What Dissolves in Water?*

** Previously entitled, "Disappearing Act."*

The objectives for the activity are aligned with the National Science Education Standards, specifically to the Science as Inquiry and Physical Science Strands. This activity uses guided inquiry to examine one of the unique physical properties of water, its ability to dissolve many different substances. Students will investigate whether several common substances are soluble in water, make and record observations, measure and draw conclusions about solubility.

Concepts

- Some liquids and solids will dissolve in water. They are soluble.
- Substances dissolved in water sometimes appear to be invisible or disappear into the solution.
- A solution is a liquid mixture in which the minor component (the solute) is uniformly distributed within the major component (the solvent).

Reference

Moreno N., B. Tharp. and J. Dresden. (2011). *The Science of Water Teacher's Guide.* Third edition. Baylor College of Medicine. ISBN: 978-1-888997-61-3. Development of this student activity was supported, in part, by grant numbers R25 ES06932 and R2510698 from the National Institute of Environmental Health Sciences of the National Institutes of Health to Baylor College of Medicine.

Image Reference

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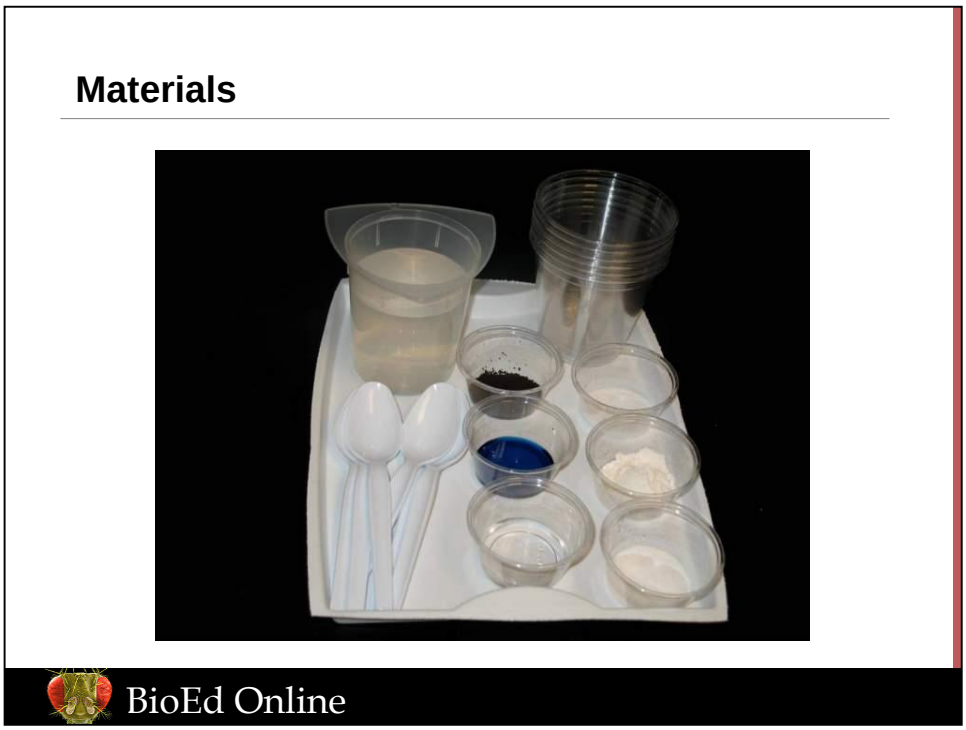
Key Words

lesson, experiment, water, water drops, water quality, water molecule, dissolve, solution, oil, solvent, solute,

What Dissolves in Water? © Baylor College of Medicine.



Materials

Have students work in groups of four. Put each group's materials on a tray and place in a central location for Materials Managers to pick up.

Materials per Student Group

- 600 mL water
- 100–250 mL beaker
- 6 clear plastic cups, 9 oz (250 mL)
- 6 clear plastic portion cups 2 oz (60 mL)
- 6 spoons or coffee stirrers
- 1 teaspoon each of clear oil, diluted food coloring, white flour, ground coffee (not instant), salt and white sugar
- Food coloring (see Setup)
- Plastic tray to hold materials
- Copy of "Disappearing Act—My Observations" page

Setup

1.You will need to prepare a dilute solution of food coloring by placing approximately 120 ml of water into a plastic drinking cup or beaker and adding six drops of food coloring.

