Body-Powered Prosthesis Project to Promote Learning of Human Centered Design in a Pre-College Engineering Camp

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Introduction

Human-centered design focuses on addressing individual needs, unlike technology-centered design, which prioritizes technological innovation over user adaptation. This empathetic approach involves putting user needs first and including them throughout the design process [1]. Research shows that incorporating user perspectives into the curriculum promotes human-centered approach to engineering [2]. This study extends last year's research on integrating human-centered design into high school curriculum via a body-powered prosthesis project [3]. The goal of this study is to assess whether this immersive project improves students' understanding of bioengineering, especially human-centered design.

Methodology

Summer Camp Design

- Day 1: Introduction to prosthetics and limb differences, with talks from an upper-limb prosthesis user and an expert prosthetist. The 7 campers then created their own cardboard body-powered prosthetic hands.
- Day 2: Campers were introduced to the HAAT (Human Activity Assistive Technology) Model and worked with case studies of prosthesis users. They were provided with prosthesis user profiles to guide their design. Students used Meccano kits to build their prosthesis.
- Day 3: Lessons were given on the use of levers, spring forces, moment arms in prosthetic limbs, and the biomechanics of human arms.
- Day 4: Students received feedback on their designs. There was an attempt to integrate myoelectric control into the prosthesis design utilizing EMG sensors, Arduino Unos, code, and servo motors.
- Day 5: A Cybathlon competition was hosted to test how well the students' prosthetic hand designs performed on everyday tasks, such as tying shoelaces and grasping objects of different shapes.
- Notes: Students were divided into 3 groups. Each finished design was attached to a provided body-powered simulator trans-radial level prosthetic limb sockets and figure-9 harness shown in figure 3.
- Data Collection: KWL (know, want to know, learn) surveys were taken before and after the camp.

Figure 3: Body-powered simulator trans-radial level prosthetic limb socket and figure-9 harness.

Results

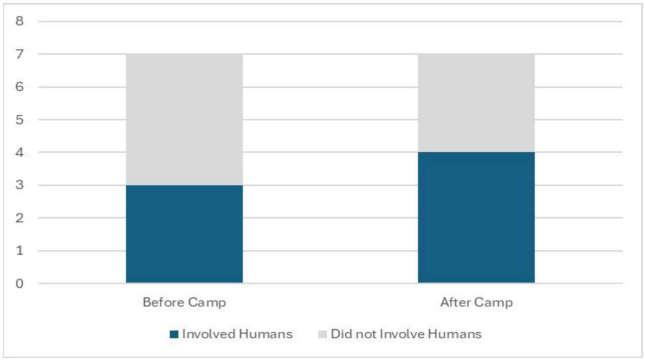

Figure 1: KWL survey displayed the number of students who included humans in their perception of bioengineering before and after the 5 day prosthetic prototype project.

Figure 2: Students competing using their body-powered prosthesis prototype.

Discussion and Conclusion

- The KWL data shows an increase from 3 to 4 instances of the inclusion of user needs in their perception of bioengineering, as seen in Figure 1.
- A larger data set is needed to determine if the activities effectively shift students' views of bioengineering to a more human-centered mindset.
- Further research should assess students' prior exposure to human-centered principles.
- Students rated their ability to recognize necessary design changes on a scale of 1 to 6 both before and after the camp. Results showed a 16.67% increase in confidence in identifying and adapting to design challenges.
- Myoelectric control integration failed due to students' insufficient coding and circuit knowledge for their prosthesis designs.
- A basic myoelectric control tutorial could improve understanding, as this year's method did not enhance their grasp of the concept.

Acknowledgements & References

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