

Emerging Issues Commentary: Teaching Our K-1 Students and Ourselves about Sustainable Development As We Raise Questions to Develop a Nuanced Understanding

Abstract

“Sustainable” development refers to development that meets our needs, while making it possible for future generations to meet their needs. Societal and personal choices will dictate if sustainable development will be possible, or, rather, if the environmental, economic and social impact of our continual lifestyle demands will lead to irreversible strain on our world, with consequences that may make human and other life unsustainable. Recent influential science standards, including the Next Generation Science Standards, recognize the need for our students to understand these ideas, and our work with kindergarten and 1st-grade students has shown that such understanding is possible. We present background about sustainable development along with a three-day unit and activities, learning assessment measures, and evaluation results. We also discuss the questions that teachers must consider to have a nuanced view of sustainable development.

Introduction

We are at a critical juncture in human history, having mastered the ability to acquire and process natural resources to continually enhance both the length and quality of life for many of our world’s seven billion people. According to the United Nations World Population Project (2012), life expectancy worldwide has increased from 48 years in 1950-1955 to 68 years in 2005-2010 (United Nations Department of Economic and Social Affairs Population Division, p.1).

In extending human lifespan, we have taken a toll on the Earth’s air, water and land. We see evidence of the harm that our industrialized lifestyles are having on our natural resources. Many countries and organizations now recognize that without concerted, immediate worldwide effort, the environmental, economic and social impact of our continual lifestyle demands will lead to irreversible strain on our world, with consequences that could be severe enough to make human and other life unsustainable (Tasker, 2010; Union of Concerned Scientists, 2011; United States Environmental Protection Agency, 2012). Creating the social, economic and scientific conditions for future generations to live is something that we must work toward, and literacy about the various facets of the problem and its solutions is critical for us and our students—the younger, the better. Elementary-level students must learn to raise relevant, thought-provoking, and often difficult, questions as part of their maturation toward being independent, inquisitive thinkers. Our work with kindergarten and 1st-grade students has shown that they can understand this key idea: as our industrial power has helped to produce everything from soup to nuts, from products that harm us to medicines that save us, our modern way of life can conflict with the goal of long-term global sustainability. Two of us worked with our students (MR with kindergarten and JM with 1st grade) using global sustainability-based activities, and, as we discuss in this paper, various formative and summative assessment tools showed that the students achieved key related learning objectives.

However, as we work with our students, we must be careful not to merely accept the shibboleths that if we use paper instead of plastic bags, or biodegradable instead of Styrofoam-based packing peanuts, our environment will be better off. Such choices are not black and white, and our students’ ability to question incisively will help them to navigate the gray areas to gain the greatest understanding. This is also true for teachers who lead such discussions. In our own reading, we need to be able to detect public rejection of the process of science, even if the references are too subtle to discuss them with our youngest students. For example, a recent report in *The Chronicle of Higher Education* is titled, “Record Summer Heat Shifts Public Opinion on Global Warming” (Basker, 2012). This titling suggests that given the record high average worldwide temperatures, more of the public is convinced that the activities of modern societies, especially manufacturing and driving, need to be examined (Basker, 2012). This is not the case. Instead, the report cites recent surveys showing that public opinion about *whether* average global temperatures have risen over the past four decades has changed, and that the change is influenced by, among other things, the temperature on the day that the respondent fills out the survey. Asking an opinion about whether the Earth is warming is akin to asking an opinion about whether gravity exists. Gravity does exist irrespective of our opinion, and according to decades of worldwide measurements, the Earth is warming. *Why* the Earth is warming, *what* are the implications of that warming, and *how* do we deal with

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it, are the key questions. They are at the interface of science and societal choices, and are part of the larger discussion of “sustainable development.”

We present herein an overview of sustainable development, an example of a related unit lesson plan and activities that we did with our kindergarten and 1st-grade students, examples of 1st-grade student work, and a discussion of the gray areas that make teaching this topic useful as a way to guide even our youngest students to raise meaningful questions.

What Do We Mean by “Sustainable Development?”

The World Commission on Environment and Development (often known as the Brundtland Commission) was convened by the United Nations in 1983 to “propose long-term environmental strategies for achieving sustainable development by the year 2000 and beyond” (p. 1) as well as, “to consider ways and means by which the international community can deal more effectively with environmental concerns” (United Nations, 1997, p.1) In their 1987 report, the commission defined “sustainable development” as “...development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations World Commission on Environment and Development, 1987, para 1).

Sustainable development (SD) as a key part of a modern interdisciplinary science curriculum includes ideas that our early childhood and elementary-level students must understand, given the current imbalance between the supply of raw materials to meet the needs and wants of humankind and the Earth’s ability to adjust to their use. The Michigan State Science benchmarks, for example, has its “Standards & Sustainability Curriculum Checklist: K-2,” with standards that include items such as, “Explain how parts of an ecosystem are related & how they interact; explain how energy is distributed to living things in an ecosystem; investigate & explain how communities of living things change over a period of time; describe how materials cycle

through an ecosystem & get reused in the environment; & analyze how humans & the environment interact. [*sic*]” (Urban and Northern Options, 2012, Standard III.5.EE.2). In June 2008, the National Science Teachers Association joined with the Siemens Foundation for their *We Can Change the World Challenge*, in which students design ways to, “use science, math, and reading/language arts concepts and skills to create sustainable, reproducible environmental improvements in their local communities” (Siemens, 2012, para 8). A core understanding of the Next Generation Science Standards is the, “Influence of engineering, technology, and science on society and the natural world.” (Next Generation Science Standards, 2012, p.5). According to the National Research Council, “From the earliest forms of agriculture to the latest technologies, all human activity has drawn on natural resources and has had both short- and long-term consequences, positive as well as negative, for the health of both people and the natural environment. These consequences have grown stronger in recent human history” (National Research Council, 2011, p. 212). These national organizations support and direct our educational imperative (as such curricula are likely to be mandated in more places in the coming years) to find as many opportunities as possible to integrate SD into our K-5 curricula.

