Resource ID#: 176008

Primary Type: Lesson Plan

Just Right Goldilocks' Café: Turbidity

This is lesson 2 of 3 in the Just Right Goldilocks' Café unit. This lesson focuses on systematic investigation on getting a cup of coffee to be the "just right" level of turbidity. Students will use turbidity sensors and code using ScratchX during their investigation.

General Information

Subject(s): Science, Mathematics
Grade Level(s): 4, 5, 6, 7, 8
Intended Audience: Educators
Suggested Technology: Computers for Students, Internet Connection, Probes for Data Collection
Instructional Time: 1 Hour(s) 45 Minute(s)

Keywords: code, coding, computer science, turbid, turibidity, sensor, probe, scratch, inequality

Instructional Component Type(s): Lesson Plan

Instructional Design Framework(s): Guided Inquiry (Level 3)

Resource Collection: CPALMS Computer Science Lessons Using Mantis Sensors

Attachment

GoldilocksTempWorksheet.docx
GoldilocksTurbid.sbx

Lesson Content

Lesson Plan Template: Guided or Open Inquiry

Learning Objectives: What will students know and be able to do as a result of this lesson?

Students will be able to develop a systematic plan for adjusting the turbidity of coffee to make it "just right".

Student will be able to use probeware/sensors to gather data and create a table to organize the data.

Students will be able to write code that utilizes probeware/sensors as data gathering tools.

Students will be able to communicate their procedure and results in writing.

Prior Knowledge: What prior knowledge should students have for this lesson?

Students should have built some knowledge of planning science lab investigations from lesson 1. Students should also have some basic knowledge of using block coding in Scratch to display different Sprites and different words on the screen based on variables from their experience in lesson 1 as well. Students should be familiar with inequalities <, > and also the equal sign.

Guiding Questions: What are the guiding questions for this lesson?

How can we systematically adjust the turbidity of a liquid to make it "just right"?

How can using probeware/sensors and code make this process more efficient?

Introduction: How will the teacher inform students of the intent of the lesson? How will students understand or develop an investigable question?

Tell the students that Goldilocks was quite pleased with the new testing code they created in lesson 1, however she is becoming a connoisseur of coffee and realized that there is a perfect turbidity level that makes the coffee "just right". (NOTE: the coffee does not need to be hot for this lesson, pick a turbidity target that is in the middle of clear coffee and coffee with a lot of cream) Discuss that turbidity is the haziness or amount of suspended solids in a liquid. A turbidity sensor tests for the amount of light that is scattered through the substance. The unit of measure is NTUs.

Provide the worksheet to the students and read over the challenge. Make teams of students depending on the number of computers and turbidity sensors available. Have students work through the plan on how to set up an investigation that allows a systematic approach to getting the "just right" turbidity level. Discuss why scientists use a systematic approach and how adding small amounts and testing the turbidity will allow for better control and observation.

Allow students to talk with other teams and perhaps verify their plan with the teacher before moving forward with the coding plan.

Depending on the level of coding skill and prior experience with the turbidity sensor, the teacher may need to show the students how to use the sensors in conjunction with ScratchX. The coding part can be done by each team, allowing for diversity in code, or the teacher can decide to walk the students through this part of the worksheet and Scratch. The minimum code at this point is to have the sensor produce a turbidity reading and say "just right" when the turbidity is at the target goal.

Investigate: What will the teacher do to give students an opportunity to develop, try, revise, and implement their own methods to gather data?

Students must first try their code and make sure it works with the turbidity sensor. Provide all students with a turbid liquid that you already have test and know the NTUs, each vial must be shook before testing. Make sure that all their code displays approximately the same turbidity before they begin their investigation. Once students are ready, provide them with the time and materials that are needed to alter the turbidity. It is suggested to provide the students with a variety of supplies like creamer and even sugar for them to experiment. Allow them to discover that clear brown coffee or even dark clear brown coffee has a turbidity that is very low, usually 0 NTUs. This allows them to realize they need creamer. NOTE: provide very diluted creamer as well as full strength creamer to test. Students may need to start over again once they use too much creamer. Students should be able to have pipets, graduated cylinders, beakers or other material to safely hold the coffee. Students must be able to transfer the coffee to the vial that fit inside the sensor. Students must always shake the liquid just before testing. Be sure the coffee you are giving the students is not already the target turbidity level.

Analyze: How will the teacher help students determine a way to represent, analyze, and interpret the data they collect?

Students will collect the data on the worksheet and organize the data to show the systematic procedure that was used. Students may need scaffolding and guidance on how to organize their data, however allow for some flexibility in this step which relates to their procedure. Students will use their code and the probe to gather data. Students may find they need to add more creamer or more water to dilute the coffee depending on the amount they add. The amount, if too turbid, may put them past the target level. Students may need to start over again once they use too much creamer. Students should call the teacher over when they have coffee that is "just right".

