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Lesson in Action

Supporting Science: Graphing Data

AT A GLANCE

Launch

- Review the experiment previously conducted and the scientific question being investigated.
- Have class analyze data collected, modeling expected behavior for the learning task.
- Have students consider sources of scientific error and relevant mathematics when analyzing data.

Learning Task

- Introduce the learning task, instructing students to work with their own experimental data.
- Circulate, listening to discussions and supporting students as necessary.
- Guide student discussion to focus on observations that relate to the conservation of mass principle.

Closure

- Lead a class discussion, making sure that data from both physical and chemical changes are examined and discussed.
- Encourage students to generalize their observations, prepping students for a future lesson on conservation of mass.

Context

Mrs. Martin's Grade 5 class is engaged in a science unit on matter. In the previous lesson, they conducted an experiment to study how physical and chemical changes affect the mass of various substances. Today, students are going to analyze the data they collected and draw conclusions based on their observations. The class was recently introduced to the coordinate system, which gives students the ability to graph their data and analyze it with this type of representation. Mrs. Martin sees this as a good opportunity to reinforce their mathematics learning and practice plotting data points.

Common Core State Standards

- CCSS.Math.5.G.A.2 (http://www.corestandards.org/Math/Content/5/G/A/1)
  Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

Lesson Objective

Graph data on the coordinate plane and use the graph to analyze the data.

Technology

- Interactive whiteboard to communicate visually with the class
- Spreadsheet tool (e.g., Google Spreadsheet) to collect and organize data
- Graphing tool (e.g., Shodor Scatter Plot interactive or Desmos) to create a data visualization

Assessment

- Graphs and accompanying observations based on Next Generation Science Standard NGSS.5.PS1.2 (http://nextgenscience.org/5ps1-matter-interactions): Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.
- Student discussion during lesson

Mrs. Martin's Class in Action

Launch

Mrs. Martin begins by reviewing the scientific question the class has been investigating:

How is the mass of a substance affected by a physical or chemical change?

"Today we're going to begin by organizing and graphing our data, and then we'll analyze the data to draw conclusions." On the interactive whiteboard, Mrs. Martin displays the data she collected yesterday while students were conducting their own experiments. She has already organized the data on the mass of salt and water, before and after mixing them together.

Salt (g)	Water (g)	Salt + Water (g)	Mass After Mixing Salt and Water (g)
3.7	13.0	16.7	16.4
6.1	10.6	16.7	16.7
5.5	11.7	17.2	17.0
4.8	13.5	18.3	18.3
8.0	14.3	22.3	22.5
9.2	18.6	27.8	19.0
8.0	19.0	27.0	27.2
9.3	12.4	21.7	21.5
5.8	12.9	18.7	18.5
6.5	23.0	29.5	29.2

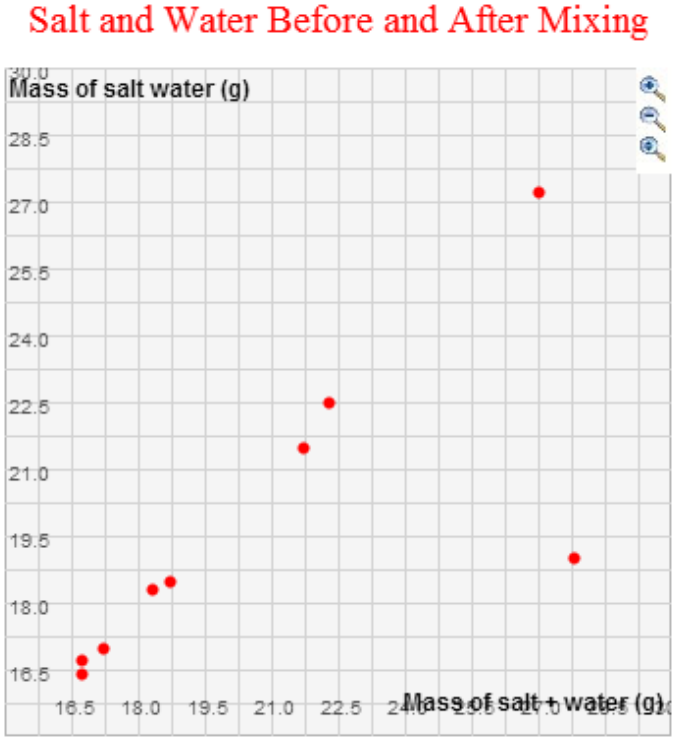
She asks the class, "How can I use these data to understand how mass is affected by a physical or chemical change?"

Hannah raises her hand. "The last column of data tells you the mass after the change, so you definitely need that set of data." Mrs. Martin nods and asks, "Is that all the data we need to look at?"

Matthew raises his hand. "We need to compare something to something else, so we need another column…." When he pauses, Mrs. Martin prompts him, "Can you be more specific?" He thinks for a moment. "We need to compare the mass of the salt water to the mass of the salt and water before mixing."

