Lesson Protocol:

Learning to Read the Thermometer

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SCIENCE INQUIRY PROTOCOL (5E LEARNING PLAN)

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1. Overview and Context

<table>
<tr>
<td colspan="2">Overview and context of lesson:
This lesson will teach students how to read a thermometer while also gaining a better understanding of different temperatures of water. After all, the goal is for students to understand how different temperatures of water (room temperature, cold & hot) produce different outcome measurements. Students will also be exposed to how water and temperature relates to weather.

A power point will follow along with the lesson to maximize comprehension for those who are more visual

ENGAGE: The students will see a demonstration that will allow them to create claims about the phenomenon at hand.
EXPLORE: The students will use plastic cups, water, and thermometers to explore the relationship between the water temperature and the thermometer reading.
EXTEND: The teacher will discuss the experiment with the students and connect the conversation with outside experiences.
EXPLAIN: The students will have a class discussion showing their understanding of the topic. While also completing a worksheet that evaluates their understanding.
EVALUATE: (do after rehearsal and enactment)</td>
<td>Intended Audience:
Cycle 1.
Grade 2</td>
</tr>
<tr>
<td>Phenomenon
Students will explore using a thermometer and water.</td>
<td colspan="2">Driving Question
How is water affected by temperature?</td>
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</table>

Lesson Resource:

This lesson plan was inspired by the article "How Hot is It?" by Governor and Carte. However, changes were made to the lesson, such as the worksheet used by the students. After the activity is finished (cups and water activity), the students will be given a worksheet to evaluate their understanding of thermometer readings.

Governor, D., & Carte, A. (2021). How Hot is it? Science and Children, 58(5), 36–42. Retrieved January 22, 2023, from https://www.nsta.org/science-and-children/science-and-children-mayjune-2021/how-hot-it.

2. Learning Goals

Students will know::

- "Working with the thermometers helped reinforce math skills for developing number sense with numbers up to one hundred" (Governor & Carter, 2021, p.37)
- Different ways to use a thermometer.
- Students will know why room temperature, hot and cold water produce different measurements on a thermometer.
- Students will know there are scientific ways of measuring temperature.
- Students will know the definition of expand, contract, Fahrenheit, and Celsius.

Students will do the following:

- Think critically about the relationship between water temperature and thermometer reading.
- Investigate the changes in the thermometer.
- Annotate their findings.
- Hypothesize what factors lead to a change in the thermometer.
- Students will work in groups to complete their given work.

Students will understand::

- Difference between Fahrenheit and Celcius.
- Difference between a positive and negative temperature reading.
- Different measurement levels on a thermometer given temperature of water.

QEP Connections

- ☑ Material World
- ☑ Earth and Space
    - ☑ Temperature (measuring instruments and seasons)

☐ Living Things

Essential Knowledges: Progress of Learning (PoL)

D. Systems and interaction	1	2	3	4	5	6
1. Everyday technical objects						
a. Describes the parts and mechanisms that make up an object	→	★				
b. Identifies the needs that an object was originally designed to meet	→	★				
4. Seasons						
a. **Describes the changes to the environment throughout the seasons (temperature, amount of daylight, type of precipitation)**	→	★				
b. Explains the sensations experienced (hot, cold, comfortable) with regard to temperature measurements	→	★				
c. Associates the changing of the seasons with the revolution and tilt of the Earth					→	★

Competencies:

- **To explore the world of science and technology.**
  - Everyday technical objects.
    - Description of parts and mechanism.
    - Identification of the needs that this object was designed to meet.

Strategies:

- Using a variety of observational techniques and tools.
- Using different tools for recording information (e.g., diagrams, graphs, procedures, notebooks, logbook)
- Comparing different possible explanations for or solutions to a problem in order to assess them (e.g., full-group discussion)

Gapless explanation:

I think no change will happen to the liquid inside the tube (claim).

I think this because I've seen or done items similar to the hand boiler (evidence 1), water does not go up by itself (evidence 2), and there is no other way for the liquid to travel since there are no holes on the tube (evidence 3).

The scientific principle or idea that helps me explain this is: liquid is trapped inside the tube, meaning there is no other place for it to travel (reasoning).

This principle or idea helps me use my evidence to support my claim because ____.

