Introducing Vision Research and Biomedical Engineering to Pre-college 8th Grade Girls

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***Abstract*- The complex yet interesting field of vision research has been evolving in the past few decades within the Biomedical Engineering curricula. As more pre- college students are exposed to vision research, it can be anticipated that this field will bring in a new generation that will take part in the various studies of the visual and ocular system. NJIT's pre-college program FEMME, allows pre-college girls to have summer workshops studying many engineering majors. Our goal was to introduce and expose vision research to girls to stimulate their research interest.**

I. INTRODUCTION

Women represent approximately half of our population but less than 10% of our scientists and engineers are women [1]. The ratio of men to women receiving baccalaureate degrees in engineering, is approximately five to one [2]. Many pre-college programs, including NJIT's Women in Engineering and Technology Initiative– FEMME program offer girls the opportunity to learn about various engineering fields and are designed to motivate them to choose college majors studying science, technology and engineering. The FEMME program, designed for female students completing 4th through 8th grade, has been established where a thematic unit has been created for each grade group [3]. For eighth grade girls, the curricula is Biomedical Engineering where they are taught how to apply the principles of engineering, computer science and mathematics to the development of methods to solve medical problems [4].

A new workshop was designed this year for the 8th grade FEMME group to introduce the girls to vision research. Vision research is a field that studies many applications from vision therapy to human machine interface development. New discoveries in vision research are being applied to the treatment of eye diseases and disorders and facilitates the development of new products for better vision correction and care [5]. Even though vision research has been progressing, it has not yet been thoroughly introduced to students who are beginning to think about college majors and careers. The vision research workshop was a mechanism to present this field to these young minds.

II. THE WORKSHOP

The workshop consisted of experiments, open discussions, and a research laboratory tour. New vocabulary and diagrams were introduced via four visual interactive exercises / experiments to keep the students interested in the program. Each exercise was followed by a scientific explanation. The students were then led into a discussion about examples of vision research seen in society. After the discussion, the students were introduced to vision research laboratory equipment.

A. Interactive Experiments to Explain the Visual System

To teach the students how the visual system operates, four exercises were taught in addition to anatomic diagrams of the eye. These experiments facilitated the explanation of the equipment seen latter in the Vision Laboratory.

In the first experiment, "*Make Objects Disappear*", the students were given a piece of paper with two objects (an 'X' and an 'O'). The drawings were 2 ½ to 3 inches apart from each other. Holding the paper up in front of their faces, the students closed their left eye with their left hand. They then focused on the 'X' while bringing the paper either closer or further from their face. At one point, the 'O' disappeared. The students learned that when the "O" vanished, it was projected onto their optic disk as explained using Figure 1. The optic disk does not contain photoreceptors, thus the image cannot be transmitted to the brain, and we do not perceive the image.

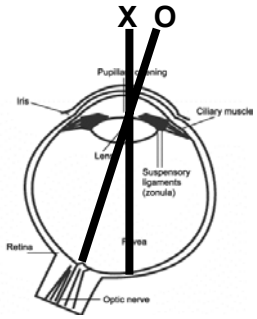

Figure1: Diagram for experiment "*Make Objects Disappear*"

The second experiment, *"Make Two Objects Become Three*", asked students to hold two pencils, one behind each other along the midline of their visual path where one pencil was the near target and the other was the far target. The students were instructed to focus on the near target, the pencil closer to their face. While doing so, the far target appeared to double. Then the students did the opposite and focused on the far target. Similarly the near target doubled in appearance. To explain the phenomena, students were taught that while they were focusing on the near target, the near target was projected onto their fovea in the retina. The far target was projected on the periphery of their retina. The image was perceived as two because it was not projected onto the same retinal location in each eye, which is diplopia.

In the next demonstration, "*Make Things Stop Moving,"* the students were given mirrors and were asked to work with partners. One student watched their partner move their eyes quickly from left to right, which is a saccadic eye movement. The students then watched themselves in the mirror while moving their eyes. While doing so, they were not able to see

their own eyes move. This phenomenon is called saccadic suppression, which is the brain's ability to suppress the movement of the image so that the world does not appear to move while the eyes make a saccadic eye movement.

In the last exercise, "*Keep Things Steady,"* the students were asked to focus on an object in the room. They were then asked to turn their head to the side to see if the object they were looking at also seemed to rotate. As the students rotated their heads, the object they were viewing did not rotate due to the vestibular ocular reflex (VOR). The VOR is the mechanism that rotates the eyes so that the visual scene does not move with head movement. The semi-circular canals in the vestibular system send a signal to the brain signifying head rotation. The brain then sends a signal to the eye to rotate as explained to the students using Figure 2.

