Investigate Solid Waste through Packaging Analysis

Grade 9-12 – Environmental Biology/Field Biology

Submitted by Sandra Sumrall-Lloyd Kotzebue High School

I have used this activity as presented in my Field Biology class which is made up of upper level students as well as modified it for a mixed class of 7th and 8th graders. Field Biology students have previously read material on solid waste and some of the problems of solid waste. They know basic definitions such as solid waste, compost, landfill, etc. Additional information would need to be given for lower grade students.

Concept: Students evaluate different packaging materials and consider impact on disposal, recyclability, landfill problems, cost effectiveness, and alternative packaging materials. They will also investigate earlier packaging materials and compare them to modern materials in relation to environmental impact. Through these exercises they gain knowledge of solid waste and its impact on the environment.

Students were asked to bring in at least 5 pieces of trash as homework and it is placed in several boxes as they come in. This gives them a little idea of what we might be doing as well but it may work better to gather items yourself. I did both to make sure that we had a sufficient amount for all activities.

Teacher Notes are provided followed by student directions and data sheets.

Objectives:

- Examine and evaluate product packaging as to its ability to be recycled.
- Determine if packaging materials are excessive to actual needs.
- Evaluate costs for transportation to our remote location of different package types.
- Identify ways to reduce package materials because of limited landfill space.
- Compare present day packaging issues (transportation costs and disposal) to traditional packaging materials.

State Standards Addressed: Science B1,4-6, D1-6 , Cultural D1,E 2
Performance Standards(15-18): Mathematics D1-5 Reading 1,4 Writing 1-4

Process Skills: Observing, Measuring, Inferring, Predicting, Evaluating

Materials: Empty Food Containers, Triple Beam Balance

Gear Up:

Venn Diagram on board: yesterday I a) drank a can of pop b) ate a pop tart c) ordered out

Have several items of trash sitting on the desk such as empty pop bottles, empty boxes from food, bottle and jars, plastic containers.

1. Discuss the venn diagram results and ask how it might relate to what is on the desk. After students have determined that they all involve trash discuss other things that they may have thrown away in the last day or two. Ask students how many pounds of solid waste they think that each of them produces in one day.
2. List estimates on the board and ask how all that is taken care of here in Kotzebue.
3. Tell students that people in the US produce an average of 5 pounds per day per person. Discuss class estimates.

Additional activity if tape and time is available: Show the move "The Rotten Truth" pausing tape as questions come up.

Explore:

1. Give out Student Exercise Sheet and Data Sheets. *Students work in groups of 4 but all turn in data sheets.*
2. Trash is randomly distributed for sorting and students sort items into type of material: aluminum, glass, tin, paper, plastic, (there may be others)
3. Types are then assigned to different groups for evaluation. *(I do this by drawing from a box with the different types on papers to avoid any problems with who gets what type.)*
4. Only containers with measurable gross and net weights should be chosen for this activity. This eliminates take-out containers, paper cups, plastic bags and the like but they will be used in the experimental section. (*You may have to explain gross and net weights: net weight is the contents only with gross weight being the container and its contents. Usually net weight is given but if only volume is given, consider1 ml equivalent to 1gram.)*
5. Use triple beam balance to determine the weight of the empty package and enter weights on Data Sheet.
6. Calculate the Gross Weight by adding weight of packaging and the printed net weigh and enter on data sheet.
7. Calculate the percent packaging for each item using the formula below…

$$\frac{\text{package weight (g)}}{\text{gross weight (g)}} \times 100 = \%\text{packaging}$$

8. Students total the packaging weight and the gross weight for all the chosen items of the same type of material and calculate the average %packaging.
9. Average is entered on a list on the board for further discussion.

Generalize

1. Students answer the question in their lab journals and then have a general discussion of the results.
2. Have students then sort trash into a set with the recycle symbol on it and that with no symbol and ask additional questions:
    a. Is some of the trash without the symbol actually recyclable?
    b. Discuss recycling in Kotzebue. *(Not much*) So what happens to most of the trash that we evaluated? *(Goes to our landfill)*
    c. Since we have limited landfill space, how could we reduce the amount of non-recycled material going into the landfill ?
    d. Are there different cost issues in Kotzebue than there would be in Anchorage? The lower 48?

Experiment

Based on the information from the earlier work, one of the ways to reduce the amount of non-recycled material going into the landfill was compaction. Students will experiment to determine how much reduction is possible using different techniques.

Materials: Trash from Explore, Scissors, Meter Stick, Hammer, Newspaper, Safety Glasses, Medium Size Cardboard Boxes- one per group and all the same size if possible.

