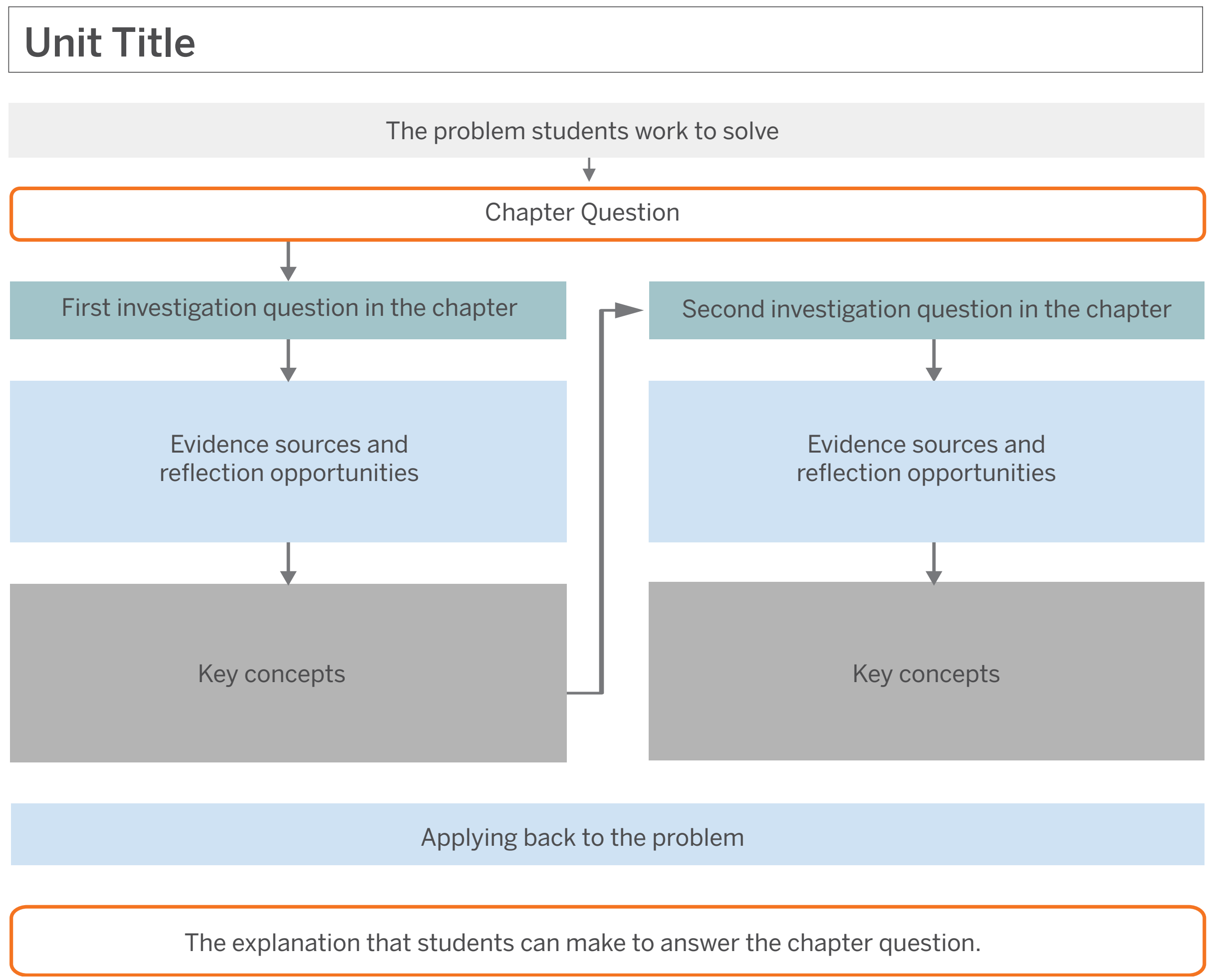
Ocean, Atmosphere, and Climate Coherence Flowchart

The storyline of the unit

In each Amplify Science unit, students figure out a phenomenon by asking questions, gathering evidence, and coming up with an explanation of how the phenomenon works. The Coherence Flowchart visually represents the storyline of the unit, showing the coherent flow of questions, evidence, and ideas that support students as they build complex explanations of the unit's anchor phenomenon. The Coherence Flowchart on the following pages (one chapter per page) can be used to see the connections between the questions that drive students' experiences, the evidence they gather, the ideas they figure out, and the new questions that those ideas generate. The diagram to the right explains the structure of a chapter in the Coherence Flowchart.

