Learning Activity 1A | **Water**

Water Footprint

Targeted Learning Objectives

1.9 Water is embodied in all materials, products, and services.

2.1 Evaluate issues of water scarcity, stress, and conflict on the global population and its effect to human well-being.

2.2 Be able to create viable solutions to meet the water demand with consideration of local resources, cultural conditions, economic constraints, etc.

2.4 Use the causal loop diagram to depict the interaction between water quantity, use, pollution, quality and energy.

3.3 Understand the segments of existing and future populations that are at a greater risk of water stress and demand due to environmental, social, cultural, political, and economic issues and pressures.

4.1 Understand that your daily actions affect the local, regional, and global well-being of others.

5.3 Feel that you, as an engineer, can help achieve more sustainable management of water resources in your region and globally.

6.1 Recognize the limits of one's knowledge around water issues.

6.2 Formulate questions that would need to be answered to address an issue involving water.

6.3 Design and execute a plan for self-directted learning.

Activity

Read the article by Hoekstra and Chapagain, titled "Water Footprints of Nations: Water Use by People as a Function of Their Consumption Pattern," found in the Water Resources Management Journal (2006). Use the article to discuss the average water footprint of four different countries and link it with the individual countries' GDP (consumption), population, and water scarcity. Pick countries with lower and greater than the global average, and average water footprints (use Figure 2 as a starting point). Then, use Table 2 to determine the water footprint for different products. Based on your analysis of four different countries (including population, GDP, water scarcity, etc) determine which products or agricultural goods are suitable for manufacturing in the different countries you selected and discuss why, based on these parameters.

Objectives	**Criterion**	**Standards**
2.1, 2.2	Application	5 PROFICIENT Includes a thorough analysis of various countries' water footprints with respect to above parameters. Appropriately compares countries and makes legitimate suggestions for suitable products or agricultural goods targeting country-specific characteristics such as consumption, population, and water scarcity. 3-4 DEVELOPING Develops analysis of water footprints, but does not show thorough understanding of how this affects the choice of suitable products and agricultural goods. 0-2 BELLOW EXPECTATIONS Only addresses a few of the aspects of the activity, very incomplete answers, not well-though out or researched discussion.

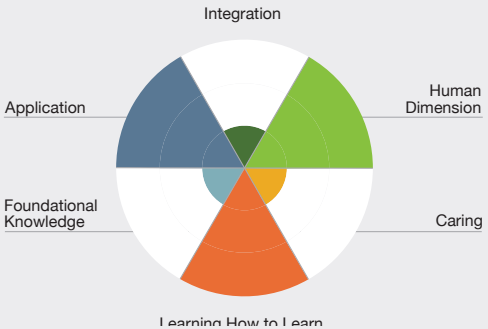
Active Learning Profile

information source: direct / indirect
experience: doing / observing
reflection: individual / group

Time Investment Profile

individual: 90-120 minutes reading
group: 40-60 minutes discussion

Development Profile



Notes to Faculty

This bulk of this activity is best completed as an individual out-of-class assignment. However, there is the possibility to have an in-class group discussion by comparing the information students have compiled for the different countries in their projects. The goal is to have students think about countries' water footprints, and how those are linked to consumption, population, and water scarcity. By requiring students to choose countries above and below the global water footprint average, students will also be able to deduce information concerning the appropriateness of certain manufactured products or agricultural goods based on their water demand.

Learning Activity 1B | **Water**

Biofuels and Water Use

Targeted Learning Objectives

1.5 Major consumption and pollution of water occurs through economic activities of the industrial-era.

1.8 Water and embodied energy are intrinsically linked.

2.4 Use the causal loop diagram to depict the interaction between water quantity, use, pollution, quality, and energy.

2.5 Use the water footprint method to consider the implications of different manufacturting and agricultural activites in a particular area.

3.1 Understand that engineering design decisions can have both positive and negative global impacts through stressors on water, energy and ecosystems.

4.1. Understand that your daily actions affect the local, regional, and global well-being of others.

5.1 Value water as a precious resource.

5.3 Feel that you, as an engineer can help achieve more sustainable management of water resources in your region and globally.

6.1 Recognize the limits of one's knowledge around water issues.

6.2 Formulate questions that would need to be answered to address an issue involving water.

6.3 Design and execute a plan for self-directted learning.

Activity

Read the article written by Dominguez-Faus, Powers, Burken, and Alvarez, titled "The Water Footprint of Biofuels: A Drink or Drive Issue?" found in the Environmental Science and Technology Journal (2009). This article discusses the water used in the production of biofuels and the link with water and energy demand. Describe the conditions that would make biofuels a beneficial replacement for petroleum-derived fuels in transportation.