1. Give out Student Exercise Sheet and Data Sheets.
2. Each group is to take an empty cardboard box and an identical set of various packaging (this may require some planning…the activity can still work if materials are basically similar in distribution of packaging types.)
3. Student groups are assigned their compaction method: crushing only, crushing and tearing, crushing, tearing and breaking glass, etc.) If there are too many groups have duplicates.
4. All groups measure the length, width, and height of the box in centimeters and calculate the volume of the empty box in cm^3.
5. Enter the volume on the data sheet.

6. Each groups fills its box with normal packaging so that it fills the box as level as possible making a list of items of trash in the box.
7. Students hypothesize (individually) as to how much they think they can compact the volume (75%, 50%, 25%, etc.) using their technique.
8. Next the groups compact their trash using the given technique and replace it in the box.
9. They find the new volume. (hint: have them place a piece of cardboard or paper over the top and measure to that level).
10. Calculate the percentage of compaction by using the following formula:

$$\%\ \text{occupied by compacted packaging} = \frac{\text{volume of compacted packaging, cm}^3}{\text{volume of uncompacted packaging, cm}^3} \times 100$$

$$\%\ \text{compaction} = 100 - \%\ \text{occupied by compacted packaging}$$

11. Students put their results on the board for further discussion and answer questions as laboratory conclusion and analysis attached to data sheets.
12. Results could be graphed as % compaction versus method.

Generalize

Discuss results and question answers.

Apply

Ask students to identify methods of reducing the amount of waste from produce packaging.
Invite an Elder to participate in discussions of the following (or have students discuss with elders at home or in the community and have later discussion in class).

- Compare modern packaging methods and materials to those used in earlier times.
- Describe traditional methods of food storage and transport.
- Discuss the importance of reuse of "modern" packaging materials in the early days and compare with now.
- Discuss issues of why Bush communities tend to "collect items" rather than dispose of them from their yards.

Extension:

- Gather cost information for similar products from various sites (Anchorage, Kotzebue, outer village) and see if there is a correlation between packaging material and difference in cost.
- Visit the landfill and investigate the Baling program in place in Kotzebue.
- Investigate how much recycling is actually done in Kotzebue.

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Assessment: A scoring guide is to be found at the end of the student worksheets. Students should be given the scoring guide prior to the work so they are aware of the criteria for grading. In addition to the scoring guide, questions are added to a skills test at the end of the unit on land-use and solid waste.

This activity is a modification of several activities included in the Environmental Science & Technology Summer Institute for High School Teachers held in Sitka Alaska. This Institute is funded by an NSF Grant DUE-0053310. The Project Director was Dr. John Carnegie. If you are interested in this Institute you should contact nicole.duclos@uas.alaska.edu .

Packaging Materials

Purpose:

- To investigate how products are packaged and what issues there might be with the type and quantity of packaging materials.
- To analyze the methods of reducing materials that need to be disposed in the landfill
- To compare modern packaging and those of earlier times

Materials: Empty Food Containers, Triple Beam Balance, Scissors, Meter Stick, Hammer, Newspaper, Safety Glasses, Medium Size Cardboard Boxes

Procedure- Part 1 Explore:

1. Sit in assigned group and discuss roles of each team member. Choose a leader for the group.
2. Leader to get a copy of the Data Sheets for each team member.
3. Group collects a box of materials and sorts them in to various types of packaging. Make a group of aluminum, glass, cardboard (paper), tin, Styrofoam, and "other".
4. Leader chooses a paper with the name of one of the groups from the box on the desk and group gathers all of that material from all other groups.
5. Examine the labels and evaluate only those containers that have a "net weight" or volume on them.
6. Determine the weight of the product: if only volume is given, let 1ml equal 1 gram. The product weight will be the Net Weight. Record this on the data sheet.
7. Determine the weight of the container and record on the data sheet.
8. Add to the package weight to the Net Weight. This will be the Gross Weight. Record on the data sheet.
9. Calculate the percent packaging for each item using the following formula and record on the data sheet:

$$\frac{\text{package weight (g)}}{\text{gross weight (g)}} \times 100 = \%\text{packaging}$$

10. Total the packaging weight and the gross weight for all items and find the average percent packaging with the same formula and record on data sheet.
11. Fill in the information on the class data sheet on the board.
12. Answer the following questions based on your data and that of the class.

Questions to help with discussion-Answer in your lab journal. (Remember to use complete sentences.)

1. Which packaging offers the lowest percentage of packaging weight?
2. Which packaging offers the highest percentage of packaging weight?
3. What advantages does your type of packaging offer?
4. What disadvantages does your type of packaging have?
5. Which, if any, of your packaging seem excessive – that is more than necessary?
6. Looking at all of the class data, what implications can be made regarding the cost of packaging, transportation, and waste disposal?
7. Are any of these issues different because of where we live compared to Anchorage or the lower 48?