How Do We Bring Sustainable Development Into the K-5 Classroom?

Sustainable Development includes many aspects of Science, Technology, Engineering, and Mathematics (STEM) education, but understanding the impact of SD on us as individuals and societies requires us to take the broad view well beyond STEM. The beauty of SD is that it is cross-curricular, and our teaching of all subjects is enriched when we see it as such. This is consistent with the view of SD from the United Nations, with its Department of Economic and Social Affairs Division of Sustainable Development having divided SD into 14 major themes, (United Nations, 2007). Among

these are: Economic Development; Consumption and Production Patterns; Biodiversity; Atmosphere; Land; Education, and; Poverty. There is no hierarchy in this list; the areas interact far too much to claim that any one is more important than any other.

Given the broad nature of SD, how can we organize ideas, information, and the resultant activities in a way that lends structure to us and our students, is consistent with learning standards, and allows students to appreciate the cross-cultural connections that are so much a part of SD? One of us (PK) met with 48 elementary school teachers who work in three of the largest school districts in Illinois – Chicago, Waukegan, and Joliet – and who were part of a science methods class taught by PK in 2010. The discussions led to these topics, which can be covered sequentially within an academic year or over several years, depending upon the available time and the science and other standards of the school district.

- Population Distribution and an Overview of Resource Use
- The Nature and Scope of Energy
- Nonrenewable Sources of Energy: Nuclear Energy and the Fossil Fuels (Oil, Coal and Natural Gas)
- Renewable Sources of Energy: Wind, Water, Solar, Hydrothermal
- Materials: Metals, Plastics, Paper
- The Impacts: Water, Air, Land, People

The National Geographic’s Education and Map-Maker sites are excellent starting places for a treasure trove of SD-related data and maps about population and demographics intended for photocopying for classroom use (e.g., National Geographic Teachers MapMaker 1-Page Maps, 2012; National Geographic Teachers, 2012). U.S. government organizations, such as the Environmental Protection Agency (EPA), currently have reliable classroom-ready data. [The authors and others believe this was not the case for several years before 2009 because data were being “redacted” – deleted for publication, in many cases toward political ends (Eilperin, J., 2007; Union of Concerned Scientists, 2008). This situation has largely changed, hence our current

confidence in such sites (Environmental Protection Agency, 2012).]

An Example Unit

One of us (JM) introduced SD (which she called “Sustainable Earth” for her 1st-grade students) via a three-day unit in which the students learned about landfills, compared the properties and usefulness of Styrofoam packing peanuts (SPP) to corn starch-based packing peanuts (CPP), and considered strategies for working toward a sustainable Earth. The complete unit lesson plan, including assessment and evaluation, along with accommodations for students with special needs and speech and language difficulties, is given in the Appendix and serves as a resource for the discussion that follows. We summarize the salient points for each day below. JM discussed why she chose this unit in her Teacher Notes and Reflections:

The opportunity to develop and implement this Earth science unit came at the perfect time for my class. Recently, the new release of the *Lorax* movie hit theaters, and many of my students viewed the film with their families. This led to the desire to hear Dr. Seuss’s story *The Lorax* read aloud. With Earth Day fast approaching students had been pondering ways to make a difference in the world. When asked to share ideas about how to keep the Earth healthy, my students readily named recycling as an appropriate activity. However, most seemed unclear as to what it really means to recycle, why it is important, or how to do it.

It was clear to me that my students needed guidance in the area of making Earth-conscious choices. I also wanted to broaden students’ knowledge about creating a healthy Earth beyond just the act of recycling. I wanted to expand students’ Earth science vocabularies and provide students with a toolbox of skills that would enable them to make Earth-conscious decisions now and in the future. Though Earth Day is an appropriate time to introduce the

topic of Sustainable Earth, I found it important to emphasize that each person in the world has the responsibility to make smart choices *every* day.

In order to achieve these goals, I determined that my instruction needed to go beyond a single lesson on biodegradable materials. I knew my students were going to need more background knowledge prior to the packing peanut lesson, as well as reflection and extension following the lesson. This would be necessary in order to foster student connections and understanding. Students needed to first become aware of landfills and pollution and the effects that they have on the Earth’s inhabitants before they would be able to appreciate solutions to the problem.

Day 1 (The detailed lesson plan is in the Appendix): Students are introduced to the notion of a Sustainable Earth. They learn about the terms *biodegradable*, *landfill*, *Sustainable (or healthy) Earth*, *reduce*, *reuse*, and *recycle* via read-alouds, group work, and a SMARTBoard lesson on landfills. During the read-aloud, students ask and answer questions about landfills and their effects on current and future members of society. They predict and record how long it takes for common items to decompose in a landfill.