2. Place a teaspoon of each test substance (clear oil, diluted food coloring solution, flour, ground coffee [not instant or coffee grinds], salt and sugar in a separate 2-oz. portion cup (or other small container).

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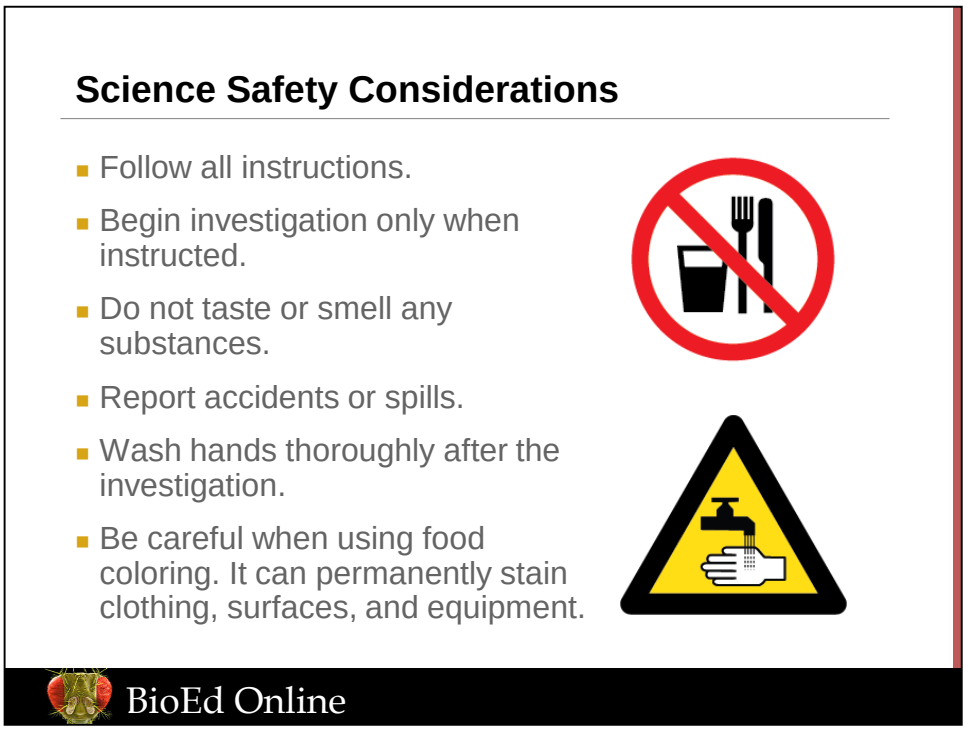
Image Reference

Photo by JP Denk © Baylor College of Medicine

Key Words

materials, materials list,



Science Safety Considerations

Students always must think about safety when conducting science investigations. This slide may be used to review safety with your class prior to beginning the activity.

Safety first!

•Always school district and school science laboratory safety guidelines.

•Have a clear understanding of the investigation in advance.

•Practice any investigation with which you are not familiar before conducting it with the class.

•Make sure appropriate safety equipment, such as safety goggles, is available.

•Continually monitor the area where the investigation is being conducted.

Safety note: Tell students to be extra cautious when using food coloring, as it

can stain surfaces, equipment, clothes and skin.