Mrs. Martin nods her head, "Yes, that's the appropriate data to use here. We could do other comparisons, like comparing the salt mass to the salt water mass, but that wouldn't address our research question."

Next, she uses the Shodor Scatter Plot to display a graph of the data on the whiteboard, making sure the students understand what each axis represents and how to label the graph correctly.

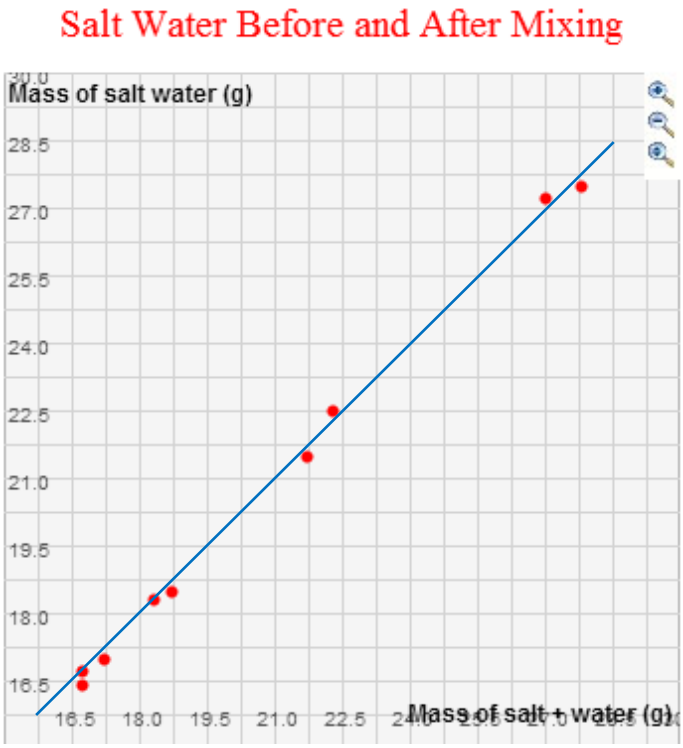


She asks the class if they can see any patterns in the graph. She calls on Daniel, who goes up to the whiteboard and traces out a line along the data. “These points go up and to the right,” he says, “but what about this one?” He points to (27.8, 19.0).

Mrs. Martin consults her notes. “I wrote in my notes that while I was mixing together the salt and water for this trial, I spilled some water out of the beaker before I could weigh it.”

Makayla raises her hand. “That means you didn’t actually measure what you were supposed to.”

Mrs. Martin agrees, “You’re right, so it won’t help me understand what happens to mass. Since this is not a valid data point, we should take it out. If we tried to take it into account when looking for patterns, it might lead us to an incorrect conclusion.” As she talks, she deletes the point from the table and the graph, displaying her work on the whiteboard so the students can see what she is doing. She also draws the line $y = x$ on the graph.



"This line contains all the points where *x* and *y* are equal. What does that mean in this situation?"

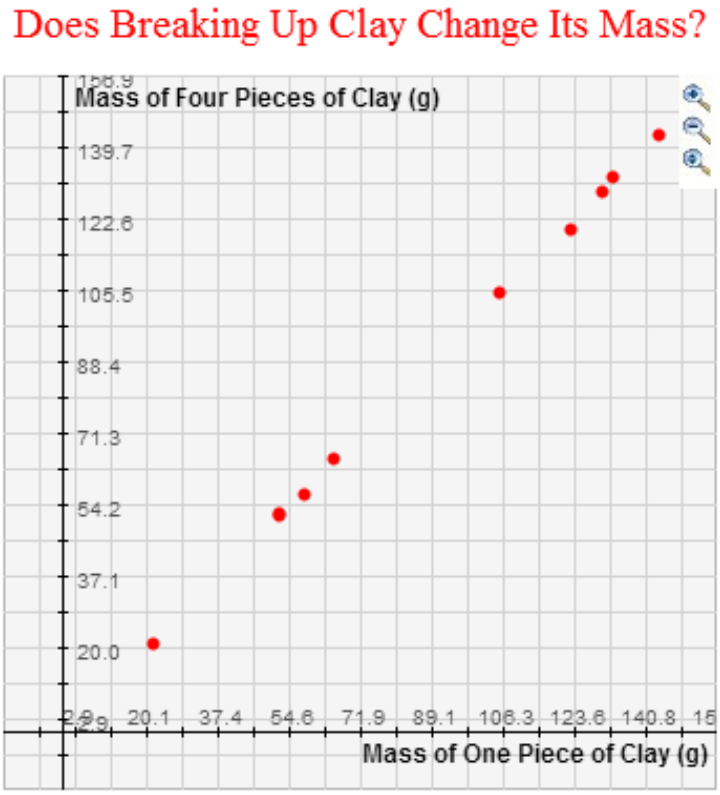
The class spends a few minutes discussing the meaning of the line and whether it can be used to describe the data. Mrs. Martin emphasizes the connections between the data and the graph, and she explains how the line can be used to predict the mass of salt water.