Day 2: Students predict, and then compare, what happens when SPP and CPP are added to water. Students record data, and describe what they learn via illustrations and written words. In doing this part of the unit, students do what scientists do – raise questions, make predictions based on past understanding, do experiments, interpret data, and explain what it means. The one missing part of the scientist experience, to design experiments, is largely a concession to the limited experience of first grade students. (Interestingly, several students did say that putting the peanuts in water would help us learn something about them, even if they didn’t quite know what!) After the activity, JM placed a premium on students explaining what they learned. This is part of the assessment/

evaluation rubric, shown and discussed in the next section. Again quoting from JM’s Teacher Notes and Reflections:

By Day 2, I felt comfortable introducing the idea of biodegradable materials. As a class, we had touched briefly on the three R’s – reduce, reuse, and recycle. I wanted to share with students the idea that we can also make better choices about the materials we use and that some materials are safer for the Earth than others. The packing peanut lesson provided students with a hands-on way to explore and observe science in action.

Students were able to see and feel the cornstarch packing peanuts dissolving, while observing the Styrofoam peanuts holding their form in water. Immediately, I heard students making connections to pollution and littering. With further class discussion, the majority of students were able to understand that the cornstarch peanuts and the Styrofoam peanuts react differently to the environment due to their chemical makeup.

When assessing students’ understanding during this lesson, I was hoping to see connections being made between the packing peanut activity and students’ own ability to contribute to Sustainable Earth efforts. Out of the 18 students involved in this lesson, all but 2 made satisfactory connections between the lesson and the knowledge they had been introduced to prior to the lesson. Though some students did not directly refer to the packing peanuts activity, these students showed a broad understanding of the importance of making good choices about materials we use. Many students demonstrated a better understanding of how reducing, reusing, and/or recycling materials can lessen the amount of trash in landfills. A few students went beyond this connection by mentioning the need to conserve resources for future generations. One

student, for example, pointed out that good choices must be made "... so that the world can live on."

Day 3: This is a summary day in which students share what they've learned with each other. JM had students complete a four-square outline (Edmond Public Schools, 2012) with the topic sentence, "I know what I can do to keep the Earth healthy!" She met with groups and individual students to assess and evaluate their understanding of key terms and ideas.

From JM's Teacher Notes and Reflections:

Day 3 of this unit allowed students to further reflect on what they had learned. It also provided them with the opportunity to generate a personal plan for contributing to Sustainable Earth efforts. We focused again on the three R's, mainly because those central ideas fit well with our four-square graphic organizer. Students developed interesting and personalized plans to make a difference in the future. For example, one student reported, "I can reduce the amount of electricity I use by turning off my 3DS [Nintendo hand-held gaming system]." Another student decided that she, "...can remind mom to take shorter showers," implying that she also planned to encourage her family to participate in the change.

My students became increasingly invested in the effort to create a healthy Earth for us, as well as for people in the future. They even requested that we make some changes in our classroom. Following Earth Day, we added a recycling box to our room, which allowed us to recycle more than just paper products. Students also brought recyclable materials from home when families were unable or unwilling to recycle. We chose to use only two of our classroom overhead lights, rather than all three, whenever possible. Students even commented that natural sunlight created a more relaxing learning environment!

Have They Learned What They Should Have Learned?

The Illinois State Standards for each day of the unit lesson are given in the Appendix. JM used pre- and post-assessments to evaluate learning among her eighteen 1st-grade students, whose demographic distribution is listed at the start of the unit lesson. Although there are many different meanings of assessment and evaluation depending on the profession and context, we use "assessment" to refer to *the tool we use to gather the data*, and "evaluation" as *the interpretation of the assessment data*. For example, a physician *assesses* (gathers data about) a patient who just returned from a tropical forest. The patient has a high fever, falling body temperature, chills, and is sweating abundantly. The physician *evaluates* (interprets) the data: the patient may have malaria. The rubrics that JM designed for use in the unit lesson plan gave a score (assessment) which JM interpreted (evaluation) as the level and nature of learning.

Pre-assessment

JM gave her students 12 minutes to write responses to the question, "What do I know about the Earth, keeping the Earth clean, landfills, and recycling?" The written responses, which are quoted verbatim, though corrected for spelling and made anonymous, indicated that half of the students began the unit with very little understanding of the Earth as something that must be sustained ("kept healthy"), or the understanding that we (people) have a role in sustaining it in order to preserve humankind. For example, students reported (1st-grade students, personal communication, April 2012):

"If there was a fire I would build a another roof. I will help the Earth clean up garbage like a garbage man. It is in important to clean the Earth."

"The Earth is a place. The Earth is big. The Earth is blue and Green."

"The Earth has a crust. The earth needs to be clean everywhere. The Earth can hold over 100000 people!

The Earth holds 2000000000000000 people! The Earth is so strong it can hold 100000000000 buildings and houses! The Earth can hold 100000 coyotes."

The other half of the students had a rudimentary understanding of the need for a healthy Earth:

"There is more water than land on Earth. I will help cleaning the Earth by recycling paper. It's very important to clean up Earth. If we didn't have Earth, we wouldn't be alive we would all be dead."

"The earth is important to clean because if we didn't there would be trash all over the place. So we should keep the earth clean."

"The earth is a BIG planet. Cleaning the earth is an important job. If we did not clean the earth it will pretty much [be a] garbage can! The earth is very important."

Post-assessment and Evaluation

The unit lesson plan requires the students to achieve the broad goal of understanding global sustainability and the more specific goal (see Appendix) of relating the packing peanut activity to this understanding. For post-assessment and evaluation, JM used an assessment rubric (shown in "Day 2 Assessment" in the unit lesson plan), and asked students to draw and write about what they learned.

Eleven of the 18 students scored in the "excellent" range, five scored "satisfactory," and two scored in the "needs improvement" range. The students not meeting expectations did not demonstrate the ability to relate the activity to the bigger picture of a healthy Earth. The 16 remaining students were able to demonstrate understanding of this relationship, often very clearly. Here are some verbatim quotes from the student responses to the question, "What did I learn?" (1st-grade students, personal communication, April 2012):

"You should recycle so the world can be [able] to live on. The world is

so important because this is the only planet to live on.”

