Carbon Student Interview, Form A

Interview written for use with middle and high school students about carbon cycling

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Culturally relevant ecology, learning progressions and environmental literacy
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ENVIRONMENTAL LITERACY CARBON INTERVIEW

FORM A

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.

Tree Growth

	
A small tree was planted in a meadow	After 20 years it has grown into a big tree, weighing 500 lb more than when it was planted.

Actor: tree
Enablers: sunlight, water, soil, and air

1. Conceptual Understanding

Enablers **[Enablers: sunlight, water, soil/nutrients in soil, air]**

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

Ask follow-up questions about each enabler. For enablers not mentioned, ask: Some students said that the tree needs water [or sunlight, soil, nutrients in soil, air] to grow, do you agree? If yes, ask follow-up questions. If no, ask: Why?

b. How does water [or sunlight, soil, nutrients in soil, air] help the tree grow?

c. What change will happen to water [or soil/nutrients, air], when it is inside the tree's body? Is water [or soil/nutrients, air] used up to help the tree grow? Does it change into other things inside the tree's body? Or, do you think it is still water [or soil/nutrients, air] inside the tree's body?

Food and increased weight

d. You said that the tree made its own food. What do you mean by food?

e. How is food different from or similar to the things that plants use to make their food?

Growth as increase of materials

a. The tree gets heavier as it grows. How does that happen?

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

c. I will ask questions about the matter that makes the tree's bark, wood, and leaves. Did the matter exist outside the tree before it became part of the tree? Is it possible that the tree made some of the matter in the bark, wood, and leaves as it grew?

d. If the student mentions glucose/starch/cellulous/carbohydrates, ask: Do you think it contains carbon atoms? [If yes], where do the carbon atoms come from?

Energy sources

a. Does the tree need energy to grow? (If no, ask why. If yes, ask the following questions.)

b. I will ask questions about the energy that is in the tree's bark, wood, and leaves. Did the energy exist outside the tree before it became part of the tree? Is it possible that the tree made some of the energy in the bark, wood, and leaves as it grew?

c. Do you think that water [sunlight, nutrients, air] provides energy for the tree to grow? Why do you think that water [sunlight, nutrients, air] has/hasn't energy?

d. If the student says that water [sunlight, nutrients, air] has energy, ask: Where does the energy of water [sunlight, nutrients, air] go? Is the energy used up? Does it change into other things inside the tree's body? Is it still energy?

e. Do you think the tree stores energy inside its body?

f. If yes, where does the tree store energy? In cells? In molecules? What kinds of molecules?

CO2—O2 exchange

a. If the student talks about CO2—O2 exchange, ask: How does that happen?

b. You said that the tree breathes in carbon dioxide and breathes out oxygen. Carbon dioxide has carbon atom, but oxygen does not have carbon atom. So, where does the carbon atom of CO2 go?

Scale (Composition)

a. Do you think that the tree is made of cells? How do you know that?
b. Do you also think that the tree is made of molecules? How do you know that?
c. You said that the tree is made of both cells and molecules. How can the tree be made of both cells and molecules? Where are the molecules in the tree's body? What are the cells made of?

2. Citizenship and Argumentation
    a. You said that ------ [summarize key claims about how a tree grows, especially about what is happening inside the tree, 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 matter of the tree come from and ask argumentation questions: (Choose one to ask).
        - If the student says weight is from air, ask: I know that someone said that the weight came from the nutrients from soil. What would you say to convince your friend that you were right?
        - If the student says weight is from air, soil, and water, ask: I know that someone said that the weight only came from air. What would you say to convince your friend that you were right?
        - If the student says that the tree create matter, ask: I know that someone said that the tree got matter from outside environment and made them into their body structure. What would you say to convince your friend that you were right?
    e. Is there anything that you have observed about plants or tree growing 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?

--- DEAD TREE DECAY ---

A tree falls in the forest. After many years, the tree will appear as a long, soft lump barely distinguishable from the surrounding forest floor.
See decomposers (change picture)

Heat comes out from compost.

Actor: Dead Tree
No enablers such as tree decay due to becoming old
Enablers: rain, wind, sun, bugs, fungi, bacteria

Enablers

a. What causes the dead tree to decay?
b. You said that **[bugs, fungi, bacteria, rain, wind, etc.]** causes the tree to decay. How does that happen?

Weight loss

a. The tree lost a lot of weight over a long time. Where did the matter go?
b. Do you think that the matter change into other things? Is it still wood?
c. If the student mention "break down", "decompose", ask: What do you mean by that?
d. Do you think chemical changes are happening to the wood of the tree? [If yes], what are those chemical changes? Could you use molecules to explain your answers?
e. Do you think a living tree's body contains carbon atoms? [If yes], where do the carbon atoms go when the tree dies and is decaying?