3. Resources and materials

Teacher materials	Student materials
☐ Thermometer ☐ Plastic cups ☐ Hand boiler	☐ Pencils ☐ Colored pencils ☐ Scissors ☐ Glue Stick

- ☐ How Hot Is It? (Governor & Carter, 2021)
- ☐ Hand Boiler Experiment (Hand Bubbler Experiment) https://youtu.be/es8pVMxWc-g?t=38
- ☐ Read a Thermometer Worksheet https://www.havefunteaching.com/resource/subject/math/temperature/read-a-thermom

Anticipated everyday experiences related to this phenomenon:

- The students will recognize that thermometers help take their temperature when they are sick.
- The students might have witnessed someone using a thermometer when cooking.
- Students might claim that thermometers are only used in warm/hot scenarios (temperature or cooking)
- Thermometers cannot tell us the weather temperature.

Image of alternative model with explanation and labels:

Students will pour food coloring inside jars and watch what occurs (each jar will contain water of different temperatures). Students will explore why the food coloring behaves differently in each jar.
The students will learn how different particles behave in different temperatures.

Source: https://coolscienceexperimentshq.com/water-temperature-experiment/

Public record of student thinking

Before beginning the demonstration, the teacher will set up a whiteboard to annotate all public records of student thinking. This will allow the students to see each other's ideas before understanding the phenomenon.
The set-up of one side of the board will be as follows:

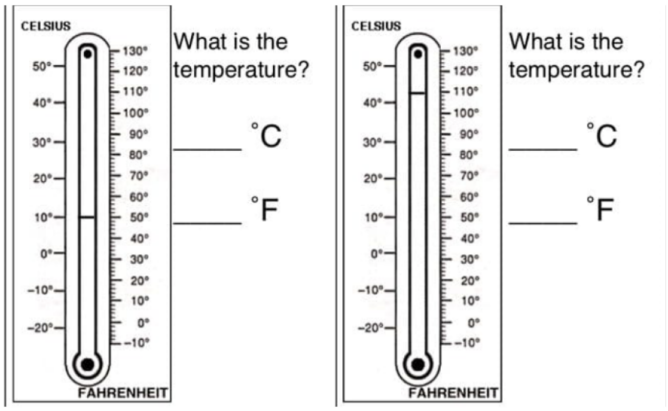
IDEAS!

What is happening inside the tube?

How is the liquid traveling up?

What is the similarity between the hand-boiler and thermometers?

The following board set-up will be for reviewing the Worksheet.



Note: Regardless of the accuracy of the student's responses, all of their ideas shall be recorded.

5. Instructional Sequence

ENGAGE (Paola)	
Management considerations: Students will start by sitting around the teacher in a moon shape to see the demonstration more clearly. - After the demonstration, the students return to their regular/assigned seats while the teacher briefly explains the topic. - Students will then be placed into groups of four by the teacher. - With the help of a few chosen students, the teacher will pass around the material (provided by the teacher) that will be utilized during the introduction/engage section of the activity.	
The teacher will: -Review students' expectations for the lesson: *T: "Before we begin our science class, I would like everyone to sit on the carpet and form a half a moon.* *<u>After the students sit:</u>* *T: I will review the classroom discussion guidelines and expectations:* *1) Express your ideas.* *2) Consider each idea with respect.* *3) There is no right or wrong response.* -Introduce the phenomenon of weather patterns and give a definition. *T: "Many people check the weather as soon as they get out of bed in the morning. It might help them know what to wear or bring to school that day based on the weather pattern. A weather pattern develops when the weather is consistent for several days or even weeks.* *The four seasons of summer, winter, spring, and fall are associated with specific weather patterns. You might already know various weather patterns, such as hot and dry, wet and rainy, or cold. Let's look more closely at these typical weather patterns."*	**The student(s) will:** -Pay attention to the teacher's expectations and, if necessary, seek clarification. -Share their prior experiences using a thermometer *S: "My parents sometimes use that when I am sick"* *S: "I have seen my family use that in our pool"* *S: "My parents sometimes use that when they are cooking"* -Carefully observe the thermometer and hand boiler and then share their observations *S: "I see the colors red and blue"* *S: "I see lots of numbers"* *S: "I notice that the shape is different"* -Listen to the consensus of what the entire class has seen and, if necessary, ask for clarifications. -Share their hypotheses with the class *S: "I think the colors will change when it gets cold or warm"* *S: "I think the weather will change the color"*

