

Carbon Cycling Student Interview Protocol B

Interview used with middle and high school students



Written by: Carbon Strand Group
Culturally relevant ecology, learning progressions and environmental literacy
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ENVIRONMENTAL LITERACY CARBON INTERVIEW

FORM B

Please start by briefly introducing yourselves---include the idea that you are a member of Environmental Science Literacy Research Project from MSU. Then, briefly explain the purpose of the interview: In our work, we seek students' ideas about such processes as tree growth, girl growth, girl running, dead tree decaying, flame burning, car running, lamp lightening, and cross processes. Our goal is to use these ideas to design classroom tools/materials for use in teaching and learning science. The purpose of this interview, therefore, is to seek your help in terms of your ideas about some of these processes. Please feel free to ask questions at any time during the interview.

Next, please write down the student's names, grade (and age) here below---you may ask the student to help you spell his/her names. At this point, you may proceed to the interview items (Page 2).

Name _____ Grade _____ Age _____

Overview

The interview protocol contains three individual socio-ecological events: tree growth, tree decay, flame burning, and car running. For the first event, tree growth, two sets of questions are asked: questions to diagnose the student's conceptual understanding and questions about citizenship, argumentation, and meta-conceptual awareness.

The conceptual understanding questions ask about macroscopic observations including enablers, weight loss/gain, gas cycle (O_2 — CO_2 cycle or CO_2 — O_2 cycle), energy sources, heat, and so on. Our research indicates that younger students tend to understand these phenomena in terms of force-dynamic reasoning: the actor uses its enablers to make changes happen. For example, the tree is the actor. It uses its enablers—water, air, soil, and sunlight—to grow. As long as the tree has the enabler, naturally it just grow. This is very different from scientific reasoning, which treat actors and enablers as composition of matter and energy and use matter transformation and energy transformation to reason about the events.

With respect to each specific observation, the interview starts with lower-level questions that ask about the actor and its enablers. If the student indicates any understanding of matter and energy, the interviewer will need to ask **higher-level Questions**, which are about changes that happen to molecules and forms of energy.

The focus for argumentation questions is to get students to conceptually present evidence to support the kinds of claims they make (how matter or energy are involved in a specific process). That is, to have them to, hopefully, logically construct an argument by presenting evidence and link these to the kinds of claims made.

--- GIRL RUNNING ---

A Girl Running



Actor: Girl

Enablers: food, air, water, sleep

1. Conceptual Understanding

Enablers [**Enablers: food, water, air, sleep**]

- a. What does the tree need in order to run?
Ask follow-up questions about each enabler. For enablers not mentioned, ask: Some students said that the girl needs food [or water, air, and enough sleep] to run, do you agree? If yes, ask follow-up questions. If no, ask: Why?
- b. How does [the enabler] help the girl run?
- c. What happens to [the enabler] inside the girl's body? Is [the enabler] used up? Does it change into other things?

Breathing (CO₂—O₂ Cycle):

- a. Do you think breathing helps the girl run? Why?
- b. Do you think moving and breathing are related events? Why?
- c. **If the student mentions carbon dioxide from breathing, ask: Do you think carbon dioxide contains carbon atoms? [If yes], where does the carbon atoms come from?**

Warmth:

- d. The girl will get hot when she runs. How could that happen?
- e. **You mentioned about heat. Do you think heat is energy? Where does heat come from?**

Weight Loss

- a. The girl lost weight after she ran everyday for a month. How does that happen?
- b. Where did the lost weight go? Was it used up? Did it change into other things? Why?

Energy sources

- a. Does the process of girl running require energy? If no, ask why. If yes, where does the energy come from?
- b. Why do you think the things you mentioned have energy?
- c. **If the student associates energy with food or body structure, ask: Where does the energy of food/body go? Is it used up? Does it change into materials? Or, is it still energy? Where is it?**



2. Citizenship and Argumentation

- a. You said that ----- [summarize key claims about how the girl runs, especially about what is happening inside the girl's body, including changes in matter and energy]. Did I summarize what you said correctly?
- b. How much confidence do you have that the ideas you give me are correct?
- c. Do you understand anything now that you didn't understand before? Did you change your ideas about tree growth after you had the class? What are those ideas? How did you change?

- d. Use a claim the student made about where the lost weight went and ask argumentation questions: (Choose one to ask).
- If the student says lost weight goes into air or becomes sweat (water), ask: I know that someone said that the lost weight was burned up to provide energy for running. What would you say to convince your friend that you were right?
 - If the student says that the lost weight was burned up, ask: I know that someone said that the lost weight becomes gas and water. What would you say to convince your friend that you were right?
- e. Is there anything that you have observed about people running that provides evidence that you are right? How does that evidence show that your reasoning is correct?
- f. Could you suggest an experiment or investigation that would show whether you are right? What would you expect the results of your investigation to be? How would those results show that you are right?

