

E-Waste

Grouping
Sequence:

Groups of 3
and "expert
groups," whole
class

Have you ever run across dusty old electronic stuff in your attic or garage? Like a cell phone the size of a cinderblock, a cassette tape player, a CB radio, an old TV monitor, an Apple II computer, a bag of drained batteries? Well, you and everybody else. Isn't it amazing how fast we acquire and discard these tools, toys, whatever they are?

We are surrounded by our own e-junk. The used-up, worn-out, tossed-aside detritus of our material lives is piled up all around us—or tucked just out of sight. Those stashes of e-junk aren't such a big problem in our own basements or attics—but around the world, day by day, humanity is increasingly imperiled by the production, use, and discarding of these electronic gizmos.

This lesson makes use of a survey, a map, and various nonfiction texts to help students explore their understanding of e-waste. First, we engage kids by reminding them of their own dependence on electronics. Then we ask them to ponder some big questions:



- Do these electronic devices improve our quality of life?
- Is our rapid consumption of electronic consumer goods necessary?
- How concerned should we be about the disposal of these products?
- What is the connection between being "plugged in" 24/7 and the accumulating space junk orbiting the earth?

TEXTS IN ORDER OF USE

Electronics Use Survey, Parts 1 and 2

Choice 1: "Types of Satellites" and "Space Junk Cleanup Needed" (easier), copied back to back

Choice 2: "E-Waste Facts and Figures"

Choice 3: "Following the Trail of Toxic E-Waste" (two pages) and the map "Who Gets the Trash," copied and stapled together

Steps and Teaching Language

Strategy 1: **TURN AND TALK**

CURRICULUM CONNECTIONS

Chemistry: Toxic substances in common electronic products.

Physics: How satellites communicate.

Earth/Space Science: Eco-space effects of e-waste, improving environmental citizenship.

Social Studies: Geography of e-waste, economics of e-waste.

Literature: Science fiction; *High Tech Trash: Digital Devices, Hidden Toxics, and Human Health.*

Language Arts: Annotating text; drawing information from multiple sources; taking and supporting a position; representing ideas in drawing; working with others to develop a synthesis.

STRATEGIES USED

Turn and Talk, Jigsaw, Text Coding, Support Your Position, Sketching Through the Text, Gallery Walk

MATERIALS NEEDED

Copy of survey for each student, one set of the other texts for each group of three, white 8½- × -11-inch paper, projectable list of discussion prompts, poster paper, markers, tape. Copying instructions for the three text sets are given under "Texts in Order of Use." It is least confusing for the students if you number the choices 1, 2, and 3 or duplicate each choice in a different color.

PART 1

ELECTRONICS USE SURVEY (10 minutes)

STEP 1

Complete the survey Arrange kids in groups of three and pass out the Electronics Use Survey. Read the Part 1 directions aloud to the class and ask if there are any questions. Give students a few minutes to complete Part 1 individually. As students finish, tell them to read the directions for Part 2 and complete it as well. Circulate and answer individual questions as students work.

STEP 2

Groups discuss

You will work with your group to compare your answers to Part 1 of the survey. Be sure to talk about the following:

- *What are the most popular electronic devices that everyone has?*
- *Which devices seem to get replaced most often?*
- *What is the most common way that members of your group deal with the old ones? In other words, were the members of your group most likely to dispose, recycle, or store old electronic products?*

STEP 3

Whole class shares As groups finish up, gather some quick responses to the questions posed using a quick show of hands. Try to determine what the most common answers were.

STEP 4 **Groups discuss Part 2 of the survey**

Now turn back to your group for a moment and compare your answers on Part 2. Observe groups and continue discussions until on-topic conversation diminishes. Take another look at this list and see if your group can figure out what all these items have in common.