“Landfills are very stinky. They are bad for the earth. Styrofoam peanuts are not good for earth because they are not biodegradable.”

Students added these comments in the follow-up all-class discussion (observed by PK):

“[I] can remind mom to take shorter showers.”

“Styrofoam peanuts would be bad for the fish, “I don’t think we should throw these [packing peanuts] away. They will end up in the landfill!”

The students’ pictures of the Earth, houses, landfills, litter, and packing peanuts supported their understanding.

The combination of one pre-assessment and three post-assessment tools, including written sentences, pictures, and class discussion, combined to show that nearly all of the 1st-grade students understood considerably more about sustainable development, or “a healthy Earth,” than they did before the unit. Although simple terms were used, the key ideas, which in many ways are quite sophisticated, came across in fine fashion to most of these 6- and 7-year-old students. The ability of these students to think critically about the topics discussed is evident in JM’s Teacher Notes and Reflections:

It was particularly interesting to note that one student even mentioned an alternative solution to landfills in his reflection. He remembered reading that some people have tried burning trash. He pointed out that burning the trash avoided the need for the landfill, but caused air pollution in the process. I later asked this student to share his idea, which allowed me to open up a brief discussion about the drawbacks that many “Earth friendly” solutions have caused. I explained that making choices toward a sustainable and healthy Earth is a constant trial and error process. With time and new developments in technology, people can continue to expand on their ideas for dealing

with these issues. (J. Molitor, personal communication, March, 2012)

Commentary: A More Nuanced View of Sustainable Development

Our example of Styrofoam packing peanuts vs. cornstarch packing peanuts is instructive for what students learn about SD and related terms, including “*recycling, reuse, landfill,*” etc. Yet in our zeal to have students be protective stewards of their world, we often miss important parts of the big picture. Packing peanuts make an excellent case study. As teachers who intend to be environmentally thoughtful, we use an activity supporting the conclusion that (biodegradable) CPP, which are produced as shown in these videos from StarchTech, are better than (non-biodegradable) SPP (StarchTech, Inc., 2011). *Why?*

The quick answer, supported by the activity, is that the CPP dissolve in the water, seeming to safely disappear, ceasing to be a threat to the environment (FP International, 2011). Out of sight, out of mind. On the other hand, the SPP do not degrade, and we are left with the task of disposing of them. However, that analysis is inadequate, becoming less valid as we look deeper. Why do we use packing peanuts? They pad items in containers to help prevent them from breaking during shipment. So far, so good. How many times can we expect to use them? We can use both types of packing peanuts many times, though because the cornstarch peanuts are water soluble, they tend to shrink when they get humid, becoming less resilient with time. This means that the non-biodegradable SPP can be used more effectively and for a longer time than CPP. In addition, SPP can be used in other products, such as beanbags, play toys, etc. CPP are not useful over the long term in such products. This means that SPP can be used time-after-time (i.e., via personal and municipal recycling) for decades, whereas the CPP must be continually manufactured because they are not as robust.

How might this impact our ability to have a sustainable world? Manufacturing

packing peanuts (or anything else!) requires energy. Shipping the products requires energy for the trucks, ships, etc. In 2010, the last year for which data are available, well over 80% of U.S. energy needs were supplied by coal (21.2%), natural gas (25.2%), and oil (36.7%), all of which are non-renewable resources (U.S. Energy Information Administration, 2011, p.9). Therefore, any additional manufacturing and shipping made necessary by the limited use of CPP is non-sustainable using current energy sources. We can further extend the discussion to examine the impact on the environment and economics of growing corn for biofuels and gasoline. Deforestation in the service of planting corn (and soybeans) in the Amazon regions of Brazil is contributing to global warming, among other negative SD-related impacts (Grunwald, 2008), though that debate is ongoing (Rosenthal, 2009).

We can have similar discussions with our K-5th-grade students. For example, which is better-cotton diapers or disposable diapers? Comparing each with respect to energy use, recycling, laundry detergent use, water needed in laundering, and other parts of the manufacturing, distribution, and disposal compels students (and us!) to raise meaningful questions and to broaden our perspective. We can gain further insight by comparing countries and different demographic groups within countries to examine how natural resources and demographic variables affect the choices made by people and their cultures throughout the world. Older students will be able to consider more incisive questions than younger ones, but all students can learn to look beyond the basic question to see the biggest possible picture.

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Appendix

Unit Lesson Plan and Activities for Sustainable Development

Possible Unit Time Frames:

- 3 lessons over 3 days, 60 minutes each
or
- 6 lessons over 6 days, 30 minutes each

Classroom Demographics:

- 1st Grade
- 18 students: 9 boys, 9 girls
- 1 student in special education
- 1 English Language Learner
- 1 student with an attention disorder
- 3 students with speech/language difficulties
- 14 White students, 3 Hispanic students, 1 student of mixed background

Background Knowledge: Students have minimal background knowledge on the topic of sustainable development. Students know the relationship between the earth, sun, and moon. Some students understand that Earth is the only known planet to sustain human life. Students also have a vague understanding of recycling and its importance.

Day 1: Introduce the topic of “Sustainable Earth”

Day 1 Lesson Outcomes and Objectives:

- Following this introductory lesson, students will be able to identify and define the terms “biodegradable, landfill, sustainable (or healthy) earth, reduce, reuse, and recycle.”
- Throughout the read-aloud, students will ask and answer questions related to landfills and their effects on current and future members of society.
- During the landfill lesson, students will illustrate and label common items in a landfill. Students will predict and record the amount of time it will take for these items to decompose.

