3.2 Ride the Current: Patterns of Matter & Energy in Ocean Currents

Unit	Utah SEEd Standard / NGSS Performance Expectation	Estimated Lesson Time:
Strand ESS.3: SYSTEM INTERACTIONS: ATMOSPHERE, HYDROSPHERE, AND GEOSPHERE	Standard ESS.3.2 Construct an explanation of how heat (energy) and water (matter) move throughout the oceans causing patterns in weather and climate. Emphasize the mechanisms for surface and deep ocean movement. Examples of mechanisms for surface movement could include wind, Sun's energy, or the Coriolis effect. Examples of mechanisms for deep ocean movement could include water density differences due to temperature or salinity. (ESS2.C, ESS2.D)	70 – 90 min

LESSON OVERVIEW

Learning Objective

Students will construct an explanation of how energy (wind/heat) and matter (water) move through ocean currents, creating patterns that influence the movement of marine organisms.

Anchor Phenomenon

Turtles and sharks in the Atlantic Ocean follow consistent, non-random paths that closely match ocean current patterns.

Driving Question

Why do turtles and sharks follow patterns in the ocean instead of moving randomly?

Lesson Level Performance Expectations

Students will construct a Claim-Evidence-Reasoning (CER) explanation that identifies wind as the energy source driving surface currents; explains how density differences move water; describes how currents transport matter (water, nutrients, organisms); uses evidence from maps and investigations; and connects these ideas to observed turtle and shark movement patterns.

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LESSON SNAPSHOT

LESSON SUMMARY:

	Estimated Time	Section Overview	How are students answering the driving question or meeting the learning objectives?
Experience the Phenomenon	~ 30 min.	Observing turtle and shark tracking websites	Students apply **Science and Engineering Practices (SEPs)** by: - **Analyzing and interpreting data** from maps and tracking visuals of organisms, winds, and currents - **Constructing explanations** that connect wind energy to surface currents patterns - **Developing and using models** to explain how energy moves through water while matter (water and organisms) is transported by currents This learning targets **Disciplinary Core Ideas (DCIs),** including: - **ESS2.C: The Roles of Water in Earth's Surface Processes** — ocean currents redistribute energy and matter - **ESS2.D: Weather and Climate** — wind drives surface ocean movement - **PS3.A: Definitions of Energy** — energy transfer through systems causes motion Students use **Crosscutting Concepts (CCCs)** by: - Identifying **patterns** in ocean currents and organism movement - Applying **energy and matter** to explain how energy flows through ocean systems and moves matter - Viewing the ocean as a **system** with interacting components (wind, water, organisms)
Investigate the Phenomenon	~ 20 min.	Observing teacher demonstrations – Salinity & Upwelling	Students engage in **Science and Engineering Practices (SEPs)** by: - **Planning and carrying out investigations** during salinity and upwelling demonstrations - **Analyzing and interpreting data** from observations of water movement and layering - **Constructing explanations** that connect density differences and wind energy to ocean motion This learning addresses **Disciplinary Core Ideas (DCIs),** including: - **ESS2.C: The Roles of Water in Earth's Surface Processes** — density differences drive ocean circulation and vertical movement of water - **ESS2.D: Weather and Climate** — wind energy contributes to upwelling and surface movement

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			- **PS3.A: Definitions of Energy** — energy transfer causes motion within ocean systems Students apply **Crosscutting Concepts (CCCs)** by: - Identifying **patterns** in water movement caused by salinity and upwelling - Using **energy and matter** to explain how energy drives water movement and redistributes matter - Viewing the ocean as a **system** where wind, salinity, and density interact.
Reason about the Phenomenon	~10-15 min.	Students synthesize ideas from observations and investigations to explain how ocean currents form and influence organism movement. Students use slide 15 ("putting it all together") to connect wind, density, and ocean currents to the observed movement pattern of turtles and sharks	Students apply **Science and Engineering Practices (SEPs)** by: - Constructing explanations through whole-class discussions - Engaging in argument from evidence by comparing and revising ideas - Developing and using a consensus model to explain ocean current systems **This learning targets Disciplinary Core Ideas (DCIs), including:** - ESS2.C: Ocean currents are driven by wind and density differences, redistributing energy and matter - ESS2.D: Energy from wind drives surface ocean movement and contributes to observable patterns **Students use Crosscutting Concepts (CCCs) by:** - Applying **Cause and Effect** to explain how wind and density drive water movement - Using **Systems and System Models** to understand interactions between wind, water, and organisms - Identifying **Patterns** in ocean currents and organism movement and explaining their causes
Communicate the Explanation (Evaluate)	~ 15 min.	Constructing an explanation for the patterns	Students construct a final explanation by synthesizing evidence from multiple observations and investigations, including organism tracking (sharks and turtles), wind patterns, surface currents, salinity, and upwelling. Using this evidence, students explain how wind energy and density differences drive ocean circulation, resulting in predictable patterns of currents that transport water and marine organisms.

