West Virginia University
Extension Service

WLG 290

DID YOU KNOW YOU WERE A SCIENTIST?

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This program topic will help participants explore the science behind everyday household items and discover the scientists in themselves.

What you will need...

* Purple cabbage indicator. You can make it like this:

  Cut a head of purple or red cabbage into smaller pieces and place them in a cooking pot. Cover the cabbage with water, and boil for 10-15 minutes. The water in the pot will turn blue. After it has cooled, pour the blue juice into jars and keep refrigerated until use.

* White vinegar.
* Baking soda.
* Baking powder.
* One-liter plastic soda pop bottle.
* Various cups and/or glasses.
* Measuring spoons.
* A balloon.
* Eyedropper or soda straw.
* Water.
* Tape.
* Flip chart and markers. (A blackboard or large sheet of paper taped to the wall will do also.)

Getting Started...Cabbage Chemistry

*Begin the meeting with the following "magic trick." (**Note:** Practice the trick before doing it for the group.)*

1. Pour some white vinegar into a clear plastic cup or glass.
2. Dissolve some baking soda in water in another clear cup or glass.
3. Use the eyedropper or soda straw to add a few drops of "mystery juice" (purple cabbage indicator) to each glass. (*Hint: Don't tell participants what the "mystery juice" is yet.*)
4. Observe what happens!

What did you observe? (*The vinegar should turn red when the cabbage juice is added, while the baking soda and water solution should turn green or blue*.) Ask participants what they think is happening. What is in the two cups? What is the "mystery juice"? Give participants some time to come up with possible explanations for what they observed. Record their answers on the flip chart so everyone can read them.

Now tell participants what was in each of the cups and what the "mystery juice" was. Does this change their explanations for what they observed? Give participants time to change or expand upon their original explanations. Record the new answers on the flip chart.

What Just Happened Here?

After participants have had ample time to devise explanations for their observations, explain what caused the color changes they observed:

The "mystery juice" is actually purple cabbage juice, which is an acid-base *indicator*. This means that the pigments in the juice turn different colors in the presence of acids and bases. Another example of an acid-base indicator that participants may be familiar with is litmus paper, available in

many pharmacies. In this case, the vinegar is an acid (acetic acid), which turns red with purple cabbage indicator. The baking soda is a base (sodium bicarbonate), which turns blue or green with purple cabbage indicator.

If time permits, try testing other household items with purple cabbage indicator. Some items that may give interesting results are soapy water, lemon juice, clear soda pop, household cleaners, milk, etc. How many items tested as acids? How many as bases?

Acid-base indicators are important tools for scientists. They use them to determine if unknown substances are acidic or basic, and to determine just how acidic and basic certain substances are. They measure this on the pH scale, which ranges from 1 to 14. A pH of 1 indicates a highly acid substance, while a pH of 14 indicates a strong base. A pH of 7 is neutral. Some practical examples of using pH testing include soil testing and water testing. It is useful for soil scientists and farmers to know the pH of soils, since plants grow best within certain pH ranges. Knowing the pH of a body of water, or even our drinking water, can give us an idea of the overall quality of that water.

Science...It's Everywhere!

What is science, anyway? Contrary to popular belief, science is not a collection of facts and figures. Science is a way of doing things. Specifically, it is a way of gaining knowledge about things we don't know yet, and organizing that knowledge into theories. So science is a *method* of gaining new knowledge, and that new knowledge is the *product* of science. There are scientific explanations for many of the things in our everyday lives, such as why purple cabbage juice causes vinegar to turn red and baking soda green.

Try a few more activities with the lesson participants to illustrate how the knowledge gained through science is at work in everyday life. You may do the activities as demonstrations for the participants, or provide the materials and instructions for small groups of participants to try themselves. If you choose the latter, allow time for the small groups to demonstrate their activities to the whole group of participants. Whichever way you choose to do the activities, make sure to practice them before presenting the lesson.

Activity One: That's Quite a Reaction!

For this activity you will use the plastic bottle, vinegar, baking soda, measuring spoons, the balloon, and some tape.

Put about one teaspoon of baking soda into the bottle. Measure out three tablespoons of vinegar. Have the balloon handy and ready to attach to the mouth of the bottle. Add the vinegar and immediately attach the balloon. Secure the balloon with tape if necessary. Observe what happens!

You will notice fizzing and bubbling when the vinegar is added to the baking soda. Enough gas may be produced to inflate the balloon. What is happening? You are observing a chemical reaction between vinegar (acetic acid) and baking soda (sodium bicarbonate). In a chemical reaction, the two substances in the reaction are changed into other substances. In this case, carbon dioxide gas is produced by this reaction, which causes the fizzing, the bubbling, and the balloon's inflation.

Activity Two: All Baking Products Are Not Created Equal

In this activity you will use baking soda, baking powder, two cups, and some water.

Put some baking soda into one cup and some baking powder into the other cup. Add some water to each cup. Observe what happens!

You will observe that nothing in particular happens when the water is added to the baking soda. It should form a white paste. When water is added to the baking powder, however, the mixture fizzes and bubbles. Why?