Day 1 Lesson Standards:

- **Illinois State Science Standards** (Illinois State Board of Education, n.d.)
 - **11.A.1b** Develop questions on scientific topics.
 - **12.E.1c** Identify renewable and nonrenewable natural resources.
 - **13.B.1e** Demonstrate ways to reduce, reuse and recycle materials.
- **Technology Standards:**
 - **3. Research and Information Fluency:** Students apply digital tools to gather, evaluate, and use information.
- **Science Processes** (*Skills that are associated with deepening students’ understanding of science content and processes.*)
 - Questioning
 - Inferring
 - Predicting
 - Communicating
 - Interpreting data

Day 1 Materials:

- How to Help the Earth-By the Lorax (Rabe, T. 2012)
- KWL on chart paper
- Pocket chart and key word strips (key words: biodegradable, landfill, sustainable earth, reduce, reuse, recycle)
- SMARTBoard Lesson: “How Long Does Trash Last?”
- Construction paper to make “Landfills” for each student

Day 1 Defining Terms:

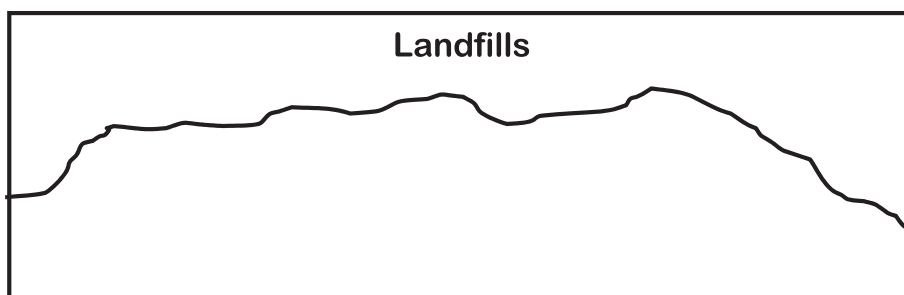
- **Biodegradable:** Break down or decompose and become safe for the Earth over time.
- **Landfill:** A place where all of our trash ends up after we throw it away.
- **Recycle:** Make something safe so we can use it again.
- **Reduce:** Make less.
- **Reuse:** Use over and over again.
- **Sustainable Earth:** A healthy Earth; Keeping the Earth healthy so people in the future can live comfortably too.

Day 1 Grouping Methods:

- Whole group class discussion
- Partner work

Day 1 Procedure:

- **Introduction:**
 - Show students the book How to Help the Earth- By the Lorax.
 - Ask students to think: “What do you already know about taking care of the Earth?” Students turn and talk to share ideas.
 - Record student responses on the “Things we **K**now” section of the KWL chart.
 - Read the introduction of How to Help the Earth- By the Lorax and inform students that the book will give us more information about how to take care of the earth.
- **Discussion:**
 - Promote inquiry by encouraging students to ask questions based on what they “**W**ant to Know” about taking care of the earth. Record ideas on the KWL chart.
 - Finish reading the story, stopping periodically to pose questions and encourage student discussion and response
 - What type of lunch box do you have?
 - How many of you bring water bottles to school?
 - What do you do with them when they are empty?
 - What other things do you throw away?
 - Where do you think trash goes when it leaves our classroom or homes?
 - What will happen if we continue to throw away so much trash?
 - Why do you think the Lorax wants us to throw less garbage into landfills?
 - How would you feel about living near a landfill?
 - What happens if all of the landfills get filled up?
 - What do you think we can do to fix the landfill problem?
- **Landfill Activity:**
 - Pass out 1 piece of construction paper to each student. Model for students how to draw the outline of a landfill. Students label their papers “Landfills.” (Ex: see below)



- Show students the SMARTBoard lesson “How Long Does Trash Last?”
- Throughout the lesson, define the terms “biodegradable, landfill, and sustainable (or healthy) earth.” Add key word strips to the pocket chart.

- Show the picture of a landfill. Discuss items that are typically thrown away. Ask students to work in partners to illustrate and label at least five of those items on their personal “landfills.”
- Ask students to work in partners to predict which items will take a long time to decompose and which items will decompose faster.
- Reveal how long various items take to decompose, and have students record this information under the items in their landfills.
- Compare true timeframes to student predictions. Discuss which items surprised students. Discuss the impact certain items have on landfills and the Earth (for example, glass, which may never decompose).

• **Extension:**

- Refer back to the Lorax story, and ask students if they remember the terms “reduce, reuse, and recycle.” Define the terms and add the corresponding key word strips to the pocket chart.
- Ask students to work with a partner to find and circle an item in their landfill that could have been reduced, reused, or recycled, rather than thrown away.
- Collect landfill papers for assessment and continuation of lesson on Day 2.

Day 1 Assessment and Evaluation:

- Listen to and observe students’ discussions and contributions throughout the lesson.
- Use the following checklist to keep track of student learning and participation throughout the lesson.

<i>Student Name (Example Below)</i>	<i>Student draws and labels at least 5 items commonly found in a landfill</i>	<i>Student is observed making predictions about various items in the landfill</i>	<i>Student accurately records the time it takes for items to decompose, based on the information gathered during the SMARTBoard lesson</i>	<i>Student circles at least one possible item that could have been reduced, reused, or recycled, rather than thrown in the landfill</i>
Sam	Draws 4/5 items	X	X	X (Circled 3 possible items)

Day 1 Modifications:

- For students with special needs (specifically, difficulty recording information)
 - Model examples of answers on a teacher copy throughout lesson.
 - Display key vocabulary words.
- For students with speech/language difficulties
 - Provide students with multiple ways to remember and recite defined terms (provide visual, auditory, and kinesthetic supports).
 - Display key terms and definitions.
 - Refer to defined terms often, encourage students’ use of key vocabulary words.

