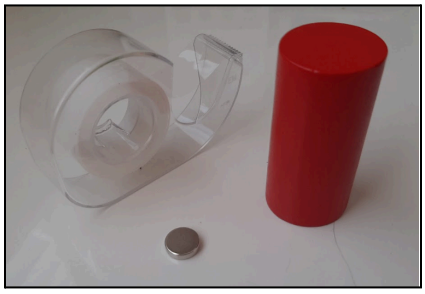
Recycling Robotic Arm Direct Instruction Summary

Teacher Tips



- In the Lesson challenge, ORA will pick up and dump a cup's contents into a sorting device. To allow ORA to pickup up the cup, a red, wooden cylinder needs to be attached to the cup (see image, right)
- If you have access to a 3D printer you can print the accessories instead of having students create them.
- Strong magnets and electronics don't always play well together, so create a "spacer" attachment for the magnet with one wooden cylinder. Keep the magnet clear of wires, electrical components, and the body of ORA.

The suggested duration for the lesson has two options:
Fast option (60 minutes): Students complete the Engage, Explore, Explain, and Evaluate as described. In the Elaborate step, only have students sort out the staples by using the magnet.
Full option (120 minutes): Students complete the Engage, Explore, Explain, Elaborate, and Evaluate as described including troubleshooting and testing sieve in the Elaborate step. The Extension is an open-ended challenge and would require time beyond 120 minutes.

Vocabulary

Single Stream Recycling - a form of recycling where all recyclables are placed in one bin
Recyclables - items that can be processed and remade into new products after being used
Physical Properties - properties of a physical object that are measurable like hardness
Job Outlook - the likelihood that an occupation will be available and hiring in the future

Direct Instruction

Engage with Recycling in the Community

Start the Engage section by presenting the students with the lesson challenge. Tell students: "For this challenge, you will assume the role of Robotic Recycling Engineers at ORA Mechatronics. GreenerIndustries, a nearby, single-stream recycling facility, has hired your team to solve a problem at their recycling facility. They need your ORA to sort mixed samples of recyclable material that have been contaminated with non-recyclable materials. Can you create a process to utilize your ORA to sort these materials into separate containers?"

Hand out the bags of recyclables. Tell students to not open their bags. Have the students spend a few minutes observing the bags and answering the questions in the Engage section of the Student Activity Sheet. Then tell the students: "Before we can solve this challenge, we need to learn more about robotic arms in recycling and the careers related to them!"

Next, show the Lesson 1 video.

Explore Robotic Recycling Engineer Career Connections

Students will do a brief guided virtual scavenger hunt related to Robotic Recycling Engineer Jobs. Individually or in small groups, have them complete the Explore section on the Student Activity Sheet. If students are struggling with the job outlook section, have them go to the US Department of Labor and Statistics Occupational Outlook Handbook. In this tool, you can find information about thousands of jobs. On the Index page, search for your career (Use Ctrl+F on a Windows machine or Chromebook). When you click on the career of your choice, there is a short video about the career as well as several key pieces of information. The careers closest to a Robotic Recycling Engineer available on the list could be the Industrial Robotics Mechanic or the Robotics Testing Technician.

Explain Recycling Center Sorting and Properties of Different Materials.

Start the Explain section by asking the students "What goes into the recyclables bin?" If you're in an area where recycling is not common or not available, you can ask "What items should be recycled?" Students will say things like newspapers, cans, pop bottles, etc. If you are in a location where recyclables are sorted into individual bins by the person putting out the recycling, ask students to image all the recyclable materials going into one bin. That is the reality for individuals who use a single-stream recycling system.

Ask the students, "Once all the materials are in the same bin and are mixed together, how can we separate them?" Students may give various responses, but the main idea is that this process should be automated for maximum efficiency.

As students have seen in the videos, the automated machines use a variety of processes to separate the different types of materials. These machines use sophisticated sensors and machine learning in conjunction with the robotic arms to automate the process.

ORA does not have these capabilities, yet. However, ORA can be used to sort the sample provided automatically.

Explain the two types of sorting they will use in the challenge. Both of these relate to physical properties. Ask the students, "What are the physical properties of the three different materials?" They should note that the staples are small but magnetic, the aluminum balls are large-ish but non-magnetic, and the rice is small and non-magnetic.

Therefore, students need to develop a process that sorts materials by size and a process that sorts by magnetism. Since the staples and rice are both small, one process must happen before the other to be successful! (Teacher hint: the magnet should remove the staples first, then the rice and aluminum can be sorted by size).

****Move on to Elaborate now, support for struggling students below**

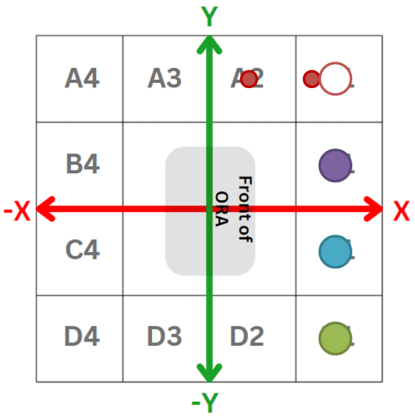
For students struggling with sorting by size, ask what tools they use to sort small bits by size. If that doesn't help, ask if they ever cook pasta. When they drain the pasta, they use a colander or strainer to hold back the large noodles and allow the water to flow out. Ask the students if they could create something like this to separate the large particles from the small particles. Hopefully, this will help them think about and design a sieve out of cardboard or other materials to separate the larger aluminum granules from the rice.