STEP 5 **Whole class shares** After another minute, take some guesses and suggestions from the groups. In the end, be sure kids realize that all of these devices/services depend on space satellites in order to function. *These communication and information satellites are increasing as our use of electronic devices increases. And as our e-waste is accumulating on earth, our waste from broken or outmoded satellites is cluttering up space.*

PART 2 JIGSAW (40 minutes)

Strategy 23: **JIGSAW**

STEP 1 **Introduce text selections** Pass out a complete text set to each group.

Today each person in your group will be reading some different information related to e-waste or space waste. Let me give you a preview.

Choice 1: "Types of Satellites" explains how we depend on satellites in the course of our daily lives; "Space Junk Cleanup Needed" (on the back) describes how more and more space junk is going to interfere with our lives.

Choice 2: "E-Waste Facts and Figures" gives some hard and fast figures about e-waste.

Choice 3: "Following the Trail of Toxic E-Waste" tells a story about how toxic and dangerous it is for the people who recycle our discarded electronics; on the back, "Who Gets the Trash?" shows where these recyclers live.

STEP 2 **Groups negotiate**

Now decide who is going to read which articles. I wouldn't worry about getting a bad one; they're all pretty interesting.


STEP 3 **Give instructions for reading**

Strategy 4: **TEXT CODING**

Now that you've chosen your articles, I want you to read with some coding in mind. As you read, please underline, code, and annotate for three things:

★ *Information that is particularly important. Underline that passage, mark with a star, and jot a quick note on what you were thinking.*

! *Information that is new or surprising. Underline that passage, mark with an exclamation point, and jot a quick note on what you were thinking.*

 *Information that connects back to the survey we took at the beginning of class. Underline that passage, mark with chain links, and jot a quick note on what you were thinking.*

Strategy 12: **SUPPORT
YOUR
POSITION**

STEP 4 "Expert groups" meet and discuss articles As kids finish, call time. *Everybody stand up and stretch. Pick up your article and pen. Now you are going to gather by articles. Hold up texts one set at a time. If you've got the "Satellite" pair, gather in this corner; if you have the "Facts and Figures" article, meet in that corner; the "Trail of Waste" people, gather over here. Go!* Give everyone a minute to move.

Now that you are with all the others who read the same article, I want you to break into groups of three and compare what you annotated, and then decide what the most important two or three pieces of information or connections are. Be sure to write down your conclusions so you'll remember them. When you return to your original group, you will be the expert on this article, so make sure you are prepared.

Give students about five minutes for discussion and then tell them to return to their original groups.

STEP 5 Jigsaw groups share and discuss information

Now that you are back in your original groups, you need to first share your information. Take a few minutes for each member to explain the highlights of his or her article, as you determined them in your expert groups. When it is your turn, remember to support your position and give specific facts or quotes in your explanation.

Monitor carefully and end discussion as soon as groups appear to be finished. Allow five or six minutes for this stage.

STEP 6 Groups discuss answers to prompts

Since everyone is done sharing, I want your groups to take the discussion a step further and come up with some answers to these questions:

- *Do these electronic devices really improve our quality of life?*
- *Is our rapid consumption of electronic consumer goods necessary?*
- *How concerned should we be about the disposal of these products?*
- *What is the connection between being "plugged in" 24/7 and the accumulating space junk orbiting the earth?*



STEP 7 Group members sketch discussion highlights Pass out blank pieces of white 8½-×-11-inch paper. *To summarize something your group discussed related to these questions, each member should draw a quick sketch that is a visual representation of something you talked about. Allow kids to sketch for five minutes.*

Strategy 5: **SKETCHING
THROUGH
THE TEXT**

Strategy 19: **GALLERY WALK**

STEP 8 Group members share sketches and display them *Turn back to your group, show your picture, and share your thoughts. After everyone has shared, tape your pictures to this piece of poster paper. Pass materials around as you explain and monitor—or have a student from each group serve as materials handler. At the bottom write a caption that captures the important ideas from all three sketches. Once you are finished, post your drawings on the wall.*

