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Summer Honors Institute for the Gifted

Background

Stephanie Robinson, Principal Partner of The Education Trust elaborates on the extensive data available at www.edtrust.org[1] that provides evidence of academic success for students in schools and youth programs that have raised expectation, teacher quality, and resources[2]. In the same vein, this paper illustrates the authors' cross-disciplinary outreach effort towards successful Mechatronics Education through Animatronics. The goal was to attract and challenge Ohio gifted secondary students to technical fields. After a development stage that included proposal writing[3], executing pilot studies with gifted students, coaching them for a national toy design competition, the authors developed a week-long summer study. It was offered for the first time during the 2005 Summer Honors Institute sponsored by the Ohio Department of Education Office for Exceptional Children. It was a residential program for Ohio 10th and 11th grade students who are officially documented to be gifted.

The Program

Biehler and Snowman observe high school students to be developing formal thought and start understanding abstractions[4]. By involving students at this level in directed and also open ended challenging activities, the authors were able to stimulate student thinking and functional processes.

This course introduced students to animatronics and robotics through hands-on activities. The schedule included mini-lessons and complimentary development sessions that reinforced informal learning principles. Students working in teams and individually in a very informal learning atmosphere used inquiry and creativity to design and build mechatronic toys. Product development process was the theme that was followed by the participants as emulation of real-world design activities. This is a novel approach that was developed by the authors. The course curriculum encompassed the following subjects in the following sequence:

- Introduction to Animatronics and Robotics
- Introduction to Engineering and Product Design
- Project Management
- Team Work Basics
- Concept Development
- Artistic and Industrial Design
- Materials and Manufacturing Process Selection
- Mechanism Design and Assembly
- Actuators, Sensors, Controls

- Controllers and Programming
- Costuming

After welcoming events, students were given an orientation about the institute program, a brief introduction on animatronics and robotics, and classroom and laboratory procedures. The students seemed eager working towards accomplishing the goals of the program since they had earlier received the curriculum, making them anticipate or prepare better. The authors realized that students were hands-on and did not want a mini-lesson to be in their way.

Initial section of the program included the presentations on engineering, engineering problem solving, design concepts and methodology. Examples and case studies were presented. The students designed a baseball bat and analyzed the design for improvements to better understand the development procedures. A simple FEM (Finite Element Model) package was utilized. Baseball bat was selected as the product since it was simple and fit in well with the time constraints. Introduction to Materials Science was briefly covered and students performed Rotational Molding, Vacuum Forming (in Figure 1), Compression Molding, and Injection Molding activities. After the completion of the previous set of introductory activities with technical content, the students were given basic information on how to manage a project and what tools available to assist in handling the projects. A Microsoft Project example, A Gantt Chart, was presented. A handout relating to team-work basics resources was prepared and given to the students. Communications, conflict managements, and leadership issues were included within the handout.

Figure 1. Students inspecting their vacuum formed plastic sheet

Second stage brought in the Art Professor who has been the collaborator to the authors since the conception of similar programs as seen in Figure 2. She presented examples of Concept Development in the Art field. Engineering concept development examples were presented as well. The authors indicated the commonalities between the two professions and show examples of art work in the product design and development process. Blind contour drawings, gesture drawings, action drawings, and story boards were included within the presentation of the Art Professor. The goal was to emphasize the free hand sketching process and its role in early stages of the design and development process. Industrial Design examples were presented in this stage informed the student about the aesthetics and human factors on use and ergonomics of products.

Figure 2. Preparing for the Concept Development

Participant body as a whole was asked to brainstorm on developing and marketing a toy that will teach toddlers. This activity allowed them to understand the importance of ideation and concept development. After this activity, the students were asked to design individual mechatronic toys or robots. The initial theme was designing hybrid beings or hybrids of beings and inanimate objects. They started with brainstorming generating design briefs on how their toys will appear and work, and developed concept drawings according to the Art Professor's presentations. They used Artist's Mannequins, modeling materials, and special construction tools to help visualize. They also utilized the Internet for obtaining further information about their prospective design components.

Next step was to present the main materials, manufacturing, and mechanisms components of the program. Students were exposed to various molding materials that included oil, water, and polymer based clays, rubber latex, various molding materials, art wires and meshes, and others. They were also given bins of mechanism components that were not in kits. Students use these materials and components in decision making in refining their design ideas by eliminating alternatives. Students were seen rapid prototyping machine and actually operated NC laser cutter and engraver to make components. Machine shop and the plastics laboratory's capabilities were utilized with the help of the authors and the department technician. A reverse engineering laboratory was also conducted as seen in Figure 3.

