**Wild Treasures: Sustainability, Naturally**

**A full-year sustainability education curriculum for middle school students**

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What follows is a full-year sustainability education curriculum for middle school students. Its genesis is a program called Wild Treasures: Sustainability, Naturally. Now in its fifth year, this program has been directed by Antioch New England Graduate School students earning an M.S. in Environmental Studies and a General Science or Biology Teaching Certification.

I’ll begin by introducing how Antioch’s Wild Treasures program works in general. This will be followed with specific ideas for how to adapt this program into a full-year curriculum that does not require external institutional support.

**Antioch’s Wild Treasures Program**

Antioch’s Wild Treasures ends in June with a class of middle school students earning a Governor’s Sustainability Award for transforming the way their school operates.

It begins the previous September in a forest along a winding path surrounding an 800,000-ton capped landfill and a symphony of sounds produced by a very active waste recovery and transfer station. Along the trail, small groups of students solve a variety of surprising problems that introduce them to 5 big ideas about sustainability: waste, exponential growth, cycling in nature, feedback loops and entropy. If they solve all the problems, they walk away with their first of 3 $500 awards!

During the next 9 months students earn an additional $1000 by applying these 5 big sustainability ideas to:

Conduct original research about their school’s sustainability practices,

Present a comprehensive proposal to their school board, detailing the necessary action-steps needed in order to improve their school’s sustainability practices (based on their research), and

Transform their school-board proposal into measurable action.

Since Wild Treasures’ inception in the fall of 1999, more than 450 students from fifteen middle schools in southern Vermont and New Hampshire have become real agents of change in their communities while learning about and applying the principles of sustainability. Students have reduced their school’s solid waste, implemented school-wide energy conservation programs, initiated large-scale composting systems and started an organic lunch program.

**Wild Treasures**

Although Antioch’s Wild Treasures begins at a capped landfill, offers significant money to participating classes, leads to an award recognized by the Governors of two neighboring states, and requires the facilitation and support of my science teaching certification students, the Wild Treasures described below can be implemented by you, without any field trips, financial awards or recognition from public dignitaries. You can also implement the entire full-year curriculum without sacrificing your other science teaching goals. Or, you can choose to take only those curricular pieces that appeal to you.

Essentially, Wild Treasures consists of 4 phases: (1) The Challenge Trail; (2) Research; (3) Proposal; and (4) Action. The classroom-based Challenge Trail can be completed in 6-8 classes, depending on the size and length of your class. You pick the deadlines that work for each of the other three phases and work backwards from those targets. You can determine how much time you want to give each phase of the program. Remember, this curriculum is extremely flexible and can be sprinkled in and around your other teaching responsibilities.

If you are a 5th-8th-grade teacher interested in hands-on, minds-on, student centered, student directed, real problem solving interdisciplinary science teaching, you will enjoy playing with the curriculum described below.

A New Science Teaching Model: Real Problem Solving

This is more than a sustainability education curriculum. Wild Treasures exemplifies what science education can look like when students are asked to solve real problems that affect their lives. It does it via a seamless integration of multiple disciplines in a joint effort to teach complex concepts. It’s an effective model for framing much of what can happen in a science classroom: (1) Work with a small set of big ideas over a long period of time, in a variety of ways; (2) Design and carrying out self-designed research about this small set of big ideas; (3) Submit proposals to real audiences like school boards and commissions in order to have an impact on the real environment in which you are a part; (4) Turn ideas, based on rational research, and democratic approval into measurable actions that effect real lives.

Although the financial awards have been an important feature of Antioch’s Wild Treasures program, it need not be an essential ingredient for your curriculum.

While the money awarded to participating schools does permit class’ to make real investments in needed equipment and services that will help realize a class’ research and action plans, it is not the catalyst for generating or sustaining students’ interests in the curriculum.

Wild Treasures offers a variety of other incentives and designs that will sustain your students’ interests. The Challenge Trail has a playful gaming structure accompanied by engaging problems with real and perceived risks. Each phase of the program provides students with positive and constructive feedback. And during the final action phase of the curriculum, students feel a wonderful sense of having accomplished something significant and meaningful. Furthermore, many wonderful changes can come about without any financial costs.

You are welcome to go on-line to use and adapt, for free, any of Antioch’s Wild Treasures’ curriculum materials: HYPERLINK "http://wildtreasures.schoolsgogreen.org" http://wildtreasures.schoolsgogreen.org

**The Challenge Trail**

Students spend their first day of Antioch’s Wild Treasures program at The Challenge Trail, a path meandering through the forest along the perimeter of a very active materials recovery and transfer station in Keene, NH, all the while listening to the never-ending symphony created by the movement and sorting of human refuse.

Students work in small groups to solve 6 major problems that introduce them to five big ideas comprising the notion of sustainability: waste, exponential growth, cycling, feedback loops and entropy.

I have redesigned each of the problems along the Antioch Challenge Trail into many practical and engaging classroom based problems. Therefore, instead of a full-day field trip to a Challenge Trail at your local materials recovery and transfer station, your students can experience their own Challenge Trail in your classroom, over a two-week period.

During your classroom-based Challenge Trail, your students will sort stuff into different categories and mess around with the meaning of waste. They will race against themselves in order to experience first-hand the meaning of exponential growth. They will examine stuff buried under different conditions, and predict which set of conditions best represents a capped landfill. They will act as miners, refiners, manufacturers, retailers and consumers of a non-renewable energy source, and in so doing learn about positive and negative feedback loops. They will interact with solar panels, as well as gas and hand-cranked generators to experience first-hand the meaning of entropy, the Second Law of Thermodynamics. And they will paint a portrait of their fantasy lifestyle. And in so doing, begin to realize how one these 5 big ideas are connected to their lifestyle choices.

**The Rewarding of Earthstones**

In return for solving each problem along your Challenge Trail, teams are awarded an Earthstone, a small rock (or piece of paper) with a word on it. Each team is trying to collect all of its Earthstones by the end of the Challenge Trail. Since each team is carrying half of their own Earthstones and half of the stones needed by another team, each group’s success is dependent on the success of another group. During the final part of the Challenge Trail, each group constructs a meaningful sentence from their six Earthstones. If their sentences match all of your sentences, they will have successfully completed the Challenge Trail.

Prepare the Earthstones before starting the Challenge Trail. Create the Earthstones either on paper or small rocks (Figure XX). Each set of four sentences should be composed of 6 Earthstones and marked in a way that distinguishes them as a set. Divide each set in half, mix them with another group and put in a bag with clear group markings.

**Earthstone Sentences**

|  |
| --- |
| **1a. Nature is the teacher of sustainability. Or, The teacher of sustainability is nature.** **2. There’s no such thing as waste.****3. Finite Earth cannot sustain exponential growth.****4. A sustainable society safeguards future generations.**Nb. Each word goes on a separate Earthstone. Make each team’s Earthstones distinct from each other so they can easily be sorted and distributed. |

Before starting the Challenge Trail, describe the entire Wild Treasures curriculum to your students, highlighting the four major phases: Challenge Trail, Research, Proposal and Action. Emphasize how the phases are connected to each other. Tell them that by June they will have done something to significantly transform the way their school operates.

Challenge 1: What is waste?

(45-minutes)

At “What is Waste” students are challenged to sort a “garbage can” full of stuff into the same “bins” (“Recycle,” “Compost,” “Reuse,” and “Garbage”) they think the Director of a Recovery Center would if she were at her home. By the end of this exercise, students will articulate their definition of “waste,” compare their meaning to that of a waste expert, and begin to wonder whether garbage is a necessary part of being human.

**Materials**

Each of the 4 stations will need:

1. A collection of materials to sort into recyclables, reusables, compostables and garbage (see chart, “What is waste?” materials). If you don’t have access to a good collection of materials to make 4 similar sets, distribute pictures (or words) of these items instead.

“What is waste?” materials: These materials are sorted according to the Director of a New Hampshire Recovery and Transfer Station\*

|  |  |  |  |
| --- | --- | --- | --- |
| **Recyclable** | **Reuseable** | **Compost** | **Garbage** |
| Glass bottle#2 bottle (milk jug)NewspaperAluminum soda canAseptic juice boxAutomobile battery | Glass bottlePlastic yogurt containerBlue jeansNewspaperWorn sweaterCereal boxAluminum soda canSkatesOld bookBroken tennis racquetBroken lampUsed automobile oil | Bag of leavesPumpkinsChristmas treesUneaten foodGrass clippingsRockSoilDead animal (insect)Dead plant | Cereal boxTooth paste tubeToilet paper roll insertMilk cartonBurnt out light bulbPencil shavingsAseptic juice box |

\*Some items can be placed in more than one container. Their placement will vary depending on the regulations in your community.

2. The Challenge Card, “What is waste?”

|  |
| --- |
| **What is waste?**Before the day is out, you will add about 4 1/2 pounds of garbage to a landfill not too far from here. Does any other life on earth produce garbage? Is creating garbage a necessary part of being human? Just what is your definition of garbage? **Your challenge is to sort the stuff at this station. Sort them into the categories you think the director of a materials recovery center in New Hampshire would if this stuff was at his home.** You have 5 minutes. Begin now. If your entire class can match at least 50% of an expert’s sorting, pick an Earthstone.**©2003 Wild Treasures** |

3. Four signs indicating the respective sorting “bins.”

**Procedure**

1. Divide your class into four equal groups and have each group gather around a station.

2. Tell students they have 5 minutes to sort their items into one of the four “bins” as well as to write down their answer.