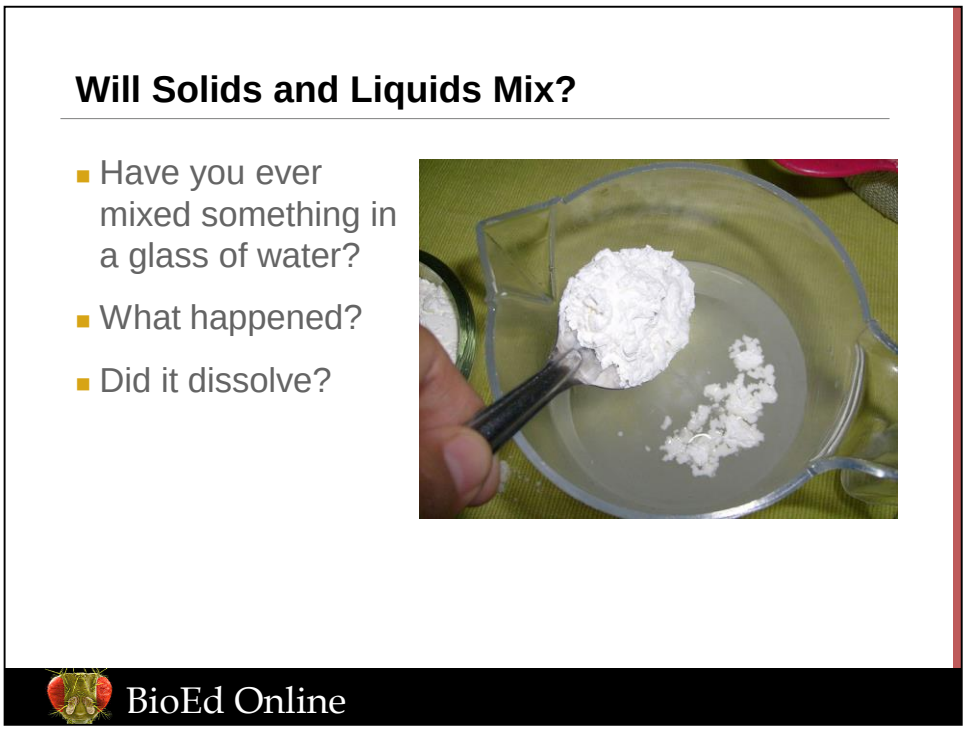
References

1.Dean R., M. Dean, and L. Motz. (2003). *Safety in the Elementary Science Classroom*. National Science Teachers Association.

2.Moreno N., B. Tharp, and J. Dresden. (2011). *The Science of Water Teacher´s Guide.* Third edition. Baylor College of Medicine. ISBN: 978-1-888997-61-3. Development of this student activity was supported, in part, by grant numbers R25 ES06932 and R2510698 from the National Institute of Environmental Health Sciences of the National Institutes of Health to Baylor College of Medicine.

Key Words

science, classroom, safety, lab, laboratory, rules, safety signs,



Will Solids and Liquids Mix?

When starting a new activity, it is always a good idea to focus students' attention.

Begin this activity by engaging students in a discussion. Ask students, *How can you tell if something is dissolved?*

Show them a glass filled with tea (or water). Gradually add sugar and stir. Ask, *Have you ever mixed or stirred something into a glass of water? What happened? Did the sugar dissolve in the water?*

Prompt students to create a working definition for determining if something has dissolved. Make sure students understand that "dissolve" means that one substance is no longer visible or becomes transparent within the other substance, and that the substance actually fades or disappears.

Ask, *Do you think that everything can mix in this way with water? What is an example of something you know does not mix with water?* Tell students that they will observe what happens when they mix different

substances with water.

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Image Reference

Photo courtesy of Teay Chula. CC-BY-SA 3.0. http://en.wikipedia.org/wiki/Starch#mediaviewer/File:Cornstarch_mixed_with_water.jpg

Key Words

lesson, experiment, water, water drops, water quality, water molecule, dissolve, solution, oil, solvent, solute,

Let's Get Started

In this activity, students will investigate what happens when six different substances (salt, sugar, flour, oil, food coloring, and regular ground coffee) are mixed with water. They will begin by predicting what will happen when each substance is mixed in water. Next, students will test each substance and record their observations, and finally determine which substances dissolved in the water.

Begin by asking students to clear their working area and remove anything that could be damaged by liquids. Have the materials managers collect supplies for each group (of four) from a central location. Explain to students that today, they will learn about an important property of water, its ability to dissolve many different substances. Remind students of the focus activity (sugar disappearing when stirred in a glass of tea or water) and the criteria they decided on for "what it means to be dissolved."

Review the worksheet with students so that they are clear about what to do. Before beginning the investigation, it is important to give the students the opportunity to decide on how they will mix the substances. They will need to

agree on how vigorously and how many times to stir each substance. Students need to understand that to have a scientifically valid test, all substances must be treated the same way. Remind students not to vary their procedure just because a substance may not seem to be dissolving. Finally, make certain that students understand they must use a clean spoon for each substance and not to mix any of the substances together. After instructions are given, each group can complete the investigation independently. This activity can be conducted step-by-step with younger students.

As you circulate through the room during the investigation, encourage students to take a closer look at each substance by using their hand lens. You might also use this opportunity to record observations for each student regarding their group participation.