T: "Can someone tell me which season(s) is hot and dry?" *"Can someone tell me which season(s) is wet and rainy?"* *"Can someone tell me which season(s) is cold?"* -Introduce the phenomenon of the thermometer. *T: " Can anyone tell me if anyone has ever seen or used one of these objects?"* **Teacher proceeds to show the thermometer and hand boil tool.* The teacher will begin by placing the hand boiler in the center of their palm. After the liquid bubbles, the teacher asks, *"Can anyone share with the class what they believe is happening inside the tube?"* *"How do you think the liquid is traveling up?"* **Teacher will write all the student's ideas on the whiteboard.* To further reinforce students' understanding, the teacher will carefully ask for volunteers and place the hand boiler in their hands. **Note: the students should not handle the item without the teacher's supervision.** Write down the words that best describe the students' observations on the board. To elicit students' observations, use talk moves. *T: "What do you notice about the hand boiler? What do you think it might be used for?"What is something interesting about this object? Do you have a hypothesis of why the liquid bubbled?"* -Establish consensus on the observations made by the entire class. *T: "Okay, from everyone's answers, we can all agree that maybe something in our palms helps*	-Students will proceed to fill out the worksheet provided to them in groups of four and ask for any clarification if needed. -The class should hear their responses. Explain their current thinking and any earlier experiences that have influenced it. Or pay close attention to your classmates' responses. Analyze their responses on the board in parallel, then ask or review them. -With guidance, establish information to begin to answer the investigation question.

the liquid travel upwards inside the boiler. This is a fantastic idea! *We have heat in our bodies, which is why most of the time, we feel warm. The heat of our palms makes the liquid inside the body heat up, so we see it rise to the top and make a bubbling sound.* *But now I have a different question for you! How is this demonstration related to thermometers? What is the connection?* **Teacher will highlight all the similar and relevant ideas brought forward by the students on the board.* -Elicit hypotheses about the phenomenon *T: "How do you think the thermometer will react to different water temperatures?"* **To answer this question, encourage students to think about what components will influence the thermometer or hand boiler* -Invite some of your students to share their answers with the class and add to the original diagram. Ask them to explain their thinking as a group. Accept all opinions at this point and refrain from endorsing any particular viewpoint (take advantage of this chance to learn about students' perspectives). Use various discourse techniques to help students share, develop, and clarify their ideas at this point. They can also deepen their reasoning or collaborate with others. -Establish the guiding questions students need to proceed to the class activity. *T: "What effect does water temperature have on a thermometer?"*	

EXPLORE **(Alessia)**
Management considerations: ● Students will be in small groups of 2-3 ○ The teacher may pick the groups or allow the students to form their groups ● The teacher can give instructions on the activity, including guiding information about how to use the thermometer. ● The teacher will place ○ A thermometer. ○ Three cups. (one with ice cubes, one at regular temperature, one is hot) ○ White labels. ○ Rags ● The water will be poured into each cup by the teacher or a trusted student from a pitcher. ● Preceding the activity, each table will designate one person to bring the marker and thermometer to the teacher. ● The teacher can ask students to pour water into a sink in the classroom or back into the pitcher if a sink is unavailable.

The teacher will:	**The student(s) will:**
The teacher will give time to explain expectations for the activity. *T: We will now do an activity where we experiment with thermometers. I would like first to describe the activity and then go over the goals and expectations for this activity.* *1) There will be three cups filled with water. Each cup will have a different temperature.* *2) You can use images or words to label the cups:* *a) Ice = coldest.* *b) House= room temperature.* *c) Fire = hot water.* *3) After labeling the cups, you can discuss what you learned with your group.*	The students will listen to the teacher explain and go over the instructions for the activity.

4) Give more explanation on how to use the given thermometer. *Remove the thermometer gently from its packaging and place the bottom into the water. The bottom of this thermometer is the colour red.* *T: I expect you all to listen to your peers and communicate with each other. If you have made a spill, do not hesitate to ask for a napkin from me.* Before grouping, the students ask if there are any questions about the task. *T: Are there any questions or comments before we split into groups?* Begin grouping process. Option 1: Group students into teams of 2-3. Option 2: Allow students to go into groups of 2-3. Begin giving out the materials or assign a student to give out three cups, one thermometer, and three cards to each group. Then go around with the water pitcher, pour enough water into one cup, and repeat with the other hot and cold water. After the students are in groups, explain: "*There are two temperature units, Celsius and Fahrenheit. Celsius is shown with a C and Fahrenheit with an F. Both units will show you different numbers in your thermometer, but that is okay! Both units are different, but the temperature they mark is the same.*" Signal to the students that it is time to begin.	If the students have any questions or comments about the activity, now is the time they will ask. Students go into their groups. Assigned students will help. The students begin to explore temperature in their groups. Students are answering questions and thinking about the topic of thermometers. The students will share their findings with the class.

During the task, the teacher will survey the students as they work. Asking guiding questions leads them to understand how the thermometer works. Some questions you may ask during this time are… *T: What did you notice about the change between the cups on the thermometer?* *T: What does the thermometer signify when the water is cold/hot?* *T: What did you notice?* *T: When was the number higher/lower?* Preceding the activity, review what the students gathered from their experiment. Begin to clean up.	The class will have a group discussion about what they have found. Students will help clean up their areas.