Note: The Coherence Flowchart is a tool for teachers and is not meant to be distributed to students.

Typical structure of one chapter in a Coherence Flowchart



Instruction is framed by questions about the unit's anchor phenomenon and the related problem students are solving. Chapter Questions then guide students in figuring out the phenomenon, piece by piece. Within each chapter, Investigation Questions focus students on a manageable piece of content that will help them figure out the Chapter Question. Each question motivates activities, and each activity provides specific evidence related to the Investigation Question. Students synthesize the understanding constructed over multiple activities, and this understanding is formalized through key concepts. Often a key concept leads students to an additional Investigation Question students need to pursue to answer the Chapter Question. At the end of the chapter, students' new understanding is applied back to the unit's anchor phenomenon and leads students to a new Chapter Question or a final explanation.

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Ocean, Atmosphere, and Climate: Cold Years in New Zealand

The problem students work to solve

During El Niño years, why is Christchurch, New Zealand's air temperature cooler than usual?

Chapter 1 Question

What determines the air temperature of Christchurch, New Zealand?

Investigation Questions

How does air get energy? (1.3)

Evidence sources and reflection opportunities

- Use the Sim to gather evidence about what causes the air temperature of a place to change (1.2)
- Set up a lamp heating experiment to compare the air temperature over a surface and the air temperature over no surface (1.3)
- Conduct a similar test to the lamp heating experiment in the Sim to gather more evidence that energy is not directly transferred to the air (1.3)

Key concepts

- Energy from the sun is transferred to Earth's surface. Some of that energy is then transferred to the air above the surface. (1.3)

Investigation Questions

Why do different locations have different air temperatures? (1.4, 1.5)

Evidence sources and reflection opportunities

- Analyze energy and air temperature maps to figure out why different locations have different temperatures (1.4)
- Use the Modeling Tool to show why the Equator and South Pole have different air temperatures (1.4)

Key concepts

- The closer a location is to the equator, the more energy it receives from the sun. Therefore, a location's air temperature is affected by its distance from the equator. (1.4)

Application of key concepts to the problem

- Write and share to explain why the average air temperature of Christchurch is different from the air temperature is different from the air temperature at another location (1.5)
- Use data from bar graphs showing energy from the sun and average ocean surface temperature during normal years and El Niño years to refute the claim that Christchurch's air temperature is cooler because the amount of energy from the sun changes (1.5)

Explanation that students can make to answer the Chapter 1 Question

The air temperature of Christchurch is determined by how much energy is transferred to the air. Energy from the sun is transferred to the surface of Earth, and then to the air above the surface. The amount of energy that is transferred to the air in Christchurch is determined by its latitude. The closer to the equator a location is, the more energy from the sun is transferred to the surface and then to the air. The amount of energy from the sun does not change during El Niño years, so there must be another cause for the cooler air temperature.

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The problem students work to solve

During El Niño years, why is Christchurch, New Zealand's air temperature cooler than usual?

Chapter 2 Question

Other than latitude, what else affects the air temperature of Christchurch?

Investigation Questions

Other than latitude, what else affects ocean, surface temperature? (2.1, 2.2)

How do ocean currents affect the air temperature of the locations they pass? (2.3, 2.4)

Evidence sources and reflection opportunities

- Read "The Ocean in Motion" (2.1)
- Revisit "The Ocean in Motion" (2.2)
- Analyze ocean surface temperature and ocean currents maps to get evidence about ocean surface temperature near Buenos Aires and Cape Town (2.2)

- Conduct a hands-on investigation to observe the effect of warm and cold water on the air above it (2.3)
- Use the Sim to observe the air temperature of two locations, one near a warm current and one near a cold current (2.3)
- Discuss claims explaining the difference in air temperature of Buenos Aires and Cape Town (2.3)
- Model ocean currents and the transfer of energy with the ocean currents game (2.4)

