Sorting No-Sort Recycling

Lesson Focus

Students will learn about the challenges waste management centers face and different methods they use to sort recycling. In small teams, students will brainstorm and design a system to sort a mixed-up recycling bin. Teams will share their designs, and the class will vote on ideas they want to move forward with. The class will then work to build and test a recycling sorter.

Age Levels

- 8-14

Objectives

Introduce students to:

- Issues surrounding single-stream recycling and how materials recovery facilities (MRFs) work.
- How they can support effective recycling in their community.
- Creative technology being used to clean up trash, litter, and pollution.

Anticipated Learner Outcomes

Students will be able to

- Plan, design, and build a recycling sorting system.
- Work effectively in a team.
- Evaluate peer designs.
- Understand the issues and challenges involved in single-stream recycling.

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- How does a Material Recovery Facility (MRF) work? (www.youtube.com/watch?v=7CFE5tD1CCI)
- PBS NewsHour: Why you shouldn't recycle plastic bags at home (www.youtube.com/watch?v=kwuBfgvfUC4)
- Casella's Zero-Sort Recycling Facility Tour (www.youtube.com/watch?v=S_U6UuFLEGQ)
- Baltimore Waterfront Trash Wheel Project (www.baltimorewaterfront.com/healthy-harbor/water-wheel)
- To sort or not to sort? That is the recycling question (www.grist.org/living/to-sort-or-not-to-sort-that-is-the-recycling-question)

- Single-Stream Recycling Is Easier for Consumers, but Is It Better? (www.theatlantic.com/technology/archive/2014/09/single-stream-recycling-is-easier-for-consumers-but-is-it-better/380368/)
- With 'Single-Stream' Recycling, Convenience Comes At A Cost (www.npr.org/2015/03/31/396319000/with-single-stream-recycling-convenience-comes-at-a-cost)

Recommended Reading

- See Inside Recycling and Rubbish by Alex Frith (ISBN: 978-1409507413)
- Tracking Trash: Flotsam, Jetsam, and the Science of Ocean Motion (Scientists in the Field Series) by Loree Griffin Burns (ISBN: 978-0547328607)
- Plastic, Ahoy!: Investigating the Great Pacific Garbage Patch by Patricia Newman and Annie Crawley (ISBN: 978-1467712835)
- What a Waste: Trash, Recycling, and Protecting our Planet by Jess French (ISBN: 978-1465481412)

Optional Writing Activity

- The Baltimore Harbor Trash Wheel Project, affectionately known as Mr. Trash Wheel, uses a turning wheel to scoop trash and debris out of the water and collect it into a dumpster barge. The current from the Jones Falls River, which flows into the harbor, powers the trash-scooping wheel. On days when the current isn't strong enough to turn the wheel, solar panels provide backup power. Mr. Trash Wheel has collected more than 999 tons of trash since May 9, 2014. What parts of the Baltimore Harbor Trash Wheel's design do you think are the most helpful and important? Why do you think it is so important to a city like Baltimore? Think about where you live. Are there areas of your community that could use an inventive cleaning machine? What sort of cleaning machine would you create to help your community? What benefits would it bring? What challenges would it face?

For Teachers: Teacher Resource

Anticipated Learner Outcomes

Students will be able to:

- Plan, design, and build a recycling sorting system.
- Work effectively in a team.
- Evaluate peer designs.
- Understand the issues and challenges involved in single-stream recycling.

Materials

- A variety of clean, dry recyclables (plastics, glass, steel cans, and paper) in a single, large recycling bin
- Four smaller bins (one for plastic, one for metal, one for glass, and one for paper)
- Fans
- Magnetic wands or other large magnets
- Broken-down cardboard boxes, or other long sheets of cardboard
- Grippy shelf liner, sheets, or other long materials that could be used as a conveyer belt
- A long table, or a few short tables
- A ladder or step stool (something that will allow changes in height for chutes, etc.)
- Loose netting
- Plastic tubs
- Other available materials that might be useful

Procedure

1. Students should read the Student Resource either in class or for homework the night before the activity. This will give them an introduction to single-stream recycling.
2. Break the class into small teams of 3 or 4.
3. Each team will brainstorm ways to sort each type of recyclable from the combined bin. Teams should feel free to get up and examine the different materials, but should leave them in the center of the room for the class. Students are allowed to help run the system—they can pour out the initial set of mixed recyclables, pull the materials across the table, act as part of the machinery (bumping, agitating recyclables, etc.). They cannot handle the recyclables directly. Also, the newspaper has to remain dry.
4. Each team will decide on their best ideas to separate each type of recyclable and then combine them to create a system that works to separate the entire bin of mixed recyclables into its four categories. The team should then sketch out their design.
5. Teams should take turns sharing their ideas with the class.
6. Lead the class in voting for the best ideas from the team presentations. The class will combine their favorite ideas into a new, final system.

7. With one elected member from each original team, a small group will work to build the sorter based on the class design. The remaining students can either observe and advise the building team or work on the Writing Activity as they wait.
8. The class will test the system. Everyone should watch carefully to see how it works. Lead the class in a discussion of how the first test went. What went wrong? What worked? As a class, students will brainstorm how the parts of the system that didn't work could be fixed or improved. The class will decide on a list of changes to make.
9. The building team will make the changes and then the class will watch as they retest the system. Lead the class in discussing how the second test went. What problems were they able to fix? What still didn't work? What changes could be made to improve on the design?
10. (Optional) Show the videos in the Internet Connections section to show the class how actual MRFs sort their recyclables.