Closure: What will the teacher do to bring the lesson to a close? How will the students make sense of the investigation?

The whole class should come back together to discuss the results and how each team may have approached the task differently and how they may have had to adjust their plan in the middle of the investigation. A discussion on how systematic and perhaps smaller amounts were key to this investigation so the turbidity didn't go past the target too quickly.

Summative Assessment

The summary section on the worksheet along with the code created in Scratch can be used to assess the students.

Formative Assessment

Throughout the lesson the students should be asked probing questions and stopped periodically to make sure they are progressing smoothly. Each team could possibly have different procedures and this should be encouraged. Important stopping points would be after the students create their plan. Students can either conference with the teacher or other groups to receive constructive feedback. Students should have a preliminary plan for their code, before allowing the lab investigation to begin the code should be correct in Scratch. Students should do a "test" using a sample of turbid water and compare their reading to that of other groups to make sure the sensor is working as expected. Students should make sure that they also have initial readings taken before they start collecting data. Teachers should look at the data periodically to make sure students are recording the correct data.

Feedback to Students

Students should receive feedback throughout the investigation from the teacher and peers. Peer interaction to improve procedure and debug code is imperative to help make stronger problem solvers. Be sure to provide feedback to the plan and to the code before allowing students to start their investigation. A trial sample to check the sensor is needed for the students to make sure their code is working as expected.

Accommodations & Recommendations

Accommodations:

Depending on the students' skills the teacher may need to scaffold the planning stages, coding stage and writing summary. The teacher can decide which groups are ready to progress with open inquiry and which groups will need more direction. Students that struggle with writing the summary can use the fill in the blank summary sample on the worksheet as a guide.

Extensions:

If students are ready, they can be challenged to create a more interesting background on their code. Students can add to the program so not only does "JUST RIGHT" pop up on the screen when the turbidity is at the target goal, a "TOO LOW" or "TOO HIGH" shows when the turbidity is > or < the target goal. Students can also incorporate sprites that depict too turbid and not turbid enough as well.

Students that are familiar with writing flowcharts can be challenged to incorporate a flowchart as their coding plan.

Suggested Technology: Computers for Students, Internet Connection, Probes for Data Collection

Special Materials Needed:

Students will need access to ScratchX Beta as well as a Mantis Turbidity sensor with Sensor Wand and Bluetooth dongle connector.

Water, coffee and creamer (full strength and diluted) will be needed, as well as beakers, graduated cylinders, pipets, and any other material that the students request in their plan. NOTE: The coffee should never be so hot it can burn. Make sure to adhere to all safety requirements.

Further Recommendations:

Since turbidity needs to be altered you should plan to provide different turbidity levels of creamer. For example, full creamer, half water and half creamer, plain water, and creamer mixed with water at different ratios. Please note that even 3 small drops of full creamer could put the turbidity level over the max 1000 NTUs causing an artificially low reading level on the sensor.

Plain dark coffee,with no particles, should provide a level of 0 NTU - about 5 NTUs. Any creamer, even diluted creamer, can quickly surpass 500 NTUs.

Source and Access Information

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Access Privileges: Public

Aligned Standards

Name	Description
SC.35.CS-CC.1.3:	Identify ways that technology can foster teamwork, and collaboration can support problem solving and innovation.
SC.35.CS-CC.1.5:	Explain that providing and receiving feedback from others can improve performance and outcomes for collaborative digital projects.
SC.35.CS-CP.2.2:	Create, test, and modify a program in a graphical environment (e.g., block-based visual programming language), individually and collaboratively.
SC.35.CS-CP.2.3:	Create a program using arithmetic operators, conditionals, and repetition in programs.
SC.35.CS-CP.2.4:	Explain that programs need known initial conditions (e.g., set initial score to zero in a game, initialize variables, or initial values set by hardware input).
SC.35.CS-CP.2.5:	Detect and correct program errors, including those involving arithmetic operators, conditionals, and repetition, using interactive debugging.
SC.35.CS-CS.1.3:	Answer a question, individually and collaboratively, using data from a simulation.
SC.35.CS-CS.2.2:	Describe how computational thinking can be used to solve real life issues in science and engineering.
SC.35.CS-CS.2.6:	Write an algorithm to solve a grade-level appropriate problem (e.g., move a character through a maze, instruct a character to draw a specific shape, have a character start, repeat or end activity as required or upon a specific event), individually or collaboratively.
SC.35.CS-CS.2.7:	Identify and correct logical errors in algorithms; written, mapped, live action, or digital.
SC.35.CS-CS.2.8:	Systematically test and identify logical errors in algorithms.
SC.4.E.6.5:	Investigate how technology and tools help to extend the ability of humans to observe very small things and very large things.
SC.4.N.1.1:	Raise questions about the natural world, use appropriate reference materials that support understanding to obtain information (identifying the source), conduct both individual and team investigations through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.
SC.4.N.1.2:	Compare the observations made by different groups using multiple tools and seek reasons to explain the differences across groups.
SC.4.N.1.3:	Explain that science does not always follow a rigidly defined method ("the scientific method") but that science does involve the use of observations and empirical evidence.
SC.4.N.1.5:	Compare the methods and results of investigations done by other classmates.
SC.4.N.1.6:	Keep records that describe observations made, carefully distinguishing actual observations from ideas and inferences about the observations.
SC.4.N.3.1:	Explain that models can be three dimensional, two dimensional, an explanation in your mind, or a computer model.
SC.4.P.11.1:	Recognize that heat flows from a hot object to a cold object and that heat flow may cause materials to change temperature.
SC.5.N.1.1:	Define a problem, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types such as: systematic observations, experiments requiring the identification of variables, collecting and organizing data, interpreting data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
SC.5.N.1.3:	Recognize and explain the need for repeated experimental trials.
SC.5.N.1.5:	Recognize and explain that authentic scientific investigation frequently does not parallel the steps of "the scientific method."
SC.5.N.2.2:	Recognize and explain that when scientific investigations are carried out, the evidence produced by those investigations should be replicable by others.
SC.5.P.8.1:	Compare and contrast the basic properties of solids, liquids, and gases, such as mass, volume, color, texture, and temperature.

