

Exploring Computer Science Through Robots: Engaging Middle and High School Students with iRobot Root (Resource Exchange)

Dr. Stephany Coffman-Wolph, Ohio Northern University

Dr. Stephany Coffman-Wolph is an Assistant Professor at Ohio Northern University in the Department of Electrical, Computer Engineering, and Computer Science (ECCS). Previously, she worked at The University of Texas at Austin and West Virginia University Institute of Technology (WVU Tech). She is actively involved in community outreach with a goal of increasing the number of women in STEM and creating effective methods for introducing young children to CS concepts and topics. Dr. Coffman-Wolph's research interests include: Artificial Intelligence, Fuzzy Logic, Software Engineering, STEM Education, and Diversity and Inclusion within STEM.

Dr. Abigail Clark, Ohio Northern University

Abigail Clark is an assistant professor of mechanical engineering at Ohio Northern University. She holds a PhD in Engineering Education from The Ohio State University. She also holds degrees in Mechanical Engineering from Ohio State and Ohio Northern University. Prior to her time at OSU, she worked at Battelle Memorial Institute in Columbus, Ohio. Her research interests include pre-college engineering education, informal engineering education, and identity development.

Sara Currier, Ohio Northern University

Exploring Computer Science Through Robots: Engaging Middle and High School Students with iRobot Root (Resource Exchange)

ABIGAIL CLARK

Assistant Professor, ME



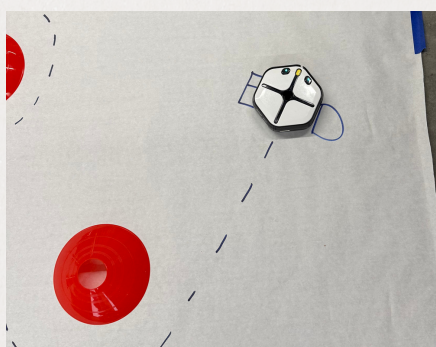
STEPHANY COFFMAN-WOLPH, PHD

Assistant Professor, ECCS

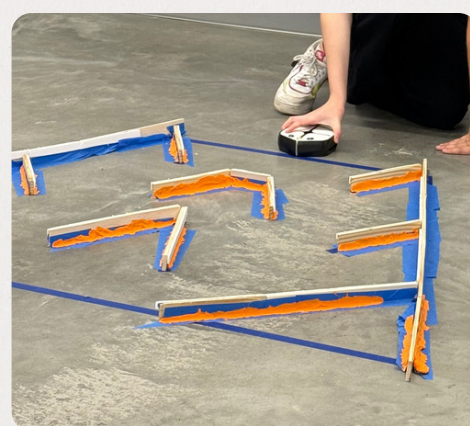
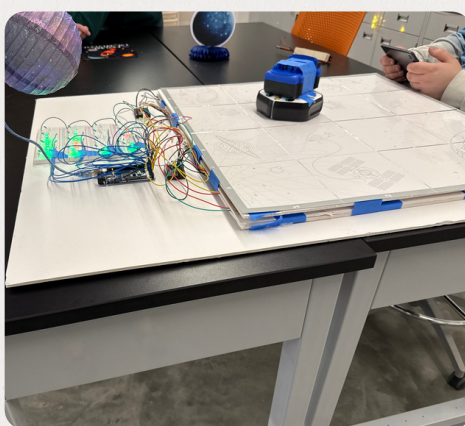


SARA CURRIER

Undergrad Student



Materials: iRobot Root robots, tablets with Root app, rolls of white paper, Expo markers, magnetic write board, small traffic cones, marble run setup, ping pong balls, colored LEDs, pressure sensors, and decorations for "space themed" stations



Grade Level: Middle and High School (Grades 6–12)

Abstract

For the past five years, faculty and students at Ohio Northern University have engaged middle and high school learners in interactive, grant-supported outreach activities introducing computer science and engineering design. Grant funding supports transportation for participating K–12 students to campus, reducing access barriers and enabling schools to participate regardless of local resources. The 50–55-minute interactive "glance into computing" experience invites students to explore computing and problem-solving concepts through a series of space-themed engineering challenges using small educational robots and an intuitive block-based coding app. While iRobot Root robots are used in this implementation, the activities can be readily adapted to other educational robots.

Students rotate through multiple stations that promote creativity, teamwork, and experimentation, set up for approximately 30 students supported by two faculty facilitators and an undergraduate student. The same core activities are used for both middle and high school participants, with pacing adjusted as needed. Informal observations suggest that middle school students often demonstrate high levels of curiosity and engagement. Each station emphasizes the engineering design process as students iteratively test and refine their robot programs. The outreach experience has been delivered as a one-off, campus-based activity across multiple schools. While no formal pre/post surveys are currently used, facilitators have observed strong engagement and sustained interest. Through this hands-on approach, students develop computational thinking, logical reasoning, and curiosity about engineering and computing careers, particularly among learners who may not otherwise see themselves represented in these fields.