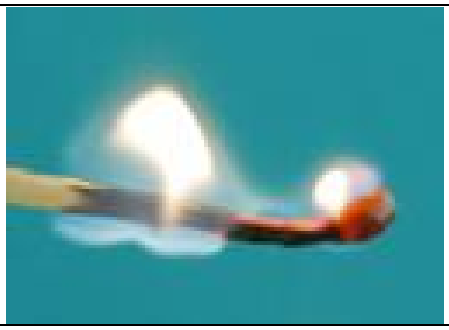
Energy

a. Do you think energy is somehow involved in the event of tree decaying? How does that happen?
b. Do you think that the tree contained energy when it was living? Why do you think so? Where does that energy go, when the tree decays? Is it still energy? Does it change into other things?

Heat in decay

c. The trunk of the tree is decaying in the first picture and the leaves are decaying in the second picture. How do you think these two events are similar or different? Why do you think so?
d. Do you know that the compost becomes warm when it decays? Why do you think so?
e. Do you think that heat is released from compost? How does that happen?
f. Where does the heat energy come from? Is the heat changed from molecules/substances or other forms of energy? Why?
g. Does this process require oxygen to happen? Why do you think so?

--- FLAME BURNING ---



Actor: flame
Enablers: wood, air

1. Conceptual Questions

Enablers [wood, air]

a. What does the flame need in order to keep burning?

Ask follow-up questions about each enabler. For enablers not mentioned, ask: Some students said that flame needs air [wood] to keep burning, do you agree? If yes, ask follow-up questions. If no, ask: Why?

b. What happens to the air [wood], when it is used to keep flame burning? Is it used up? Does it change into other things? Or, do you think it is still air [wood]?

Weight loss

a. What change will happen to the wood of the match, when the flame is burning?
b. Do you think the match will lose weight? [If yes], where does the matter go? Is it used up? Does it change into other things? Why?
c. Do you think that wood contains carbon atoms? [If yes], where do the carbon atoms go when the flame is burning?

O2—CO2 cycle

d. If students say that oxygen becomes carbon dioxide, ask: Carbon dioxide has carbon atom in it, but oxygen does not have carbon atom. So, where does the carbon atom in the carbon dioxide come from?

Energy and fuels

a. Wood burn, but sand and stone cannot burn. Why? If yes, ask: Why?
b. Do you think that flame needs energy to keep burning?
c. If yes, where does the energy come from? Why do you think the things you mentioned [e.g., oxygen/wood] have energy?
d. Where does the energy of oxygen/wood go? Is it used up? Does it change into materials? Or, is it still energy? Where is it?

Warmth and heat energy

a. Why do you feel warm when the flame is burning?
b. Do you think heat energy is released from burning?
c. If yes, where does the heat energy come from? Do you think it is created in the reaction, or do you think it is changed from other forms of energy? Please explain.

--- CAR RUNNING ---

Car Running

Tom's family went to Chicago on vacation. When they came back, Tom's dad found that their car consumed 50 gallons of gasoline for the trip.

Actor: Car

Enablers: gasoline, air

Enablers [gasoline, air]

a. Do you think that the car needs gasoline in order to run?

Ask follow-up questions about each enabler. For enablers not mentioned, ask: Some students said that flame needs air [or wax, wick, wood] to keep burning, do you agree? If yes, ask follow-up questions. If no, ask: Why?

b. You said that the car needed [gasoline, air] to run. How does it help the car run?

c. What happens to the gasoline/air inside the car when the car runs?

Weight loss

a. When your family arrived at Chicago, the gas tank was almost empty. Where did the gasoline go?

b. Do you think the gasoline is used up? Or, does it change into other things?

c. Do you think gasoline contains carbon atoms? If yes, where do the carbon atoms go when the gasoline is used by the car?

Fuels and energy sources

a. Why do people use gasoline instead of water to run their cars? How is gasoline different from water?

b. Does the process of car running require energy? If yes, where does the energy come from? If no, why?

c. Why do you think the things you mentioned [e.g., gasoline/oxygen] have energy?

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

e. If the student mentions motion/kinetic energy, ask: When the car stops, where does the motion/kinetic energy of car running go? Does it disappear? Does it change into materials? Is it still energy? Where is it?

f. If the student mentions CO_2 as a product, ask: You said that CO_2 is produced. If you put CO_2 back to engine, do you think the car can run? Why?

g. If no, ask: Gasoline has carbon in it. Carbon dioxide also has carbon in it. Why can gasoline power the car but carbon dioxide cannot?

Warmth and heat energy

a. After the car runs for a while, the front part of the car will become very hot. Do you know why?

b. Do you think heat energy is coming out? If yes, where does the heat energy come from? Do you think that heat is created in burning, or do you think it is changed from something else? Please explain.