Water Mix-ology!

Subject Area(s): water, physical properties, temperature, mixing

Associated Unit: Properties of Water (Grade 4, NYC PS)

Associated Lesson: Water Mix-ology! (Lesson Plan)

Activity Title: Water Mix-ology! (Activity)

Figure 1

ADA Description: An image of a clear glass of water with red colored fluid being poured into it, and causing the clear fluid to change colors

Caption: Water Mixing

Image file name: getty_rf_photo_of_mixing_juice_with_water.jpg

Grade Level: 4 (3-5)

Activity Dependency: None

Time Required: 45 minutes

Group Size: 4

Expendable Cost per Group: US $5

Summary

Students will combine the power of their own five senses, as well as a mechtronic temperature sensor, to investigate the properties of water, and how the properties of water change upon addition of various materials. Students will also gain greater experience with use of the scientific method by making predictions about how different materials will affect the properties of water, and comparing these predictions to the changes actually observed.

Students will actively learn how mechatronic sensors can enhance their own senses, by observing that the temperature sensor can very precisely measure temperature, while their hands can only

give a relative measure of temperature. This will help illustrate how, in some cases, our own senses are not precise enough to observe differences in material properties, while engineered sensors are able to measure such properties.

Finally, students will also gain practice with the use of synthesizing information, and presenting it to share what they've learned with their classmates. After completing the investigation of what happens when a given material is mixed with water, the students will use chart paper they've used to collect information throughout their investigation to display what they've learned, and make a presentation to the rest of the class so that other students listening can benefit from the work and knowledge of their peers.

Engineering Connection

The engineering connection of this lesson is two-fold: (1) the active use of mechatronic and human sensors, as well as (2) learning about how material properties can be changed (engineered).

(1) Sensors—students will learn how to use temperature sensors in order to measure changes in water temperature, and students will compare the abilities of the mechatronic temperature sensor with their own abilities to measure temperature. Students will also use their innate senses of sight, taste, smell, and touch to investigate a material, and see the utility of having a mechatronic sensor versus a human sensor.

(2) Material Property Utility & Modification—students will also learn that one way to alter a material's physical properties is to add another material to it. They will observe that sometimes the physical property changed observed is somewhat obvious, as in the case of addition of sugar making water sweet, whereas in other cases, such as the addition of salt water to ice water, the material property changes are not so intuitive. The students will observe the changes in. This lesson will serve as an effective precursor to a lesson in which students can observe how specific changes in material properties can make a material useful for a given application.

Engineering Category

(#1) relates science concept to engineering

Keywords

water, mechatronics, sensors, senses, temperature, taste, sight, smell, touch, sound, physical properties, material properties

Educational Standards (New York City Public Schools)

State science: PS 3.1, 3.2, 4.1
State math: 4.M.2, 4.RP.7, 4.CM.1, 4.CM.3, 4.CM.6, 4.CM.10

Pre-Requisite Knowledge

A working familiarity with water and the other additive materials used (salt, sugar, food coloring, rice crispy cereal, oil).

Learning Objectives

After this lesson, students should be able to:

- Understand that mechatronic sensors can be used to detect temperature, and use mechatronic temperature sensors to measure temperature

- Understand the pros and cons of mechatronic versus human sensors
- Understand that material properties can be modified by changing the material composition
- Use the scientific method to make hypothesis about experiments, and use experimentation to investigate their hypothesis
- Further their experience with the use of presentations to share information

Materials List

Each group needs:

- a mechatronic temperature sensor (BASIC Stamp)
- 2 clear plastic cups (one filled with 1.5 cups of water, one filled with 1 cup of water and ½ of a cup of crushed ice)
- 1 plastic stirring spoon
- 3 large sheets of chart paper
- A set of colored marking pens
- 4 dixie cups
- 1 plastic disposable pipette

Depending on the Group (Name indicates the "most interesting" change that will be observed):

Taste Group: 2 plastic baggies each containing 1/8 of a cup of powdered sugar

Temperature Group: 2 plastic baggies each containing 1/8 of a cup of powdered salt

Sight Group: 2 plastic cups of 4 Tablespoons sesame seed oil (or other dark colored oil)

Smell Group: 2 plastic cups of 4 Tablespoons Molasses with a strong smelling essential oil (such as Mint) added