3. After 5-minutes, give two teams 5+/- minutes to share their answers with each other and make any changes they can agree on.

4. Ask members from the two larger teams to put their answers on the board and to circle any contested items. Tell the class they have 5 minutes to work together to determine their final answer.

5. Before providing your students with the expert’s sorting arrangement, ask each of the smaller teams to write down their definition of waste by explaining what all the stuff they put into the garbage bin have in common?

6. Have a member from each team write their definition on the board. Use their definitions to facilitate a class-wide discussion on their shared definition of waste. Encourage students to elaborate. When the discussion ends write the following expert’s definition on the board, “Garbage is ‘stuff I think doesn’t have any more purpose or value. Garbage can also be stuff we haven’t figured out a way to make valuable.’” Ask students to articulate how their definition compares with the expert’s.

7. Share a few copies of the expert’s sorting arrangement with each team. (or project one copy for all to see). Ask each team to calculate whether or not they matched the expert at least 50% of the time.

8. If they matched more than 1/2 of the expert’s sorting, ask each team to randomly pick and set aside one Earthstone from their Earthstone bag.

Challenge 2: What’s so sneaky about exponential growth?

(45 minutes)

During “What’s so sneaky about exponential growth?” your students will race against the clock to create two piles of something in order to experience first-hand the true meaning of exponential growth. They make their first pile linearly by adding 10 items to each subsequent round for 10 rounds. Then they make their second pile exponentially by doubling the amount of items for each subsequent round for 10 rounds. Their analysis of their experience reveals why exponential growth is so sneaky. If available your students can conclude this challenge by listening to Alan Atkisson’s humorous and disturbing song, “Exponential Growth.”

If your class has convenient access to a forest with lots of leaves on the ground, do this challenge there. If not, complete the challenge with paper squares instead of leaves.

**Materials – Inside or Outside**

Each of the 4 stations will need:

1. Challenge Card, “What’s so sneaky about exponential growth?”

|  |
| --- |
| **What’s so sneaky about** **exponential growth?**Human population and garbage are growing in a way that is different from all other life on earth. Human population and waste are growing at increasingly faster rates. If we don’t deal with our current population growth rate, many people believe that we will severely compromise the quality of life for future generations. But just what does this growth rate really feel like? And why is it so sneaky? Here’s a way to find out.**Your challenge is to create two piles of objects in the following way:****Pile 1: Begin by collecting 2 objects and then add 10 objects to each previous round for 10 rounds.** **Pile 2: Begin by collecting 2 objects and then double the amount of objects each round for 10 rounds.** Your teacher will tell you how to proceed. **©2003 Wild Treasures** |

2. Exponential Growth Chart – Empty

|  |  |  |
| --- | --- | --- |
| **Exponential Growth Chart: Empty**Directions: Complete the following chart before creating any of the piles.  |  |  |
| **Round** | **Pile 1** | **Pile 2** |
| 1 | 2 | 2 |
| 2 | 12 | 4 |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |

3a. Inside version: 1200 1” square pieces of paper in a large plastic or cardboard container (large enough for 6 kids to reach in and count the number of squares they will need for each round).

3b. Outside version: 30’ x 30’ area with lots of fallen leaves. Mark off the perimeter of each area with colored ribbons.

4a. Inside version: Two tall thin clear cylinders, big enough to fill with 1024 1” squares. Label “Pile 1” and “Pile 2” respectively.

4b. Outside version: Two tall thin containers (clear if possible), big enough to fill with 1024 leaves. Label “Pile 1” and “Pile 2” respectively.

5. Exponential Growth Chart – Completed

|  |  |  |
| --- | --- | --- |
| **Exponential Growth Chart: Completed** |  |  |
| **Round** | **Pile 1** | **Pile 2** |
| 1 | 2 | 2 |
| 2 | 12 | 4 |
| 3 | 22 | 8 |
| 4 | 32 | 16 |
| 5 | 42 | 32 |
| 6 | 52 | 64 |
| 7 | 62 | 128 |
| 8 | 72 | 256 |
| 9 | 82 | 512 |
| 10 | 92 | 1024 |

6. Exponential Growth Graph

<Insert Exponential Growth graph>

7. Optional: Alan Atkisson’s song, “Exponential Growth.”

**Procedure**

If a procedure doesn’t indicate “inside” or “outside” then it can be applied to either setting.

1. Read aloud:

a. You have 7 minutes to create Pile #1. You will then have 7 minutes to create Pile #2.

b. Outside: You can only collect leaves in the area within the indicated blazing. Leaves should be ON THE GROUND and close to their full size.

c. You must complete the chart, “Exponential Growth Chart - Empty” before you begin collecting.

d. Collect the exact number of items you think you need for each round and put them into their bin. You must complete each round before you can begin the next round.

e. Any questions? (Pause) You have 7 minutes to complete the chart and create pile 1. Begin. (Begin timing)

2. Let students know when 1 and 2 minutes remain during each pile race. Stop after 7 minutes. Start pile #2 as soon as pile #1 is over. If necessary say,

a. You can still earn an Earthstone if you didn’t complete pile 1.

b. Do not press down on your piles.

3. Regroup the teams after 7 minutes have passed for creating pile #2 and say,

“If you didn’t complete all 10 rounds for pile 2, you can still earn an Earthstone if your chart matches the chart, “Exponential Growth Chart – Completed.” Have each group compare its chart with the completed one.

4. Distribute and/or hold up the “Exponential Growth Graph” and ask, “Which graph, “A” or “B,” represents how you made pile 2?”

5. After they state their answer say, “Look at the chart or graph. Notice which pile was gathering more items each round for the first 5 rounds? (Pause. They should notice that they collected fewer items in pile 2 during rounds 2-5.) What happened after the 5th round? (Pause. They should notice that they collected a lot more items for pile 2 during rounds 6-10.) Why do you think exponential growth is considered to be so sneaky? (Pause. They should explain that something can grow exponentially for a long time before one notices that it’s going to grow at an extraordinary pace.)

6. Play Alan Atkisson’s song, “Exponential Growth.”

7. Tell students they can pick an Earthstone if their group’s chart matched your chart AND / OR if their group said Graph B represents how they went about creating pile #2.

Challenge 3: What’s the difference between landfills and Nature?

(45 minutes to set up plus periodic observation over time)

At “What’s the difference between landfills and Nature?” students create an experiment that will help them determine what happens to stuff that have been exposed to three different conditions: (1) laying on top of the ground in an open, mesh-like container, (2) buried just below the ground in a similar open mesh container, and (3) buried in an air-tight container. Throughout the school year they can return to their experimental plots and observe how their materials have changed. Through the process of setting up their experiments, your students will be able determine which of the three conditions best represents a capped landfill and explain a fundamental difference between a capped landfill and Nature.

**Materials**

(Per 2 students)

1. “What’s the difference between landfills and Nature?” Challenge Card

|  |
| --- |
| **What’s the difference between landfills and Nature?** What’s different between a landfill and the phases of the moon, the seasons of the year, the circulation of air, water, and blood, the exchange between your breath and a leaf, and the ability of a forest to stay alive by eating itself? Since the very essence of Nature is cycles, it would be wise to take a close look at anything we do that is NOT part of one. **Your challenge is to start an experiment that will help you observe what happens to stuff under 3 different conditions: on the surface of the soil in open containers; buried just below the ground in open containers; and buried in closed containers.** There are two sets of directions. Option A is more open-ended in that you need to figure out a way to use the materials to solve the challenge. Option B is more directed in that it provides the instructions for what to do with the materials. Your teacher will tell you how to proceed. **©2003 Wild Treasures** |

2. Three samples of each of the following types of organic and inorganic materials:

|  |  |  |
| --- | --- | --- |
| Dead insects | Fruit | Soda can |
| Deciduous leaves | Iron nail | Dead mouse |
| Coniferous leaves | Waxed milk carton | Other |

3. 2 pairs of latex gloves

4. 2 1’ x 2’ wire mesh (1/2” mesh)

5. 1 clear Tupperware container (large enough to hold one set of items)

6. Duct tape

7. Permanent marker

8. Option A: Open-ended Challenge directions (for those groups you determine the open-ended approach is appropriate)

**Option A: Open-ended Challenge**

Arrange the provided materials so that you can place them outside in order to determine under which of 3 conditions the living and nonliving objects will have changed the most. After setting up the materials, work with your original Challenge Trail team to answer your teacher’s questions.