Objectives	**Criterion**	**Standards**
3.1	Systems thinking	5 PROFICIENT Shows creativity across social, political, technological and environmental conditions connected to biofuel development and use. 3-4 DEVELOPING Is able to identify at least three different issues embedded in the biofuels supply chain that must be address in order for biofuel production and use to be beneficial. 0-2 BELLOW EXPECTATIONS Is unable to articulate the issues in biofuel use and development or can only identify one or two.

Active Learning Profile

information source: direct / indirect

experience: doing / observing

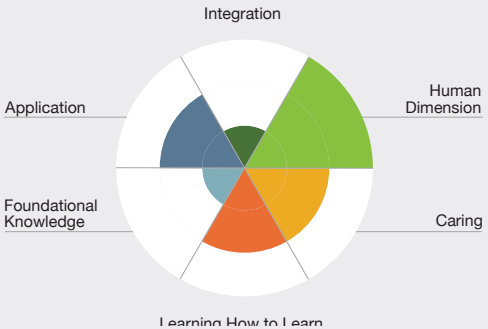
reflection: individual / group

Time Investment Profile

individual: 90 minutes reading

group: 30 minutes discussion

Development Profile



Notes to Faculty

The important part of this activity is to initiate critical thinking about the relationship between design and impact and the embedded assumptions within assertions.

The activity is also meant foster creative and broad thinking in the part of describing the conditions that would make biofuels a beneficial replacement. This activity is also likely to surface different value systems about what is beneficial.

Learning Activity 1C | **Water**

Pathogens and Disease Transmission

Targeted Learning Objectives

1.3 Identify the major physical, chemical, and biological constituents, including pathogens, that are found in the different bodies and sources of water, and note their typical concentrations.

1.6 Water quality and availability is linked to the local, regional and global systemic conditions caused by the economic activities of the industrial-era.

2.2 Be able to conceptualize alternative ways to meet the water demand with consideration of local resources, cultural conditions, and economic constraints.

2.3 Describe functional requirements of a treatment process to improve water sources that is appropriate for different given situations.

3.3 Understand the segments of existing and future populations that are at a greater risk of water stress and demand due to envionrmental, social, cultural, political, and economic issues and pressures.

4.1 Understand that your daily actions affect the local, regional, and global well-being of others.

5.2 Care about equalling serving all human welfare through global water resources and sanitation.

6.2 Formulate questions that would need to be answered to address an issue involving water.

6.3 Design and execute a plan for self-directted learning.

Activity

Pathogens are biological constituents found in water and contribute to poor water quality. These pathogens promote disease transmission and cause negative health effects in humans. Incidence of water and sanitation-borne diseases is more common in the developing world than in developed countries.

1 | Discuss the pathogens found in water and wastewater (small-scale sanitation systems) and the diseases that they cause. **2** | Discuss the reasons why the incidence of water and sanitation-borne disease is higher in the developing world (including social, political, economical, and cultural reasons). **3** | Innovate a viable and sustainable solution to solve this problem that so greatly affects the world's poor, by using the Millennium Development Goals as a guideline.

Objectives	**Criterion**	**Standards**
3.1	Systems thinking	5 PROFICIENT Able to identify and link a range of societal actions to the greater incidence of f water and sanitation-borne diseases in the developing world 3-4 DEVELOPING Able to idenfy and link a at least three societal actions that account for the water & sanitation disease trends mention above 0-2 BELLOW EXPECTATIONS Able to identify and link fewer than three societal actions that account for the trends

Active Learning Profile

information source: direct / indirect

experience: doing / observing

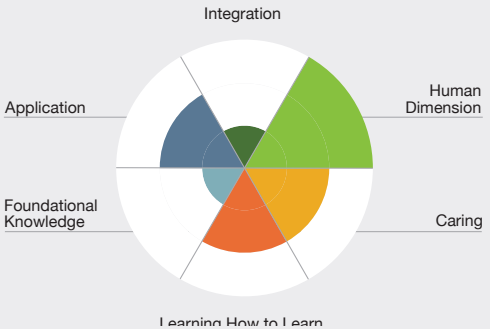
reflection: individual / group

Time Investment Profile

individual: 90 minutes reading

group: 30 minutes discussion

Development Profile



Notes to Faculty

This activity may be done both in groups or individually, but requires a great deal of out-of-class responsibility for data collection and research. Furthermore, it is encouraged that students expand their findings and draw valid conclusions based on the social, political, economic, and cultural differences between these kinds of countries and their presence or lack of water quality issues.

Group Discussion encourage students to share their ideas on poor water quality in developing vs. developed countries, and can help students develop a greater appreciation of views of others.