STEP 9 Gallery walk *Once all pictures are posted, say: With your group, take a quick gallery walk and look at all of the drawings. Stop and discuss what other groups' drawings have in common with yours and also notice how each group's drawings and ideas were different.*

STEP 10 Share with the whole class *End with a quick whole-class discussion. As you looked at all the drawings, what were some key ideas that really stood out?*

Tips and Variations

- **NOT ENOUGH TIME?** Part 2 of this lesson is somewhat lengthy. If you do not have the time for all of the steps, here are some ways to shorten this segment.
 - Skip the drawing completely and end the text study with a whole-class discussion after groups have completed their jigsaw conversations.
 - Rather than a Gallery Walk on the day of reading, students can quickly share some ideas from their drawings and then post the art around the classroom in the last couple of minutes for later perusal.
 - Use pairs instead of trios and eliminate the “Facts and Figures” handout.
 - Pairs can also eliminate the search for an “expert group,” if your desks are arranged in rows or if students are sitting four to a table. Shoulder partners should each read a different article and the face partners will work together as expert pairs. (See Strategy 17, Arguing Both Sides, for an explanation of how face partners and shoulder partners are used.)

Electronics Use Survey: Part 1

DIRECTIONS: Complete the following survey. Place a check in each box that applies. Read the complete definition of each survey category before beginning.

Currently use: Which of the following electronic devices do you currently use/possess/can be found in your home?

Replaced when broken/new model available: Have you ever replaced this device when it broke or a newer model with more features came out?

Discarded old model: You threw away the old model; it went out with the trash.

Recycled/reused old model: You took the device to Best Buy or someplace else that officially recycles electronic waste. Or you gave the device to another person or organization.

Store old model: You kept the device you no longer use and still have it stored in your house.

Electronic Device	Currently use	Replaced when broken/ new model available	Discarded old model	Recycled/ reused old model	Store old model
Cell Phone					
Smart Phone					
Laptop Computer					
Desktop Computer					
Television					
DVD Player					
Gaming System					
Digital Camera					
Video Camera					
iPad					
e-Reader (e.g., Kindle)					

Electronics Use Survey: Part 2

DIRECTIONS: Read the list of electronic devices and services below and check off any that you have ever used.

- | | | |
|---|--|--|
| <input type="checkbox"/> Cell phone | <input type="checkbox"/> XM/Sirius radio | <input type="checkbox"/> Air travel |
| <input type="checkbox"/> Smart phone | <input type="checkbox"/> Internet | <input type="checkbox"/> Weather.com/
Weather Channel |
| <input type="checkbox"/> Wireless gaming | <input type="checkbox"/> GPS | |
| <input type="checkbox"/> Cable/Satellite TV | <input type="checkbox"/> Google Maps | |

Types of Satellites and Their Uses

<http://www.satellite-orbits.info/articles/satellites/types-of-satellites.php>

Many types of satellites are in constant orbit around the Earth. Each has a specific job, whether it's as a storm-tracker, communications station or as part of our nation's military surveillance operations. Any object that orbits another is technically a satellite. Natural satellites include the moon, as it orbits Earth, and the Earth as it orbits the sun. Artificial satellites are those that are manmade and provide useful information for everyday use and scientific advancement as they orbit Earth.

Different Types of Satellites

Communications satellites are vital to our everyday lives. They're responsible for beam-ing signals around the world for a host of correspondence devices, including:

- computers
- fax machines
- pagers
- telephones
- television

Military satellites provide a number of services to the government and private sector. They do act as spy satellites and perform reconnaissance missions within their orbits. These satellites can also:

- observe land and sea transport movements
- offer navigational assistance
- provide top-secret communications on secure channels
- track weather

Navigational satellites have been around for many years. They provide location data to ships and planes. Vehicles now incorporate global positioning systems (GPS) and even individuals can carry handheld systems to avoid getting lost.