Day 2: Styrofoam Packing Peanuts v. Cornstarch Packing Peanuts

Day 2 Lesson Outcomes and Objectives:

- Prior to the activity, students will be able to use background knowledge to predict what will happen when the cornstarch and Styrofoam packing peanuts are added to water.
- During the activity, students will observe and record what happens to the peanuts, using illustrations and written words.
- Following the activity, students will use illustrations and at least two key vocabulary words to explain what they learned about sustainable earth from the lesson.

Day 2 Lesson Standards:

- **Illinois State Standards:**
 - **11.A.1a** Describe an observed event
 - **11.A.1b** Develop questions on scientific topics.
 - **11.A.2b** Collect data for investigations using scientific process skills including observing, estimating and measuring.
 - **11.A.2d** Use data to produce reasonable explanations.
 - **11.A.2e** Report and display the results of individual and group investigations.
 - **12.E.3c** Evaluate the biodegradability of renewable and nonrenewable natural resources.

- **13.A.1c** Explain how knowledge can be gained by careful observation.
- **13.B.1e** Demonstrate ways to reduce, reuse and recycle materials.
- **Science Processes** (*Skills that are associated with deepening students' understanding of science content and processes.*)
 - Observing
 - Questioning
 - Inferring
 - Predicting
 - Communicating
 - Interpreting data

Day 2 Materials:

- 1 bag of 5 Styrofoam packing peanuts per group
- 1 bag of 5 cornstarch packing peanuts per group
- 2 plastic cups, each filled half way with water, per group
- 2 plastic spoons per group
- 1 box filled with Styrofoam and cornstarch packing peanuts
- Pocket chart and key word strips (key words: biodegradable, landfill, sustainable (or healthy) earth, reduce, reuse, recycle, cornstarch, Styrofoam)
- “Packing Peanuts and the Earth” recording sheet for each student
- Reflection paper
- Video: “Visiting a Recycling Plant” (<http://www.teachersdomain.org/resource/ess05.sci.ess.Earthsys.recycleplant/>)

Day 2 Defining Terms:

- **Biodegradable:** Break down or decompose and become safe for the Earth over time.
- **Landfill:** A place where all of our trash ends up after we throw it away.
- **Recycle:** Make something safe so we can use it again.
- **Reduce:** Make less.
- **Reuse:** Use over and over again.
- **Sustainable Earth:** A healthy Earth; Keeping the Earth healthy so people in the future can live comfortably too.
- **Styrofoam:** The material from which common packing peanuts are made.
- **Cornstarch:** Made from corn. A material that is in some forms of packing peanuts and other things that decompose.
- **Conservation:** Only using as much as we need, keeping the rest safe for later use.

Day 2 Grouping Methods:

- Whole Group class discussion
- Small Group work (4 students per group)
- Independent Self Reflection

Day 2 Procedure:

- **Introduction- Reviewing Prior Knowledge**
 - Return students’ “Landfills” papers and review what they know so far about taking care of the earth. Review key vocabulary words and definitions using pocket chart terms.
 - Gain student interest by telling a personal story: “Over the weekend, I received this package from my grandma in Arizona! She sent me a very fragile glass figurine. I was so excited, but then I realized that there was also a mystery material inside the box! Can you help me figure out what it is?” (Throw some packing peanuts out to the students)
 - Ask the following questions:
 - What is this mysterious material? What is it used for?
 - What should I do with it now that I am done using it?
 - What will happen if I just throw it away? Where will it end up?
 - Do you notice anything about the packing peanuts? Are they all the same?
 - How do they differ? Why do you think some look different than others?
 - Show students one cornstarch packing peanut and one Styrofoam packing peanut. Discuss only the similarities and differences that students are able to see. Add “Cornstarch” and “Styrofoam” to the pocket chart, without definitions.

- Explain that, “The two packing peanuts are made up of different materials. One might be healthier for the Earth than the other, depending on how we use them. We are going to conduct an experiment to help us understand both materials better. Then, we will think about the impact these and other materials have on the Earth.

• **Activity:**

- Provide each group with materials (1 bag of Styrofoam peanuts, 1 bag of cornstarch peanuts, 2 cups of water, spoons, etc.).
- Explain that scientists sometimes learn information about things based on how they interact with water. Remind students that, as scientists, they can learn about the world by using observations to gather and record data or information.
- Discuss:
 - Question: “What happens to different items when they get wet?”
 - Possible Answers: “Some things float, some sink, some dissolve, some soak up water,” etc.
- Provide students with the “Packing Peanuts and the Earth” recording sheet. Students write a prediction about what will happen to each type of packing peanut when they are added to water.
- Each group adds the Styrofoam packing peanuts to the first cup of water, using the spoon to stir. Remind students to observe!
- After about 2-3 minutes, tell the students to stop stirring. Ask all students to record what they observed on the **Styrofoam side** of their recording sheet. (See below). Each student draws a picture and writes one sentence to explain what the group observed.
- Each group then adds the cornstarch packing peanuts to the second cup of water, using the spoon to stir. Encourage students to discuss what they see, comparing the reaction to that of the Styrofoam packing peanuts.
- After 2-3 minutes (or when the cornstarch packing peanuts have mostly dissolved), ask students to stop stirring. All students record the group’s observations using a picture and sentence on the **Cornstarch side** of the recording sheet. (See below).