Key concepts

- An effect may have more than one cause; these may be linked into a chain of causes and effects. (2.1)
- When an ocean current comes from the equator, it brings warmer-than-expected water to the places it passes. When an ocean current comes from the pole, it brings colder than expected water to the places it passes. (2.2)

- Energy transfers from warmer substances to colder substances. Warmer currents transfer energy to cooler air and warmer air transfers energy to cooler currents. (2.3)
- When an ocean current comes from the equator, it brings warmer-than-expected water to the places it passes, and that water is warmer than the nearby air. When an ocean current comes from the pole, it brings colder than expected water to the places it passes, and that water is colder than the nearby air. (2.3)

Application of key concepts to the problem

- Use the Modeling Tool to show the effect of the ocean current that passes Christchurch, New Zealand on the air temperature (2.4)
- Analyze an ocean surface temperature graph to conclude that the ocean current changes during El Niño years (2.4)

Explanation that students can make to answer the Chapter 2 Question

Ocean currents are another factor that can affect the air temperature of Christchurch. In normal years, a warm current comes from the equator and flows past Christchurch. The current is warmer than the air in Christchurch. Energy transfers from the warmer current to the cooler air. Something might disrupt this current during El Niño years.

Ocean, Atmosphere, and Climate: Cold Years in New Zealand

The problem students work to solve

During El Niño years, why is Christchurch, New Zealand's air temperature cooler than usual?

Chapter 3 Question

What determines how ocean currents near Christchurch move?

Investigation Questions

What determines the direction of ocean currents? (3.1, 3.2)

Evidence sources and reflection opportunities

- Read "The Gulf Stream" (3.1)
- Revisit "The Gulf Stream" (3.2)
- Use a currents tank model to simulate how currents move in the same direction as prevailing winds in some, but not all places in the ocean (3.2)

Key concepts

- Prevailing winds and the position of continents determines the direction of ocean currents. (3.2)

Investigation Questions

How can changes to prevailing winds affect the air temperature of a location? (3.3, 3.4)

Evidence sources and reflection opportunities

- Use the Sim to find evidence about how changes to the prevailing winds can affect the amount of energy in the air (3.3)
- Write and share about how prevailing winds determine the air temperature of different locations (3.4)

Key concepts

- Changes to prevailing winds affect ocean currents. Changes to ocean currents affect how much energy is brought to (or taken away from) a location (3.3)

Application of key concepts to the problem

- Model what determines Christchurch's air temperature during a normal year in the Modeling Tool (3.3)
- Analyze evidence and revise claims, concluding that both the ocean currents and prevailing winds change during El Niño years. (3.4)

Explanation that students can make to answer the Chapter 3 Question

The direction of prevailing winds determines how the ocean current near Christchurch moves. Prevailing winds set ocean currents in motion, and when the ocean current hits a continent, it changes direction. Prevailing winds push the ocean current along the equator and it bends to flow south toward Christchurch. In El Niño years, the prevailing winds that normally drive a warm current from the Equator past New Zealand are disrupted and may stop or even reverse. This interrupts the warm current, which means less energy is transferred to the air of Christchurch.

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Ocean, Atmosphere, and Climate: Cold Years in New Zealand

Problem students work to solve and the Chapter 4 Question

In South China during the late Carboniferous period, was the air temperature warmer or cooler than the air temperature in that location today?

Application of key concepts to new problem

- Analyze and sort evidence based on claims (4.1)
- Participate in the Science Seminar (4.2)
- Use the Reasoning Tool to connect the evidence to the claims (4.3)
- Write an argument to support a claim (4.3)

Explanation that students can make to answer the Chapter 4 Question

One possible explanation students can make:

South China was warmer in the late Carboniferous than it is today. In the late Carboniferous, South China was closer to the equator than it is today. This means more energy was being transferred from the sun to the surface there. Also, the pattern of prevailing winds suggest that there was an ocean current pushed by the wind along the equator. The current would have hit the continent and flowed down the coast of South China. It was carrying energy from the equator and was warmer than the air of South China, so the ocean transferred energy to the air there. Since the winds were stronger back then, the current moved faster and brought more energy to be transferred to the air in South China.

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