Matter
Lesson 4: Variables Affecting Dissolving

Grade: 5	Length of lesson: 70 minutes	Placement of lesson: 4 of 7
Anchoring Phenomenon: A healthy pond near a school has changed, and students see that there are a few dead fish in the pond.		
Unit Learning Goal: We can use our understanding of the particulate nature of matter and properties of matter to explain the world around us.		
Lesson Main Learning Goal: There are variables that affect how easily new matter will dissolve into the water, such as water temperature, particle size, and stirring. **Science and Engineering Practices** • Planning and Carrying Out Investigations: Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials is considered. • Planning and Carrying Out Investigations: Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. **Crosscutting Concept:** Scale, Proportion, and Quantity: Natural objects exist from the very small to the immensely large.		
Unit Central Question: How can we figure out what was mixed with pond water that could have changed the water?		**Lesson Focus Question:** What factors affect how soluble solids dissolve into water?
Science content storyline: There are variables that affect how easily new matter will dissolve into water. Increasing the temperature of the water will speed up how fast something dissolves. Decreasing the temperature slows it down. Smaller particles dissolve faster than larger particles. Stirring the mixture will speed up how fast something dissolves.		
Ideal student response to the Lesson Focus Question: Some factors affect how quickly soluble solids dissolve, while other factors don't make a difference. Water temperature, particle size, and how intensely we stirred it all affected how quickly salt dissolved.		

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

Preparation

MATERIALS NEEDED	AHEAD OF TIME

Teacher Resources: none
 	
Materials
• Supplies for the materials station
  ○ plastic containers with lids for holding pollutants (2 per pollutant: salt)
  ○ 10-mL measuring spoons (1 per plastic container of dry pollutants)
  ○ 9-oz. clear cups (2 per small group, 1 per activity, wash and reuse)
  ○ craft sticks for stirring (1 per mixture, wash and reuse)
  ○ 6 50-mL syringes for measuring water
  ○ medium-sized containers for groups to get water from the materials station
  ○ small bottles with lids that could be used to shake mixtures
  ○ hand lenses (1 per group)
  ○ #2 paper coffee filters (1 per group if they choose to use it in their observations)
  ○ coffee filter holders (3 per class, groups can take turns using if they choose to collect data about filtering pollutants)
  ○ 1 kitchen scale sensitive to the gram
  ○ thermometer
• 10-30 mL ice melt (very large crystal)
• 10-30 mL kosher salt (with large crystals)
• 100 mL hot water (teacher provides)
• Small container of ice for cooling water (teacher provides)
• chart paper and markers
	• Review the "The Particulate Nature of Matter," "Interactions of Matter," and "Speeding up Dissolving" sections in the *Content Background* document.
	• Figure out how to have warm/hot water and ice on hand in the classroom. The group investigating water temperature will use hot water (safe to the touch for kids), room temperature water, and ice water for their investigation.

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

Lesson 4 General Outline

Time	Phase of lesson	How the science content storyline develops
3 min	**Link to Previous Lesson:** Review the meaning of *dissolving* and *solubility*.	
2 min	**Focus Question:** Introduce today's focus question: **What factors affect how soluble solids dissolve into water?**	
25 min	**Setup for Activity:** Brainstorm a list of variables that may change the rate at which salt is dissolved (or use list from Lesson 2). Develop a common procedure to test variables.	
15 min	**Activity:** Each group tests at least one variable: water temperature, particle size, stirring speed, and others brainstormed by the class.	There are variables that affect how easily matter will dissolve into water.
10 min	**Follow-up to Activity:** Combine results from each group on a class data table and interpret any patterns we see in the results across all the groups.	Increasing the temperature of the water will increase the speed at which something dissolves. Decreasing the temperature slows it down. Smaller particles dissolve faster than larger particles. Stirring the mixture will increase the speed at which something dissolves.
10 min	**Summarize and Synthesize:** Create a class chart to summarize what factors about a body of water would make salt dissolve either more or less quickly.	
5 min	**Link to Next Lesson: L**inks science ideas to the next lesson.	