DISCIPLINARY CORE IDEAS	SCIENCE & ENGINEERING PRACTICES	CROSSCUTTING CONCEPTS
NGSS Appendix E	NGSS Appendix F Constructing Explanations Analyzing and interpreting data	NGSS Appendix G Patterns Matter & Energy Systems and System Models

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This lesson could be one in a series of lessons building toward the following Performance Expectation(s):
Construct an explanation of how heat (energy) and water (matter) move throughout the oceans, causing patterns in weather and climate. Emphasize the mechanisms of surface and deep-ocean movement. Examples of mechanisms for surface movement could include wind, the Sun's energy, or the Coriolis effect. Examples of mechanisms for deep-ocean movement include density differences caused by temperature or salinity.

Materials

Link to all materials on the 3DRST website (3drst.byu.edu): https://3drst.byu.edu/ess-3-2-ocean-currents
Link to all materials on Canvas Commons: https://tinyurl.com/3DRSTearth

Student Materials	Teacher Materials	Lab Materials/Other Resources
Worksheet Colored Pencils/Markers	Teacher Slides	Funnel Straw Clear cups/beakers Food dye Salt 3 Eggs Either: Clear cups, a large clear container, or a density tank

Lesson Preparation

Demo Instructions:
Salt and eggs (density)
Cup 1: No salt
Cup 2: Low salt – 20g dissolved in 250mL of water
Cup 3: High salt – 40 g dissolved in 250mL of water
** These numbers are just estimates.**
To make the egg neutrally buoyant, add salt a little at a time until it suspends. Every egg will be a little bit different. This should be done before teaching this lesson.

Upwelling tank:
*This worked best in a density tank with a divider***
Large clear cup with warm/hot water.
Cold water in a smaller cup with blue dye.
Funnel
Straw

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Upwelling Directions:
If using a density tank: Pour cold blue water on one side and red warm water on the other. Next, use the straw blow the surface of the water away. Cold water should begin moving up.

If using a large container or clear cups: Pour cold water with blue dye into the cup with warm water, using the funnel to limit mixing. Next, use the straw blow the surface of the water away. Cold water should begin moving up.

Required Previous Knowledge:
Students should know the basics behind ocean currents. The difference between surface and deep ocean currents.

Vocabulary:
Surface currents
Deep Currents
Upwelling
Salinity
Density

EXPERIENCE THE PHENOMENON/PROBLEM (ENGAGE)

What Students Are Doing	Teacher Tips
- **Slide 2:** Students watch a short clip of the sea turtles riding the EAC from Finding Nemo. - **Slide 3:** Students will navigate to https://tinyurl.com/4xstds6w (turtles) or https://www.ocearch.org/tracker/ (sharks) and observe where turtles and sharks have been traveling. While they observe their paths, they should draw them on the left-hand map in their worksheet. - **Slide 4:** After tracking the turtles, have a quick discussion about initial patterns in these paths and what could be causing them. - Students identify patterns AND propose possible causes of those patterns - **Slide 5:** Next, the students will navigate to the link on earth.nullschool.net (https://tinyurl.com/3th7b58s) to see how the Gulf Stream and the surface winds are traveling. They should then draw the general paths of the currents and wind. - **Slide 6:** Students will then compare the two maps and identify patterns.	- Discussion point: Where do most turtles and sharks spend their time? - You could also have the students look at each other's maps. They might be looking at different individuals. - On the Gulf Stream Link, make sure students can identify ocean currents and wind, and how to switch between them. - Ask open-ended questions like: *"What do you notice?"* and *"What do you wonder?"*
What Teachers Are Doing	**Teacher Tips**

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- The teacher is answering any questions the students might have and helping navigate the websites. - The teacher should also help guide students in seeing how the two maps are connected. - Press students to connect organism movement to water movement early (do not wait until the end)	- Revoice student ideas to validate thinking and clarify meaning. - Gently steer the conversation toward patterns caused by wind energy interacting with ocean water.