Sound Group: ¼ of a cup of Rice Krispies breakfast cereal

Touch Group: ¼ cup of corn starch

Extra Group idea:

Sight Group: 10 drops of red food coloring in a 2 tablespoons of water in a little bottle

Introduction / Motivation

Discussion & Lecture with Students—Pt. 1 Material Properties

Today, we're going to investigate how we can change water's properties, and better understand how we know if a property has changed or not. First of all, let's understand what a property of a material is. Can anyone tell me what I mean when I say a "property"? [Take answers from students] Good answers! When I say a "property," I mean something that can be used to describe a material. For example, we all know that many rocks are hard, so a property of many rocks is hardness. Or, we could say that a cup of juice, when spilled, will flow, so a property of juice is an ability to flow.

We can change material properties by modifying them—for example, if we wanted to make rocks flow, we could break them up into little pieces, and thus turn a rock into sand. Then, if you spill a cup of sand, it will flow, kind of like juice! And, if we wanted to change sand's properties

from being able to flow, to being able to stick together, we could add water to it, and have a really good sandcastle building material!

Instead of investigating rocks, sand, and juice today, we're going to investigate the properties of water when it's mixed with different materials, and how the properties of water change. We'll use our senses of sight, sound, touch, smell, and taste to investigate! We'll use both water, and iced water to investigate the changes of water in upon addition of a material.

Checking for understanding:
Can anyone give me an example of how adding several materials together can change the material properties?

Recap
So, to recap, we've heard a few examples about how material properties can be changed upon addition of other substances, and we've mentioned that we ourselves can actually do this kind of materials engineering, and that that's exactly what we will do today, with water!

Discussion & Lecture with Students—Pt. 2 Using our Senses, and Enhancing our Senses
So, we've heard about how we can change material properties by adding different substances, but how do we know if we've changed a material property? We can use our senses! Can anyone tell me one of our senses? [Wait for response. Repeat until 5 senses have been mentioned, or students have come to a limit in thinking up ideas]. Great job everyone, we have 5 different senses—sight, touch, smell, taste, and hearing.

If I had wanted to investigate whether or not the addition of sand and water had changed the properties of sand, I could use my eyes to **see** that the sand no longer looked dry, and I could use my hands to **feel** that the sand felt wet, and stuck together when I held it. It would probably smell the same, and I probably wouldn't hear anything different, and I might not want to taste it [Wait for laugh]. Today, we'll be using our senses to find out if the materials we add to water change the properties of water.

What if I wanted to find out more about a material than my senses could tell me? For example, if it was a very hot day on the beach, and the sand on the beach was so hot that it burned my feet, but the water in the ocean was so cold it felt freezing. I might want to know just how hot the sand was, and just how cold the water was. I could use a temperature probe to determine both these temperatures, and then I could find how much the temperature of both changed when I mixed the two to make the perfect sand castle material. This way, I'd know—without having to touch the stuff—if the material was at a good enough temperature to work with without burning or freezing my hands.

Today, we'll use mechatronic temperature probes to enhance our sense of touch! We'll be able to tell if whatever we're working with changes temperature upon addition of a new material. Who knows, maybe we'll see something interesting… Salt group, I'm looking at you.

Checking for understanding:
If I wanted to find out more about a material than my senses could tell me, what could I use?

Recap

So, we've discussed a little bit about how we'll use our senses to determine whether or not material properties have changed upon addition of a substance, and we've also discussed how will gain a bit of experience with enhancing our senses ability to determine material property changes by using a mechatronic temperature sensor.

Discussion & Lecture with Students—Pt. 3 Making Predictions

We've discussed a bit about changing material properties, and how we can determine the changes in material properties using either our own senses or enhanced mechatronic sensors. Now, we'll discuss a bit about how we make predictions of material property changes.

Before we mix sand and water, we can make a prediction how the material properties will change upon mixing. Making a prediction about what will happen is useful, so you can compare what actually happened with what you thought would happen, and thus learn more about your system by comparing the differences between what you predicted and what you observed.

Checking for understanding:

What do you think will happen if I mix…dirt and soda!? Will the resulting mixture taste good? Would it smell good? Would it feel good? Would it look good? Would it sound good? Great guesses! See how fun it is to hypothesize?

Recap

Today, we'll make predictions about what we expect to see, and what we see, to better learn about our material connections!