Elaborate: Use ORA as a Recycling Assistant!

Students receive a sample of mixed, 'recyclable' material. Using ORA and other materials, students will sort the materials into three plastic cups.

Setup:

Take four plastic cups, place the one with the wooden cylinder handle in A1, Place one in B1, place one in C1, and place one in D1. Empty the contents of the 'recyclable' bag into the cup in A1. Place the wooden cylinder with the magnet in A2. Students may place any student-created sorting devices needed in A3.



Task Requirements:

1. ORA must start in the initial position.
2. ORA must use the finger grippers to interface with various, student-created sorting devices to automatically place each material, by type, into the three different cups.
3. If a magnet is used, materials do not need to be removed from the magnet. The magnet can be placed in the material cup.
4. ORA must finish in the Initial Position.

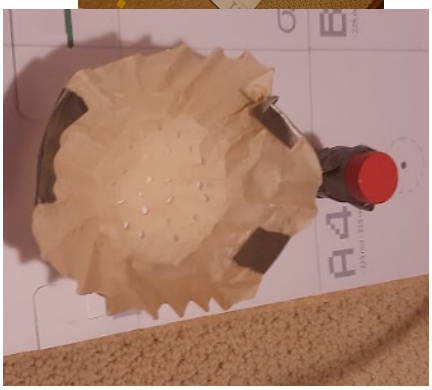
Direct students to plan this code in the Elaborate section of their Student Activity Sheet. After designing/sketching the sorting devices, writing the pseudocode, and drawing the code blocks, direct them to create the sorting devices. Encourage students to create unique sorting devices different from the video and examples! Then, instruct students to create the code on their devices in the Ozobot Editor. Ensure students are connected to your shared workspace.

As students complete their code, they will test it using the session sharing feature in the Ozobot Editor. Click on a given student's or student group's tab and click "Run" to execute the code. Reset the materials and cups by emptying each back into the source bag and replacing the cups in their locations between each code run. Remember to follow the Safety Protocol established in ORA Essentials.

If students are waiting for the ORA, they could:

- Answer Questions on the Student Activity Sheet
- Complete the Evaluate section to be used as an Exit Ticket.

Elaborate: Example solution



1. Setup
2. Designed Materials

a. For this challenge, students are asked to sort out the three different materials in the recyclables bag into three different cups. The staples can be sorted out using the magnet on the red, wooden cylinder (see Teacher Tips for instructions). Students will design a second device that can be used to sort the large aluminum balls from the rice. To the right are two sieve-like devices. Note that the red, wooden cylinder is used as a handle so ORA's finger grippers can easily pick it up.

3. Sample Code

a. Example solution code.

4. Code Description

a. The program starts by picking up the wooden cylinder with the attached magnet in A2. ORA moves the cylinder to A1 and lowers it into the cup with the mixed recyclables. The cylinder is moved slightly to collect all of the staples. The cylinder is then lifted and deposited with attached staples in the cup in B1.

b. The program then moves to pick up the cup from A1 and pours the remaining aluminum and rice into the student-created sieve in A3. The sieve is then picked up and shaken back and forth over the cup in C1 to separate the rice from the aluminum.

c. The sieve contents (aluminum balls) are then dumped into the cup in D1.
d. ORA moves the sieve back to A3 and deposits the sieve.
e. ORA returns to the starting position.

Evaluate: Exit Ticket
Students will fill out and submit the Evaluate section of the Activity Sheets as an exit ticket.

Optional Extension: Calculating Material Quality

Note: If you plan to do this activity, do not let the students dump the bin contents together.

In this activity, students will evaluate the effectiveness of the sorting method and provide suggestions on improving and optimizing the process.

Source: Canva

Setup: Collect the three recyclable sorting bins, a weigh boat, and a scale.

Task Requirements:
1. Collect the mass of all of the materials in the rice bin, and record it in grams.
2. For any foreign/non-sand objects in the bin, separate them and mass them.
3. Mass the remaining rice to confirm values add up to the step 1 value.
4. Repeat the process (Steps 1-3) for the staple and aluminum ball bins.

Data Analysis:
1. Find the percent contamination for each recycling material bin. To find contamination, divide the mass of the non-bin material by the bin material.
2. Find the percent loss for the sorting process. To find the percent loss, add the mass of all missing bin materials and divide by 27 (or the exact mass of recyclable materials if different from instructions).

Questions:
1. Report the findings (percent contamination and percent loss) from your material sorting run.
2. What improvements can you suggest to the **physical setup** of your ORA Recycling Robotic Arm to minimize contamination and loss?
3. What improvements can you suggest to make for the **programming** of your ORA Recycling Robotic Arm to minimize contamination and loss?

Example calculations:

Example Results from Elaborate Challenge:

Total Mass: 25.5 grams

Staple Bin: 3 grams

Aluminum bin: 4.5 grams

Rice bin: 18 grams

Staple bin = No other materials = 0% contamination

Aluminum bin = 4 g aluminum, 0.5 g rice = 0.5/4=0.125*100=12.5% contamination

Rice bin = No other materials = 0% contamination

Percentage loss = 27-25.5g=1.5g/27g=0.0555*100= 5.6% material loss.

Since some rice remained with the aluminum, the physical setup could be changed (i.e. more holes in the cardboard sieve) or the programming could be altered to increase agitation of the sieve. Also, since some rice (1.5g) was spilled, the sieve could be placed over the collection container before dumping the contents of the source container.