Baking *soda* is sodium bicarbonate, while baking *powder* is a mixture of sodium bicarbonate and a powdered acid. Adding water activates these powders and allows the sodium bicarbonate to react with the acid. What is the product of such a chemical reaction? (See Activity One.) When sodium bicarbonate reacts with an acid, carbon dioxide gas is produced. This gas is useful when it makes a cake or bread rise during baking! Using baking powder as an ingredient makes this happen.

Using baking soda alone, however, will not be effective in this way. As science teacher Janice Van Cleve (1989) explains,

> Baking soda contains sodium bicarbonate and it will only produce carbon dioxide when combined with an acid. An acid would have to be added to a batter if baking soda was used as the source of carbon dioxide. Vinegar, cream of tartar, and buttermilk are all used as a source of acid. Any one of these substances could be used with baking soda to produce carbon dioxide gas.

Activity Three: All Things Change

Activities One and Two illustrate chemical reactions, or *chemical changes*. In a chemical change, the substances that are reacting are changed into different substances. That is, they have a different chemical composition after the reaction than they did before the reaction.

Many of the changes that occur in the world around us are chemical changes. Some, however, are *physical* changes. In a physical change, there is no change in the chemical composition of the substances involved in the change. For example, cutting fabric is a physical change. The fabric is the same chemically before and after the change. Only the shape changes. On the other hand, adding vinegar to baking soda is a chemical change. A new chemical substance (carbon dioxide) is formed in this reaction.

Discuss whether the following changes are chemical or physical changes:

* Toasting bread until it is burned.
* Boiling water.
* Baking a loaf of bread.
* Slicing a loaf of bread.
* Burning a candle.
* Tarnish forming on silverware.
* Using vinegar to clean hard water stains.
* Piecing a quilt.
* Growing a vegetable garden.

(**Answers:** Toasting bread, baking bread, burning a candle, tarnish forming on silverware, and using vinegar to clean hard water stains are all chemical changes. Boiling water, slicing bread, and piecing a quilt are physical changes. Growing a vegetable garden is a tricky one! The plants change physically as they grow by water moving into and enlarging their cells and by the division of their cells. However, there are lots of chemical changes taking place in plants as they carry out photosynthesis to make "food" and respiration to metabolize it.)

How Are You a Scientist?

Do you ever think of yourself as a scientist? We tend to think of chemists, physicists, biologists, and other laboratory researchers when we hear the word "scientist." Actually, anyone who uses the scientific method can be a scientist, and we all do that whether we know it or not.

The scientific method is the way scientists *do* science. It's really very simple. The first step is to ask a *question*. (Sometimes this is the hardest part!)

This is usually a question about how some part of the world works. For instance, "what will happen if...?" After the question has been identified, the scientist makes an educated guess (a *hypothesis*) about what the answer to that question will be. Next comes the experiment to *test* the hypothesis. This is where you find out if your educated guess was correct or not. If it wasn't, that's okay.

Scientists learn as much from incorrect hypotheses as they do from correct ones. After the experi-ment has been performed, scientists draw some sort of *conclusion* related to the question being asked.

During this part of the lesson, ask participants to brainstorm some examples of how they are scientists. What activities do they perform in their daily lives that follow the scientific method? Are they involved with any hobbies or other specialized activities in which they are scientists? Record participants' ideas on the flip chart.

Some examples of using the scientific method in daily life are following a new recipe, making changes to a recipe for the first time, using a new product for the first time, and so on. Can you think of others?

What About Technology?

Technology is a term that is often used in conjunction with science. Many people lump science and technology together, but they are not exactly the same thing. While science is the process of gaining new knowledge, technology is the process of *using* scientific knowledge, along with tools and skills, to meet human needs. Like science, technology is a way of doing things. Just as there is a scientific method, there is also a technological method. Inventors and engineers are examples of people who use the technological method.

The technological method starts with *designing* a solution to a human need. Inventors and engineers do this when they design new products, or new models of existing products, to meet new human needs (hence the phrase "necessity is the mother of invention"). The next step is to *produce* the product according to the design. After producing the new product, technologists *test* the product to make sure it works as they hoped it would. De-pending on the results of the test, the technologists may then *revise* the design to make it better. From there, the process starts all over again.

Now ask participants to brainstorm ways in which they are technologists. Record their ideas on the flip chart. Do any of the examples of using the technological method overlap with examples of using the scientific method?

Some examples of using the technological method in daily life include designing and making a new quilt, changing a recipe because you do not have one of the ingredients, making an item of clothing from a pattern, assembling a product labeled "some assembly required," and so on.

Notice that not all of the above examples utilize all of the technological method. Sometimes part of it has been done for you. When you assemble a product according to the instructions in the box, the design has already been carried out. You do the producing and the testing. When you design and make a new quilt, you may test it in various ways, but whether you revise it may depend on how much time you have.

Science and technology are two different processes, but they go hand in hand. Science provides the knowledge that technology uses to meet human needs. On the other hand, technology often provides new tools and processes that make the work of scientists easier. Whether we realize it or not, science and technology are everywhere, and we are a part of them!

References

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