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
3 min	**Link to Previous Lesson** Synopsis: Review the meaning of *dissolving* and *solubility*.	Link science ideas to other science ideas. (Slide 1-2)	Let's start our investigation today by recalling some ideas from last time about ways to test water. Turn to a partner and share what we learned in the last lesson about the ideas of *dissolving* and *solubility*. You can use the ideas in your notebook if it helps you remember.	
2 min	**Focus Question** Synopsis: Introduce today's focus question: What factors affect how soluble solids dissolve into water?	Set the purpose with a focus question. (Slide 3)	***NOTE TO TEACHER:*** *Adjust the next section to reflect student ideas. If the class didn't generate any questions around dissolving or how materials mix with water, introduce the day's focus question yourself as the first matter the class will need to investigate to help us figure out what's happening with the pond water. You should be able to draw on the questions generated in Lesson 2 around variables that affect how a substance dissolves to use student ideas to move into the focus for this lesson.* Let's take a look at some of the ideas you all clustered together on our Driving Question Board. This cluster you all put together because it relates to how materials mix with water. During this lesson we'll work together to figure out this focus question: **What factors affect how quickly soluble solids dissolve into water?**	

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
25 min	**Setup for Activity** Synopsis: Brainstorm a list of variables that may change the rate at which salt is dissolved (or use list from Lesson 2). Develop a common procedure to test variables.	Engage students in communicating in scientific ways. (Slide 4)	Let's consider what might affect how quickly our possible pond water pollutants dissolve in water. Oil and dirt have been eliminated from our list of possible pollutants based on visual observations. They are water insoluble. Now you are going to discuss your ideas with a partner or table group. Remember to use your CSW sentence stems as you share ideas. ***NOTE TO TEACHER:*** *As students share their ideas, walk around the room and listen to their discussions for the use of the CSW prompts and connections to questions on the Driving Question Board.* Now that we've had a few minutes to talk, I would love for some of you to share your ideas with the class about **what factors might affect how quickly soluble solids dissolve into water.** I'll capture them here. ***NOTE TO TEACHER:*** *Write student ideas on chart paper or a whiteboard. As an alternative to this section, if you have the list of variables generated during Lesson 2, you can remind students about that list and ask if they'd like to add anything to the list they already came up with. Students will need to investigate changing water temperature, particle size, stirring (speed and/or amount). If there's another factor that won't affect the speed of dissolving that they're able to test, let them test that as well. If students suggest other possible*	

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			factors, they could be added to the list of variables being tested if they are manageable and easy to test. Other variables may include quantity of salt, size of container, or quantity of the water. The materials list includes ice melt, kosher salt, and iodized salt. These have salt crystals of different sizes. If the idea of different-size particles does not come up in the class discussion, you can point out this option. *Move the class to consensus around variables that the class will test, including water temperature, particle size, speed and/or amount of stirring, size of the container, and any other variables the class members have agreed upon. Circle those variables or rewrite them on a new chart.* *As you move through the next part, model on the board or on new chart paper how you could create a visual procedure to represent your investigation.* Let's think about *how* we should test these factors. We learned in Lesson 2 that we need to make sure that we all run our investigations the same way, or it will be difficult to share our results. Let's pick one of these variables and think about how we would need to design an investigation. If my group were to investigate how the temperature of the water affects how quickly the salt dissolves, **what would be the one variable I**	

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			want to change in each of my trials? This is called our *investigative variable*. That's right. The temperature of the water would need to change. **What would my testable question be?** ***NOTE TO TEACHER:*** *Be careful how this testable question is phrased. Using the sentence frame "How does ____ (variable) affect how quickly the salt dissolves?" will be scientifically accurate. The question you model will serve as the model that all other groups will mirror. Students may offer an idea about how water temperature or another variable will affect solubility. Avoid questions with language about the solubility changing like, "How does the amount of water affect the solubility of salt?" The mechanism that causes substances to dissolve or not has to do with the structure of the particles and while the concept of solubility and dissolving are discussed in fifth grade, the reasons why something dissolves easily or not is beyond the scope of learning for fifth graders. Rather, we want the questions to focus on how each variable affects how quickly the salt dissolves. Students will be able to state patterns they observe to answer their question. A question about solubility may not be scientifically accurate.* I would want to test at least three different temperatures to help me look for a pattern as I	Temperature of the water. How does the temperature of the water affect how quickly the salt dissolves?

