AC 2012-3822: GENERATING INTEREST IN TECHNOLOGY AND MEDICAL DEVICES THROUGH AN INTERACTIVE EDUCATIONAL GAME

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Introduction

The issue of motivating students to be engaged in the educational process and inspire them to excel in the fields of science, technology, engineering, and mathematics (STEM) has received much attention as affiliated universities and industries strive to encourage children to pursue interests in these areas[1]. This is evidenced by the proliferation of STEM schools and increasing requirements at the state level to provide engineering education at all ages[2]. The end goal of efforts in these areas is to produce a larger quantity of students who ultimately pursue post-secondary education in STEM fields and thus advance the technological capability of our society[1]. Similarly, the goal of the work presented in this paper is to demonstrate a method for generating interest in the applied engineering field of medical devices with primary-school aged children in a non-academic setting.

Methodology

In order to provide an interactive way to engage children and educate them in the field of medical devices, a modified, life-sized version of the game Operation® by Hasbro, Inc. was made. The overall goal of the game was to stimulate interest in engineering and technology through the demonstration of a relatable application. The basic premise employed here is grounded in the model of experiential learning as described by Kolb where it is stated that learning is achieved through immediate personal experience that provides a connection with the abstract[3]. This display is used in a variety of situations ranging from community outreach events held at local fairs to in-school and museum demonstrations. The need for this sort of interactive display arose from the observation that a traditional display consisting of medical devices placed next to their descriptions on a table received little attention from the general public and did not elicit interest or excitement in children.

As shown in Figure 1, the cavities of the game board contain a variety of medical devices which are placed in locations appropriate to their real-life use. The included medical devices consist of an implantable artificial pacemaker, a laparoscopic trocar, a hip replacement implant, a drug delivery pump, a femoral rod implant, a fracture plate, an oversized cardiovascular stent, and a knee replacement implant. These devices represent a variety of sub-disciplines within the field of medical devices and were chosen for their relatability and logical placement within the body.

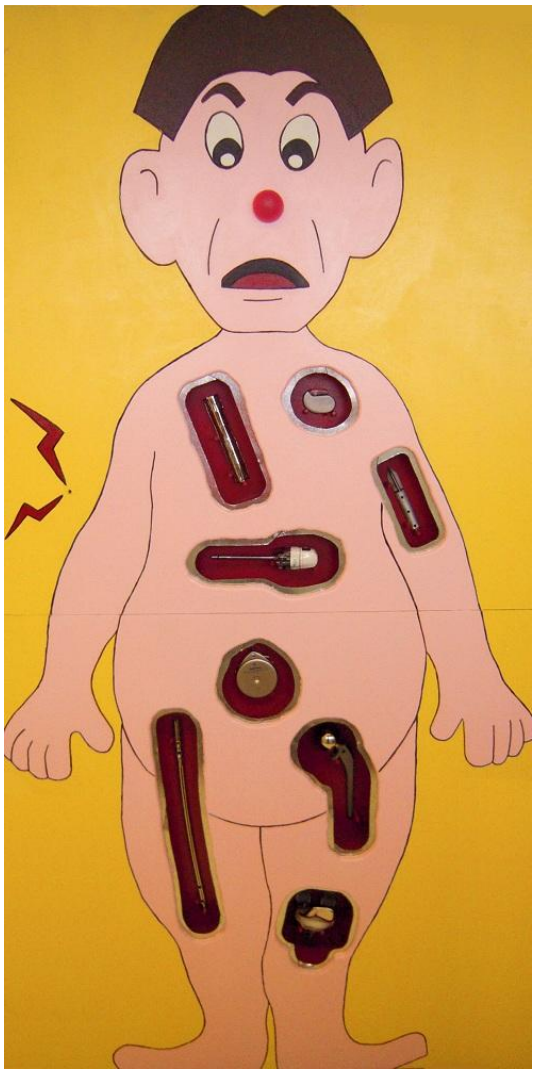

Figure 1. Image of life-sized Operation® game showing placement of medical devices.

The game board as a whole stands six feet tall and includes the traditional game play aspects of the original game, a nose that illuminates and a buzzer that sounds when the grasper comes into contact with the edges of a cavity, in order to incorporate a fun and engaging experience for children. The format of the game encourages children to grasp the various devices thus allowing them to examine them up close and inquire about the nature of the device and what it is used for. Device interaction is further supplemented by verbal explanation of what the device is and what it is used for. By making use of both tactile and auditory forms of sensory input, retention of the transferred information about each medical device is enhanced[4].

Evaluation

To assess the effectiveness of the Operation® game at engaging children and stimulating an interest in technology and medical devices, a study consisting of both observational and survey components was performed.

