Lesson Topic: Temperature and Total Energy

Objective:
Students will be able to:

1. Discern the difference between temperature and total energy.

Time Required: 50 minutes

Materials Needed:

- 3 cups per group; one with cold water, one with room temperature water, and one with hot tap water. Caution: students will immerse their fingers into this water, so do not make it too hot to the touch.
- Timer or clock with second hand
- 2 clear cups of water per group, one with hot water (it can be hotter than hot tap water, but extremely hot water is not necessary) and one with ice water. Students will not immerse their fingers in this water.
- Food coloring
- Heat lamp, beaker filled with sand, beaker filled with water, two thermometers. If a heat lamp isn't available, the teacher can place pyrex containers of each substance on a hot plate and heat them for the same amount of time.

Teacher Preparation:

- Assign a Legends of Learning Content Review Quick Play playlist for the day after the lesson.
    - Content Review - Middle School - Temperature and Total Energy
- Prepare all hands-on materials for the lesson; be sure to watch the temperatures of the substances and reheat as necessary.
- Copy the activity sheet.

Engage (10 minutes):

1. Create lab groups of 2 students. Ask the students to work together to define temperature.
    a. Students usually express that temperature is how hot or cold something is.
2. Give each lab group the three cups of differing temperatures of water.
3. One student should act as the timekeeper.
4. The second student will place his or her right hand fingers into the cold water and fingers from the left hand into the hot water for one minute.
5. After one minute, alternatively place the fingers from the left and right hands into the cup of room temperature water.
6. Ask the students to switch roles and repeat the activity.
7. Ask the students to discuss whether or not humans are good "thermometers."
    a. Students should respond that it was difficult to tell the temperature of the third cup of water using their "hot" and "cold" fingers.
8. Explain that how hot or how cold something feels is dependent on how hot or cold your skin feels. We need more information to understand temperature. That's why freezing temperature and boiling temperature are typically used for consistency. Still,

there is more to temperature than just the amount of hot or cold.

Explore (5 minutes):

1. Ask the groups of students to take a clear cup of hot water and a clear cup of ice water. To each cup, add one drop of food coloring.
2. Make observations of the two cups and propose an explanation for the phenomenon observed.
    a. Students should observe the food coloring in the hot water dissipate more rapidly and fill the cup with color. The ice water will appear to “slow down” the movement of the food coloring.
    b. Explanations may include comments such as the heat moves the molecules of food coloring or the ice blocks the color’s movement.

Explain (10 minutes):

1. Provide the scientific definition of temperature (the average kinetic energy of particles of matter).
2. Ask students how that definition relates to the food coloring investigation.
    a. Students should deduce that the hot water had greater kinetic energy, or energy of motion, which allowed the coloring to diffuse more rapidly.
    b. Students may also assume that greater kinetic energy is always proportional to the “heat” in the cup of water. This is not always the case, so be prepared to correct misconceptions.
3. The relationship between the temperature and the total energy of a system depends on other factors such as the type of matter present and the amount of matter present. These variables will be further explored.

Elaborate (10 minutes):

1. Student pairs will explore/discuss scenarios to deepen their understanding of temperature and total energy. See attached worksheet.
    a. Scenario 1: Student pairs will observe the sand/water/heat lamp investigation the teacher has set up prior to the lesson. They should review the temperature data and discuss the differences.
        i. Students should see that even with the same heat source (sun, heat lamp, etc.) providing energy, that the temperature of the sand is much greater. This is due to the type of matter in sand compared to the type of matter in water. This could also lead to a discussion of specific heat capacity for more advanced students.
    b. Scenario 2: Students will not need any physical prompts, but they should discuss the explanations provided and determine which they most agree with.
        i. Students need to consider the amount of energy, not just the temperature. The pool, with a greater amount of matter, should have greater energy, even if the cup has very hot water.

Evaluate (15 minutes):

1. Have your students sign in to Legends of Learning. Instruct students to complete the Content Review playlist.
2. Responses on Temperature and Total Energy Activity Sheet.

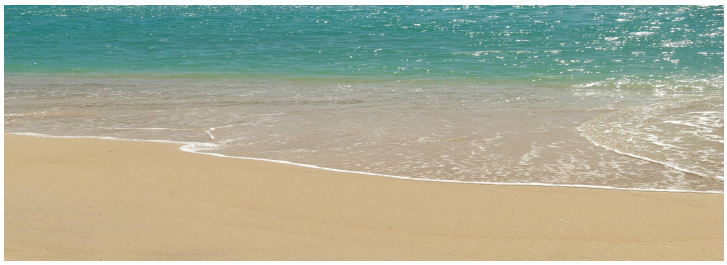
Additional Lesson Strategies:

- To use Legends for additional instruction, create a custom playlist with an instructional game and pre and post assessment.
- To use Legends for a quick formative assessment, create a 5-question assessment in a playlist.
- To use Legends for a student-directed experience, create a targeted freeplay playlist.
- Encourage students to play on their own at home in Legends of Learning: Awakening for a student-driven experience including avatars, battling, and quests all centered around topics they are covering in class.

Temperature and Total Energy

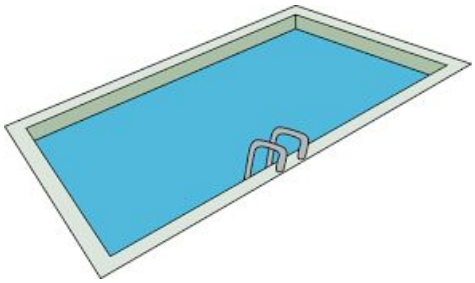
Name:

Scenario 1: A Day at the Beach



The sun's energy heats a beach in July. Excited visitors to the beach kick off their shoes and step onto the sand. Almost immediately they start running to the water, but not because they are excited to go play in the surf! Explore the model your teacher set up and construct an explanation for why people run to the water based on the science of temperature and total energy. Write your explanation below.

Scenario 2: Cup of Hot Cocoa vs. Swimming Pool



Two students are discussing whether a cup of hot cocoa or a swimming pool has greater total energy. Student A says it must be the cup of hot cocoa because the temperature is greater in the cup than in the pool. Student B says the swimming pool has greater total energy because the amount of matter present is far greater than that in the cup of cocoa. Determine which student you agree with and provide a rationale for your choice below.