Experiment in Compaction: In this portion of our investigation, you will experiment with one of the methods the class determined would be a way to improve our landfill disposal of solid waste -compaction.

Procedure- Part 2

1. Work in the same groups as before and choose a different leader.
2. Obtain an empty cardboard box and a "set" of trash.
3. Measure the length, width, and height of the box in centimeters and calculate the volume in cm^3.
4. Record on data sheet.
5. Fill the box trash without altering it in any way. Fill the box as close to full as possible.
6. Leader again draws from the box on the desk to determine which type of compaction will be done.

7. Hypothesize how much you think you can compact the trash using the method assigned. Record on your data sheet.
8. Using the method assigned, remove the trash from the box and compact it to the best of your ability.
9. Replace compacted trash into the box and place a piece of cardboard over the top to help measure.
10. Measure the volume of the box that is now filled with the trash and record on the data sheet.
11. Calculate the percent compaction using the formula below.

$$\%\ \text{occupied by compacted packaging} = \frac{\text{volume of compacted packaging, cm}^3}{\text{volume of uncompacted packaging, cm}^3} \times 100$$

$$\%\ \text{compaction} = 100 - \%\ \text{occupied by compacted packaging}$$

12. Place your results on your data sheet and then on the class results table on the board.
13. Answer the questions below for later discussion.

Questions to include in lab analysis and conclusion.

1. Was your hypothesis proven? If not, how far off was your hypothesis.
2. Which items compacted the best using your method?
3. Which type of compaction method worked the best?
4. What does this activity suggest about handling of solid waste before landfill disposal?
5. Discuss whether or not compaction actually reduces the amount of waste?
6. Describe some methods of reducing the amount of waste from product packaging?

Application:
After listening to how packaging materials were different in earlier times than now, discuss in your final report, those differences and some of the advantages and disadvantages of modern packaging.

Data Sheet –Part 1.

Product	Pkg Wt (g)	Net Wt. (g)	Gross Wt (g)	Package % Wt
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
Totals				

Average package % weight_____

Data Sheet –Part 2.

Hypothesis:

Volume of cardboard box (A) _____

Volume of compacted packaging (B) _____

$$\text{\% occupied by compacted packaging} = \frac{B}{A} \times 100$$

Percent occupied by compacted packaging (C) _____

% Compaction = 100 - C

Percent compaction _____

Scoring Guide : Packaging Laboratory

CATEGORY	4	3	2	1
Participation	Used time well in lab and focused attention on the experiment.	Used time pretty well. Stayed focused on the experiment most of the time.	Did the lab but did not appear very interested. Focus was lost on several occasions.	Participation was minimal OR student was hostile about participating.
Calculations	All calculations are shown and the results are correct and labeled appropriately. Neatly placed on data sheets.	Some calculations are shown and the results are correct and labeled appropriately. Properly placed on data sheets.	Some calculations are shown and the results labeled appropriately. Not in proper place on data sheet.	No calculations are shown OR results are inaccurate or mislabeled.
Safety	Lab is carried out with full attention to relevant safety procedures. The set-up, experiment, and breakdown posed no safety threat. Safety glasses worn at all times when needed.	Lab is generally carried out with attention to relevant safety procedures. The set-up, experiment, and breakdown posed no safety threat, but one safety procedure needs to be reviewed. Safety glasses worn on top of head –not over eyes	Lab is carried out with some attention to relevant safety procedures. The set-up, experiment, and breakdown posed no safety threat, but several safety procedures need to be reviewed. Safety glasses not worn.	Safety procedures were ignored and/or some aspect of the experiment posed a threat to the safety of the student or others.
Procedures	Each step is followed in sequence and with no further instruction needed.	Procedures followed in sequence but required additional information.	Some procedures in order but required significant direction from teacher.	Procedures not followed or required constant guidance.
Conclusion	Conclusion includes whether the findings supported the hypothesis, possible sources of error, and what was learned from the experiment. All questions clearly answered.	Conclusion includes whether the findings supported the hypothesis and what was learned from the experiment. All questioned answered with minimal response.	Conclusion includes what was learned from the experiment. Most questions answered minimally.	No conclusion was included in the report OR shows little effort and reflection. Questions not answered.
Summary	Summary describes the skills learned, the information learned and some future applications to real life situations.	Summary describes the information learned and a possible application to a real life situation.	Summary describes the information learned.	No summary is written.
Scientific Concepts	Report illustrates an accurate and thorough understanding of scientific concepts underlying the lab.	Report illustrates an accurate understanding of most scientific concepts underlying the lab.	Report illustrates a limited understanding of scientific concepts underlying the lab.	Report illustrates inaccurate understanding of scientific concepts underlying the lab.