgical System)
- Monitor
- Camera
- Joystick and pedal
- Table
- Seat
- Plastic bowl
- Fun-size candy

The hands-on activity was demonstrated and then performed by students who attended Engineering Expo. The students sat in the seat and placed their hand on the joystick and their foot on the pedal. The students looked at the monitor showing the raised surgical arm over the bowl of candy on the table behind them. Next, the students used the joystick to move the surgical arm laterally in four directions, depending on the candy they wanted. When the students established their desired lateral position of the robotic arm, they used the foot pedal to lower the arm in the vertical direction to grab the piece of candy. The students pressed a button to open and close the claw to grab the candy and used the pedal and joystick to remove the candy from the bowl and place it on the table.

During the activity, presenters demonstrated the activity, monitored the activity and helped students who were having trouble. Each team member led the hands-on part of the activity at different times and different days of Engineering Expo. This was primarily a hands-on activity.

Special considerations for the activity include the space requirement. The surgical robot takes up a significant amount of room and in order to have enough room for the robot, controls, monitor, table and space for participants to stand and watch, at least 25 square feet of space is needed. Some experience with the robot (or user manual) is needed in order to set up the hands-on activity.

Appendix A: Figures demonstrating the setup of the ZUES Robotic Surgical System.

Figure 1: Setup of the ZUES Robotic Surgical System in a clinical setting (http://www.ufrgs.br/imunovet/molecular_immunology/surgery_robotical.html)..

Figure 2: Setup of the ZUES Robotic Surgical System during engineering Expo.