• **Example of Recording Sheet:Discussion:**

- Ask students to explain what they observed. (The cornstarch peanuts dissolved and the Styrofoam peanuts did not).

Packing Peanuts and the Earth	
When I add the Styrofoam peanuts to water, I predict _____	
When I add the Cornstarch peanuts to water, I predict _____	
Styrofoam Packing Peanuts: S	Cornstarch Packing Peanuts: C
Draw what you see:	Draw what you see:
Write about it! What did you notice?	
_____ _____	

- Ask students to discuss why the two peanuts reacted differently to the water. (They are made up of different materials).
- Remind students that we introduced two new words, “Styrofoam” and “Cornstarch,” to the pocket chart. Explain that Styrofoam is the material that normal packing peanuts are made of and that it is not biodegradable. Cornstarch, on the other hand, is a material made from corn, which breaks down in water and becomes safe for the earth again.

- Ask students to think about what we can do with both types of peanuts in order to be safe for the earth. (Styrofoam peanuts could be saved and re-used, while the biodegradable Cornstarch peanuts could be dissolved in water).
- Explain that it is important that we all make an effort to choose materials that are safer for the Earth and to only use as much as we need so that there is enough left for people to use in the future. When possible, we should reuse materials, rather than throw them away. Add and define the key word “conservation” to chart.
- Review all key vocabulary words and definitions.

• **Independent Reflection:**

- Tell students that you would like to give them the opportunity to share what they have learned over the past two days about keeping the Earth healthy.
- Provide students with reflection paper (one with space for both illustrations and written response). Instruct students to draw a picture that shows what they have learned about helping the earth. Then, ask students to write about what they learned, using at least two key vocabulary words from the pocket chart.
- Provide students with 10-15 minutes of time to record their learning. Collect papers for assessment and evaluation.

• **Extension:**

- Play the short video clip, “Visiting a Recycling Plant.”
- Discuss key information following the movie.
 - How many trees are saved by each bail of paper recycled (15 trees).
 - How many trees are saved per day at each recycling plant (7,500 trees, or one forest, per day).
- Discuss the importance of recycling, and remind students that materials which are not recycled end up in the trash, and eventually, the landfills.

Day 2 Assessment and Evaluation:

- Listen to and observe students’ discussions and contributions.
- Use the following rubric to evaluate student learning after collecting the observation and reflection papers.

Criteria	Established 3	Progressing 2	Needs Improvement 1	Score
Neatness and Presentation (optional category)	Student handwriting is neat-illustrations are planned and demonstrate understanding of material.	Student handwriting is legible and illustrations demonstrate understanding of material.	Student handwriting lacks neatness and illustrations are unclear.	
Content Knowledge	Student demonstrates understanding of content knowledge.	Student is progressing toward an understanding of content knowledge.	Student is lacking an understanding of content knowledge.	
Making Connections	Student clearly uses prior knowledge and experiences to make connections throughout reflection.	Student attempts to use prior knowledge and experiences to make connections throughout reflection.	Student does not use prior knowledge or experiences to make connections throughout reflection.	
Use of Key Vocabulary	Student appropriately uses two or more key vocabulary words in reflection.	Student appropriately uses at least one key vocabulary word in reflection.	Student does not use key vocabulary words, or inappropriately uses key vocabulary words in reflection.	
Final Score	Excellent = 10-12 points	Satisfactory = 7-9 points	Needs Improvement = 4-6 points	/12

Day 2 Modifications:

- For students with special needs (specifically, difficulty recording information)
 - Display key vocabulary words.
 - Encourage student to focus on illustration and to label pictures.
 - Record students’ dictated sentence, if necessary.
- For students with speech/language difficulties
 - Provide students with multiple ways to remember and recite defined terms (provide visual, auditory, and kinesthetic supports).

- Display key terms and definitions.
- Refer to defined terms often, encourage students' use of key vocabulary words.

Day 3: Four-Square Topic: I know what I can do to help keep the Earth healthy!

Day 3 Lesson Outcomes and Objectives:

- When provided with sticky notes, students will contribute at least one idea about what they have learned during the Earth Science Unit.
- When provided with a topic sentence, students will use a four square graphic organizer to list at least three things he/she can do to keep the Earth safe, along with a conclusion sentence about how helping the Earth makes him/her feel.

Day 3 Lesson Standards:

- **Illinois State Standards:**
 - **13.B.1e** Demonstrate ways to reduce, reuse and recycle materials.
 - **13.B.2f** Analyze how specific personal and societal choices that humans make affect local, regional and global ecosystems (e.g., lawn and garden care, mass transit).
- **Writing Standards:**
 - CC.1.W.2 Text Types and Purposes: Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure.
 - CC.1.W.5 Production and Distribution of Writing: With guidance and support from adults, focus on a topic, respond to questions and suggestions from peers, and add details to strengthen writing as needed.
 - CC.1.W.8 Research to Build and Present Knowledge: With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- **Science Processes** (*Skills that are associated with deepening students' understanding of science content and processes.*)
 - Communicating

Day 3 Materials:

- KWL chart paper from Day 1.
- “We Love Earth” chart paper for class brainstorming.
- Copy of 4-square outline for each student.
- “Our Class is Going Green” By Mrs. Nickels’ Kindergarten Class.

Day 3 Defining Terms:

- **Recycle:** Making something safe so we can use it again.
- **Reduce:** Make less.
- **Reuse:** Use over and over again.