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Image Reference

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http://commons.wikimedia.org/wiki/File:SaltInWaterSolutionLiquid.jpg

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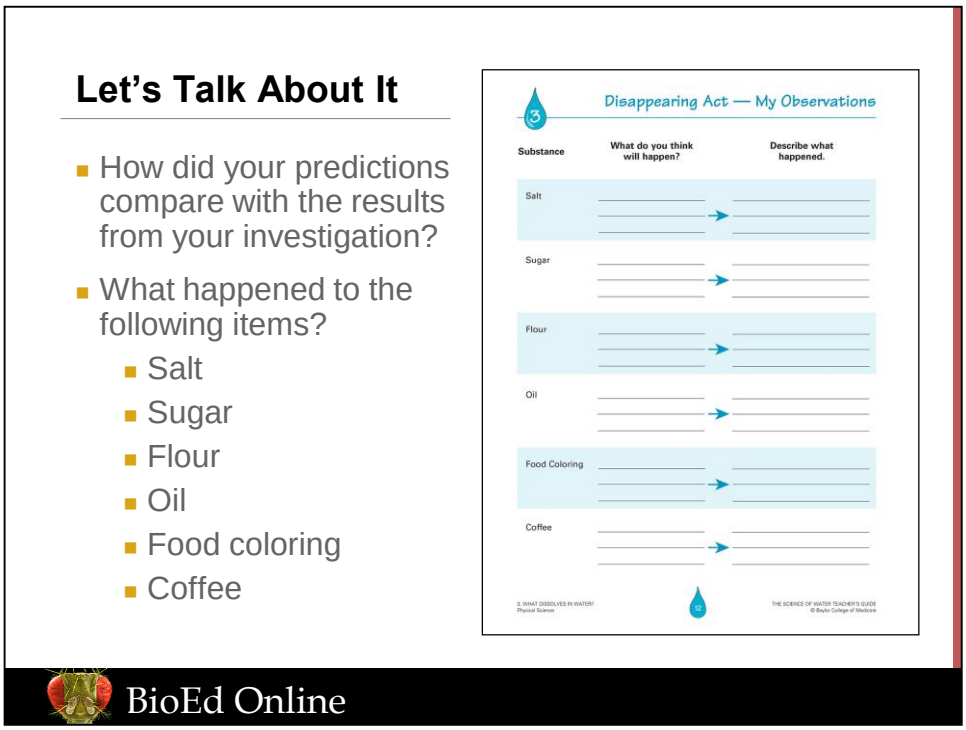

Let's Talk About It

This activity affords students an opportunity to learn about water's ability to dissolve several common household substances and to begin to build an understanding of some basic physical science concepts, such as polarity of molecules. The forces of attraction of water molecules pull certain types of molecules (such as table salt) apart or allow some substances (such as alcohol) to mix evenly with water. In addition, this activity provides practice in making and recording observations.

After students have had an opportunity to complete their observations, review each question on the student recording page and discuss students' responses as a class. When conducting a class discussion, expect a variety of answers and observations, and use questions to encourage students' thinking.

Students should have found that both sugar and salt disappeared or dissolved in the water. Remind students about the "sticky" nature of water and how tiny units of water (molecules) are attracted to one

another like small magnets because they have a positive end and negative end. The “sticky” or polar nature of water molecules pulls apart or separates other substances that also have a positive and negative end so that they mix evenly with the water.

You may find that students have a hard time deciding if the flour dissolved in the water. To help students, remind them that in order to judge if a substance has dissolved, the resulting mixture must be clear or at least transparent. Students should have found that when flour is mixed with water, the result is a cloudy mixture. The flour did not disappear or dissolve. The particles of the flour in the water mixture were greater in size than the particles of salt and sugar in the previous steps. In fact, with salt and sugar, the mixing that occurred was at the level of molecules.

The oil did not dissolve in water. The tiny oil particles found in the teaspoon of oil have a relatively neutral charge. Since the attractive forces among the water molecules are much stronger, the water molecule “prefer” to stick to each other than to mix with the oil. The oil remains separate from the water and does not disappear or dissolve. In addition, the oil is less dense that the water and will float on the surface of the water.

The addition of food coloring (which consisted of a chemical colorant already dissolved in water) to the water resulted in a transparent mixture. It did not clump up like the oil and unlike the flour mixture, light easily passes through.

The coffee may have surprised some of your students; perhaps they thought it was instant coffee and would dissolve. Instead it was ground coffee beans. Coffee beans are made of many different substances. Some of the particles in coffee will dissolve in water as demonstrated by the transparent brown color of the water. Other substances in the coffee are too big or consist of oils that will not mix with water.