--- BABY GIRL GROWTH ---

A Baby Girl Growing

	
<p>The baby weighed 22 lb when she was 5 months old.</p>	<p>The baby has grown into a big girl, weighing 50 lb.</p>

Actor: Girl's body

Enablers: food, water, air, exercises, sleep

Enablers [Enablers: food, water, air, sleep]

a. What does the baby need in order to grow?

Ask follow-up questions about each enabler. For enablers not mentioned, ask: Some students said that the baby girl needs food [or water, air, and enough sleep] to grow, do you agree? If yes, ask follow-up questions. If no, ask: Why?

b. How does [the enabler] help the baby grow?

c. What happens to [the enabler] inside the baby's body? Is [the enabler] used up to help the girl grow? Does it change into other things inside the girl's body?

Growth as increase of materials

a. Do you think that the baby girl is putting on more and more weight as it grows? If yes, where does the increased weight come from?

b. I will ask questions about the matter that makes the baby's arms, legs, and other parts of her body. Did the matter exist outside the baby's body before it became part of the body? If yes, how did those things change into the baby's body structure?

c. Do you think the girl's body can naturally create more and more materials? Why? [If no], why can't the girl's body create materials?

d. If the student mentions that the girl's body is made of glucose/starch/carbohydrates, ask: Do you think it contains carbon atoms? If yes, where do the carbon atoms come from?

Energy sources

a. Does the baby's body need energy to grow? How?

b. I will ask questions about the energy that is in the baby girl's arms, legs, and other parts of her body. Did the energy exist outside the baby's body before it became part of the body?

c. If yes, where does the energy come from? Why do you think the things you mentioned have energy? Do you think water provides energy for the baby? Do you think air/oxygen provides energy for the baby? How does that energy become energy of the girl's body?

d. If the student associates energy with food, ask: Where does the energy of food go? Is it used up? Does it change into materials? Or, is it still energy? Where is it?

e. Do you think the baby stores energy inside her body?

i. [If yes], where does the baby store energy? In cells? In molecules?

ii. [If yes], where does that energy come from?

Scale

a. Do you think that the girl's body is made of cells?

b. Do you also think that the baby girl's body is made of molecules? Why?

c. You said that the girl's body is made of both cells and molecules. How are the cells and molecules related? How does that happen?

--- USING ELECTRICAL APPLIANCES ---

Lamp lighting



Actor: lamp

Enabler: electricity

Enabler

- a. The lamp will not light if it is not plugged in. Do you know why?
- b. What does the lamp get from the outlet? If the student mentions electricity or electrical energy, ask the following questions:
 - Do you think electricity is related to energy? If yes, what energy form is it?
 - Where does the electrical energy go, when the lamp is lighting?
 - Where does electricity come from?
 - [If the student mentions power plants ask]: Where do power plants get the energy from to generate electricity?

Energy sources

- a. About 50% of electricity used in US comes from coal.
 - Do you know how do people use coal to make electricity? Can you use energy to explain this question?
 - Where does the energy of coal come from?
- b. If the student mentions about burning coal, ask:
 - a. Do you think coal has energy? Where does that energy go, when the coal is used to produce electricity?
 - b. Do you think the coal changes into energy? Or do you think it changes into other things?
 - c. Do you think that using a lot of electricity will cause global warming? Why?

CROSS PROCESSES

1. *Pictures: Plant growth, Baby girl growth, Girl running, Tree decaying, Flame burning, Car running.*

Each of these pictures is about a **process or change**.

- Can you divide the pictures into three groups in terms of process or change? Explain each group.
 - Show students a different grouping (Group 1: Tree growth; Group 2: Baby girl growth; Group 3. Girl running, flame burning, car running, and tree decaying.), and ask: Here is a different grouping. Can you see any reasoning for that?
 - How many pictures can you connect together? Please make as many connections as you can. Could you explain how these events are connected?
 - Do you think these pictures are connected in their ways of using and changing air?
2. EcoSphere



NASA scientists invented the EcoSphere – inside a sealed glass container, there are air, water, gravel, and three living things – algae, shrimps, and bacteria. Usually, these three living things can stay alive in the container for two or three years until the shrimps become too old to live. The picture above shows an EcoSphere and its inside part. The EcoSphere is a closed ecosystem and has no exchange of matter with the outside environment.

- Why can the tree/shrimp/bacteria keep alive? Do you think it can get everything it needs? What are those things? Where do they come from?
- Do you think the organisms in the EcoSphere rely on each other to keep alive? Could you explain that?
- Do you think the EcoSphere has energy exchange with the outside environment? Why? If your answer is yes, what is the energy input and what is the energy output?
- If I put the EcoSphere in a dark room for one week, what will happen? Why? Will the organisms still alive? Why?
- Do you think that matter is recycled in the EcoSphere?
- Do you think that energy is recycled in the EcoSphere?