INVESTIGATE THE PHENOMENON (EXPLORE)

What Students Are Doing	Teacher Tips
Salty Egg Demo **Purpose:** Understand how density differences affect water movement **Slide 7:** Students will examine three cups or beakers—one with no salt, one with a little salt, and one with a lot of salt—and guess which one will make the egg float. After making their guesses, they will observe what happens. They should notice that the egg sinks in the no-salt water, is suspended in the slightly salted water, and floats high in the highly salty solution. Then, the discussion will focus on why the egg floated. This helps students understand that saltier water is denser and sinks. **Optional** (**Slide 8)**: discuss how salinity influences ocean currents. **Upwelling Tank Demo** **Purpose:** Understand how wind and density interact to move water vertically **Slides 9-12:** Next, the students will either perform this demo in small groups or observe the teacher demonstrate. Students should notice that warm, less dense water rests on top of cold, dense water. When a fan or a straw blows wind over the water, the warm water is pushed away, creating a space for the cold water to move in. They should observe that the dyed cold water begins to rise. After watching the demonstration, students will draw a simple model showing upwelling. Students should begin connecting each investigation to how ocean currents form and influence the movement of organisms	- If crunched for time, you could omit the egg demo. - Make sure to use fresh eggs, as old eggs float in unsalted water. - Encourage students to record observations using diagrams and written explanations. **See the lesson preparation section for more details on demonstrations.**
What Teachers Are Doing	**Teacher Tips**
Perform the two demonstrations Connection prompts: - How could this affect ocean currents? - How might this affect where organisms are found?	- Resist explaining conclusions too early—let students discover patterns first. - Circulate to challenge misconceptions

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Briefly introduce that Earth's rotation (Coriolis effect) causes currents to curve, contributing to large-scale patterns. (No need to go deep with this, just acknowledge)	- Prompt students to use evidence when revising their explanations.

REASON ABOUT THE PHENOMENON

What Students Are Doing	Teacher Tips

Slide 13: The students will watch a short video reinforcing upwelling and nutrient movement.
Slide 14: After the video, students will identify how matter and energy are being cycled throughout the ocean. This can occur through upwelling and wind-driven surface currents.
Slide 15: Putting it all together
- Students discuss how all investigations connect to explain ocean patterns
  ○ Wind → surface currents
  ○ Density → Deep currents
  ○ Currents → organism movement
- Students contribute to a class consensus model
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What Teachers Are Doing	**Teacher Tips**

- Facilitate a whole-class discussion using guiding questions:
  ○ How does wind start ocean movement?
  ○ How does density affect where water moves?
  ○ How do these together explain the patterns we saw in turtles and sharks?
- Press for cause-and-effect reasoning
- Record students' ideas publicly (board/model)
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COMMUNICATE THE EXPLANATION (EVALUATE)

What Students Are Doing	Teacher Tips
Slide 16: On the student worksheet, students construct a claim-evidence-reasoning (CER) explanation connecting: - Wind (energy) - Water movement (matter) - Density differences - Patterns in turtle and shark movement	- Discussion: "How does upwelling move both **matter** (nutrients) and **energy**?" - What forms of matter are being moved by ocean currents? - What forms of energy are being transferred? - Use student models as discussion tools to highlight strengths and misconceptions.

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What Teachers Are Doing	Teacher Tips
Clarifying any misconceptions and helping students connect the movement of matter and energy to the paths of turtles' and sharks' movement. **Student Assessment Criteria** Students should: - Identify wind as the energy source driving surface currents - Explain how density differences move water - Describe how currents transport matter (water, nutrients, organisms) - Use evidence from maps and investigations - Clearly connect to turtle/shark movement patterns	

POSSIBLE EXTENSIONS/ALTERNATIVE ADAPTATIONS

Extension: How does upwelling affect the location of civilizations and their economies?
The upwelling scenario in the Gulf of Panama. https://stri.si.edu/story/upwelling-failure

Adaptation: To support diverse learners and instructional environments, this lesson offers multiple entry points aligned with Utah SEEd Earth Science standards. Visual models, diagrams, and simulations help students understand how energy moves through ocean surface waves as water particles follow predictable patterns. Hands-on investigations using wave trays or simple materials promote kinesthetic learning and reinforce system interactions.

Language supports such as sentence frames, word banks, and labeled diagrams help English learners and students develop scientific explanations. Scaffolded modeling tasks and guided notes enable students to focus on key concepts of energy transfer and matter movement. Extensions for advanced learners might include exploring how changes in wind energy influence wave patterns or linking wave energy to coastal processes.

These adaptations ensure all students can construct explanations of ocean wave patterns across varied learning needs and settings.

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