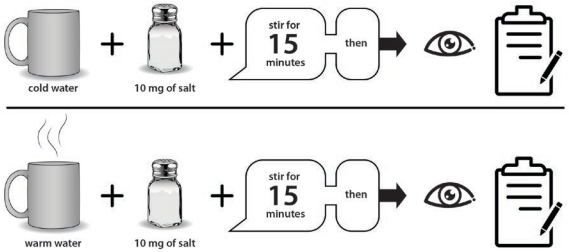
Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			analyze my data. We will record our ideas in pictures about how we will do our investigation. **How could I represent three different temperatures of water in a sketch that shows how I'll conduct my investigation?** OK, so for this investigation, we've figured out the one variable that we're changing in each of our trials—the temperature of the water. If that's the variable we're changing, **what do we need to make sure we're keeping the same in each trial?** These are called our *control variables*. ***NOTE TO TEACHER:*** *Not all these variables will affect how quickly the salt dissolves, but that's OK. Students won't be sure which variables will matter. Ideally the class will test each variable and notice that not all of them matter. If they list additional variables to control, add them to your example procedure.* *Allow table groups a few minutes to discuss how they might conduct these next tests. They do not need to conduct "perfect" tests, but they should consider methods that will produce results that we will consider reasonably trustworthy. Facilitate their discussion to get an agreed-upon amount of both salt and water, temperature of water, and method of stirring (fast or slow or a certain number of stirs). You will also need to agree on how long to let the salt dissolve, such as number of stirs or relative time*	You could draw one cup of water with steam coming out of it one cup that's just plain, and one cup with ice in it. Amount of salt, type of salt, amount of water, size of the container, how much and how fast we stir it. [There may be other variables suggested that may or may not affect how quickly the salt dissolves. These can all be included in the discussion since it's important to consider controlling for variables that aren't being tested.]

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			elapsed. Students don't need an exact time but can use descriptive data like "faster" and "slower." Let's think about the rest of our sketch that shows how we'll do our investigation and our control variables that we just listed. For example, we might draw the variables, like the spoon to represent how much it's stirred or the cup to represent how much water we'll use. We might also show some other steps in the process like the notebook for recording our observations. We want to think of representing our variables and steps with visual images. **How could I represent each of those on my sketch?**	You could show the measuring spoon labeled with "10 mL" with the salt in it. You can label the water "50 mL". Draw the cups both the same size. Write on there to stir it 30 times at a medium speed.
		(Slide 5)	Each of our expert groups will test at least one investigative variable that we think may affect how quickly salt dissolves in water. Your group will pick one variable, write your testable question at the top of a horizontal sheet of paper, (8 ½ x 11" or 11x17") and sketch out your procedure similar to how we did this one together. Be sure to save some space at the bottom where you can write your results as a complete sentence.	

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
		(Slide 6) (Slide 7)	Our slide has another example of how you could show a procedure. There isn't only one right way to represent how your group will do the investigation. Just be sure to show what it is that your group will change in each trial and what all you will keep the same, or control, in each trial. ***NOTE TO TEACHER:*** *Have groups each pick the variable they want to test. Some groups may test more than one. Make sure that across all the groups, all the variables are tested. The example of the visual procedure that is on the slide is shown below:*  With your group, take 5–10 minutes to show how you'll conduct your investigation. ***NOTE TO TEACHER:*** *Facilitate the groups' work so they have a reasonable (not perfect) plan. Try to get groups to complete their plan in 10 minutes or less.* You will record your results at the bottom of your paper underneath your procedure. Which condition	

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			dissolves the salt the fastest? You might use these sentence frames to record your results: "The salt dissolved faster when _____." "The salt dissolved slower when _____." **Are there any remaining questions?**	
15 min	**Activity** <u>Synopsis</u>: Each group tests one variable: water temperature, particle size, stirring, and additional variables brainstormed by the class. <u>Main science idea</u>: There are variables that affect how easily matter will dissolve into water.	Engage students in analyzing and interpreting data and observations.	***NOTE TO TEACHER:*** *Allow students to gather their materials and to begin their tests. As students complete their tests, walk around the room and observe their progress. Ask elicit questions about what they're observing and challenge questions if students need to make connections between their investigation and what that tells them about the answer to their testable question. Also listen to how groups are communicating with each other as they work. If you note examples of students using Communicating in Scientific Ways, note that for students. You might say something like, "I hear you all agreeing and disagreeing with each other's ideas" or "As you're doing the investigation, you're each supporting your claims/ideas with evidence."* Now that we have finished our tests and cleaned up our materials, I would like each group to share your results with the class. Let's record our findings on a class data table:	**What do you notice as you do your investigation?** **Are others noticing the same pattern?** **What does that tell you about your testable question?** **How would you explain how that answer to your testable question, or your claim, is supported by evidence from your investigation?** **Sounds like there's some disagreement about the results of your investigation. What could you do to resolve those disagreements?** Run the investigation again.