Scientific or research satellites operate in several different ways. They may focus on the Earth or can be catapulted into space to study the universe. Scientific satellites' uses are numerous and include:

- crop studies
- freshwater depletion tracking
- locating pollution sources

Weather satellites relay real-time information to meteorologists and databases around the world. They provide instant information that individuals can access through most means of communications. These satellites are capable of assessing atmospheric conditions and can collect information through infrared or standard cameras. Weather satellites are also vital in following the paths of storms, including hurricanes and cyclones.

Space Junk Cleanup Needed, NASA Experts Warn

January 19, 2006, Stefan Lovgren

Space is filling up with trash, and it's time to clean it up, NASA experts warn. A growing amount of human-made debris—from rocket stages and obsolete satellites to blown-off hatches and insulation—is circling the Earth. Scientists say the orbital debris, better known as space junk, poses an increasing threat to space activities, including robotic missions and human space flight. “This is a growing environmental problem,” said Nicholas Johnson, the chief scientist and program manager for orbital debris at NASA in Houston, Texas.

The U.S. Space Surveillance Network is currently tracking over 13,000 human-made objects larger than four inches (ten centimeters) in diameter orbiting the Earth.

Johnson and his team have devised a computer model capable of simulating past and future amounts of space junk. The model predicts that even without future rocket or satellite launches, the amount of debris in low orbit around Earth will remain steady through 2055, after which it will increase. While current efforts have focused on limiting future space junk, the scientists say removing large pieces of old space junk will soon be necessary.

Since the launch of the Soviet Union's Sputnik I satellite in 1957, humans have been generating space junk. The U.S. Space Surveillance Network is currently tracking over 13,000 human-made objects larger than four inches (ten centimeters) in diameter orbiting the Earth. These include both operational spacecraft and debris such as derelict rocket bodies. “Of the 13,000 objects, over 40 percent came from breakups of both spacecraft and rocket bodies,” Johnson said.

In addition, there are hundreds of thousands of smaller objects in space. These include everything from pieces of plastic to flecks of paint. Much of this smaller junk has come from exploding rocket stages. Stages are sections of a rocket that have their own fuel or engines. These objects travel at speeds over 22,000 miles an hour (35,000 kilometers an hour). At such high velocity, even small junk can rip holes in a spacecraft or disable a satellite by causing electrical shorts that result from clouds of superheated gas.

Three accidental collisions between catalogued space-junk objects larger than four inches (ten centimeters) have been documented from late 1991 to early 2005. The most recent collision occurred a year ago. A 31-year-old U.S. rocket body hit a fragment from the third stage of a Chinese launch vehicle that exploded in March 2000.

Johnson believes it may be time to think about how to remove junk from space. Previous proposals have ranged from sending up spacecraft to grab junk and bring it down to using lasers to slow an object's orbit, causing it to fall back to Earth more quickly. Given current technology, those proposals appear neither technically feasible nor economically viable. “Space junk is like any environmental problem,” Johnson said. “It's growing. If you don't tackle it now, it will only become worse, and the remedies in the future are going to be even more costly.”

E-Waste Facts and Figures

How Much Electronic Waste Is Being Discarded? Whether trashed or recycled, what are we getting rid of each year in the US? (See next section for what we stockpile.)

EPA Report on E-Waste in 2007 – Was It Trashed or Recycled?

Products	Total Disposed** (millions of units)	Trashed (millions of units)	Recycled (millions of units)	Recycling Rate (by weight)
Televisions	26.9	20.6	6.3	18%
Computer Products*	205.5	157.3	48.2	18%
Cell Phones	140.3	126.3	14	10%

*Computer products include CPUs, monitors, notebooks, keyboards, mice, and "hard copy peripherals," which are printers, copiers, multis and faxes.

