Program a Friend

Lab Related Activity: *Social Robots*

The Tech Museum of Innovation

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In this activity, students will learn the language of robots as they "program" a partner to perform a simple task.

Grades 1-8| Estimated Time: 30-45 minutes

Student Outcomes

Students will be able to explain how a robot completes a task by following a list of specific sequential directions
Students will be able to write an algorithm or program with clear and precise steps to complete a specified task

Next Generation Science Standards

Engineering Design
Grades 1-8: DCI ETS1.B – Developing Possible Solutions
DCI ETS1.C – Optimizing the Design Solution

Common Core ELA Standards

Speaking and Listening **Grades 1-8:** SL1.a-d

Vocabulary

Familiarity with these terms and concepts will enhance students' experience in the activity.

- **Algorithm:** a process or set of rules to be followed in problem-solving operations, especially by a computer or robot.
- **Programmer:** the person who writes code (programs) a machine, devise, or robot.
- **Robot:** a programmable machine capable of carrying out a series of complex actions.
- **Beta test:** when a program has been written, but it needs to be tested before sharing with the public.
- **Inputs:** directions or code put into a computer, device, or robot that will help it achieve a goal.
- **Outputs:** the actions taken by a computer, device, or robot based on the program inputs.
- **Sequence:** a series of data that goes into a specific and connected order.

Materials (one set per group of 4 students)

- Paper and pencil

Teaching points:

1. Introduce the concept that robots must be programmed to perform certain tasks
    a. Begin with a discussion about how people learn new tasks. Ask students "how do we learn how to do new things?" Take student responses and write on board, responses will likely be along the lines of reading about it, watching someone else do it, practice, etc.
    b. What about robots? Ask students "how do you think a robot learns how to do new things or complete tasks?" For example, if you asked a robot to make a peanut butter and jelly sandwich, how would it know how to do it?
    c. Robots are not able to learn like humans; they have to be programmed, or given a specific list of instructions, to complete a task.
2. Demonstrate how robots need specific step-by-step instructions to complete a simple task.
    a. Ask for a volunteer to be the "programmer." The "programmer" will give you (the teacher "robot") a simple goal, such as waving hello. Their instructions will be the "input" and what the robot does will be the "output". This is similar to if we wanted to turn on a light. Our input would be flipping the switch and the output would be the light coming on.
    b. Ask the volunteer to tell the robot what to do to wave hello.
        i. Students will likely just say "wave your hand" (a robot does not know what "wave your hand" means.
        ii. As the "robot," only do exactly what the "programmer" has said. If they do not give specific enough instructions, say "does not compute" or follow the instruction exactly as given, even if it is not the correct step to do the task.

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iii. If after a few tries the student is not specific enough or giving wrong steps, stop and remind the class that you have to tell the robot exactly what to do because a robot can't learn or observe and follow.
iv. Programming a robot takes carefully thought out instructions to get the task done.
v. Good instructions for sharpening the pencil may look like the following: stand up, lower your right arm toward the pencil, open your right hand and place it on top of the pencil, close your hand around the pencil, raise your right arm, take seven steps to your right, lift your right arm 3 feet, insert the pencil into the hole in the pencil sharpener, lift your left arm 3 feet, open your left hand, grasp the handle of the pencil sharpener and turn it ten times.
vi. Discuss the difference between how detailed you had to be with the "robot" and how detailed you would have to be when giving instructions to a fellow human. Why do you need to be so specific with the "robot?"
    - A human is able to use stored knowledge to fill in the gaps when given incomplete instructions; a robot does not have stored knowledge so it can't proceed when the instructions are incomplete.
    - A robot requires precise step-by-step instructions, also called algorithms, to complete a task
    - An algorithm is much like a recipe for a cake. If you do not follow the directions exactly, the cake will unlikely turn out.

Procedure:

1. Students create an algorithm for a robot to perform a specific task
    a. Divide students into pairs. Student pairs will take turns being the programmer and robot.
    b. Each student will decide on a simple task for their partner "robot" to do; the simpler the task, the better.
    c. Each partner will write their algorithm for their specific task-students will likely need a minimum of 15 minutes to write their algorithm.
2. Students "beta" test their algorithms
    a. Students will take turns being the robot to perform their partner's algorithm. Student "robots" need to remember that they can only do exactly what the algorithm tells them to do.
    b. The programmer should read their algorithm to the "robot" step by step. If one of their steps is incorrect or not specific enough, there is a "bug" in their algorithm and it will need to be redone.
    c. Have the partners switch places.
3. Students debug their algorithms and run additional tests

Teaching Points:

1. After students have written and tested their algorithms several times, have partners pair up with another pair to discuss the programming process.
    a. Was it harder or easier than you thought it would be? Why?
    b. What was the most challenging part of programming your "robot?"
    c. What did you learn about the programming process?
2. Have groups share out their discussions with the whole class.

Adaptations:

- For younger students, you can have them do very simple algorithms to walk through a maze or in a square as opposed to doing a particular task (e.g. pushing in a chair, sharpening a pencil, etc.)

Extended Learning:

- Have the students try coding programs on their own.
    a. https://www.khanacademy.org/hourofcode
    b. https://code.org/

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Sample Program

"The Hokey Pokey"

Read the instructions to a student "robot" to have them do exactly as the programmer says. Have the rest of the class try to guess what the program is.

Student demonstrator should start with his or her legs and arms together, facing the class. The teacher can also be the "robot" and a student can read the program aloud. For younger students, the degree of bending can be removed.

1. Extend right leg forward 45 degrees
2. Move right leg backwards 90 degrees
3. Extend right leg forward 90 degrees.
4. Turn right foot to the right 45 degrees
5. Turn right foot to the left 45 degrees
6. Turn right foot to the right 45 degrees
7. Move right leg backwards 45 degrees and distribute weight between two legs evenly
8. Turn body one step to the right
9. Turn body one step to the right
10. Turn body one step to the right
11. Turn body one step to the right
12. Extend left leg forward 45 degrees
13. Move left leg backwards 90 degrees
14. Extend left leg forward 90 degrees.
15. Turn left foot to the right 45 degrees
16. Turn left foot to the left 45 degrees
17. Turn left to the right 45 degrees
18. Move left leg backwards 45 degrees and distribute weight between two legs evenly
19. Turn body one step to the right
20. Turn body one step to the right
21. Turn body one step to the right
22. Turn body one step to the right