9. Option B: Directed Challenge directions (for those groups you determine the more directed approach is appropriate)

**Option B: Directed Challenge**

a. Create 3 identical sets of materials.

b. Spread out the items in Set 1 and Set 2 on 1/2 of each of the two wire meshes, so that each mesh has the same materials.

c. Fold over the wire mesh on top of your materials and seal the edges with Duct tape. Label each mesh with your names and condition (e.g., buried open or surface open). Be sure not to cover the materials under the duct tape.

d. Seal the third set of items inside the provided Tupperware container. Label it with your names and “Buried Closed.”

e. Place the materials outside. Mark them so you can find them throughout the year.

f. Share your predictions.

g. After setting up the materials, work with your original Challenge Trail team to answer your teacher’s question(s).

10. Outside: Find the area outside in which the experimental plots can be set up without being disturbed.

11. Cross-sectional diagram of a capped landfill:

<Insert diagram, “Landfill Cross-Section”>

**Procedure**

1. Divide each team into pairs and provide each pair with a Challenge Card.

2. Ask students to read the Challenge Card and ask you at least 4 questions to clarify what they are about to do.

3. Discuss and clarify Challenge Options A and B. Determine which pairs will do Option A or B.

4. Distribute the materials.

5 Circulate around the room and make sure students have the necessary materials. Ask questions like, “Under which condition do you think the materials will change the most? Why do you think that?”

6. Help students with setting up their experiments outside. Ask, “Which of the conditions do you think best represents a capped landfill?” Show them a copy of the cross-section of a capped landfill. Elicit students’ responses and affirm that the sealed buried container is the condition that best represents a capped landfill.

7. Have students discuss among their original Challenge Trail teams, “What’s the difference between capped landfills and Nature?” Elicit students’ ideas and affirm that capped landfills are designed to prevent the cycling of materials, whereas essentially every process in Nature is part of and is dependent upon many cycles.

8. Have each team pick an Earthstone if: (1) the groups worked well together at setting up their experiments; (2) they made well-thought out predictions, (3) students explained why they think stuff will change more under one of the conditions, (4) the groups selected the “Buried Closed” condition as the one that is most like the capped landfill, and (5) the entire class had an interesting discussion about the difference between capped landfills and Nature.

Challenge 4: What’s the difference between a good and bad loop?

(45 minutes)

During “What’s the difference between a good and bad loop?” your students simulate an entire market economy by mining, refining, manufacturing, distributing, retailing, consuming and disposing of “Earthsquares” (1/2” square pieces of paper representing a nonrenewable energy source that is mined from below ground). During this simulation, groups experience an exponential increase in demand for Earthsquares accompanied by an exponential increase in waste production. After three rounds, the students will have experienced a pattern that will help them figure out if what they simulated represents a positive or negative feedback loop.

Although this enactment requires a lot of materials and set up time, it will be well worth it. It’s not often that one gets to be a part of and watch the entire operation of an otherwise mysterious economy. It is recommended that you involve each group in creating and setting up their own simulation areas.

**Materials**

(1 set for each of 4 teams)

1. Feedback Loop Challenge card:

|  |
| --- |
| **What’s the difference between a** **good and bad loop?** You are about to become a part of a story about small packages of energy called Earthsquares. Earthsquares are small white pieces of paper about the size of your thumbnail. Earthsquares represent a non-renewable resource. It is mined nearby and used to power all the stuff in your homes. **Your challenge is to have fun acting out this story. Then, figure out if what you were doing is in the best interest of future generations.** Your teacher will tell you how to proceed. **©2003 Wild Treasures** |

2. An assortment of props to help each role create and display their identify from afar. Each of the roles must have at least the following materials:

**I. Miner**

a. A pile of 1000 1” colored squares (4 colors, including white) mixed up in a clear unbreakable container

b. A large spoon with which to mine the Earthsquares.

c. A large clear yogurt container to act as a trash can. Label it “Garbage.”

d. A means in which to transport its mined Earthsquares to the Refiner.

e. A “Miner” sign that can be seen from across the room

e. Directions for Miner (see below)

**II. Refiner**

a. An empty clear unbreakable container like a yogurt container to serve as a container in which to receive the miner’s deliveries

b. A large clear yogurt container to act as a trash can. Label it “Garbage.”

c. A means in which to transport its refined Earthsquares to the Manufacturer.

d. 1 clothes pin (spring-loaded)

e. A “Refiner” sign that can be seen from across the room

f. Directions for Refiner (see below)

**III. Manufacturer**

a. 1 small table

b. 15 clear plastic sandwich bags

c. 15 ties for sandwich bags

d. 15 labels saying, “Earthsquares – 5 per pack” (small enough to put into sandwich bag with the Earthsquares.

e. A large clear yogurt container to act as a trash can. Label it “Garbage.”

f. 1 large yogurt container for receiving the Refiner’s deliveries.

g. A “Manufacturer” sign that can be seen across the room.

h. Directions for Manufacturer (see below)

**IV. Retailer**

a. 1 small table

b. 1 cash registrar or equivalent (on table)

c. 1 bell or buzzer (on table)

d. A cardboard box to act as a trash can. Label it “Garbage.”

e. 8 crayons or magic markers

f. 20 8 1/2” x 11” sheets of paper

g. A “Retailer” sign that can be seen across the room

h. Directions for Retailer (see below)

**V. Consumer**

a. 4 SUV or pickup truck plastic vehicles (approximately 8” x 16”). Each vehicle should be labeled: 1 Billion people.

b. $100 of monopoly money

c. An assortment of actual or representations of common household products (T.V., radio, phone, microwave, stove, refrigerator, etc.)

d. A large clear yogurt container to act as a trash can. Label it “Garbage.”

e. A “Consumer” sign that can be seen across the room.

f. Directions for Consumer (see below)

**VI. Disposer**

a. 1 large plastic dump truck or alternative way to pick up players’ trash.

b. 1 large container (at least 8” x 12” x 4” deep) to act as landfill.

c. A “Disposer” sign that can be seen across the room

d. Directions for Disposer (see below)

**Procedures**

1. Provide each team with the materials list for each player and explain your to plan for distributing the materials.

2. Distribute the materials and allow students time to set up their own site, decide on their roles and review their directions.

3. Tell the teams that they have 15 minutes to complete all 3 rounds. Their ability to complete all 3 rounds is essential for answering the questions that follow the exercise. Tell them to begin.

4. When 15 minutes is up say, “To earn an Earthstone, you need to answer a few questions.” Distribute or project Feedback Loop A and Feedback Loop B diagrams (see below). Explain, “You have 5 minutes, in your groups, to answer the following questions:

a. Which feedback loop best represents what your entire group was doing? What makes you think so?

b. Which type of feedback loop do you think is NOT in the best interest of future generations? Why?

c. Does a thermostat’s operation reflect Feedback Loop A or B? Why?

d. Describe at least one other common example of both types of feedback loops?

6. When 5 minutes is up, facilitate a whole class discussion around their answers.

7. After the discussion say, “Each group can pick an Earthstone if your group (1) Said Feedback Loop “B” represents what you acted out, AND/OR (2) Said Feedback Loop “B” is NOT in the best interest of future generations because a change in one part of the loop changes the original part even more in the same direction. An increase will cause a further increase; a decrease will cause a further decrease, AND/OR (3) Participated in thoughtful discussions around the questions.

**Miner**

Role: Your job is to mine Earthsquares and deliver them to refiners. Refiners separate out the indicated number of white squares from the rest of the material and deliver them to the manufacturers.

Earthsquares are small white paper squares that represent nonrenewable sources of energy that people use to power everything they can-from TVs to SUV’s and all the stuff you have in your homes.

FOLLOW THESE STEPS EXACTLY. Please make truck sounds if you want. Do each step right after you read it. Your have 15 minutes.

|  |
| --- |
| Use the spoon to load your vehicle with 2 spoonfuls of an even color mix of Earthsquares. |
| Put 1/4 of a spoonful of Earthsquares from your vehicle into your trash.  |
| Deliver what’s left in your vehicle to the refiner’s receiving container. Then drive back here and continue. Please drive safely.  |
| Use the spoon to load your truck with 4 spoonfuls of an even color mix of Earthsquares.  |
| Put 1/2 of a spoonful of Earthsquares from your vehicle into your trash. |
| Deliver what’s left in your vehicle to the refiner’s receiving container. DUMP YOUR LOAD ONLY WHEN THE REFINER IS THERE. Then drive back here and continue. |
| Use the spoon to load your vehicle with 8 spoonfuls of an even color mix of Earthsquares.  |
| Put 1 full spoonful of Earthsquares from your truck into your trash. |
| Deliver what’s left in your truck to the refiner’s receiving container. DUMP YOUR LOAD ONLY WHEN THE REFINER IS THERE. Then drive back here and continue. |
| Please help the manufacturers do their job.  |

Refiner

Role: Your job is to refine the mixed colored squares into a more “pure” form that can be used for fuel. You then deliver these refined Earthsquares to a manufacturer who changes them into a form retailers will sell and consumers will buy.

Earthsquares are small white paper squares that represent nonrenewable sources of energy that people use to power everything they can-from TVs to SUV’s and all the stuff in your home that needs energy.