To recap ask, *Which substances disappeared into the water when it was stirred? Is the salt or sugar still there? How could you find out? Were there any surprises?*

References

1.Moreno N., and B. Tharp. (2011). *The Science of Water Teacher's Guide.* Third edition. Baylor College of Medicine. ISBN: 978-1-888997-61-3.
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2.National Science Foundation. *The Chemistry of Water*. http://www.nsf.gov/news/special_reports/water/index_low.jsp?id=properties

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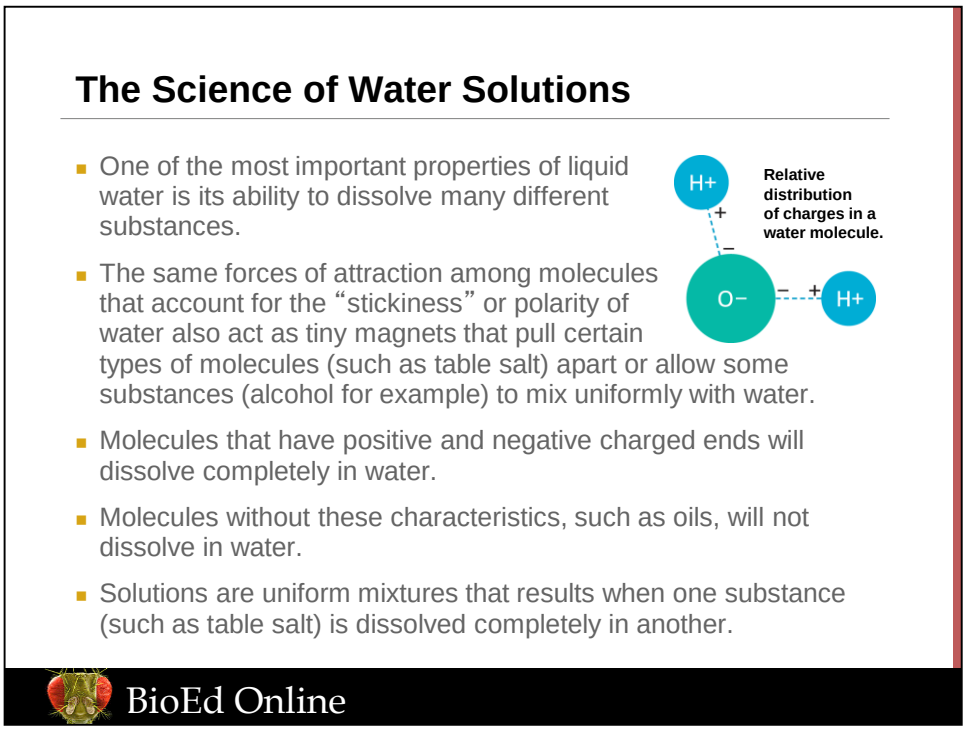

The Science of Water Solutions

Properties of water are related to the structure of the water molecule. Each water molecule consists of two hydrogen atoms and one oxygen atom. As with all molecules of this type, the oxygen atom and the hydrogen atoms share electrons. However, the electrons are not shared equally. They are pulled toward the oxygen side of the molecule, which ends up with a slight negative charge. Correspondingly, the hydrogen side of the molecule ends up with a slight positive charge. Each molecule in liquid water, therefore, has a positive end and a negative end. This separation of positive and negative charges (polarity) makes each water molecule act like a tiny magnet, capable of clinging to other water molecules and to other particles. When salt is added to water, the force from the polarity of the water is able to pull the salt molecule (sodium chloride) apart into positively charged sodium ions and negatively charged chlorine ions. The negative oxygen ends of the water molecules will surround the positive sodium ions while the positive hydrogen ends of the water surround the chlorine ions. Other substances, such as sugar, have a positive and negative end (polar) and can be separated and surrounded by water molecules.

A uniform mixture that results when one substance (such as table sugar) is dissolved completely in another substance (such as water) is called a solution. There is a point at which a solution will not dissolve more of the introduced substance. At this point the solution is said to be a saturated. Many common items are solutions. Household vinegar, for example, is a solution of acetic acid in water.