**These totals don't include products that are no longer used, but stored.

- 41.1 million desktops & laptops The EPA (in report summarized above) estimates that 29.9 million desktops and 12 million laptops were discarded in 2007. That's over 112,000 computers discarded per day!
- 31.9 million computer monitors The EPA report (above) estimates that 31.9 million computer monitors were discarded in 2007—both flat panel and CRTs.
- 400 million units of e-waste In a 2006 report, the International Association of Electronics Recyclers projects that with the current growth and obsolescence rates of the various categories of consumer electronics (a broader list than the EPA used above, including DVDs, VCRs, mainframes), somewhere in the neighborhood of 3 billion units will be scrapped during the rest of this decade, or an average of about 400 million units a year.
- Over 3 million tons of e-waste disposed in 2007 in USA In 2007, we generated 3.01 million tons of e-waste in the US. Of this amount, only 410,000 tons or 13.6% was recycled, according to the EPA. The rest was trashed—in landfills or incinerators.
- 20 to 50 million metric tons of e-waste disposed worldwide each year Selected consumer electronics include products such as TVs, VCRs, DVD players, video cameras, stereo systems, telephones, and computer equipment.
- E-waste is still the fastest growing municipal waste stream in the US According to the 2006 United Nations Environment Programme report, "Some 20 to 50 million metric tons of e-waste are generated worldwide every year, comprising more than 5% of all municipal solid waste. When the millions of computers purchased around the world every year (183 million in 2004) become obsolete they leave behind lead, cadmium, mercury and other hazardous wastes. In the US alone, some 14 to 20 million PCs are thrown out every year. In the EU the volume of e-waste is expected to increase by 3 to 5 per cent a year. Developing countries are expected to triple their output of e-waste by 2010."
- Only 13.6% of disposed e-waste is recycled The category of "selected consumer electronic products" grew by almost 6% from 2006 to 2007, from 2.84 million tons to 3.01 million tons. While it's not a large part of the waste stream, e-waste shows a higher growth rate than any other category of municipal waste in the EPA's report. Overall, between 2005 and 2006, total volumes of municipal waste increased by only 1.2%, compared to 8.6% for e-waste.
- According to the EPA, only 13.6% of the consumer electronic products generated into the municipal waste stream (meaning, that people tossed out) were "recovered" for recycling in 2007.

How Much Electronic Waste Gets Stored or Stockpiled?

- 68% of consumers stockpile A Hewlett Packard survey revealed that "68 percent of consumers stockpile used or unwanted computer equipment in their homes."
- 235 million units in storage as of 2007, including 99 million TVs The EPA estimates the following quantities of electronics were in storage by 2007 (not including cell phones):
- | | |
|---------------------------------|-------------------------------------|
| Televisions: 99.1 million | Notebook computers: 2.1 million |
| Desktop computers: 65.7 million | Hard copy peripherals: 25.2 million |
| Desktop monitors: 42.4 million | (printers, copiers, faxes, multis) |
- TOTAL: 234.6 million units in storage**

FOLLOWING THE TRAIL OF TOXIC E-WASTE

60 Minutes Follows America's Toxic Electronic Waste as It Is Illegally Shipped to Become China's Dirty Secret

60 MINUTES

CBSNews.com, August 30, 2009



60 MINUTES is going to take you to one of the most toxic places on Earth. It's a town in China where you can't breathe the air or drink the water, a town where the blood of the children is laced with lead and much of this poison is coming out of the homes, schools and offices of America. This is a story about recycling—about how your best intentions to be green can be channeled into an underground sewer that flows from the United States and into the wasteland.

Computers may seem like sleek, high-tech marvels. But what's inside them? Lead, cadmium, mercury, chromium, polyvinyl chlorides. All of these materials have known toxicological effects that range from brain damage to kidney disease to mutations, cancers. E-waste is the fastest-growing component of the municipal waste worldwide. In the United States alone we throw out about 130,000 computers every day and over 100 million cell phones are thrown out annually.

At a recycling event in Denver, *60 Minutes* found cars bumper-to-bumper for blocks, in a line that lasted for hours. They were there to drop off their computers, cell phones, TVs and other electronic waste. Most folks in line were hoping to do the right thing, expecting that their waste would be recycled in state-of-the-art facilities that exist here in America. But really, there's no way for them to know where all of this is going. The recycling industry is exploding

and, as it turns out, some so-called recyclers are shipping the waste overseas, where it's broken down for the precious metals inside.