The first phase of the study was conducted during a day-long exhibit at the Minnesota State Fair. The Operation® game display was located in a building which houses a variety of displays all originating with the University of Minnesota – Twin Cities. The display was located in a high-traffic area which resulted in approximately 1500 visitors throughout the day with a roughly even distribution of adults and children. The display consisted of the Operation® game and next to it a table with additional medical devices and an informational description of each device. Observations of visitor's interactions with the display were conducted and the results of these observations were collected at the end of the day. The purpose of these observations was to assess the relative popularity of the Operation® game compared with the table-top display in a high-traffic setting.

The second phase of this study was performed as part of the family fun-night at Cedar Park Elementary STEM School located in Apple Valley, Minnesota. The school caters to K-5 aged children and the event provides an opportunity for the children and their families to engage with displays, demonstrations, games, and activities brought in from a variety of sources. The same Operation® game display as was used in phase one was set up at the school (see Figure 2). The event lasted 1.5 hours during which visitors to the display were asked to complete an exit survey on a voluntary basis.

Figure 2. Photograph of display at Cedar Park Elementary STEM School family fun-night.

The survey included questions for both the child and their parents. Also, due to the age of some of the children, parents were encouraged to help their child complete the survey as necessary. The survey questions targeted at the children were qualitative and were used to gauge the child's enjoyment while interacting with the game, for example, "Was the Operation game fun?" Further, one question asked the children to choose which of the devices, shown in a series of photographs, they interacted with while visiting the display. In addition to the devices mentioned previously as being part of the Operation® game, this series of photographs included images of medical devices only found on the table next to the game as well as an image of a device not found anywhere within the display. The purpose of this question was three-fold: first, to assess the usage trends of the devices to determine which are the most popular, second, to provide a quantitative comparison between the devices included as part of the Operation® game and the

devices found on the table, and third, to provide a measure of control regarding the validity of the results.

The survey questions targeted towards the parents included both qualitative and quantitative assessments. Parents were requested to ask their child the name of a medical device and record the first answer they come up with. The purpose of this question was to assess the recall of the child and determine if the display stimulated the child to name a device not presented as part of the display. Parents were then asked to rate their child's engagement and stimulation while playing the Operation® game on a scale of one to five where five was very engaged/stimulated and 1 was not at all engaged/stimulated. Finally, parents were asked to indicate the age of their child for analysis purposes. Survey questions were kept intentionally simple in order to promote successful completion in a high throughput environment.

Outcomes

Based upon observations collected during phase one of the study, it was found that the interactive game board has received significantly greater attention than a traditional table top display when placed together at the same event. It was observed that greater interest in the Operation® game and in medical devices was generated amongst all age groups including adults without children present despite the game being targeted at the K-5 age range (5-11 years old). This result was likely due to the nostalgic value of the game and relatability to previous experiences. The table-top display attracted the attention of only a few children in the target age range and their engagement was significantly less when compared with the game display on the basis of device handling and information gathering. The significant observed benefit of the Operation® game display was that it encouraged hands-on interaction with the medical devices as shown in Figure 3. This interaction provided an educational opportunity and a chance to engage the kids with a topic that would otherwise be ignored.

Figure 3. Photograph of Operation game in use during the State Fair exhibit.

Further, it was found that children related to the devices and tools more easily when presented with them in the context of a human body with accompanying verbal explanation rather than a table display and written explanation. This result is consistent with the notion that children require concrete examples of a subject matter to overcome their lack of abstract thought[5].

Similar outcomes were observed during the family fun-night event. In addition to observational results, attendees were asked to complete an exit survey. A total of seventeen responses were gathered from children aged between four and twelve years as well as their parents. The results of this survey are discussed below.

Survey results indicated that all respondents enjoyed interacting with the Operation® game. Further, the children were asked to indicate which of the devices they interacted with while playing the game. Through this it was found that on average each child selected two devices from the board, which indicated that many children were sufficiently engaged in the game to play more than once. Further, from these results it was found that the two most popular devices were the femoral rod implant and the cardiovascular stent followed by the laparoscopic trocar and the fracture plate. These devices were likely targeted because they represent the "easiest" devices to select in terms of game play. By using accessible devices, the barrier to participation is lowered which is particularly important for younger children. Observationally it was found

that children that continued to play the game moved towards progressively more difficult devices. This would suggest that the selection of devices used in the game created a level of challenge that encourages increased interaction because the game play becomes more interesting. This inherently provides more opportunity for interaction and transfer of information to the child. These results also revealed that only one child indicated that they used any of the devices that were not found in the Operation® game but were placed on the table. This shows agreement with the observation that the table display received little attention during the event and that the devices on the table were not recalled frequently when completing the survey. Finally, no children selected the control device which was not found anywhere in the display allowing for some measure of confidence in the validity of these survey results.

