Science Project – Grades III, IV, V, & VI
Lesson Plan for Inquiry – The Use of Polymers in Diapers

Rationale:

In addition to its use in disposable diapers, sodium polyacrylate has many other uses. It is one of the few fields of study where school age children are actually able to engage in scientific inquiry and will be able to make genuine contributions to science. This super absorbent polymer and other such polymers are widely used in applications such as forestry, gardening, and landscaping as a means of conserving water.

This inquiry lesson will give the children an opportunity to examine the advantages and disadvantages of using these polymers in various fields. For example, the super absorbent polymer is able to reduce the amount of time that is spent watering a lawn, a garden, or even a house plant by 50 to 80 percent! While students may consider water-absorbing polymers to be a modern convenience, they will also foresee the impact that such technology is having on parts of the world that are plagued by drought.

The students will also investigate some of the concerns about using disposable diapers. The concerns have been about the dyes, sodium polyacrylate (the super absorbent gel), and dioxin (which is a by-product of bleaching paper) that are used to manufacture disposable diapers. While disposable diapers have the ability to hold large quantities of urine, there tends to be a slight wetness against the baby's skin, which can lead to rashes. Sodium polyacrylate has also been linked in the past to toxic shock syndrome, allergic reactions and is very harmful and potentially lethal to pets. Other concerns about disposable diapers include the cost and environmental harm it can cause to the earth.

Goals:

Children are naturally curious. To encourage this curiosity and foster learning, certain types of mental and physical skills are needed, which are skills for acquiring useful information that has practical value and carries real meaning for learners, meaning that is constructed from the learners' experiences. The children, by engaging in the inquiry process of this lesson will develop positive attitudes towards science, use their curiosity to construct new ways of investigating and understanding, and acquire knowledge for practical learning and everyday living. This is the fundamental premise of constructivism and is addressed in this lesson by encouraging the children to predict, examine, extend, and evaluate (steps of the learning cycle) through a hands-on approach.

Instructional Objectives:

Cognitive:

- The students will be able to verbally explain what a polymer is by conducting an experiment.
- The students will discuss the properties of the polymer sodium polyacrylate by conducting an experiment with diapers.
- The students will differentiate between the characteristics of hydrophilic (sodium polyacrylate, gelatin in Jell-O, pudding, silly putty etc.) and hydrophobic (water-fearing or non-absorbent) polymers such as plastic cups, bags, and toys etc.
- The students will be able to verbally generate examples of the hydrophilic or water-loving polymer (sodium polyacrylate) applications used in real life.

Affective:

- The students will appreciate and examine the advantages and disadvantages of the use of polymers in real life applications.
- The students will participate in the inquiry process, and value the importance of the whole process.
- Students will develop a positive attitude towards science by feeding their curiosity.

Psychomotor:

- The students will use their senses, motor skills and hand-eye coordination to carry out the experiment with polymers using diapers.

SOL:

Scientific Investigation, Reasoning, and Logic

3.1 The student will plan and conduct investigations in which
- a) predictions and observations are made;
- b) objects with similar characteristics are classified into at least two sets and two subsets;
- c) questions are developed to formulate hypotheses;
- d) volume is measured to the nearest milliliter and liter;
- e) length is measured to the nearest centimeter;
- f) mass is measured to the nearest gram;
- g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
- h) temperature is measured to the nearest degree Celsius;
- i) time is measured to the nearest minute;
- j) inferences are made and conclusions are drawn; and
- k) natural events are sequenced chronologically.

Matter

3.3 The student will investigate and understand that objects are made of materials that can be described by their physical properties. Key concepts include
- a) objects are made of one or more materials;
- b) materials are composed of parts that are too small to be seen without magnification; and
- c) physical properties remain the same as the material is reduced in size.

Scientific Investigation, Reasoning, and Logic

4.1 The student will plan and conduct investigations in which
- a) distinctions are made among observations, conclusions, inferences, and predictions;
- b) hypotheses are formulated based on cause-and-effect relationships;
- c) variables that must be held constant in an experimental situation are defined;
- d) appropriate instruments are selected to measure linear distance, volume, mass, and temperature;
- e) appropriate metric measures are used to collect, record, and report data;
- f) data are displayed using bar and basic line graphs;
- g) numerical data that are contradictory or unusual in experimental results are recognized; and
- h) predictions are made based on data from picture graphs, bar graphs, and basic line graphs.

Scientific Investigation, Reasoning, and Logic

5.1 The student will plan and conduct investigations in which
- a) rocks, minerals, and organisms are identified using a classification key;
- b) estimations of length, mass, and volume are made;
- c) appropriate instruments are selected and used for making quantitative observations of length, mass, volume, and elapsed time;
- d) accurate measurements are made using basic tools (thermometer, meter stick, balance, graduated cylinder);
- e) data are collected, recorded, and reported using the appropriate graphical representation (graphs, charts, diagrams);
- f) predictions are made using patterns, and simple graphical data are extrapolated;
- g) manipulated and responding variables are identified; and
- h) an understanding of the nature of science is developed and reinforced.