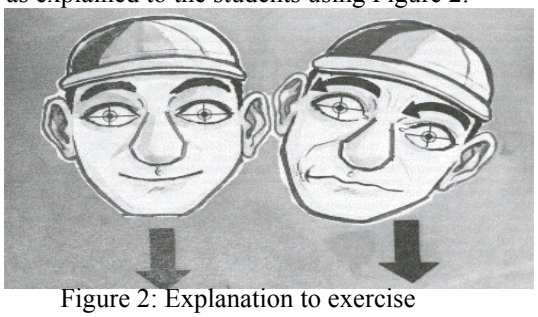

Figure 2: Explanation to exercise "*Keep Things Steady*"

B. Open Discussion of Vision Research in Society

After the exercises, the students participated in an open discussion of vision research examples in society. The students before the workshop answered questionnaires and most students did not answer the question "What examples of vision research do you see in society?" A few students gave the answer of glasses or Lasik surgery.

We discussed several examples such as research studied by NASA, virtual reality rehabilitation, optometric vision therapy to improve visual skills such as depth perception, focusing, and eye-hand coordination, as well as research in glaucoma and cataracts. We further discussed the implication vision research has on machine instrumentation such as the design of an airplane cockpit or automobile dashboards.

C. Demonstration of Vision Research Equipment

The last section of the workshop was a tour of the Vision Research and Engineering Laboratory. The students saw demonstrations of two eye movement tracking devices, the ISCAN which is a video tracking system and the Skalar which is a limbus tracking system. Utilizing the anatomy explained during the first part of the workshop, the students were taught the method of infrared reflection which is used in both systems to track an eye movement.

III. DISCUSSION

Before and after the workshop, the eighth grade students answered questionnaires. We feel that our workshop was successful because the students were enthusiastic in doing the experiments and asked many questions. Furthermore, the questionnaire showed that after the workshop, there was an increase in the interest in vision research and the desire to study Biomedical Engineering as seen in Figures 3 and 4. The questionnaire also revealed that the vast majority of students (15 / 17) answered that they understood the interactive experiments.

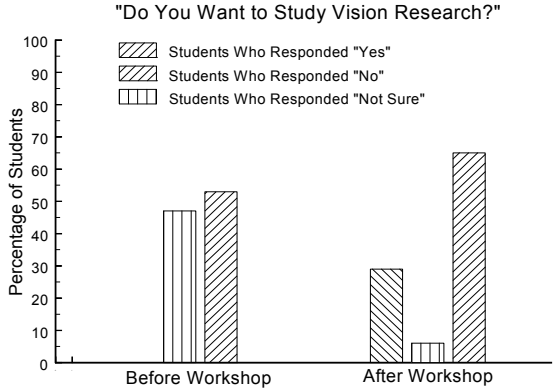

Figure 3: Number of students stating their interest in vision research

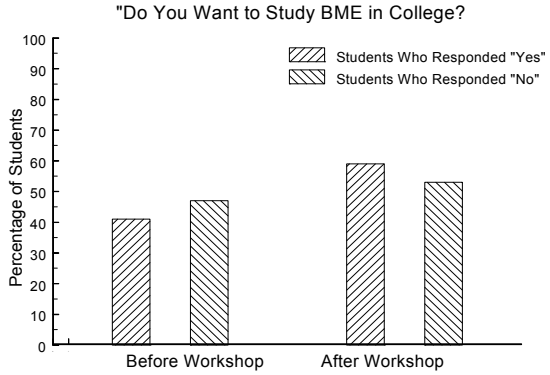

Figure 4: Number of students stating their interest in studying Biomedical Engineering (BME) in College

The majority of students found the tour and demonstration of the equipment in the Vision Research and Engineering Lab to be the most interesting part of the workshop. Furthermore the number of examples listed to the question "What examples of vision research do you see in society" increased after the workshop, which implies that, the students remembered many of the examples discussed during the seminar.

REFERENCES:

[1] R. Cano, H. Kimmel, N. Koppel, and D. Muldrow, "A First Step for Women into the Engineering Pipeline," Proceedings for the 31st ASEE/IEEE Frontiers in Education Conference, Reno, Nevada, 10/ 2001.

[2] J.R. Johanna, "Secret of Their Success," NJIT Magazine, The Alumni Magazine of NJIT, Fall 2001/Winter 2002

[3] H. Kimmel and C. Rosa, "K-12 and Beyond: The Extended Engineering Pipeline," Proceedings for the 31st ASEE/IEEE Frontiers in Education Conference, Reno, Nevada, October 2001.

[4] R. Cano, H. Kimmel, N. Koppel, and D. Muldrow , "A First Step for Women into the Engineering Pipeline," Proceedings for the 31st ASEE/IEEE Frontiers in Education Conference, Reno, Nevada, October 2001.

[5] http://www.nei.nih.gov/