FOLLOW THESE STEPS EXACTLY. Please make truck sounds if you want. Read all of these directions while waiting for the miner to deliver the Earthsquares. Your whole group is depending on you to find the pattern in what you are about to do. Your have 15 minutes.

|  |
| --- |
| Help the miner dump the 2 spoonfuls of Earthsquares into your receiving container.  |
| Pick out all of the squares one at a time with the clothespin, except 15 white ones. Put all the rejected squares into your trash.  |
| Deliver the 15 Earthsquares to the manufacturer. Then return here. Please drive safely. |
| Notice how much garbage you created.  |
| Help the miner dump the 4 spoonfuls of Earthsquares into your receiving container.  |
| Pick out all of the squares one at a time with the clothespin, except 30 white ones. Put the rejected Earthsquares into your trash. |
| Deliver the 30 Earthsquares to the manufacturer. Then return here. Please drive safely. |
| Notice how much garbage you created. |
| Help the miner dump the 8 spoonfuls of squares into your receiving container.  |
| Pick out all of the squares one at a time with the clothespin, except 60 white ones. Put the rejected Earthsquares into your trash. |
| Deliver the 60 Earthsquares to the manufacturer. Then return here. Please drive safely. |
| Notice how much garbage you created. |
| Please help the manufacturers complete their job. |

Manufacturer

Role: Your job is to turn Earthsquares into packages of energy that retailers will want to sell to consumers. An Earthsquare package consists of 5 Earthsquares and an “Earthsquare Energy” label in a baggie. Each package is sealed with a tie.

Earthsquares are small white pieces of paper that represent nonrenewable sources of energy that people use to power everything they can-from TVs to SUV’s and most of the stuff in your home.

IMPORTANT: After miners and refiners complete their tasks, they are expected to assist you in your manufacturing job. Please explain to them how they can help your production.

FOLLOW THESE STEPS EXACTLY. Please make truck sounds if you want. While waiting for your first delivery, read all of the directions below. Your group is depending on you to find the pattern in what you are about to do. Your will have 15 minutes.

|  |
| --- |
| Help the refiner dump 15 Earthsquares into your receiving container.  |
| Make 3 new packages of Earthsquares (5 white Earthsquares/package) |
| Toss 1 of these packages into your garbage.  |
| Deliver the remaining 2 packages to the Retailer. Then drive back here. Please drive safely.  |
| Help the refiner dump 30 Earthsquares into your receiving container. |
| Make 6 new packages of Earthsquares.  |
| Toss 2 of these packages into your garbage.  |
| Deliver the remaining 4 packages to the Retailer. Then drive back here.  |
| Help the refiner dump 60 Earthsquares into your receiving container. |
| Make 12 new packages of Earthsquares. |
| Toss 4 of these packages into your garbage.  |
| Deliver the remaining 8 packages to the retailer. Then come back here.  |

Retailer

Role: Your job is to sell to consumers small packages of energy called Earthsquares.

Earthsquares are small white pieces of paper that represent nonrenewable sources of energy that people use to power everything they can-from TVs to SUV’s and most of the stuff in your home.

FOLLOW THESE STEPS EXACTLY. Please make truck sounds if you want. While waiting for your first delivery, read all of the directions below. Your group is depending on you to find the pattern in what you are about to do. You have 15 minutes to complete all of these steps.

|  |
| --- |
| Help the manufacturer unload 2 packages of Earthsquares into your store.  |
| Toss 1 Earthsquare package into your garbage. |
| Create 1 “Earthsquares 4-Sale” sign using only one marker.  |
| Ring the bell to let the consumers know that their Earthsquares packages are in. |
| Give the consumer 1 Earthsquare package. |
| Throw the 1 marker and “4-Sale” sign into your garbage pail.  |
| Help the manufacturer unload 4 packages of Earthsquares into your store.  |
| Toss 2 Earthsquare packages into your garbage. |
| Create 2 “Earthsquares 4-Sale” signs using 2 markers.  |
| Ring the bell to let the consumers know that their Earthsquares packages are in. |
| Give the consumers 2 Earthsquare packages. |
| Throw the 2 markers and 2 “4-Sale” signs into your garbage.  |
| Help the manufacturer unload 8 packages of Earthsquares into your store.  |
| Toss 4 Earthsquare packages into your garbage. |
| Create 4 “Earthsquares 4-Sale” signs using 4 markers.  |
| Ring the bell to let the consumers know that their Earthsquares packages are in.  |
| Give the consumers 4 Earthsquares packages. |
| Throw the 4 markers and 4 “4-Sale” signs into your garbage.  |

Consumers

ROLE: Your job is to buy packages of Earthsquare Energy from the retailer and use it to power everything you can in your home-from TV’s to SUV’s and all the other stuff in the billions of homes you represent.

FOLLOW THESE STEPS EXACTLY. Please make truck sounds if you want. Your group is depending on you to find the pattern in what you are about to do. Read the first 5 steps before beginning. You have 15 minutes.

|  |
| --- |
| Go sightseeing in one of your vehicles (representing 1 billion people) while waiting for the Retailer to ring the bell. Drive around to all the stations and check out what everyone is doing.  |
| When you hear the Retailer’s bell, drive 1 vehicle to the store and pick up 1 package of Earthsquares. Then drive home. (Each vehicle represents 1 billion people.) Please drive safely.  |
| Toss 2 of the Earthsquares from the package into your garbage.  |
| Empty all of your other Earthsquares into one of your devices needing energy.  |
| Throw out the baggie and tie into your garbage. |
| While waiting for the next delivery, go sightseeing in one of your trucks. Drive around to all the stations and check out what everyone is doing. Look for a pattern.  |
| When you hear the Retailer’s bell, drive 2 vehicles to the store and pick up 2 packages of Earthsquares. Then drive home.  |
| Toss 4 of the Earthsquares from the packages into your garbage.  |
| Empty all of your other Earthsquares into your device needing energy.  |
| Throw out all the baggies and ties into your garbage. |
| When you hear the Retailer’s bell, drive 4 vehicles to the store and pick up 4 packages of Earthsquares. Then drive home.  |
| Toss 8 of Earthsquares from the packages into your garbage.  |
| Empty all of your other Earthsquares into your energy device.  |
| Throw out all the baggies and ties into your garbage.  |

Disposer

ROLE: Your job is to collect and landfill all of the garbage that is produced during the mining, refining, manufacturing, retailing, and consuming of Earthsquares.

Earthsquares are small white paper squares that represent nonrenewable sources of energy that people use to power everything they can-from TVs to SUV’s and all the energy devices in your home.

FOLLOW THESE STEPS EXACTLY. Please make truck sounds if you want. Your group is depending on you to find the pattern in what you are about to do. Your group has 15 minutes, starting now.

Directions:

Continuously check and collect all of the players’ garbage into your vehicle and dump it into your landfill.

If you have some spare time, help the manufacturer package Earthsquares.

Please drive safely. Remember to look for a pattern.

Feedback Loop A

Feedback Loop B

Challenge 5: What’s the big deal about entropy?

(45 minutes)

During “What’s the big deal about entropy?” students are presented a series of engaging challenges involving a solar panel, a gas generator and a hand-cranked generator. First, students experiment with covering up a solar panel connected to a solar-powered radio. They are then asked to determine if the solar panel is creating energy. Then they observe a gas powered machine and debate if it is creating energy. Most groups assert confidently that the “passive” solar panel isn’t creating any energy, unlike the gas being burned in a generator. Your students learn that neither of these technologies creates any energy; that all technologies are only transformers of energy and that energy cannot be created or destroyed. So then what’s all the hype about an energy crisis? To figure that out, they are challenged to use two small hand-cranked generators and a couple of wires to find out what happens every time energy changes from one form to another. It turns out, every time energy transforms into another form, it becomes less useable and organized to do work. This phenomenon is called entropy (i.e., the second law of thermodynamics).

**Materials**

(For Whole-Class Demonstration)

1. 1 Solar cell powering some easily observable device like a radio or small car

2. 1 Automobile or other gas powered equipment

3. 2 Genecons, each with a pair of wires (aka, small hand-cranked generators available from many science education supply companies)

<Insert picture of Genecon>

**Procedure**

1. Demonstrate a solar powered radio or solar powered model car. Ask volunteers to experiment with covering the panel.

2. Have students break up into their Challenge Trail groups to answer, “Is the solar panel creating energy?” (3-minutes). While rotating among the groups, play devil’s advocate when appropriate.

3. Do not process as a whole group yet.

4. Demonstrate a gas-powered device. Turn it on and off a couple of times.

5. Have each group answer, “Is the gas generator creating energy? (3-minutes) Continue to circulate and ask students to explain their reasoning. Try to play off of the dissonance that might occur between their different reasoning between the solar panel and gasoline generator.

6. Invite the whole class to share their answers to both questions. Facilitate a whole class discussion by playing devil’s advocate. When you think the discussion has peaked, state the following:

“It’s reasonable to think that both the solar panel and the gas generator are creating enough energy to help operate things. But GET THIS. They’re not creating any energy. Neither the solar panel in all of its grand quietness, nor the gasoline engine, in all of its fury, is creating any energy. It’s true.

The solar panel is just changing the sun’s energy from light energy into electrical energy.

Same deal with the gasoline generator. For something that makes so much noise, and seems to have so much power, it doesn’t create an ounce of energy. Like the solar panel, it is only a transformer.