Scientific Investigation, Reasoning, and Logic

6.1 The student will plan and conduct investigations in which
- a) observations are made involving fine discrimination between similar objects and organisms;
- b) a classification system is developed based on multiple attributes;
- c) precise and approximate measurements are recorded;

d) scale models are used to estimate distance, volume, and quantity;
e) hypotheses are stated in ways that identify the independent (manipulated) and dependent (responding) variables;
f) a method is devised to test the validity of predictions and inferences;
g) one variable is manipulated over time, using many repeated trials;
h) data are collected, recorded, analyzed, and reported using appropriate metric measurements;
i) data are organized and communicated through graphical representation (graphs, charts, and diagrams);
j) models are designed to explain a sequence; and
k) an understanding of the nature of science is developed and reinforced.

Materials Required:

Diapers (one per child)
Gallon-sized zip-lock bags (with zippers)
Gloves (non-latex) – child size
Droppers
Colored liquid – preferably 2 colors to choose from
Disposable cups (clear)
Safety goggles
Frog dissecting aprons
Scissors
Magnifying glasses
Teaspoons or plastic spoons
Salt
Paper towels and wipes
Polymer tri-fold display
K-W-L sheets
Pencils
*Several examples of polymers, both hydrophobic and hydrophilic

Procedure:

(**Exploration** – 5-7 minutes)

Allow students to examine the examples provided. This can be accomplished at the table or sitting as a group on the floor.
"These items all contain polymers. You may or may not know what a polymer is. Take a few moments and discuss these items as a group, then place them into 2 sets. Each item must fit into one of the two sets."
Have the students, working as a group, discuss the items' similarities and differences, and then have them place the items into 2 different sets according to a similar property or properties.

"Let's take a look at your 2 sets of items and examine how you separated them. What is your reasoning for placing these items into this set? What about the items in the second set?"
Some students may not agree with the reasoning or placement of items. Allow them an opportunity to discuss their grouping strategies. Time may not allow for every student to actually rearrange the items according to their individual reasoning.

(**Explanation** – 5-7 minutes)

At this point, discuss what a polymer is.
"After looking at these items, how can we begin to describe a polymer? What do you think a polymer does?"
Eventually, the discussion should involve water, and the students should be introduced to the terms "hydrophobic" and "hydrophilic." Find out if the students already know what these terms mean.
"Let's look at our items again and, this time around, let's think about these items in relation to water. How might we begin to separate these items?"
Allow discussion. Have the students separate the items according to water absorption – do they repel (hydrophobic) or absorb (hydrophilic) water?
"Today we are going to take a closer look at the hydrophilic polymer, sodium polyacrylate. This polymer is found in diapers. But before we examine this polymer, let's take our K-W-L sheet and write down what we already know about polymers in the K-section of the sheet."
Some students may not have used K-W-L sheets before – take a moment and discuss the importance of these learning tools.
"Now that we know a little bit about polymers, what would you *want* to know about the polymer found in the baby diaper? You will put this information in the W-section of your sheet."
Begin the experiment.

(**Expansion** – 15-20 minutes)

(CAUTION:
The powder found in the diaper (sodium polyacrylate) will irritate the nasal membranes if inhaled. Avoid eye contact. If it gets into the eyes, they will become dry and irritated. Be sure to wash hands after use.)

Have students put on safety goggles and non-latex gloves, to protect eyes and skin. "Why do you think the goggles and gloves are necessary?"

Use a pair of scissors to cut off the paper or plastic edge around the entire diaper. Place the padded, middle part of the diaper into the zip-closing plastic bag.

Reach into the bag with both hands and separate the cotton, paper, and plastic layers of the diaper. "What would be a reason for leaving the diaper in the bag as you separate it into its layers?" Leave all material in the bag. Seal the bag, and shake it for about 1

minute. Look at the bottom of the bag as you tilt it to one side. The students should notice white granules collecting in the corner of the bag. "Stop and look at your bag. What do you observe happening inside the bag?"

Now, without opening the bag, move the cotton, plastic, or other large pieces of material toward the top of the bag. Keep the material up there as you shake the bag again. This will allow the granules to fall down to the bottom without getting picked up by the cotton.

After you have about one teaspoon of granules in the corner of the bag, slowly open the bag and remove the large pieces of material. Throw them away. Now, carefully pour the granules into a small cup. Fill another plastic cup about half full with colored water – the students may choose which color to use.

Using a dropper, add one drop of the colored water to the granules. Continue adding one drop at a time to the granules and observe. "What do the granules appear to be doing?"

"Predict what might happen if you begin to add larger amounts of water, such as a teaspoon." Have students increase the amount of colored water added. "What is happening? What do you observe? How does your observation compare with your prediction?"

**If time permits, have students experiment with salt. "What do you think will happen to the polymers when salt is added? Why?" Have students begin adding small amounts of salt to the polymer. The polymers should actually begin to release the water.

(**Evaluation** – 1-2 minutes)
Have students complete the L-section of their sheet with what they have learned about the hydrophilic polymer, sodium polyacrylate.

Assessment:

The students will discuss what they have learned about polymers, and more specifically, about the hydrophilic polymer, sodium polyacrylate.

What is a polymer?
How are polymers similar? How are they different?
What are the properties of sodium polyacrylate?
How does it hold so much moisture?

Critical thinking:
What are some of its applications in the real world?
What are some of the disadvantages of using it?