LEARNING GOALS

* Engineering Design

Apply the engineering design process to robotic problem solving

* Computational Thinking

Develop computational thinking, logical thinking, algorithmic problem-solving, and teamwork skills.

* Sensors & Iteration

Explore how programming, sensors, and iteration relate to real engineering design.

Procedure

Students visit robot stations that simulate space-themed engineering missions: defying gravity by drawing shapes, finding hidden routes using colored LED and pressure sensors, navigating obstacle fields with bump sensors, rolling ping-pong balls to trigger marble runs, and programming paths on paper or rugs. Each team iterates to improve accuracy and performance, guided by mentors who connect the experience to real-world engineering problem solving.

Next Generation Science Standards (NGSS)

Standards Covered

These activities cover the following Next Generation Science Standards (NGSS):

- MS-ETS1-2 Engineering Design
- HS-ETS1-2 Engineering Design

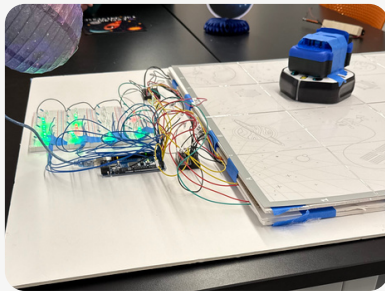
(Citation: NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press).

These activities also cover the following CSTA K-12 Computer Science Standards:

- 3B-DA-05 Data & Analysis
- 3B-DA-06 Data & Analysis
- 3B-IC-26 Impacts of Computing
- 3B-IC-27 Impacts of Computing

(Citation: Computer Science Teachers Association (2017). CSTA K-12 Computer Science Standards, Revised 2017. Retrieved from <https://csteachers.org/k12standards/>).

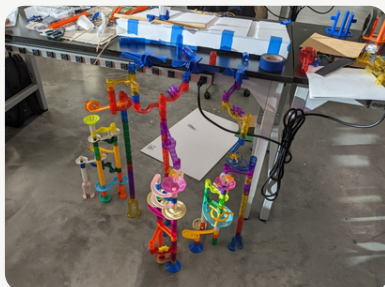
Highlights of Stations



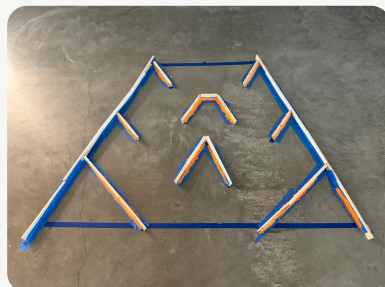
Find the safe path along the "moon surface" to get the robot back home.



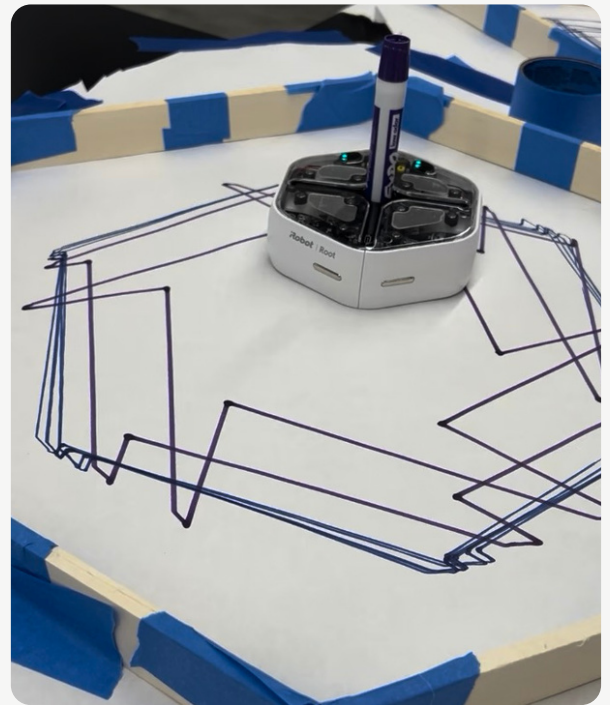
Navigate the iRobot Root around the cones by programming the correct path.



Use the robot to navigate a ping pong ball up a path to set off a marble through the space pipe system.



Program the robot using the bump sensors, navigate the robot through the course.



Final Thoughts

List of Activities

Stations are set up around the classroom with plenty of room for the entire group to participate. Some stations may have a couple of activities or multiple robots if space allows.

- Orbital Navigation Training: navigate the robot around cones via programming a path
- Moon Surface Rescue Mission: identify safe terrain and guide your rover home
- Orbital Cargo Transfer: push the ping pong ball to set off the marble run
- Rover Obstacle Avoidance System: use bump sensors to navigate the robot
- Defying Gravity: draw shapes on magnetic whiteboard
- Cosmic Art Command Center: program the robot to draw a picture
- Orbital Pattern Generator: Old-school spirograph meets robots

More Info? Full Activities available here:



SCAN ME