So here are a couple of important punch lines. First: All technologies are only transformers of energy. Second: Energy cannot be created or destroyed. The amount of energy that existed in the Universe at its creation is the same amount of energy that exists right at this moment. The amount of energy that exists at this moment will be the same for generations to come.

So what then is the big deal? Why not drive the big cars with low gas mileage? Why not wear the cotton clothes that require more energy to create than the hemp? Why not just keep eating the processed foods rather than the fresh ones? Why not just collect more and more stuff: TV’s, SUVs, some of these, some of those?”

Ah, if life was so simple. You see there’s a catch.

If energy can’t be created or destroyed, why worry? Well actually, something incredibly powerful happens every time energy is transformed, and for that matter, every time matter changes form. Some say the fate of humanity depends on how well we’ll respect this power.

Your challenge is to help you experience what happens when any energy changes from one form into another. So...

6. Write the following challenge on the board: “By using 2 small hand-crank generators and four wires demonstrate that whenever energy is transformed from one form to another, it becomes less ordered, less available, and less useable to do work. Be sure to crank only one of the Genecons at a time.” Ask for one volunteer from each of the four groups who are willing to work together to solve this problem in front of the class. Tell them they have 5 minutes. If they don’t solve the problem within by then have another 4 students, one from each group, take their place.

7. You may provide hints that lead them to connecting the two Genecons with the wires. If they crank one of the Genecons 30 or more times, ask them to notice how many times the handle on the other Genecon turns. Then ask, “Why didn’t the second handle turn the same number of times?”

8. If necessary, explain, “It’s because every time energy changes from one form to another, no matter how big or small that energy is, it becomes less organized, and less available to do useful work. This is called entropy.” Share this chart on the board and ask them to find an example of an energy transformation that doesn’t do this.

|  |
| --- |
|  The Effects of EntropyUsable --------------- UnusableAvailable --------------- UnavailableOrdered --------------- DisorderedComplexity --------------- Simplicity |

9. Put the following on the board and discuss: “Consider this: entropy is increasing at an exponential rate. This means that increasingly more and more amounts of energy are becoming unavailable, and unusable at a faster and faster rate.”

10.Tell your students they can pick an Earthstone for working so hard at trying to understand a very complex concept.

Challenge 6: Lifestyle Challenges

(45 minutes)

During Lifestyle Challenges, your students will try to predict what the majority of their classmates would choose to buy and do if money and age is no object. At a transportation exhibit, they will decide between 5 vehicles. At the clothing exhibit, they will choose between an outfit made from 100% cotton and one made of 100% hemp. At the food station, they will select between a conventional and a locally grown organic lunch. And at the recreation station, your students will elect three recreational activities (ranging from watching TV to shopping at the mall) they think the majority of their classmates would prefer to do the following weekend.

**Materials**

(Per station; 4 stations total)

**Dream Car: Transportation**

1. One picture of each of the following vehicles: (1) four-door sedan – gas engine; (2) four-door sedan – hybrid engine; (3) sports car – gas engine; (4) SUV – gas engine; and (5) pickup truck – gas engine.

2. Display the question, “Which of these vehicles would most of your classmates choose to buy if money was no object?”

3. Display next to each respective picture the following transportation data

**Transportation Data**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **DREAM****CAR** |  **SUV** | **Pick-up****Truck**  | **Sedan** | **Hybrid Sedan** |
| Power | 8-cylinder | 6-cylinder engine | 4-cylinder engine | 4-cylinder hybrid engine w/ automatic electric motor |
| **Mileage** | 13 mpg city16 highway | 16 mpg city19 highway | 23 mpg city30 highway | 52 mpg city45 highway |
| **Transmission** | 4-wheel drive; 4-speed automatic | 4-wheel drive; 4-speed automatic | front-wheel drive; 4-speed automatic | front-wheel drive; 4-speed automatic |
| **Energy** | gasoline;non-rechargeable lead-acid battery | gasoline; non-rechargeable lead-acid battery | gasoline; non-rechargeable lead-acid battery | gasoline; nickel-metal hydride battery; recharges during braking |
| **Emissions****Driving this vehicle 100 miles produces:**  | 150 pounds CO233 pounds CO1.5 pounds NO2 | 130 pounds CO227 pounds CO1.3 pounds NO2 | 90 pounds CO219 pounds CO1 pound NO2 | 40 pounds CO28 pounds CO0.5 pounds NO2 |

**Fashion Statement: Clothing**

1. At least one or more identical pairs of clothing. One of the pairs should be made from 100% cotton and the other should be made from 100% hemp. It’s even better if you can display a similar looking outfit of each.

2. Display the question, “Which one of these outfits would most of your classmates choose to buy if money was no object?

3. Display on each set of clothing material the following clothing data

**Clothing Data**

|  |  |  |
| --- | --- | --- |
|  | COTTON | HEMP |
| PLANT USES | Textiles, paper, cosmetic products | Energy, textiles, paper, rope, plastics, food, medicine, construction, oils, paints |
| TEXTILE FIBER YIELD | 635 pounds per acre | 2,700 pounds per acre |
| PesticidesHerbicidesSoil erosionBleachingAlternatives | 50% of the world’s pesticides are used for growing cotton plantsChemical herbicides required to prevent weed growthA heavily irrigated crop; Farming techniques can cause soil erosionFibers usually bleached; Bleaching process uses chlorine dioxide, which produces dioxin(water and soil pollutants)Unbleached organic cotton is available | Naturally pest resistant; Minimal pesticides requiredNo herbicides required; tightly spaced plants prevent weed growth Farming techniques promote efficient use of water & prevent soil erosion Natural bright color rarely requires bleaching; bleaching process uses hydrogen peroxide, which produces no dangerous pollutants |

**Food for Thought**

1. Create two meals with real and/or plastic props or in a menu format that looks something like this:

**Meal 1**: Beef burger, turkey hot dog, cow milk, potato chips, brand name soda, canned corn, apple.

**Meal 2**: Vegetable burger, soy hot dog, soymilk, organic blue corn chips, locally produced soda, corn-on-the cob, organic cucumber.

2. Display the question, “Which of these two meals do you think most of your classmates would choose to eat?”

3. Display at the station the following food-related data.

**Food Data**

|  |  |  |
| --- | --- | --- |
|  | **Vegetable Burger****Meal** | **Beef Burger****Meal** |
| **Waste****Pollution** | Organic foodsNo pesticides, no herbicides, no chemical fertilizers\*Most soy products are not grown organicallyMultiple croppingMore attractive to beneficial insects and birds, and uses less pesticides and herbicides than mono-cropping.25 gallons of water needed to produce one pound of most fruits, vegetables and grains. | Conventional farmingUses pesticides, herbicides & chemical fertilizersMono-croppingPracticed at most U.S. commercial farms where a field contains only one type of plant. These crops require more pesticides and herbicides2600 gallons of water and 16 pounds of grain needed to produce one pound of beef. |
| **Garbage** | Fresh foodsCan be composted to return nutrients to the soil. Buying in bulk reduces packaging waste.  | Canned & frozen foodsCreate solid waste such as metal, plastic and paper.  |
| **Entropy** | Fresh foodsRequire 10 times less energy to produce than frozen foods.Locally grown fruits & vegetables reduce entropy contribution by saving on transportation-related waste | Meat protein The production of one pound of meat protein requires 40 times more fossil fuel than for one pound of soy protein.Foreign foodsThe typical mouthful of American food travels 1,200 miles from farm to consumer. |

**You Can Do Anything: Recreation**

1. With either real props or pictures from magazines, create an exhibit that depicts the following 6 recreational choices: shopping; watching TV; reading; creating arts & crafts; hiking; playing sports.

2. Display the question, “Which 3 of the following 6 activities would most of classmates choose to do this weekend if age and money were no object?”

**Procedure**

1. Set up the four stations around the room.

2. Tell the class that each of the 4 stations consists of a lifestyle exhibit. Each exhibit presents a lifestyle choice. Their goal is to predict what they think the majority of their classmates would choose to do or buy at each exhibit if money and age is no object. After rotating through all four stations, they will share their decisions. If two or more groups match all of their lifestyle choices, then all the teams can earn all of the remaining Earthstones.

3. Tell your students that they will have 5 minutes at each station and that they must keep their discussions and answers confidential.

4. Ask students to submit to you in writing their lifestyle prediction and group name as they leave each station.

5. After all the groups submit their lifestyle choices, have one member from each group write their predictions on the board. Determine if any two groups match. If not, you can still award the remaining Earthstones based on your students’ cooperation and effort.

6. If necessary, pick any remaining Earthstones.

**Earthstone Sentences**

Have students redistribute their Earthstones so that each group has its own set. Give students 5 minutes to compose their respective sentences. If they can compose 4 sentences that match the ones below, they will have succeeded with the first phase of Wild Treasures: Sustainability, Naturally.

Earthstone Sentences

**1. Nature is the teacher of sustainability. Or, the teacher of sustainability is nature.**

**2. There’s no such thing as waste.**

**3. Finite Earth cannot sustain exponential growth.**

**4. A sustainable society safeguards future generations.**

Make each sentence visible to the entire class. Ask students if they agree or disagree with the statements and why. Consider posting these statements in the classroom for the remaining of the curriculum.