EXPLAIN (Grace)

Management considerations:

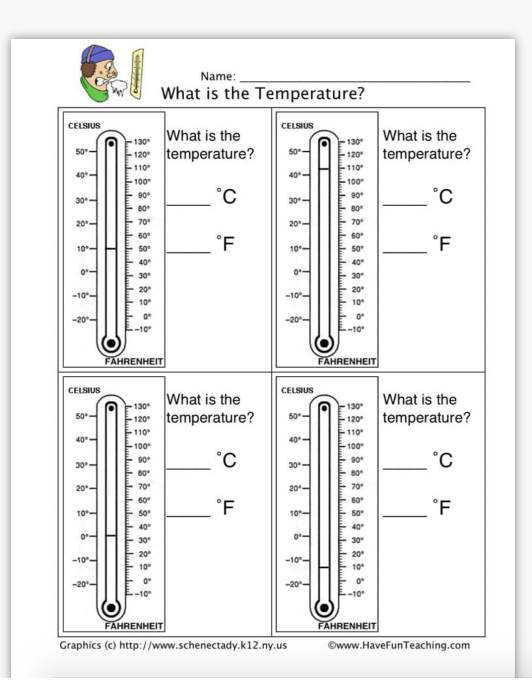
- After the clean-up, students will be asked to remain in small groups of 2-3. This may help students feel more at ease to discuss their discoveries.

- To begin, the teacher will ask students to show by lifting their hands if they enjoyed the activity and if they believed it was an important experiment related to science.
  **A theoretical approach by speech and one virtually will help differentiate the lesson.

- The teacher will instruct students to complete a small worksheet to expand their comprehension. Students might work alone if they wish. Before handing out worksheets, an example of what to expect will be gone over.

- Once the teacher has had the opportunity to interact with all students, the class will be asked to be quiet and respectful as the class will begin to share their ideas with everyone, and the teacher will call upon those chosen.
- The teacher will ask the students what they have learned by doing this activity and what they think the purpose of it was.

- The discussion will allow us to go over answers and clear up any confusion, hopefully leading to a consensus of understanding. If students require extra help, time will be allocated to meet their needs.



The teacher will:	**The student(s) will:**
T: Class, listen up. We are going to start a discussion altogether. Now you may stay in your small groups; however, I expect you to all be respectful, quiet, and ready to interact.	Students listen attentively.
T: By using your hands and staying quiet, can you all tell me if you enjoyed this activity?	Students raise their hands.
T: Great! Please show me if you believe this was a science-related experiment by just raising your hands.	Some students raise their hands as others seem unsure.
T: After completing the experiment, what do you guys think the effect of water temperature has on a thermometer?	S: Students put their hands up and individually give answers. (thermometers work with numbers) (thermometers involve math). (thermometers can tell us how hot it is outside). (thermometers can tell us how cold it is outside). (wait! That means it can also measure the temperature in this classroom). (thermometers can be measured in Fahrenheit and Celsius). (how can temperature be two different numbers). (another student helps clarify with the teacher's help that it is two levels of measurement that, although they are different numbers, both have the same meaning) (one student tries to help discuss pounds and kilos).
T: These are some excellent answers. Now I will hand out a small worksheet to have you all complete. Each one of you has to complete the worksheet. However, you may stay in your	

small groups if you remain quiet. If you wish to work individually, you may do that as well. Once students finish, the teacher will pick up all the worksheets	Students move around and place themselves.
T: Before I hand out the worksheet, I would like to take a moment to review an example first to ensure you all understand what needs to be done.	Students listen attentively.
The teacher goes through an example on the board while pulling up directions on the PowerPoint that have been followed for the whole lesson.	Students watch the board and raise their hands if they do not understand Students begin to work on the worksheet.
T: With all these great answers, I will put a table together to show you guys the outcomes of what we have learned, and I will display it in the class for you all to remember the experiment. *T: How do you guys feel about signing the bottom of the table, as all your ideas will have brought the table together?* *T: That sounds great, it will add a nice punch of colour.* The idea behind asking them to sign the table is to give them meaning and purpose for their actions. Students will be re-interacting with the experiment they did, hopefully heightening their knowledge	Students share their answers S: Students shout out answers, all resulting in yes!