Student Resource: What is Single Stream Recycling?

Single-stream (or no-sort) recycling is a system in which recyclables, such as paper, metals, plastics, and glass, are mixed together rather than being sorted by citizens before collection. In a single-stream recycling system, people don't need to separate their recyclables. Instead, all recyclables are collected in a single truck, and then are separated for reuse at a materials recovery facility (MRF). At a MRF, materials are separated using conveyor belts and multiple separation methods. Once the materials are separated, they are collected together and sold for reuse.

◆ Advantages

Single-stream recycling means there are fewer barriers to recycling for citizens. The hope is that since it takes less effort to recycle, more people will do it, and more materials will be collected. In Minneapolis, the switch to single-stream recycling lead to a 29 percent increase in recycled materials within a few years.

Single-stream recycling also makes the collection of recyclable materials cheaper, easier, and safer. Recyclables can be collected in one single-compartment truck, which costs much less than multiple-compartment trucks. Collecting recyclables in a single compartment also makes the job easier and safer for materials collectors.

◆ Disadvantages

Single-stream recycling comes with a number of disadvantages as well. Since recyclables need to be sorted before they can be sold, the cost to process them is higher. It costs about $3 more per ton to process recyclables in a single-stream system.

There's also a higher chance that recyclables will become contaminated. Contamination can happen when materials that can't be recycled get mixed in with those that can. This can slow down or stop sorting at MRFs. Broken glass and wet paper can also get mixed in with other recyclables. This can mean that the recycled materials are worth less when sold. It can even mean that some materials that would normally be recycled may end up in the landfill.

How It Works

MRFs use an elaborate mix of machinery to sort materials. Some of these machines are fairly basic and mechanical, while others use newer and more sophisticated. Materials are spread out on a conveyor belt, then moved through a series of machines, such as a cardboard screen, a fines screen (which sorts out materials less than 2 inches long), a newspaper screen, magnets, and optical sorters that can detect and remove different types of plastics, and various other sorters and balers. Technologies like infrared sorters can be used to identify different kinds of plastic, image processing systems can sort materials based on color, and electromagnetic sensing technology can be used to eject metal objects from the main conveyor belt. At some point in most systems, people are also needed to remove unwanted objects by hand.

How You Can Help

When a single-stream recycling system is running smoothly, it can mean saving more recyclables from the landfill and helping to keep recycling profitable. If you live in an area that uses single-stream recycling, you can help make this happen by closely following the recycling rules and guidelines put out by your local recycling center. Following these rules means recyclables will arrive at the MRF facility in the best possible state for sorting. Some simple rules to follow are making sure loose plastic bags and unrecyclable plastics stay out of the recycling bin, and making sure that your recyclables are rinsed and allowed to dry, since wet paper and cardboard can't be recycled.

Student Worksheet:

In a single-stream recycling system, a series of machines is used to sort mixed recyclables into their correct categories. In this activity, you will work in teams and as a class to design a system to sort mixed recyclables (plastics, glass, steel cans, and paper) into their four categories.

1. Working in teams of 3 or 4, brainstorm ways to separate each type of recyclable from the mixed bin. You should feel free to get up and examine the different materials available. Your team is allowed to help run the system, acting as part of the machinery (students can pull materials on a conveyor belt, bump and agitate materials, etc.), but you cannot directly handle the recyclables. The paper recyclables are also required to remain dry.

2. As a team, choose your best ideas for separating each type of recyclable. Then combine these ideas together to create a full system for sorting the entire bin.

3. Sketch out your design and present your team's plans to the class.

4. The class will vote on the best ideas and create a new, final design.

5. A designated member of each team will work to build this system using the available materials.

6. The building team will test the system. Watch to see how the system works.

7. Discuss with the class what worked and what didn't. Brainstorm ways to improve the system and decide what changes should be made.

8. The building team will make the changes and test the improved system.

9. Discuss with the class what worked and what didn't. What changes helped improve the system? What changes didn't? If you were going to build a third version, what other changes would you make?

Student Worksheet: Reflection

1. What were the characteristics (magnetism, weight, etc.) of each type of recyclable that allowed it to be sorted? What other characteristics and methods of sorting do you think could be used?

2. How important do you think human eyes and hands would be to a single-stream sorting process? When and for what materials do you think people would be needed most?

3. Given the advantages and disadvantages of single-stream recycling, do you think it's a worthwhile system? Why or why not?

4. What do you think could be done to improve recycling where you live?

For Teachers: Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:

- U.S. Next Generation Science Standards (www.nextgenscience.org)
- U.S. Common Core State Standards for Mathematics (www.corestandards.org/Math)
- International Technology Education Association's Standards for Technological Literacy (http://www.iteea.org/TAA/PDFs/xstnd.pdf)
- Computer Science Teachers Association K-12 Computer Science Standards (http://csta.acm.org/Curriculum/sub/K12Standards.html)

◆Next Generation Science Standards

K-ESS3-3 Earth and Human Activity

- Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics

- Evaluate competing design solutions for maintaining biodiversity and ecosystem services

ETS1: Engineering Design

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

ETS2: Links Among Engineering, Technology, Science, and Society

- ETS2.A: Interdependence of Science, Engineering, and Technology
- ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

◆Standards for Technological Literacy - All Ages

The Nature of Technology

- Standard 3. Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

Technology and Society

- Standard 5. Students will develop an understanding of the effects of technology on the environment.

Design

- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities for a Technological World

- Standard 11: Students will develop abilities to apply the design process.
- Standard 13. Students will develop abilities to assess the impact of products and systems.