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

<table>
<tr><th>Time</th><th>Phase of lesson and how the science content storyline develops</th><th>STeLLA strategy</th><th>Teacher talk and questions</th><th>Possible student and teacher dialogue</th></tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>
<table>
<tr><th>Variable</th><th colspan="2">Results</th></tr>
<tr><td>Temperature of water</td><td>When in warm water, the salt dissolved … (faster/slower)</td><td>When in cold water, the salt dissolved …</td></tr>
<tr><td>Stirring speed
OR

Amount of stirring</td><td>Fast stirring …

100 stirs…</td><td>Slow stirring …

20 stirs…</td></tr>
<tr><td>Salt size</td><td>Big salt …</td><td>Small salt …</td></tr>
<tr><td>Possibly other variables like:
Container size</td><td>Big container …</td><td>Small container …</td></tr>
</table>

Let’s now pause and discuss the data we collected.

What do you notice in the data for our tests?
To help you think about this, you can use sentence stems similar to these for water temperature:

When in warm water the salt dissolved _____ (faster, slower, at the same rate).

When in cooler water the salt dissolved _____ (faster, slower, at the same rate).

As you all discuss the data, I’ll walk around the room and listen to the discussions.
</td>
<td>The salt dissolved in the warm water faster than in the cold water.</td>
</tr>
</table>

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			NOTE TO TEACHER: *If groups are struggling, support their thinking by asking some questions such as these:* **How would you summarize the results of the investigation?** **What is different about the data from this variable?**	The salt dissolved faster when we stirred it faster. The salt dissolved slower when we stirred it less. The large salt particles dissolved slower than the small ones. *Other possible responses include:* The size of the container does not matter. Salt dissolved at the same rate in both sizes of containers.
10 min	**Follow-up to Activity** <u>Synopsis</u>: Combine results from each group on a class data table and interpret any patterns we see in the results across all the groups. <u>Main science ideas</u>: Increasing the temperature of the water will increase the speed at which something dissolves. Decreasing the		We learned a great deal today during these investigations about how salt dissolves in water. This will help us understand what happened to our pollutants when they mixed with the pond water. We planned and conducted investigations today to learn about variables that affect how quickly salt dissolves in water. **If we had more time, what could we do to make our investigations even more accurate?**	We could do more than one trial of each condition to see if our results are the same each time. Instead of testing three particle sizes, we could test with more to see if the pattern is the same. We could test even more variables to see what else affects how fast salt dissolves.

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

<table>
<tr><th>Time</th><th>Phase of lesson and how the science content storyline develops</th><th>STeLLA strategy</th><th>Teacher talk and questions</th><th>Possible student and teacher dialogue</th></tr>
<tr><td></td><td>temperature slows it down. Smaller particles dissolve faster than larger particles. Stirring the mixture will increase the speed at which something dissolves.</td><td></td><td>Let’s consider how our investigations today might relate to the pond or other bodies of water.

Discuss with a partner your ideas about how the data relate to the pond or other bodies of water.

Invite a few students to share their thinking.</td><td>If the temperature of the water gets warmer, salt would dissolve more quickly.
If there’s salt in water that’s moving, it would dissolve more quickly than in still water.</td></tr>
<tr><td>10 min</td><td>Summarize and Synthesize

<u>Synopsis</u>: Create a class chart to summarize what factors about a body of water would make salt dissolve either more or less quickly.</td><td>Summarize key science ideas.

(Slide 9)</td><td>PROGRESS TRACKER

Let’s see if we can summarize what we have figured out so far. In your notebook, continue your Progress Tracker. Let’s fill in today’s focus question and what we figured out about it.

<table><tr><td>Question</td><td>What I figured out</td></tr><tr><td>What factors affect how quickly soluble solids dissolve into water?</td><td>Some factors affect how quickly soluble solids dissolve, while other factors don’t make a difference. Water temperature, particle size, and how intensely we stirred it all affected how quickly salt dissolved.</td></tr></table></td><td></td></tr>
</table>

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			As we wrap up our time today, let's take a look at our Driving Question Board. **Are there any questions that we answered today that we can add a check to? Are there any new questions that we thought of today?** Let's add those to the board.	
5 min	**Link to Next Lesson** Synopsis: Teacher links science ideas to the next lesson.	Link science ideas to other science ideas (next lesson). (Slide 10)	***NOTE TO TEACHER:*** *Link ideas from the Driving Question Board to the next lesson, if possible. If not, you can make the link between this lesson and the next.* During our next lesson we'll continue to investigate the pollutants based on their properties. We'll design an investigation to figure out which pollutants are in the pond water.	

Copyright © 2024 BSCS Science Learning
This work is licensed under CC BY-NC-SA 4.0.
To view a copy of this license, visit https://creativecommons.org/licenses/by-nc-sa/4.0/