**Research**

(Intermittent over 2-3 month period)

\*Deciding on research project[s] – 3 classes

\*Designing research project - 2-3 classes

\*Carrying our research – variable and often intermittent

\*Writing research report – 4-6 classes

During the Research Phase of Wild Treasures, your class will use one or more of the 5 concepts introduced during the Challenge Trail to design and carry out original research about their school’s sustainable practices. Students participating in Antioch’s Wild Treasures have measured their school’s waste production, surveyed their school’s interest in an organic lunch program, and analyzed their school’s energy consumption patterns.

The length of the Research phase of this curriculum varies depending on the extent you choose to integrate into your curriculum. In Antioch’s Wild Treasures’ program, we give classes 15 school days in which to determine their research questions and any equipment or services they might need to carry out their research. We believe deadlines are great motivators.

Below you will find suggestions for how to facilitate this phase of the curriculum, a rubric for evaluating a research report, and a brief section highlighting the significance and school-based research ideas related to each of the 5 primary concepts.

Antioch’s Wild Treasures’ Website (http://wild treasures.schoolsgogreen.org) includes a more comprehensive review of each concept presented along the Challenge Trail. You can also find sample research reports, and other Research phase support materials. You are welcome to use and adapt any of these resources.

There are many ways your school may be choosing products and activities that contribute to compromising the quality of life for future generations. This section will help your students identify and choose to carry out research projects into how your school:

(1) Contributes to the exponential increase in human population, garbage, and the consumption of finite resources,

(2) Participates in processes that interfere with the cycling of material,

(3) Contributes to feedback loops that increase the consumption of finite resources, the production of garbage, and population growth, and

(4) Contributes to the exponential increase in entropy.

**Procedure**

During the Research phase, students should work in groups of 2-3 maximum. Here are some ideas on how to proceed.

1. Explain to students that they are beginning the Research phase of this curriculum. Their goal is to figure out what kinds of research they want to design and carry out regarding their school’s sustainable practices. Remind them that they will turn their research into a proposal for real action that they will present to their school board.

2. Review the text below. It highlights the “So What” component of each of the concepts introduced along your Challenge Trail. It also offers school-based research ideas associated with each concept. Divide the different concepts among your class and give each student a copy of the corresponding text.

3. Have students brainstorm other possible research ideas that are of interest.

4. Help your students decide on which research ideas are feasible and compelling. Depending on your own teaching style, comfort and other teaching goals, decide whether you will facilitate one or more different research projects.

5. As your students are carrying out their research, introduce to them the “Criteria for Writing an Excellent Research Report.” Review the criteria and support them in following it as they turn their research experience into a written document.

6. Determine with your students how they will collaboratively approach the writing of the research report. Identify everyone’s specific roles, responsibilities and deadlines.

Criteria for Writing an Excellent Research Report

|  |  |
| --- | --- |
| **Quality** | **Description** |
| Cover Page | -Clear title revealing the contents of the research report-A relevant image (not included in sample)-Teacher’s name and specific class -School name, address, phone, fax, email, and grade |
| Abstract | 1 page summary of the key research questions, research methods, results, and conclusions.  |
| Intro | -**The Whole**: 2-page discussion that connects the concept of sustainability to the research carried out by your class and how you think the research can lead to improving your school’s sustainable practices.  |
| Body | -**Research Questions**: clear and concise list of specific research questions-**Research Design**: a detailed description of how you designed and conducted your research-**Major findings**: summary of your most important data. Data should be summarized in various forms when appropriate (charts, graphs, diagrams, words) |
| Conclusion | -**Interpretation of major findings**: What patterns do you see in the data? What sense do you make of the data? -**Implications**: What do you think are the implications of your research? Based on your research, what ideas do you have for improving the sustainable practices of your school? |
| Format | -**Length**: approximately 12-18 pages double-spaced with 12-point font. -**Subheadings**: appropriately placed to indicate a new section -**General appearance**: neat and attractive-**Table of contents**: accurate and useful  |
| References | -**Endnotes** used when appropriate-**References** are listed in alphabetical order and are in a consistent format |
| Collaboration | The research report reflects a collaborative effort and involved most of the students. |

What follows is a section on each of the concepts introduced along the Challenge Trail. Each section begins by addressing the “So What?” of each main idea and is then followed by a list of possible research ideas.

**Garbage**

So What?

In Nature there is no such thing as waste. No other organism on the planet, except humans, produces garbage. Everything in Nature (sticks, stones, piles of leaves, dead trees, rotting logs, dead deer, wildlife scat, etc.) can be recycled back into Nature to help nourish and sustain life. “In a sustainable society, landfills will become a place to bury waste that cannot be recycled, reused, or composted.” (Chiras) Since waste is a human invention,

**In what ways, if at all, do you think garbage can be a part of our lives without compromising the quality of life for future generations?**

Consider this. Garbage is growing exponentially. This is because as human population grows exponentially, so does the production of stuff. As more people produce more stuff, they create more garbage-just like what happened during the mining, manufacturing and consumption of Earthsquares.

“Flowing through the lives of each of the six+ billion people alive on Earth today is a stream of stuff... This [is an] enormous flow of stuff-out of field, forest, ocean, and mine, through the factories and processing plants and transportation systems of the global economy, into a brief lifespan of use by human beings, and back out into the world as junk, sewage, poison, or waste...” (AtKisson)

If you’re going to work toward creating a more sustainable school, you’ll need to figure out to what extent your school’s practices should mimic what happens in Nature.

Garbage Research Ideas

There are many ways your school may be contributing to the production of garbage. Here’s how you can find out:

(1) Research if your school has a policy about their production of waste. If it does, find out what students and school officials think about that policy. If it doesn’t, interview students and school officials to find out what kind of waste policy, if any, they would support.

(2) Research how much garbage, and what kinds are produced at your school. Figure out how it gets created-by whom, when, where, and why? How does it vary by grades, and types of activities (school lunch program, operation of offices, cleaning and maintenance)?

(3) Research how waste is being produced at your school that does not end up in garbage pails. For example, what kinds of air, water, or land pollution are being created when your school uses energy for electricity, heating, and cooling? Or, what kinds of pollution are created while maintaining the school’s grounds?

(4) Research how waste is being produced in places far away from your school, but as a result of your school’s operation. For example, if your school is heated by an oil burner research the waste produced from the mining, refining, manufacture, distribution, use, and disposal of oil and oil related products. Calculate your school’s annual contribution to that waste stream.

(5) Research the process of what happens to your school’s garbage after it leaves school. Where does it go? How does it get there? What becomes of it?

**Exponential Growth**

So What?

Human population is growing in the same way.

“Scientists estimate that 2,000 years ago there were about 138 million people in the world. A thousand years later that population doubled to 275 million. By 1650, the population had doubled again, and 200 years later, it had again doubled. At that point, around 1850, a phenomenal rise in the human population began, and population continued to soar through the 1900's.” (World Book™) Between two one hundred year periods, 1700-1800 and 1800-1900, the human population doubled. In the last 100 years, however, human population has tripled, from 2 billion to 6 billion.

But just what is a billion anyway, and is it really something to be so concerned about? Consider this. Imagine you had a full-time job counting to 1 billion. That’s all you did from wake to sleep, day in and day out, starting the second you were born. If it takes you about 3 seconds to say most of the numbers between 1 and 1 billion, you would still be counting at your current age. In fact, you would still be counting when you’re as old as your teacher. And, you would still be counting when you’re as old as your grandparents. That is unless they are 95 years old. That’s when you could stop. Remember though, the Earth now has over 6 billion people. To reach 6 billion, you would have to count continuously for 570 years. Ready, set, go.

It is the illusion that things are growing slowly at first that makes it so hard for people to anticipate the impact of exponential growth.

Human population, human waste, clear-cut forests, landfills, the depletion of raw materials like oil, and metal ores are just a few examples of human activities that are growing exponentially. That may not be such a big deal if the availability of clean water, arable land, agricultural production, and the availability of raw materials also increased exponentially. And here is where the problem lays. The Earth, and all of its features are finite. A finite Earth cannot sustain a population growing indefinitely at an exponential rate.

Exponential Growth Research Ideas

There are many ways in which your school may be contributing to the exponential growth of human population, human waste, and/or consumption of finite resources. Here’s how you can find out:

(1) Research the amount and type of garbage that is discarded at your school over a month period. Can you find out how the amount of garbage produced at your school has changed over the last 10 or more years?

(2) Research the various materials your school purchases and determine how those purchases may contribute to the exponential consumption of finite resources or the exponential growth of waste. Consider the following types of purchases:

a) Paper

b) School meals

c) Maintenance, cleaning, and landscaping supplies

d) Energy used for electricity, heating, and cooling

e) Clothing (sports uniforms and other types of fabrics)

f) Fund raising goods

(3) Examine your school’s science, social studies and health curriculum books and materials to determine if and how well they teach about exponential growth?

**Cycling**

So What?