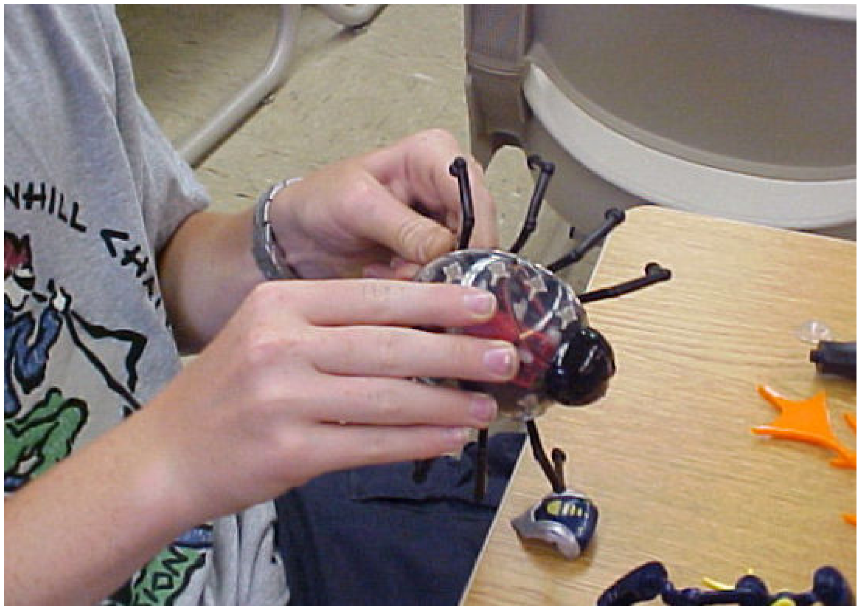

Figure 3. Reverse Engineering Laboratory – Dissecting a mechatronic ladybug

While still being involved in further development of the structure and mechanisms, students went through basic electronics laboratory exercises and completed these exercises rapidly. The experiments gave background on various types of actuators, sensors, and controls were presented. Students were given the options of remote (cable), radio, or autonomous controls through microcontrollers.

Inclusion of controllers and programming content needed to be limited due to lack of time. Students were exposed to the MIT's Handy Board and the Interactive C, its programming language. Only one student showed interest in learning the controller since the others were deeply involved in completing the development process. The student spent time in writing simple programs to trigger the motors in his design, but choose to generate a toy with remote (cable control) alike others.

Results and Conclusions

While working on their designs incorporating the product development process and job shop practices into their efforts, the participants also worked towards understanding complex mechatronic design and integration in a fun and creative environment that encompassed both technical and artistic fields. The end-result of the student efforts were animated/mechatronic blob, penguin, robotic trash can, and a human/monster hybrid.

They cruised, wave their swords, flip their wings and lit their eyes. The only project that was incomplete was the robotic trash can due to the student's interest in laser processing. The other three functioned very well. Unfortunately, the pictures documenting the results were erased accidentally by the computer support personnel of the university. However, the authors will contact the participant for new pictures and these may be presented at the conference.

Students worked after dinners even though there was no scheduled laboratory time. They were deeply involved into the projects and showed comradory in helping each other. The Gifted Coordinator of the Hardin County in Ohio who was instrumental in the grant application visited the program. She indicated her pleasure towards the success of the program. A local newspaper visited the program as well.

The authors and the undergraduate assistant closely worked with the participants in recruitment of the student into the technical fields. There were extra-curricular activities such as swimming and bowling, or a movie hour. Students also chose to operate the industrial robots in the Robotics and Automation Laboratory. Movie hour featured the movie, I ROBOT. Students were asked to fill a simple survey about the movie as well tying the learning experience and the futuristic and robotic concepts they saw during the movie. The idea of ethics was also emphasized.

Students were given pre- and post-tests. Post tests results showed (in Figure 4) great improvements in each student's confidence on most of the fields covered. Lack in influence in microcontrollers can be explained by time constraints as mentioned previously.

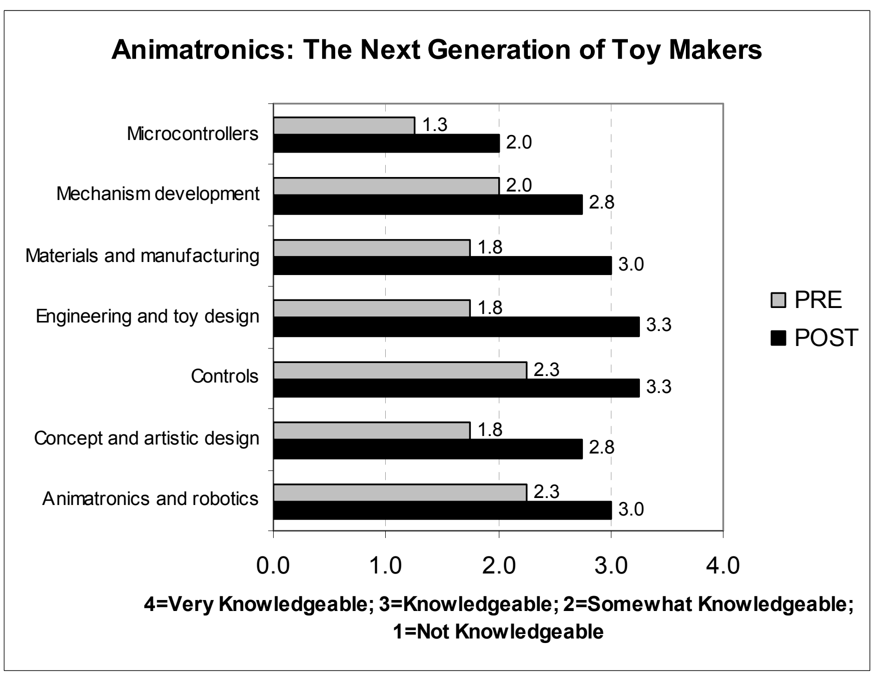

Figure 4. Pre and post-test comparisons for assessment

The major feedback from the students was the need of longer laboratory hours, even with the addition of evening hours. They indicated that most of the technology in the laboratories was not available in their schools. Parents were extremely happy about the outcome and demanded a second program at a higher level. Students presented their designs to a group composed from the families, the authors, the undergraduate assistant. The program was concluded with a cook-out where the families and staff of the different institute programs socialized. The students were presented with certificates. In all, higher expectations with quality instruction and ample resources yielded higher results.

References

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