SC.6.N.1.1:	Define a problem from the sixth grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
SC.6.N.1.4:	Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.
SC.6.N.1.5:	Recognize that science involves creativity, not just in designing experiments, but also in creating explanations that fit evidence.
SC.68.CS-CP.2.3:	Develop problem solutions using a block programming language, including all of the following: looping behavior, conditional statements, expressions, variables, and functions.
SC.68.CS-CP.3.1:	Select appropriate tools and technology resources to accomplish a variety of tasks and solve problems.
SC.68.CS-CS.1.3:	Evaluate what kinds of real-world problems can be solved using modeling and simulation.
SC.68.CS-CS.2.2:	Solve real-life issues in science and engineering (i.e., generalize a solution to open-ended problems) using computational thinking skills.
SC.68.CS-CS.2.6:	Create a program that implements an algorithm to achieve a given goal, individually and collaboratively.
SC.68.CS-CS.2.7:	Design solutions that use repetition and two-way selection (e.g., for, while, if/else).
SC.68.CS-CS.6.1:	Explain why some tasks can be accomplished more easily by computers.
SC.68.CS-CS.6.3:	Identify novel ways humans interact with computers, including software, probes, sensors, and handheld devices.
SC.7.N.1.1:	Define a problem from the seventh grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
SC.7.N.1.3:	Distinguish between an experiment (which must involve the identification and control of variables) and other forms of scientific investigation and explain that not all scientific knowledge is derived from experimentation.
SC.7.N.1.4:	Identify test variables (independent variables) and outcome variables (dependent variables) in an experiment.
SC.7.N.3.2:	Identify the benefits and limitations of the use of scientific models.
SC.7.P.11.1:	Recognize that adding heat to or removing heat from a system may result in a temperature change and possibly a change of state.
SC.8.N.1.1:	Define a problem from the eighth grade curriculum using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
SC.8.N.1.2:	Design and conduct a study using repeated trials and replication.
SC.8.N.3.1:	Select models useful in relating the results of their own investigations.
MAFS.4.NBT.1.2:	Read and write multi-digit whole numbers using base-ten numerals, number names, and expanded form. Compare two multi-digit numbers based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons.
MAFS.4.NBT.1.3:	Use place value understanding to round multi-digit whole numbers to any place.
MAFS.6.EE.2.8:	Write an inequality of the form x > c or x < c to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form x > c or x < c have infinitely many solutions; represent solutions of such inequalities on number line diagrams.
MAFS.7.EE.2.4:	Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. a. Solve word problems leading to equations of the form px + q = r and p(x + q) = r, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. *For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?* b. Solve word problems leading to inequalities of the form px + q > r or px + q < r, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. *For example: As a salesperson, you are paid $50 per week plus $3 per sale. This week you want your pay to be at least $100. Write an inequality for the number of sales you need to make, and describe the solutions.* **Clarifications:** **Fluency Expectations or Examples of Culminating Standards** In solving word problems leading to one-variable equations of the form px + q = r and p(x + q) = r, students solve the equations fluently. This will require fluency with rational number arithmetic (7.NS.1.1–1.3), as well as fluency to some extent with applying properties operations to rewrite linear expressions with rational coefficients (7.EE.1.1). **Examples of Opportunities for In-Depth Focus** Work toward meeting this standard builds on the work that led to meeting 6.EE.2.7 and prepares students for the work that will lead to meeting 8.EE.3.7.