Learning Task

Mrs. Martin directs students to work in the pairs they were in when they conducted the experiments. As students organize work, she walks around the room, providing support as needed.

For students who need additional support, Mrs. Martin suggests sorting the rows in descending order of the mass before the change. She also reviews which value should be the *x* coordinate. Some students are ready to return to the interactive tool with this level of differentiation. Others, however, need to plot a few points on graph paper to see a pattern emerge.

Makayla and Daniel have plotted their data and are now studying it. Mrs. Martin pauses to listen to their conversation.

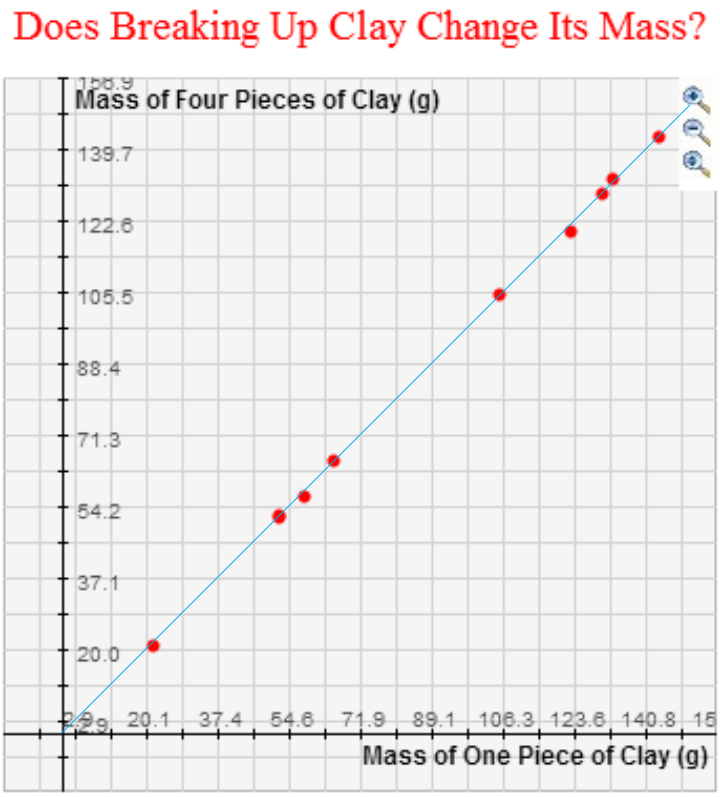


Makayla looks at the graph. “Our data makes a straight line. Is that all we need to say?”

Daniel responds, “That doesn’t actually help us understand how the mass of a substance changes before and after a physical change.” He reads from the board. “Before the change, the clay is in one piece and after we break it up, the clay is in four pieces.” He points to the appropriate axes.

Mrs. Martin waits a few moments before asking, “If you want to know about the mass before and after the change, how can the graph tell you that?” Makayla points to the data point at (130.0, 129.0) and says, “If you look at this point, it shows that the mass after is very close to the mass before.” She looks at a few other points and comments, “It seems that this is true of all the data we collected.” Makayla and Daniel continue to confer and make observations.

Before she leaves them, Mrs. Martin asks them to consider Makayla’s initial comment about the data following a straight line. They draw the line $y = x$ on top of their data and discuss how well the line approximates their data.



Sam and Sophia have finished organizing and graphing their data and have written up a short summary of their observations:

> *When we measured the mass of vinegar and baking soda before and after combining them, it was about the same. On a graph, the data points fall close to a straight line where y = x. For a lot of our data, the mass after the reaction was less than the mass before, but we think that this is because it was difficult to capture all of the gas formed during the reaction.*

Mrs. Martin talks to them about what could have caused the error in their experiment. She suggests alternative methods that might more accurately measure the mass.

Since there are still a few minutes left in the learning task, she asks Sam and Sophia to consider a larger context. “Your conclusions hold true for the mass of vinegar and baking soda that undergo a chemical reaction, because that is what you specifically tested in your experiment. How is this similar to the data I collected about salt water? What conclusions can you make based on these two experiments?”

Closure

Mrs. Martin brings the students back together to debrief. She asks a few students to share their findings, and she chooses particular students to ensure that the class is presented with experiments of both physical and chemical changes, as well as data on a range of masses. They discuss the similarities and differences in their findings.

Finally, Mrs. Martin asks the students what they think can be said about mass in general. “Is the mass always the same before and after a change? Does it matter what the mass is? Or the substance? Or the type of change?” They discuss these questions for a few minutes.

Reflection

Mrs. Martin is pleased with the experiments and the subsequent graphing and analysis that her students conducted this week. In the next lesson, she will finish up the discussion about mass, using their data to demonstrate Conservation of Mass. She is confident that, moving forward, students will be able to conduct more complicated experiments and apply mathematics to understand other scientific concepts.