A mixture containing fine particles dispersed throughout another substance can be an example of a colloid. In the case of colloids, particles larger than many molecules (from 1–1,000 nanometers) are dispersed through another continuous medium, such as water. An easy way to distinguish many colloids (such as with flour mixed with water) from true solutions is to shine a light through the mixture. The beam of light will pass through a solution without any without any visible effect. However, when light is shown though a colloid, the beam's path will be illuminated clearly. There are many different types of colloids. A sol is a solid dispersed in a liquid. An aerosol is a solid or liquid in a gas (fog is an aerosol). An emulsion is small globules of one liquid in a second liquid and a foam is gas bubbles in a liquid or a solid.

The properties of water that students observed in this activity are:

•Liquid water is an excellent solvent of many substances. This makes water particularly valuable to living organisms. All of the thousands of chemical processes inside cells take place in water. Water also carries dissolved nutrients throughout the bodies of living organisms and transports wastes. Unfortunately, the same characteristics make liquid water easy to pollute, because so many different chemicals can be dissolved in it.

•Not all substances will dissolve in water. In the activity, students discovered that oil, flour and most of the coffee grounds do not dissolve in water

References

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2. National Science Foundation. *The Chemistry of Water*. http://www.nsf.gov/news/special_reports/water/index_low.jsp?id=properties

Image Reference

Graphic by M.S. Young © Baylor College of Medicine

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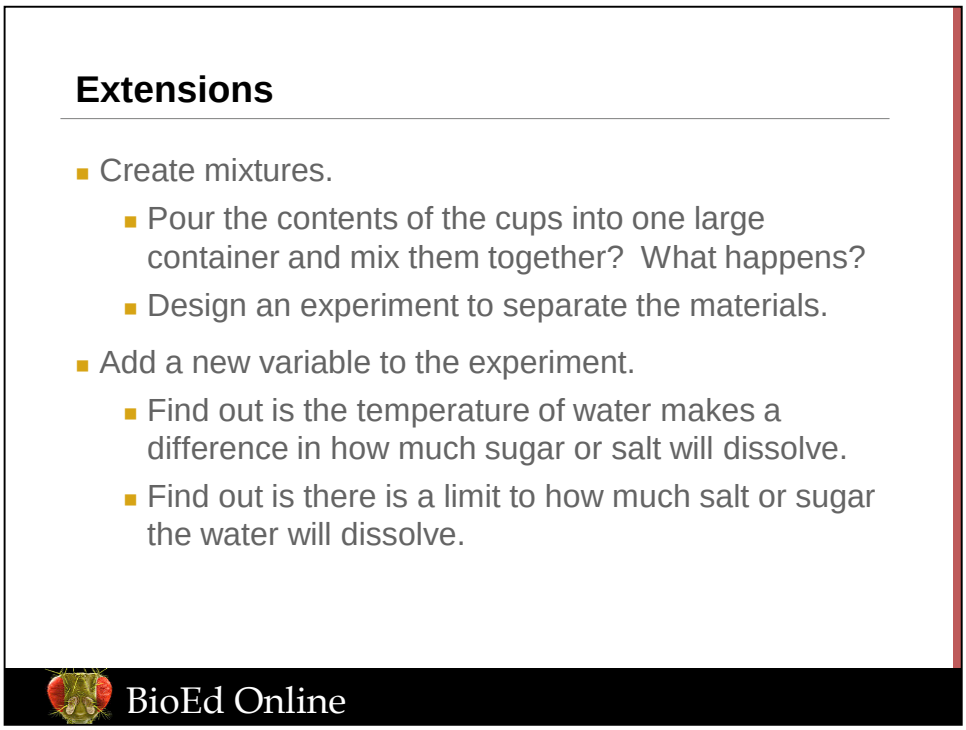

Extensions

This lesson can be extended by creating filters using cups with holes punched in the bottom and lined with coffee filters or other methods the students might design to filter the substance that were mixed together in the lesson.

Students may wish to investigate if the temperature of the water makes a difference in how quickly it will dissolve something.

Have students devise an experiment to find out if there is limit to how much sugar can dissolve in a given amount of water. They will discover that at some point, water will not dissolve any more sugar. The water molecules in the container have a limited number of negative and positive ends to pull apart the sugar molecules or to dissolve the sugar. Have students increase the amount of water in the container to see if they can dissolve more sugar. They may want to experiment with heat to see if that influences how much sugar the water can dissolve.

Have students create a strong salt solution. Leave the container in the open and allow the water to evaporate. Have students predict if the salt will evaporate or remain.

References

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