Life Cycle Assessments Over a Cup of Coffee

Overview: Following the lesson, students will have an understanding of the creation and uses of life cycle assessments.

Keywords: Lifecycle, environmental impacts, inventory, life cycle assessment, product , sustainability

Age / Grade Range: **Grades 9-12**

Background: According to the ISO (International Organization for Standardization), a life cycle assessment (LCA) is the "Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle." Life cycle assessments consider all stages of a product from manufacture/creation to disposal. They are useful in assessing environmental impact as they provide a conceptual model to assist in the visualizing of different stages in a product's life. By examining each stage, resource inputs and waste outputs can be considered. By approaching a life cycle assessment at each stage, decisions can be made to reduce environmental impacts. There are four main components of a LCA: **inventory analysis, impact analysis, improvement analysis,** and **interpretation**. This lesson explores all four areas.

Next Generation Science Standards & Common Core:

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problem that can be solved through engineering

Goals: Students will explore coffee as a product in order to understand life cycle assessments. Through creation of a mind map and small group discussion, life cycle assessments will be introduced. Students will become familiar with the comparison of product life cycles to the life cycles of living things.

- Where does a life cycle assessment begin?
- Where does a life cycle assessment end?
- Why are life cycle assessments important?
- How do life cycle assessments connect with environmental impact?

Objectives:

- Students will be able to explain the basic steps of a life cycle assessment.
- Students will be able to explain how a life cycle assessment is a useful

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Northwest Advanced Renewables Alliance

tool for engineers, manufacturers, and product users.

- Students will be able to use a life cycle assessment to suggest methods for reducing environmental impact.

Materials:

- Paper
- Writing utensils

Classroom Time: Less than one hour

Introduction (Engage): Watch "Life Cycle Analysis in Practice" video. Following the video, discuss the role of LCA in determining sustainability and being "green."

Activity (Explore): Draw comparison between a product's LCA and the life cycle of an organism (i.e. butterfly: egg, birth, caterpillar, chrysalis, death) in order to activate prior knowledge. Using the familiarity of an organism's life cycle, instruct students to draw a mind map of the life cycle of a cup of coffee in order to create a life cycle inventory (LCI), or **inventory analysis**. Emphasize that this is a brainstorming type activity with no wrong answer. Encourage students to use drawing or writing. Ask questions to help facilitate connections.

Explanation: Share mind maps and discuss similarities and differences. Allow students to augment maps where necessary. Introduce the steps of product lifecycle: raw material acquisition, material manufacture, product manufacture, use, and disposal. Introduce inputs and outputs: energy, raw materials, wastes and emissions. Encourage students to identify each of these steps in their maps (**inventory analysis**, continued). Introduce and explain three types of LCA:

- Cradle to gate: partial LCA that begins at resource extraction and ends at factory before transportation to consumer
- Cradle to grave: full LCA that begins at resource extraction, continues through use, and ends at disposal
- Cradle to cradle: begins at resource extraction and continues through use and disposal. In this case, disposal is a recycling process. Also known as *closed loop production*

Elaboration: Discuss potential environmental impacts at each stage of the life cycle inventory to form an **impact analysis**. Following addition of potential impacts, instruct students to brainstorm methods to reduce environmental impact at different phases of the LCI. Discuss and allow time to work in groups to add suggested steps for reduction of environmental impact to mind maps (**improvement analysis**). Before wrapping up, instruct students to write down a paragraph on their map summarizing how LCAs are useful tools and how we use them (**interpretation**)

Evaluation: Collect maps. Subjectively assess, or use rubric found at the end of this lesson.

Additional resources:

Life Cycle Analysis in Practice Video:

"The American Hardwood Export Council's ground-breaking Life Cycle Assessment (LCA) research helps the Royal College of Art students produce detailed Life Cycle impacts for their furniture designs."

https://www.youtube.com/watch?feature=player_embedded&v=3-HgvSgM3Hk

Life Cycle Assessment Overview

A University of Texas created lesson that delves deeply into the creation and purpose of LCAs. A good resource for a foundational understanding of LCA.

http://www.utexas.edu/research/ceer/esm282/dfe/LCAoverview.PDF

NARA Life Cyle Assesment Resources

A collection of NARA-specific LCA resources detailing the processes and uses involved wit LCAs.

http://teachingadventurelearningatmoss.wordpress.com/2014/03/17/life-cycle-assessment/

LCA Rubric*	3	2	1	0
Section				
Describe the steps in a product lifecycle assessment	Description (verbal, written, illustrated, etc.) includes relevant vocabulary such as materials acquisition, disposal, transport, etc., and clearly moves through each stage. Student can communicate what happens at each step.	Description uses some relevant vocabulary and moves clearly through each stage. Student can explain what happens at each step.	Description uses little vocabulary and steps in the product life cycle assessment are missing or out of order. Student has difficulty explaining what happens during each step.	No description
Suggest ways to reduce the environmental impacts of a product	Suggestions are logical, clearly communicated and pull from prior knowledge, data from the class discussion, and scientific reasoning	Suggestions are logical, and reference prior knowledge, data from the class discussion, and scientific reasoning. Connections to the class activity could be stronger OR there is some faulty scientific reasoning	Suggestions are not very logical or feasible, but student does reference prior knowledge or data from the class discussion.	No suggestions
Explain how a lifecycle assessment is a useful tool	Explanation (verbal, written, visual, etc.) references class discussion. Explanation is clear, logical, and creative	Explanation (verbal, written, visual, etc.) has some references to the class discussion. Explanation is fairly clear and logical	Explanation (verbal, written, visual, etc.) has few references to the class discussion. Explanation is not very clear and logical	No explanation included

*adapted from Teachers try Science: http://teacherstryscience.org/sites/default/files/uploads/lessonplan/resources/product_lifecycle_rubric.pdf