As part of the adult survey questions, parents were asked to have their child name a medical device. As shown in Figure 4, the majority of children provided the name of a device that was included as part of the Operation® game. This demonstrates that the children were engaged while playing the game and were able to recall the devices that they learned about through game interaction. Further, an additional three respondents were able to name devices that were not included in the display. This shows that some level of technical interest was stimulated with those children such that they were able to search outside their most recent experience and identify related devices. It was assumed that the children had little or no prior knowledge of medical devices and received their first introduction to the field when visiting the display.

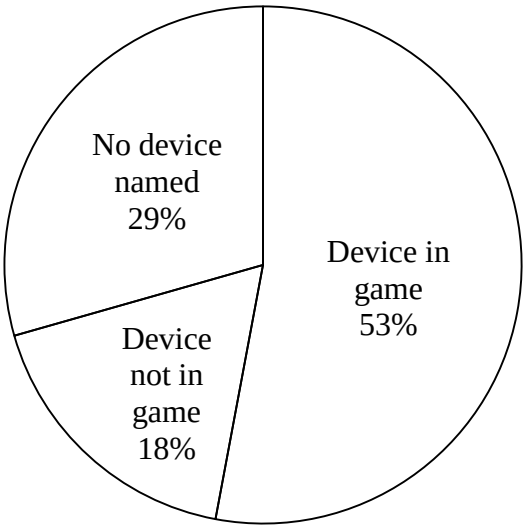

Figure 4. Survey results showing the break-down of how children responded when asked to name a medical device by a parent reported as percentages of the total number of respondents.

Parents were also asked to rate both their child's engagement and stimulation while interacting with the game as compared with other displays and activities at the event on a scale of one to five. These results are presented in Figure 5 and show that in both cases, a majority of parents indicated that their child was very engaged/stimulated by this activity. The charts show that in terms of child engagement, no parents selected a value of one from the scale and similarly, in terms of child stimulation, no parent selected either values of one or two from the scale. Further,

the respondents that rated their child's engagement or stimulation as three or lower in response to either question corresponded with children that were aged between ten and twelve years. This is not unexpected since the game play aspect of the display was likely not sufficiently challenging for older children. This indicates that some thought as to how to reach the top of the targeted age group may be necessary.

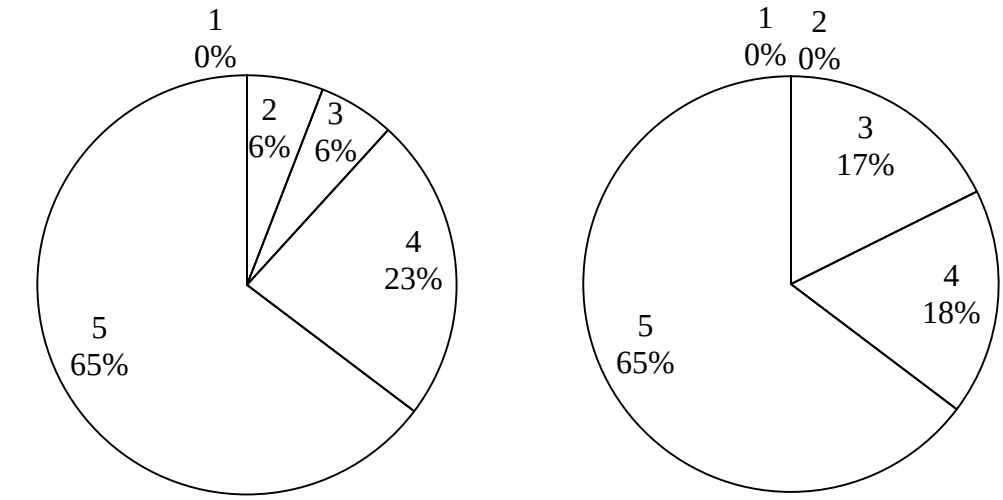

Figure 5. Survey results showing parent-reported child (A) engagement and (B) stimulation on a scale of one to five as percentages of the total number of respondents.

Summary

Much was learned about how to transform a subject matter previously inaccessible to children into something that is both engaging and relatable. By engaging the children in a fun and interactive way, it was possible to transmit knowledge about medical devices and get them thinking about the potential directions that can be explored by pursuing a future in engineering and technology. Further, by presenting the medical devices in the context of their real life applications, the children were able to make the connection between the concrete and the abstract[6].

While the results presented here were specifically targeted towards engineering outreach with a focus on medical devices, it is expected that these results are applicable to many areas where it is desired to relay material to children in an accessible and contextual manner. The results demonstrated that this method of information transfer resonated well with children aged four to nine years. Further, it was found that the engagement of children older than ten years was somewhat mitigated and it may be necessary to pursue additional interaction methods for children in this age group. It terms of medical device engineering outreach, an example of this could include a simulated surgical procedure where children attempt to perform a task with difficulty catered to their age group.

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