We are the only creatures on Earth that do things that prevent living and nonliving matter from being recycled. The main purpose of a landfill is to do just that: prevent stuff from being part of a cycle. Broken and uncared for toys, torn clothing, broken bulbs, dead batteries, empty paint cans, cereal boxes, packaging, food waste... you name it you can find it inside a landfill. It contains all the stuff we haven’t figured out how to return back into air, land, and water in a way that helps sustain life.

Cycling Research Ideas

There are many ways your school may be preventing materials from being recycled back into the air, land, and water in ways that will help sustain life. Here’s a few ways you can find out:

 (1) Do a complete inventory (amounts and types) of all the stuff that is thrown out in classrooms, lunchrooms, offices, bathrooms, maintenance rooms, and other places in your school. Find out which of these materials can be recycled in your town.

(2) Find out all the materials that your school throws out that can’t be recycled and find out if there are other products that can be used to do the same thing that can be recycled or reused. Find out if these substitutes would cost more or less than what your school currently spends.

(3) Research what it would take (rules, costs, administrators’ and teachers’ support, student interest, etc.) to create a school-wide composting program for all the food waste that is created at your school.

(4) Research the ways in which the production process of things your school buys on a regular basis becomes a part or not a part of a cycle.

**Feedback Loops**

So What?

When you were mining and processing Earthsquares, you were participating in a “positive” feedback loop. The use of the word “positive” here can confuse things. That’s because the story you acted out can only lead to one disastrous final chapter: severe human suffering. Many ecologists predict that human suffering will result when the exponential depletion of Earth’s finite resources (like oil, coal, natural gas, metal ores) sneaks up on and surprises the exponentially growing human population. When the human population needs more than what the Earth has to offer, humans will suffer.

A positive feedback loop is a chain of cause-and-effect relationships. It happens when “a change in any one part in the loop changes the original part even more in the same direction. An increase will cause a further increase; a decrease will cause a further decrease.

Positive Feedback Loop

Whenever a positive feedback loop is present in a system [like a forest or a city], that system has the potential to produce exponential growth or exponential decline.” (Meadows, Meadows, & Randers) Positive feedback loops generate runaway growth. Finite Earth cannot support exponential growth.

Feedback Loop A was a “negative” feedback loop. It is a very different story. The name negative feedback loop can also be confusing. This is because a negative feedback loop can be a very positive process. Negative feedback loops can help prevent us from compromising the quality of life for future generations. Negative feedback loops tend to regulate growth. They tend to hold a system in a balance.

Your processing of Earthsquares would have been very different if you acted out a story about negative feedback loops. First, the energy supply would have to be renewable, like trees; and they would have to be replaced faster than they were being consumed. The Miner would change into being a Harvester. Second, there would be no such thing as garbage. The Disposer’s job would be eliminated and replaced with a Recycler or Reuser. Finally, the consumer population would not be growing exponentially. Rather the population would maintain a relative balance around the fluctuating supplies of renewable energy.

This is a similar story to what happens between predators and prey like fox and rabbits. It is like the diagram, “Feedback Loop A.” All you would have to do is replace the human population with the fox population, and replace the renewable Earthsquare supply and consumption with the rabbit population.

Negative Feedback Loop: A Natural System

Human population, waste production, and consumption of finite resources are all growing exponentially. They are growing exponentially because they are part of a positive feedback loop. They don’t have negative feedback mechanisms in place regulating these human activities.

There are a number of negative feedback mechanisms that can help control these human activities: increased scarcity of resources, pressures from increasing amounts of waste, increased awareness and actions by producers and consumers, and good alternatives to nonrenewable energy sources.

Feedback Loops Research Ideas

There are many ways your school may be contributing directly or indirectly with undesirable positive feedback loops. And there may be ways in which your school is not participating in desirable negative feedback loops. Here’s how you can find out:

(1) Research where your school’s paper comes from. Find out if your school buys recycled or non-recycled paper. If the paper is not recycled, find out if it comes from trees that are harvested sustainably. Prove whether or not the students, teachers, and administrators at your school would use only recycled paper.

(2) Research where the different foods in your school lunch program come from and determine if their production is part of a positive or negative feedback loop.

(3) Investigate the history of other products purchased by your school on a regular basis and determine if their production and consumption are in some way part of a positive or negative feedback loop.

**Entropy**

So What?

When your students were mining, refining, manufacturing, retailing, consuming and disposing of Earthsquares, they were adding to the pool of entropy. The miner’s equipment needed Earthsquares to dig up the soil containing the Earthsquares. The refiner’s machinery needed Earthsquare energy to extract the Earthsquares from the miner’s mixture. The machines used by the manufacturer to package the Earthsquares needed Earthsquares. The retailers used Earthsquares to heat and light their stores, as well as to advertise to the consumers that they had Earthsquares for sale. And of course the consumers used the Earthsquares to run their stoves, refrigerators, computers, stereos, TV’s, VCR’s, pickup trucks, and so on.... And even the disposers used Earthsquares to run the dump trucks and to operate the landfill. In this respect, each player was also a consumer. Every time Earthsquares were used, their energy became less available. All the energy that was used to produce and consume Earthsquares can never be captured again to do the same amount of work.

When you put all your students’ roles together they made a system. Their system created, consumed, and disposed of Earthsquares.

Similarly, your school is part of an energy system. And every time it uses energy to run the buses, light and heat your classrooms, and run equipment your school is adding to the pool of entropy. Because the world’s population is growing exponentially, your school system is adding to the exponential increase in entropy.

There’s another huge problem with entropy that we haven’t even touched upon yet. It has to do with how entropy affects natural systems as small as a forest and as large as the Earth.

Every time energy or matter is transformed from one form into another it moves from complexity to simplicity. To make sense of this, we need to extend what you did with the 2 small hand-cranked generators to something like an ecosystem (e.g., forest, desert, ocean, wetlands) that supports a diversity of life.

Many ecologists think forests as either getting more complex, being in balance, or becoming simpler. For a forest to become more complex, it must support a greater diversity of life. To do this, more energy must enter the system then leave it. For a forest to reach a state of equilibrium (balance), in which it is hardly growing, the amount of energy going into it must equal close to the amount of energy going out.

A forest becomes simpler when more energy leaves the forest than enters it. This is entropy at work. If energy coming into a system is less than the energy going out, the system is going to get more and more disorganized and simple. This is true even for a system as large as the Earth itself.

For most of Earth’s history, more energy has been coming into the Earth than going out. Most of this energy is stored in dead and living plants, fungi, and animals. Throughout most of Earth’s history, there has been an increase in the diversity of life (most of which is invisible to the naked eye).

As the human population increases exponentially, so does the number of energy transformations. The exponential increase in the burning of fossil fuels uses far more energy than is coming into the Earth via photosynthesis. Currently, more energy is being used (transformed) on the Earth than energy coming in. As a result, the Earth as a system for sustaining life is becoming simpler.

There are lots of signs of how our planet is becoming more simple: a decrease in species; a decrease in forests; increases in the area of fields and pavement; increases in erosion (a type of disorder); global warming; and the depletion of ocean fisheries, to name just a few. These major biosphere problems are all examples of entropy.

In order to slow down how quickly we are degrading the Earth through entropy, we need to use less energy than we currently do. PERIOD!

Every additional step involved in the production of something whether it is Earthsquares, your dream car, your favorite fashions, or your preferred meal causes more entropy on a global scale. If you want to contribute to less entropy then consider purchasing those products that require fewer steps than their alternatives. These products might involve less transportation, less packaging, less manufacturing, less pollution, fewer metals, less processing, and less destruction of ecosystems.

Entropy and The Solar Age

The use of solar energy technologies is likely to flourish in your lifetime. You can expect to see an increase in the use of solar panels to create electricity. At first glance the solar panel appears quiet, pollution free, and the answer to all energy production problems including entropy. But like the Earthsquare production process, solar panels require the mining, refining, manufacturing, retailing, and consumption of silica, plastics, copper, and rubber to name just a few materials. The good news is that once a solar powered electric system is up and running, there is little energy transformation occurring relative to other more polluting, nonrenewable, and less efficient energy systems.

The bad news is that even a booming solar industry will not necessarily free us from the degrading grip of entropy. If we continue to buy inefficient products, produce and consume stuff we don’t need, and consume nonrenewable minerals and metals at an exponential rate solar-powered technologies will at best buy us a little time. Eventually, the quality of life for future generations will be severely compromised.

By increasing our use of solar and renewable technologies, consuming energy more efficiently, and reducing our rate of consumption we can make a contribution to the quality of life for future generations.

Entropy Research Ideas

There are many ways your school may be contributing to the rising pool of entropy. Here’s a few ways you can find out:

(1) Research your school’s various uses of energy. What types of energy does it use? How much and for what purposes? How has your school’s energy use changed over time? What changes does the principal anticipate? In what ways do your school’s energy use add to the exponential increase in entropy?

(2) Research how efficiently energy is being used at your school. Do an energy efficiency audit. Analyze everything including the types of light bulbs used, the efficiency of your heating system, the location and total area of air leaks, the stoves and refrigerators used in your lunchroom, the implications of turning computers off or leaving them in sleep mode, etc.