Vocabulary / Definitions

Word	Definition
material property	A material property is something which describes a material.
mechatronic sensor	A type of electrical sensor which can measure temperature by converting an electrical reading to a digital display.

Procedure

Background

The background information required to successfully carry out this lab is:

- A familiarity with the BASIC Stamp mechatronic temperature sensor

Before the Activity

Assign Students into Groups

- Assign each into a group of 4 students
- Assign each group: (1) **Taste**, (2) **Touch**, (3) **Sight**, (4) **Smell**, (5) **Sound**, (6) **Temperature**

Assemble Materials for each Group onto Group Desks

- On each group desk, place one set of all materials listed on the Materials section

With the Students

- Complete the Introduction/Overview Section Discussion (Pre-Activity Assessment)
- Instruct the Groups to Complete the Following Procedure**:**

  (*variability in the "addition of material" step according to their group type*)

  PROCEDURE:

  1. Have the group members make and record initial observations of the water cup, and the ice water cup, including sight, touch, smell, sound, odor, taste (with dixie cups & 1 pumps worth of pipette material), and temperature sensor readings on the provided sheet of chart paper. (1) Observation guidelines, and (2) a chart paper template for each observation are listed below:
     - Temperature observation: According to the mechatronic temperature sensor, what is the temperature in each of the cups. Record this temperature in the appropriate location on the chart paper.
     - Sight observation: What do each of the cups look like? Draw a picture of how each of the cups look on appropriate location on the chart paper.
     - Smell observation: How do each of the cups smell? Have each member describe how each of the cups smell, and record all unique observations on the chart paper in the appropriate location.
     - Sound observation: Do the cups have any sound coming from them? Have each member describe any sound coming from the cups, and record all unique observations on the chart paper in the appropriate location.
     - Taste observation: Using the pipettes and the dixie cups, have the students pipette one pipette's worth of material into their dixie cup, and taste it. Have each member describe the taste, and record all unique observations on the chart paper in the appropriate location.
     - Touch observation: Using the remainder of the material in the dixie cup (or a second pipette's worth if necessary), have each member feel the material in their cup, and record all unique observations on the chart paper in the appropriate location.

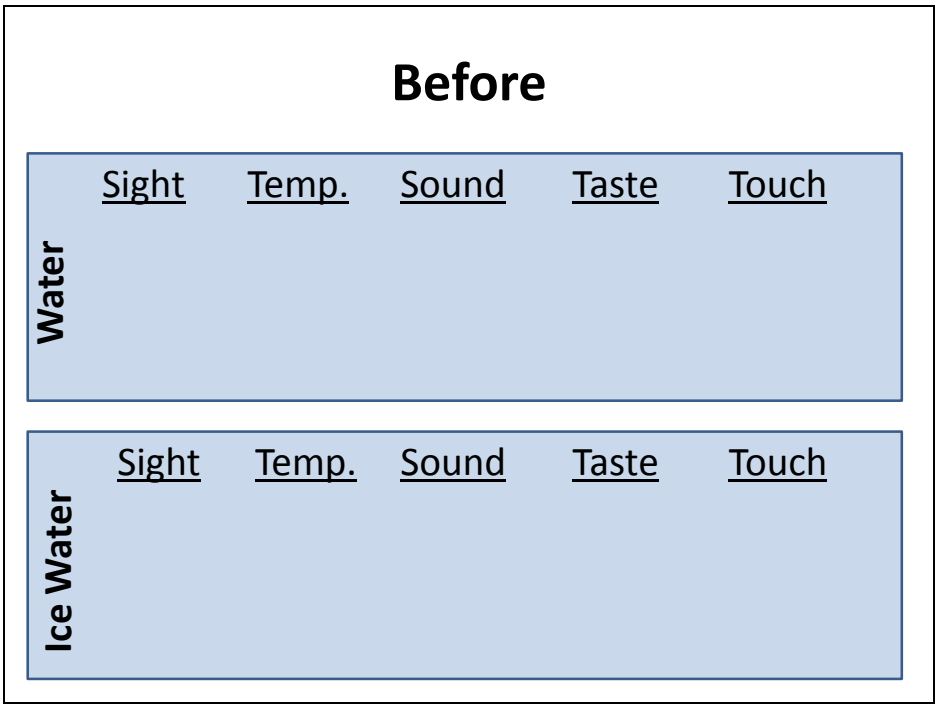

Figure 1: Chart Paper Template of "Before" Observations

2. Have each group make a list of predictions of how each property (sight, smell, touch, odor, taste, and temperature), will change upon addition of their substance, and record this in the "**Changes Predicted**" section of their second piece of chart paper their chart paper in list form using the template below:

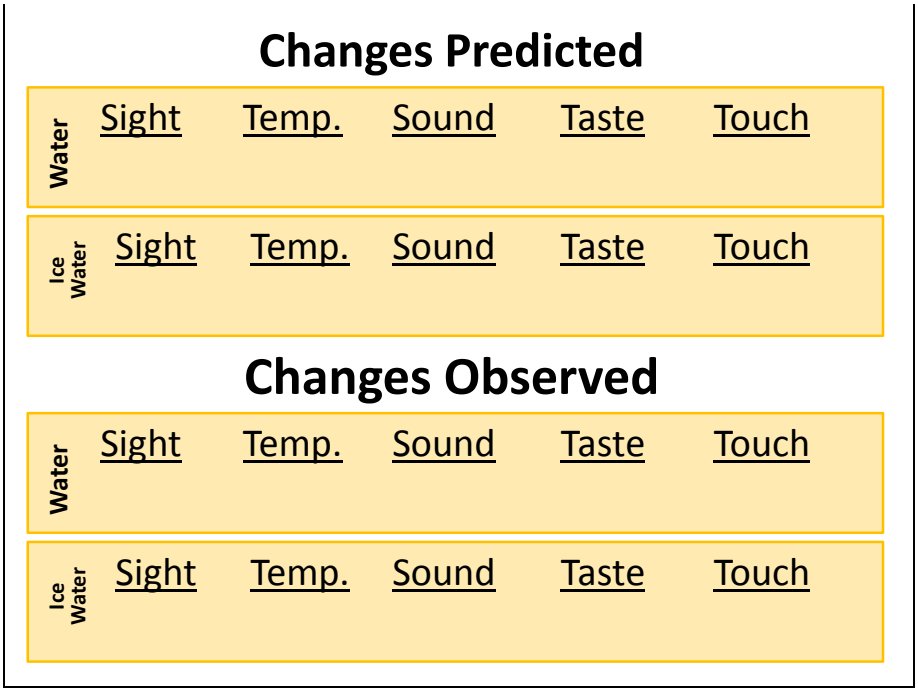

Figure 2: Chart Paper Template of "Changes"

3. ADDITION OF MATERIAL
   Depending on the group designation, have the group add the following materials (one cup or baggie each) to their cup of water, and their cup of ice water:

   Taste Group: 2 plastic baggies containing 1/8 of a cup of powdered sugar

   Temperature Group: 2 plastic baggies containing 1/8 of a cup of powdered salt

   Sight Group: 2 plastic cups of 4 Tablespoons sesame seed oil (or other dark oil)

   Smell Group: 2 plastic cups of 4 Tablesppons Molasses with a strong smelling essential oil (such as Mint) added

   Sound Group: 2 cups each with ¼ of a cup of Rice Krispies breakfast cereal

   Touch Group: ¼ cup of corn starch

4. Have one student make 2 quick stirs of each experimental cup, and wait 1 minute before proceeding to the next step.
5. Have each person make an observation of the sight, touch, smell, sound, odor, taste (with dixie cups & 1 pumps worth of pipette material), and temperature sensor readings on the provided sheet of chart paper post addition of the material, and fill out an observation piece of chart paper using the guidelines of step 1, and the following chart paper template:

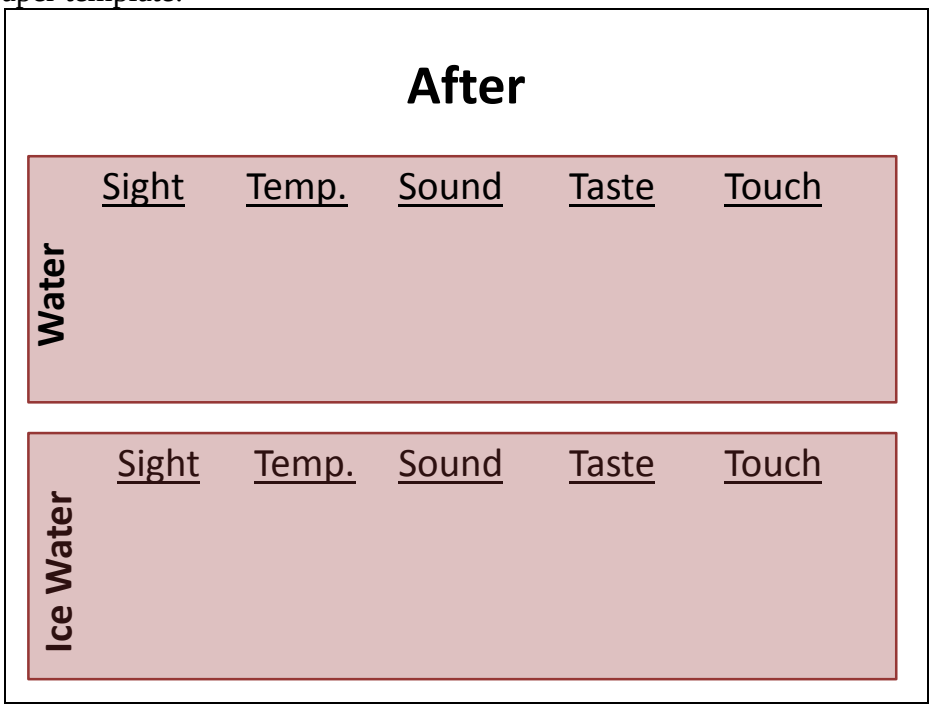

Figure 3: Chart Paper Template of "After" Observations

6. Have the students use these two sets of observations to compare what happened between the first and second set of observation, and state if any of the material properties (sight, touch, smell, sound, odor, taste, or temperature) change by circling with a marker the observations which are different between "**Before**" and "**After**" on the respective pieces of chart paper.

7. Have students use their circled differences from step 6 to develop and fill out their "**Observed Changes**" section of chart paper.
8. Have students present their three pieces of chart paper to tell other students their initial observations, their predictions of change, and the changes they actually observed.

Figure 4
ADA Description: A mixture of oil golden oil & clear water
Caption: Oil & Water
Image file name: olive_oil_in_water.jpg
Source/Rights: Copyright © Filipe Varela

Attachments
None

Safety Issues
None

Troubleshooting Tips
If students are having difficulties reading their BASIC Stamp Temperature probe, make sure the temperature probe is completely submerged in liquid, otherwise the probe will not be able to effectively measure the temperature of the solution.

Investigating Questions
- Can material properties change if they are mixed with other substances?
- How do we know if a material's properties have changed?
- What can we use to enhance our five senses?
- Why is developing and testing a hypothesis useful?

Assessment
Pre-Lesson Assessment
Call-out Question & Answer Session
During the initial introduction of the lesson, students will be asked questions related to material properties, modification of material properties via substance addition, methods of investigation of material properties, as well as use of the scientific method for hypothesis development and testing. These questions will stimulate the students thinking along the appropriate context lines for participation in this activity. Example text of possible questions integrated with introductory content can be found in the "Introduction/Motivation" section of this TeachEngineering Activity.

Lesson Summary Assessments
Development of Chart Paper Presentation on Findings
Students use their three pieces of filled out chart paper to understand how their predictions of property changes compared to their observed changes.
Presentation Chart Paper Presentation

Students will present their three pieces of filled out chart paper to the class, so that each student can learn from the work of the other groups by seeing their experiments, and the results of their experiments synthesized by their peers.

Discussion of Groups Work, and Recapping of Concepts Learned

Complete a brief discussion of the work they did:

- Changing of material properties
- Use of the student's senses
- Use of a mechatronic sensor
- Use of the scientific method
- Use of presentations to share information

Activity Extensions

"How Cold Can You Go?" – A follow up activity which applies the material property of a depressed freezing point to the making of ice cream.

Activity Scaling

- For lower grades, emphasize the scientific method, and hypothesis development more, as these students will be far less familiar with this than the grade for which this activity is intended.
- For upper grades, include significant discussion of why each additive material has the effect of changing water's properties in the way observed, and ask students to include this information in their presentation of results.

Additional Multimedia Support

None

References

None

Other

None

Redirect URL

None

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Supporting Program

School:
Polytechnic Institute of NYU

Grant:
This TeachEngineering Lesson was developed with the support of the AMPS Project via National Science Foundation GK-12 grant # 0741714