Executive Recycling, of Englewood, Colo., which ran the Denver event, promised the public on its Web site: "Your e-waste is recycled properly, right here in the U.S.—not simply dumped on somebody else." Executive does recycling in-house, but *60 Minutes* was curious about shipping containers that were leaving its Colorado yard. *60 Minutes* found one container filled with monitors. They're especially hazardous because each picture tube, called a cathode ray tube or CRT, contains several pounds of lead. It's against U.S. law to ship them overseas without special permission. *60 Minutes* took down the container's number and followed it to Tacoma, Wash., where it was loaded on a ship. When the container left Tacoma, *60 Minutes* followed it for 7,459 miles to Victoria Harbor, Hong Kong. It turns out the container that started in Denver was just one of thousands of containers on an underground, often illegal smuggling route, taking America's electronic trash to the Far East.

Our guide to that route was Jim Puckett, founder of the Basel Action Network, a watchdog group named for the treaty that is supposed to stop rich countries from dumping toxic waste on poor ones. Puckett runs a program to certify ethical recyclers. And he showed *60 Minutes* what's piling up in Hong Kong. It's literally acres of computer monitors. "This is absolutely illegal, both from the standpoint of Hong Kong law

FOLLOWING THE TRAIL OF TOXIC E-WASTE

60 MINUTES

CBSNews.com, August 30, 2009

but also U.S. law and Chinese law. But it's happening," Puckett said.

60 Minutes followed the trail to a place Puckett discovered in southern China—a sort of Chernobyl of electronic waste—the town of Guiyu. "This is really the dirty little secret of the electronic age," Jim Puckett said. Greenpeace had been filming around Guiyu and caught the recycling work. Women were heating circuit boards over a coal fire, pulling out chips and pouring off



Women were heating circuit boards over a coal fire, pulling out chips and pouring off the lead solder.

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Pollution has ruined the town.

Drinking water is trucked in.

the lead solder. Men were using what is literally a medieval acid recipe to extract gold. Pollution has ruined the town. Drinking water is trucked in. Scientists have studied the area and discovered that Guiyu has the highest levels of cancer-causing dioxins in the world. They found pregnancies are six times more likely to end in miscarriage, and that seven out of ten kids have too much lead in their blood. The recyclers are peasant farmers who couldn't make a living on the land. Destitute, they've come by the thousands to get \$8 a day.

Back in Denver, we told Brandon Richter, CEO of Executive Recycling that we'd

tracked his container to Hong Kong. "This is a photograph from your yard, the Executive Recycling yard," our correspondent, Scott Pelley, told Richter, showing him a photo we'd taken of a shipping container in his yard. "We followed this container to Hong Kong. The Hong Kong customs people opened the container . . . and found it full of CRT screens which, as you probably know, is illegal to export to Hong Kong," Pelley said.

"No, absolutely not. It was not filled in our facility," Richter said. But that's where *60 Minutes* filmed it. And we weren't the only ones asking questions. It turns out Hong Kong customs intercepted the container and sent it back to Executive Recycling, the contents listed as "waste: cathode ray tubes." U.S. customs x-rayed the container and found the same thing. *60 Minutes* showed Richter this evidence, and later his lawyer told us the CRTs were exported under Executive Recycling's name, but without the company's permission.

But here's one more fact: the federal Government Accountability Office set up a sting in which U.S. investigators posed as foreign importers. Executive Recycling offered to sell 1,500 CRT computer monitors and 1,200 CRT televisions to the GAO's fictitious broker in Hong Kong. But Executive Recycling was not alone. The GAO report found that another 42 American companies were willing to do the same. Since *60 Minutes* first broadcast this story, federal agents executed a search warrant at the Executive Recycling headquarters as part of an ongoing investigation.

TEXT SET LESSONS / E-WASTE