(3) Look at any type of maintenance practice like cleaning floors, painting walls, vacuuming, mowing, etc. Find out if there are more efficient and affordable alternatives to currently used products and practices.

**Proposal**

(4 classes for writing proposal; 3 classes to create live presentation agenda and props; intermittent rehearsal)

During the Proposal phase your students will first write and submit to the school board a persuasive proposal for taking action to improve the school’s sustainable practices. Then your students will prepare and make a live presentation to their school board.

Procedure for Writing a Persuasive Proposal

During Proposal phase, students should work in groups of 2-3. Here are some ideas on how to proceed.

1. Describe the goals of the Proposal phase of the curriculum. Tell your students that they will work in small teams to help write a proposal to persuade their school board to support an action plan for helping to improve their school’s sustainable practices. Explain that the proposal must stem from their original research.

2. Tell students the date you’ve booked with the school board for their presentation. A copy of the written proposal should be submitted to all members of the board at least 10 days before their live presentation.

3. In small groups, have students brainstorm a list of actions they think your class should and can take between now and the end of the school year to improve their school’s sustainable practices. Make sure their brainstorms are informed by what they learned from their research. Invite each group to share their best ideas with the entire class.

4. Decide as a class which actions are feasible and desirable. Ask students to explain how their proposed actions are connected to one or more of the 5 big ideas introduced to along the Challenge Trail.

5. Share and discuss the “Criteria for Writing an Exemplary Proposal.”

Criteria for Writing an Excellent Proposal

|  |  |
| --- | --- |
| **Quality** | **Criteria** |
| **Cover Page** | √Title clearly reveals the proposal’s purpose. √A relevant image makes the cover interesting.√Teacher’s name, class, and grade are included.√School name, address, phone, and email included. |
| **Intro** | √Includes a 1-2 page summary of your: --Involvement with Wild Treasures--What you found out from your research, --The general action plan you are asking your school board to support. √Be sure to include what makes you think that your actions will improve your school’s sustainability practices.  |
| **Body**Describe specific plans | √5-7 pages √Describe your research methods, and findings. √Describe a specific plan to improve your school’s sustainability practices. √Discuss how your plan applies one or more of the 5 big ideas of sustainability introduced along the Challenge Trail.√Include charts, graphs, and/or diagrams to enhance text.√Include an illustration of your plan.  |
| **Action Budget** | √Describe exactly what your action plan will cost the school.√Include a budget that is consistent with the proposal. √The budget is neat and grammatically correct. |
| **Format** | √Page length is between 10-12 pages, double-spaced, 12-point font, numbered, and stapled. This does not include the “Bibliography,” or Appendix (The Appendix includes an “Action Budget”) √Subheadings are appropriately placed to indicate each new section. √The document is neat, attractive, and grammatically sound. √Table of contents is accurate and useful.  |

6. Figure out what needs to be done, by whom and by when. Consider creating subgroups to lead the development of the various parts to writing the proposal, including a very thorough and complete budget. Post everyone’s duties and due dates on a classroom calendar for all to see. Work backwards from when the board needs to receive your written proposal.

7. Create opportunities for all the groups to check in with each other, to offer help and to coordinate their efforts.

Procedure for Making a Live Presentation to the School Board

1. Ask students to work in groups of 2-3 to prepare an agenda for their school board presentation. Encourage them to imagine the sequence, length, and props they will need for each part of their presentation.

2. Have pairs join up with another pair to integrate their agenda ideas into an even stronger agenda.

3. Have one member from each group write their agenda on the board. Use these as a reference for deciding as a class on the best presentation plan.

4. Decide on what needs to be done, by whom and by when.

5. Provide in-class time to create props to support the presentation. Consider creating large displays on research results, action plan, etc… Props should be able to be seen clearly from at least 30’ away. Create graphic analogies to help make a point.

6. Encourage those students who will be doing the actual speaking before the school board to speak very loud, clearly and without notes. Help them realize how much they know their stuff. The members of the school board will listen better to someone with a more conversational tone than to someone reading a speech.

7. Invite the principal and other teachers to a dress rehearsal. Encourage the guests to ask questions of clarification and to play devil’s advocate.

Although standing up and speaking in front of a 16-member school board can feel extremely intimidating, it can also feel tremendously rewarding. It offers a wonderful opportunity for young people to level the playing field between themselves and adults. Your students will have spent months doing research, writing a research report, and preparing a proposal. They are the experts now. They have original knowledge about their school that only they can speak about from first-hand experience.

**Action**

(Variable and intermittent class time to implement Action plan; 2-4 classes to prepare Action tour; 1 class for the Action Tour)

During the Action phase, your students will begin implementing their school board approved proposal as well prepare and give a tour of the actions they have taken to a small group of invited guests. Your class will have successfully completed the Wild Treasures curriculum and can earn a District Sustainability Award if they can persuasively and creatively demonstrate to their Action guests that:

1) They have taken significant steps toward implementing their proposal, and

2) They can explain their actions by applying all of the ideas introduced to them during the Challenge Trail: waste, exponential growth, cycling, feedback loops and entropy.

Procedure for Implementing the Action Plan

During this part of the Action phase, students should work in groups of 2-3. Here are some ideas for how to proceed.

1. List on the board all of the actions the school board approved. With your students help, list next to each action what has to happen to realize each goal (making phone calls, ordering materials, building, etc.).

2. Tell students the date of the anticipated Action Tour.

3. Figure out who is going to do what, how and by when. Keep this information visible until all actions are completed.

4. Discuss as a whole class how you plan to support their efforts to implement their Action Plan.

5. Create opportunities for all the groups to check in with each other, to offer help and to coordinate their efforts.

6. While the Action Plan is being implemented, begin to prepare for the Action Tour.

Procedure for Preparing Action Tour

1. Explain to students that the purpose of the Action Tour is to convince invited guests that they have indeed begun to seriously implement their school board approved proposal.

2. Ask students whom they would like to invite to their Action Tour. Their guests should at least include the chair of the school board, superintendent of schools, principal and a local state representative.

3. Ask students to work in groups of 2-3 to design a 1-class period Action Tour. Encourage them to imagine the sequence, length, and props they will need for each part of their tour. If an action doesn’t necessarily have an observable component, ask them to create something that will help the guests imagine it.

4. Have pairs join up with another pair to integrate the best parts of each of their Action Tour.

5. Have one member from each group write their tour on the board. Use these as a reference for deciding as a class on the best Action Tour.

6. Decide on what needs to be done, by whom and by when. Try to involve everyone with some component of the tour.

7. Provide in-class time to create props to support the tour.

8. Encourage those students who will be speaking during the tour to speak loudly, clearly and without notes.

9. Invite parents and other teachers to a dress rehearsal. Encourage the folks to ask questions of clarification, play devil’s advocate and ask students to explain what their actions have to do with sustainability.

**Closing Remarks**

Wild Treasures: Sustainability, Naturally is searching for teachers who value real problem solving, real rewards, real decision-making and consequences, original scientific research, real community involvement and active civic participation rooted in rational processes.

These are only some of the attributes that inspired Brattleboro’s Karen DiIorio-Bowen of Oak Grove Elementary School to assert, “Wild Treasures provided the structure and support that nurtured the growth of my students’ abilities to learn, take notice, care and articulate a plan. It was an amazing experience for my students and our school.”

Credits

“Wild Treasures: Sustainability, Naturally” is designed by Jimmy Karlan, Ed.D. Academic Director and Director of the Teacher Certification Programs of the Masters Program in the Environmental Studies Department at Antioch New England Graduate School in Keene, NH. HYPERLINK "mailto:jkarlan@antiochne.edu" jkarlan@antiochne.edu. All Antioch Wild Treasures’ curriculum are available on-line for free at HYPERLINK "http://wildtreasures.schoolsgogreen.org" http://wildtreasures.schoolsgogreen.org.

 Atkisson, Alan. Compact Disc, song, “Exponential Growth”

 Chiras, Daniel (). Lessons From Nature: Learning to Live Sustainably on the Earth.

 AtKisson, Alan (). Believing Cassandra.

 Meadows, Meadows, & Randers, (). Beyond the Limits: Confronting Global Collapse; Envisioning a Sustainable Future.

 = Increase

**Human Population**

An increase in human population causes an increase in Earthsquare supply.



A decrease in Earthsquare supply causes a decrease in human population.



A decrease in human population causes an increase in Earthsquare consumption.



An increase in Earthsquare consumption causes an increase in human population

**Human Population**

**An increase in fox population causes a decrease in rabbit population. population**

**Earthsquare Consumption**

An **increase** in Earthsquare demand causes an **increase** in Earthsquare production.

An **increase** in Earthsquare production causes an **increase** in garbage.

An **increase** in garbage causes an **increase** in Earthsquare demand.

**Garbage**

**Earthsquare Production**

**Earthsquare Demand**

An increase in human population kicks off the following loop:

**Earthsquare Supply**

**A decrease in fox population causes an increase in rabbit population.**

**An increase in rabbit population causes an increase in fox population.**

**An increase in rabbit population causes an increase in fox population.**

**-**

**+**

**An increase in Earthsquare consumption causes an increase in human population.**

**An increase in human population causes an increase in Earthsquare consumption.**