EXTEND (Jo)	
Management considerations -Review key ideas and findings that were discussed throughout the lesson. This will primarily be done using class discussion and the white board to summarize ideas. -Provide Feedback, the educator will provide feedback to students on their learning and help them with future science concepts -Educator will have a follow-up activity planned so that students will go home and complete a task related to thermometers in order to further develop on the concepts discussed in the lesson plan. **The teacher could:** *T: Okay class! After the activity you did, and the worksheet, we can review the topic quickly. So who can tell me:* *"what do you think is different between the thermometer you use for the experiment and the thermometer you use when you are sick?"* *"I now want you all to discuss in small groups at your table the question asked, I will write it on the board for reference"* *"Do you think we could use this thermometer we used in class to check our body temperature?"* If the student is not sure of an answer, prompt them further.	**The student(s) could:** *S: The thermometers we use to check our own body temperature are smaller, and we put them in our mouths or armpits!* *S: Maybe!* *S: At the doctor's!* *Kitchen? Cars?* *S: There are giant thermometers somewhere that read the weather.*

"I now want you all to discuss in small groups at your table the question asked, I will write it on the board for reference" *"Do you think there are other types of thermometers?" if so, what are they?"* *"I now want you all to discuss in small groups at your table the question asked, I will write it on the board for reference"* *"How do you think thermometers are used to read the weather temperature?"* *"I now want you all to discuss in small groups at your table the question asked, I will write it on the board for reference"* To continue the conversation and learn outside the classroom, you can ask the students the following: *T: For homework, you will attempt to find other types of thermometers in your home. You can ask a friend or family member. If you do not have any in your home. Next class, we will look at the pictures you brought and discuss the differences between the thermometers. You can submit your pictures on SeeSaw.*	

EVALUATE (after the Rehearsal and Enactment)

Management considerations:

Assessments will be taken in both summative and formative form found below. Observation will be key as far as evaluating students' knowledge and participation. Students will have the opportunity to work alone and in pairs/groups. The homework assigned will be a form of evaluation as well which will be done independently at home.

Cleaning up the classroom will be fairly easy and manable as every person responsible for materials will bring them back up to the front if they worked individually and if they worked in the group, the nominated person will gather all materials for the group to deliver.

Include and justify management considerations for this part of the lesson (e.g., number of students who will be working together on a particular task such as whole class, small group, or as individuals, how you will manage the distribution and clean-up of materials, transitions between segments of instruction)

The teacher will:	**The student(s) will:**
Formative Assessment. The teacher will note each student's participation in the experiment. Completing the temperature worksheet will assess the students' understanding of how to read the temperature.	Do the temperature worksheet. The worksheet can be done individually or in pairs.
Summative Assessment: The completion of the homework submitted to SeeSaw. (Option to have them even take their own temperature and/or those in their household as well and share the results)	Students will submit pictures of different types of thermometers on SeeSaw. Students will have the opportunity to share their pictures with the class. As well as their thermometer readings for those that were interested.
I will say … *"Does anyone want to share their pictures of their thermometers with the class?"* OR *"Does anyone want to explain if they have used different types of thermometers?"* I will ask…	

Students can explore the different types of thermometers. OR Students to identity when the reading on the thermometer will be different I will do… Participate in the task, and I will show pictures of the thermometers I have in my house. OR I will take my own temperature to show an example and ask students to do so at home if they are interested.	

Changes Done to Lesson Sequence:

- Alternative model was changed. The alternative model added is a different experiment following a similar pattern to the original one. We aim to show the students a more visual way to see how water temperatures can affect how other liquids react.
- The whiteboard set-up was updated to represent how the students' ideas will be recorded.

Changes Done to the Engage Section:

- Teacher will explain to students that the hand-boiler does not boil the liquid; instead, bubbles form at the top.
- The teacher will explain to the students how and why the liquid rises and bubbles inside the hand boiler. This will allow the students to thoroughly understand what is happening with the object.

Changes Done to the Explore Section:

- Clearler instructions (how to handle the thermometer to avoid accidents).
- Teacher will explain to the students how to read the thermometer and the different units we can use to read temperature (Celcius and Fahrenheit).
- Allow for discussion time after the experiment is finished (allowing the students to hear the ideas of their peers).

Changes Done to the Explain Section:

- The teacher will do an example of a question from the worksheet. The example will be done on the board, allowing the students to understand the task clearly.

- Teacher will explain to the students that similarly to the thermometer they handled previously, the ones in the picture have two sides, Celcius and Fahrenheit.

Changes Done to the Expand Sections:

- Management consideration were added to the expand section
- Teacher will additionally give time for students to reflect and discuss in small groups
- Students will have a chance to discuss in there small groups to work with their peers to come up with new ideas and perspectives on the questions being asked