Day 3 Grouping Methods:

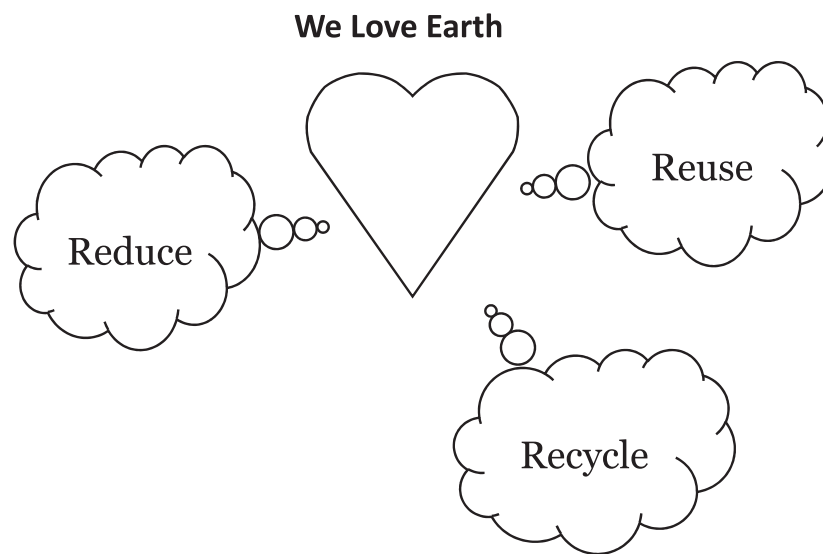
- Whole group class discussion.
- Independent writing time.

Day 3 Procedure:

- **Introduction:**
 - As a class, complete the KWL chart created on day 1.
 - Provide students with sticky notes. Ask each student to write down one of their ideas.
 - One-by-one, have students come up and read his/her sticky note. Have each student place his/her sticky note in the “Things we Learned” section of the KWL chart. Clear up misconceptions and answer questions as needed.
- **Brainstorming:**
 - Review steps for paragraph writing and the author’s purpose—to inform.
 - Show students the book “Our Class is Going Green,” and explain that a class of kindergarteners wrote it to tell people how to care for the Earth. Review reasons why caring for the Earth is important (this is the only planet that sustains life).

- Read the story. Review the key vocabulary words reduce, reuse, and recycle.
- Show students the “We Love Earth” chart paper. Add three bubbles to the graphic organizer- reduce, reuse, and recycle (see example below). Explain that the heart in the center represents our love for Earth!
- Ask students to brainstorm ways to reduce, reuse, and recycle certain materials.
 - Ask students, “which items make more sense to reduce? To reuse? To recycle?”

Example of Chart Paper:



• Writing:

- Pass out the four-square outlines. Read the topic sentence, “I know what I can do to help keep the Earth healthy!”
- Review the process for completing a four-square. Remind students that there should be only one big idea per box, with at least one example or description for each idea.
- Encourage students to use the class brainstorming chart to help them with their writing. Students write about one thing that they can recycle, one thing that they can reduce their use of, and one thing they can reuse.
- Model examples for student writing:
 - Example for box number 2: “I can reuse materials. I can reuse my empty water bottle to water plants in my garden, rather than throwing it away.”
 - Example for box number 3: “I can recycle my paper when I am done writing on it. Then, it can be turned into new paper for others to use.”
 - Example for box number 4: “I can reduce the amount of electricity I use. I can turn off my computer and unplug it when I am done.”
- When all students have completed boxes 2, 3, and 4, model a conclusion, or feeling, sentence in box number 5:
 - Example for feeling sentence: “Keeping the Earth healthy is important to me because I want it to be a safe place for future people to grow up. It makes me feel good to know that I am making a difference!”
- Provide students with time to write their own conclusion/feeling sentences.
- Throughout the next few days, students should complete the editing and revising process in order to “publish” their final copies on clean paper. Collect completed writing for assessment and evaluation.

Day 3 Assessment and Evaluation:

- Listen to and observe students’ discussions and contributions.
- Use the following rubric to evaluate student learning after collecting completed four-squares.

Criteria	Established 3	Progressing 2	Needs Improvement 1
Conventions Student uses accurate punctuation and capitalization. Grade level appropriate spelling is used.			
Sentence Fluency Student has a variety of sentence lengths. There are few incomplete sentences. Sentences make sense.			
Organization Student has at least three detail sentences, with an opening and a closing sentence. Student uses transitional words where appropriate.			
Content Student accurately states at least 3 specific things he/she can do to help keep the Earth healthy.			
Writing Process Student attempts some editing and revising, with the help of teacher and peers. Student completes a finished product.			
Final Score	Excellent 12-15 points	Satisfactory 8-11 points	Needs Improvement 4-7 points

Day 3 Modifications:

- For students with special needs
 - Display key vocabulary words.
 - Encourage student to illustrate ideas as part of his/her planning process.
 - Provide sentence starters for each box.
 - Record students' dictated sentence, if necessary.
- For students who have difficulty writing on topic and developing ideas independently
 - Complete a four-square together with a small group of students (3-4). Make sure each student is able to contribute to the completion of the four-square.
- For students who have difficulty with fine motor skills and writing
 - Allow students to type final draft, rather than re-write it.
- For students with speech/language difficulties
 - Provide students with multiple ways to remember and recite defined terms (provide visual, auditory, and kinesthetic supports).
 - Display key terms and definitions.
 - Refer to defined terms often, encourage students' use of key vocabulary words.

Example of Four Square:

2.	3.
1. I know what I can do to help keep the Earth healthy!	
4.	5.