At Your Service: A Human-Centered Approach to Robotics

Dr. Maggie McHugh, La Crosse Design Institute; Andrea Gomoll, Indiana University

Summary

BB-8 and R2D2 from *Star Wars*. Rosie from *The Jetsons*. Baymax from *Big Hero 6*. Robots in science fiction are often conceptualized as humanoid, having personalities and interacting with their human counterparts. Yet, as we bring robots to students, the technical skills of programming robots often outweighs the social and cultural contexts in which people practice and experience them. This research brief focuses on a robotics unit that asks students to identify authentic problems in their everyday school environment that robotics can help them address. Human-centered robotics—robots that help people with daily activities—provides teachers and students with a context that connects technical aspects of robots to social issues and concerns.

Unit Overview

In executing this unit, an Engineering Design Cycle helped frame the major steps of this inquiry-based project (see Figure 1). This unit addresses several cross-cutting NGSS standards (see standards section at the end of this brief) and helps students make connections between the technical components involved in coding a robot and the social presence it has in a human environment.

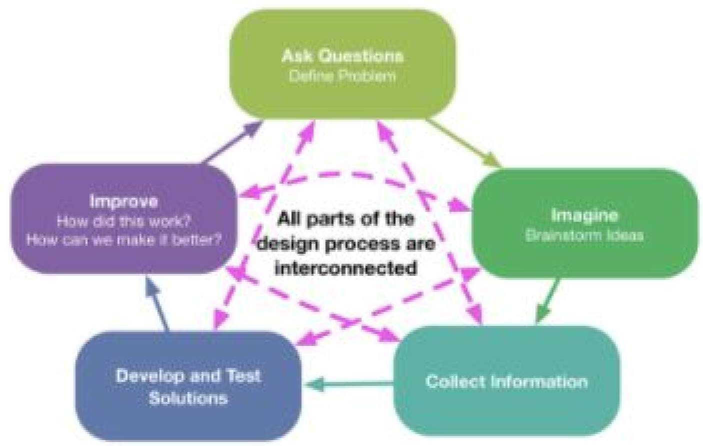


Figure 1. Engineering Design Cycle

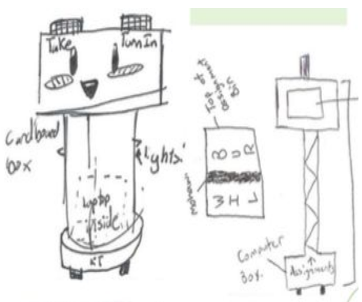
Students began by brainstorming how robots can fulfill needs within their classroom or school, imagining robotic possibilities such as delivering medication for the school nurse or providing telepresence for students who are out sick. Then, students mapped their classroom and hallways in order to eventually code robots to move within the physical environment. As students began programming their robots, problems arose that teams needed to troubleshoot by asking critical questions and redesigning the social function of the robot. In the final stages, students developed prototypes of their human-centered robot, testing their robot in the school environment, making adjustments as needed, before showcasing their final designs to their classmates, families, and school community.

Facilitating the Human-Centered Robotics Unit

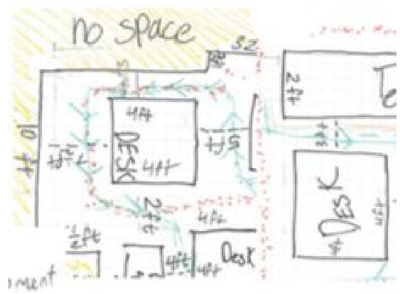
In inquiry-based projects, the role of the educator transforms into a facilitator of learning, where asking critical questions and navigating the trials of the student groups becomes the norm. Helping students to identify their high-level goals for the unit and develop concrete plans to achieve these goals. This can involve structured check-in points, providing information “just-in-time” as students articulate the challenges they are facing, facilitating peer-to-peer feedback opportunities, and asking probing questions that move students forward. When educators take on the role of facilitator, students are empowered to take ownership over their learning.

Implementation Example

This human-centered robotics unit has been implemented in several classrooms in Indiana and Alaska with students in grades 6 - 12. Specifically, this research brief explores how 7th and 8th grade students in an Applied Science class worked through the Engineering Design Cycle to develop human-centered robots over the course of five weeks. See the images below (extracted from Gomoll et al., 2017, p. 7) for examples of student work throughout this implementation.



Students began by sketching designs of their human-centered robot. This group named their robot Wilbur, a robot designed to collect assignments for a teacher.



Students created maps of their local classroom environments to better understand the constraints of the space, which will be needed as they program their robot.

Students built their prototypes, continually testing and refining them, before presenting their final products to a community audience.

Through this inquiry-based project, students gained skills beyond just the technical aspects of programming. One 12 year-old boy reflected on the of the Engineering Design Cycle, “For imagine, we kinda thought up our ideas, kinda drew it out a little bit, see if it would work. To collect information, we...saw what was weak or wasn’t as sturdy, and so we added to it. And then, develop and test solutions, after we saw what was weak, we added to it, and if it still didn’t work, we added more” (Gomoll et al., 2017, p.7). The ability to verbalize the design process presents evidence of higher-order thinking and meta-cognitive reasoning.

So what? Now what?

Robotics provides an engaging, hands-on experience for students to navigate the technical world while balancing the needs of human society. The Engineering Design Cycle acts as a scaffold for an inquiry-based learning process that, through iteration, helps students move forward with the assistance of a facilitator (teacher) who asks critical questions and provides just-in-time learning opportunities. The research explored here presents one example of what human-centered robotics can look like in a middle school classroom. However, the inquiry-based practices and focus on social aspects of technology design can be incorporated into diverse contexts and content areas. This overview provides an insight into the connections of engineering design, systems thinking, and user-centered design approaches that teachers can use in their classroom. These connections can inspire students to see themselves in STEM and support the development of high-order thinking skills.

Source

Gomoll, A., Šabanović, S., Tolar, E., Hmelo-Silver, C. E., Francisco, M., & Lawlor, O. (2017). Between the Social and the Technical: Negotiation of Human-Centered Robotics Design in a Middle School Classroom. *International Journal of Social Robotics*, 1-16. Doi: 10.1007/s12369-017-0454-3

Additional Resources

- Canvas course site: https://iu.instructure.com/courses/1596748/
  - This site includes lesson plans, student assignments, and information about materials needed in this human-centered robotics unit. The content can be imported as a course if you'd like to use it in your classroom!

- A short video featuring aspects of this curriculum: http://stemforall2017.videohall.com/presentations/1007

- iRobot Create 2 robotics platform
- Robotmoose website
  - This site, developed by collaborating researchers at the University of Alaska Fairbanks, can be used to program and drive the iRobot Create 2 robotics platform. It also features several tutorial videos and resources for students and teachers.

Contact

For more information about the materials associated with this project or any questions, please contact Andrea Gomoll at agomoll@indiana.edu.

NGSS Engineering Connections

Engineering Design Middle School Standards

- ETS1.A: Defining and Delimiting an Engineering Problem
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution

CCSS-M Standards for Mathematical Practice Connections

- CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them.
- CCSS.MATH.PRACTICE.MP4 Model with mathematics.
- CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically.