Learning Activity 1 A | **Population**

Global Stressors

Targeted Learning Objectives

1.6 Understand that the ability of the earth to sustain the human population depends on the environmental impact of the lifestyle behavior of the population. This can be thought of as the product of the A and T terms in the IPAT equation.

1.8 Remember that the earth's area of bioproductive land is a finite resource that can be increased through restoration or decreased through destruction.

2.1 Critique ways in which engineering activity influences population.

3.2 Relate the connection of population with sustainability through a systems thinking/systems model approach.

4.1 Come to see themselves as part of the global population system.

4.3 Come to see themselves as having great power ("self-authorship") as an engineer to improve or worsen the well-being for the population.

5.1 Feel they (the students) are important in terms of addressing population challenges.

5.2 Care about serving all of humanity, including populations of lower socioeconomic status and indigenous peoples in both developed and developing countries.

5.4 Feel "part of the solution" for sustainable development.

6.5 Practice the virtues of critical thinking when evaluating new information:

1. Intellectual integrity, ***2.*** Intellectual humility, ***3.*** Confidence in Reason, ***4.*** Intellectual Perseverance, ***5.*** Fairmindedness, ***6.*** Intellectual Courage, ***7.*** Intellectual Empathy, ***8.*** Intellectual Autonomy

Activity

Individual: Critically read the passage "Global Stressors on Water Quality and Quantity" by Julie Beth Zimmerman, James R. Mihelcic and James Smith, Environmental Science and Technology, 42: 2008, pp 4247-4254. **1** | The article explained that a realistic way to approach ideal and, "sustainable water systems is likely one that considers the stressors as a system with positive and negative feedback loops, synergies, and interfaces." Construct a Causal Loop Diagram to show cause and effect relationships like that which exist between stressors, their affected systems, and the population. **2** | Demonstrate your knowledge of the "hockey-stick" relationships which exist within multiple stressors in Figure 4 by explaining the obvious trends that have developed over time. Additionally, expand on the interconnectedness of these relationships and that, "the impacts of global stressors are not independent." **3** | Given this golbal picture, what do you believe to be necessary when designing and selecting technology?

Objectives	**Criterion**	**Standards**
3.1	Application Human Dimension	5 PROFICIENT Shows understanding of cause and effect relationships between indicated stressors, systems, and associated populations. 3-4 DEVELOPING Creates a Causal Loop Diagram, but incorrectly or incompletely demonstrates understanding of connectedness of all parts. 0-2 BELLOW EXPECTATIONS Shows little understanding of causes and effects of associated systems, populations, and stressors and possibly no diagram.

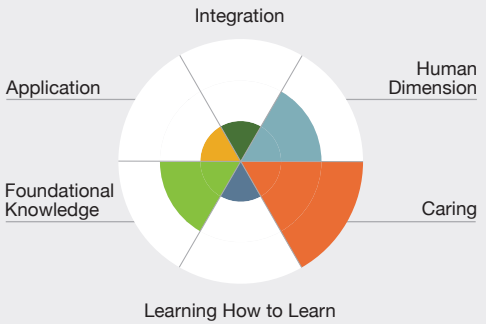
Active Learning Profile

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

Time Investment Profile

individual: 90 minutes reading and reflection
group: 30 minutes discussion

Development Profile



Notes to Faculty

This activity requires a foundational understanding of systems thinking. The Systems Thinking Learning Suite can provide introductory information if needed. The purpose of the activity is to begin to see the interrelatedness of social, economic, health, and environmental factors with population. There are no correct answers. However, the activity should help people to begin thinking in systems.

Learning Activity 1 B | **Population**

Urban Metabolism and Material Flow Analysis

Targeted Learning Objectives

1.1 Remember that as an essentially closed thermodynamic system, all substances annually consumed by humans must be annually produced by the earth's biological systems (e.g., food) or from a finite reserve stock of that resource (e.g., fossil fuels).

1.2 Remember that as an essentially closed thermodynamic system, all wastes annually produced by the human population must annually be absorbed or detoxified by earth's biological systems. If they are not absorbed or detoxified, they will accumulate within the earth system.

1.4 Understand that the environmental impact of the earth's population is a product of that population and the way in which they live ("life style"); this can be simply expressed as the I=P*A*T equation where I is the impact, P is the population, A represents the affluence per person and T represents the technological resource impact per affluence.

2.2 When given Meadows' nine levels of systemic intervention, create an example of a specific intervention at each of the nine levels that can potentially decrease the environmental impact of a population.

3.2 Relate the connection of population with sustainability through a systems thinking/systems model approach.

3.4 Relate the choices of one's own life style to potential global impact through the ecological footprint.

4.1 Come to see themselves as part of the global population system.

4.3 Come to see themselves as having great power ("self-authorship") as an engineer to improve or worsen the well-being for the population.

4.4 Come to see that recognizing and suspending one's viewpoint is needed in order to understand the perspective of another.

5.4 Feel "part of the solution" for sustainable development.

6.1 Identify what one needs to learn to achieve a learning objective;.

6.2 Formulate relevant questions around 6.1.

6.3 Identify resources for information to answer questions from 6.2.

6.4 Answer 6.2 by synthesizing information found through self-directed learning.

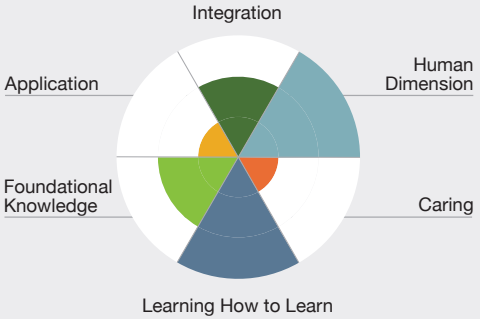
6.5 Practice the virtues of critical thinking when evaluating new information:

1. Intellectual integrity, ***2.*** Intellectual humility, ***3.*** Confidence in Reason, ***4.*** Intellectual Perseverance, ***5.*** Fairmindedness, ***6.*** Intellectual Courage, ***7.*** Intellectual Empathy, ***8.*** Intellectual Autonomy

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



Learning Activity 1 B | **Population**

Urban Metabolism and Material Flow Analysis

Activity

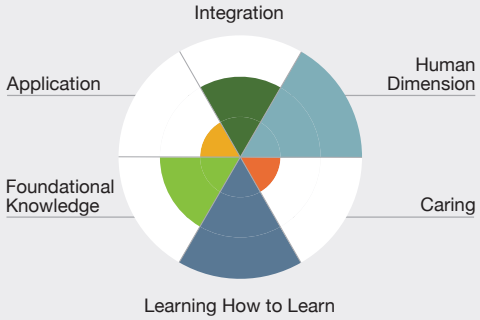
Individual: **1** | Develop a material flow diagram and analysis for solid waste in your house, apartment, or dorm room over the period of one week (approximate it based on mass basis). What is going in and out of your defined system and, more specifically, where does it go (i.e. disposal, recycling, consumption, reuse, accumulation, etc)? To expand upon this, what would it be like if the population of your house doubled? Consider a larger population to potentially have consumption patterns like yours, how would this affect the environment, public health, and the economy? What if your economic wealth increased? How would this relate to the global material flow and waste generation if the global population doubled?
2 | Propose methods to address the potential concerns.

Objectives	**Criterion**	**Standards**
6.5	Learning How to Learn	5 PROFICIENT Demonstrates the virtues of critical thinking by openly listening to others' perspectives and reflectively considering all input with fairmindedness. 3-4 DEVELOPING Demonstrates some of the virtues of critical thinking or demonstrates all in part. 0-2 BELOW EXPECTATIONS Is too attached to their own point of view to be able to listen to others. This is demonstrated by repeated assertions of one's own viewpoint as the correct viewpoint.

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

The emphasis in this activity is on thinking through the flows required to support a life style and on practicing the virtues of critical thinking. There are no right or wrong answers. Doing the analysis should surface many questions about what to include and what to exclude. Doing this activity as a group project is likely to aid the development of more questions that integrate ideas across social, environmental and economic issues.

Learning Activity 1 C | **Population**

Populations Served By Engineers

Targeted Learning Objectives

1.2 Remember that as an essentially closed thermodynamic system, all wastes annually produced by the human population must annually be absorbed or detoxified by earth's biological systems. If they are not absorbed or detoxified, they will accumulate within the earth system.

2.1 Critique ways in which engineering activity influences population.

2.4 Identify environmental, social, health, public policy, and economic factors that influence population growth; state how population growth is influenced.

3.1 Relate the interaction among social, economic, health, and environmental factors to population dynamics.

4.1 Come to see themselves as part of the global population system.

4.3 Come to see themselves as having great power ("self-authorship") as an engineer to improve or worsen the well-being for the population.

5.2 Care about serving all of humanity, including populations of lower socioeconomic status and indigenous peoples in both developed and developing countries.

6.5 Practice the virtues of critical thinking.

Activity

Read the article by Graham et al., titled "Who Lives Near Coke Plants and Oil Refineries? An Exploration of the Environmental Inequity Hypothesis," found in Risk Analysis, vol. 19, No. 2 (1999), pp. 171 – 186. The engineer's creed contains a pledge that says "I dedicate my professional knowledge and skill to the advancement and betterment of human welfare.... I pledge to place service before profit, the honor and standing of the professional before personal advantage, and the public welfare above all other considerations." In your estimation, is participating in the design of these plants constitute adherence to or violation of the engineer's creed? Elaborate on your rationale.

Objectives	Criterion	Standards
6.5	Virtuous critical thinking	5 PROFICIENT Balances inquiry - listening to other points of view- and advocacy - stating one's own point of view. Seeks to understand others, without judgement of their position. Is able to articulate their rationale and identify five or more interventions. 3-4 DEVELOPING Can express their own point of view and listen to others. The listening to others does not result in new understanding as evidences by a reasserting of one's viewpoint. 0-2 BELLOW EXPECTATIONS Can articulate their own position, but argues with or ignores other views that are expressed.

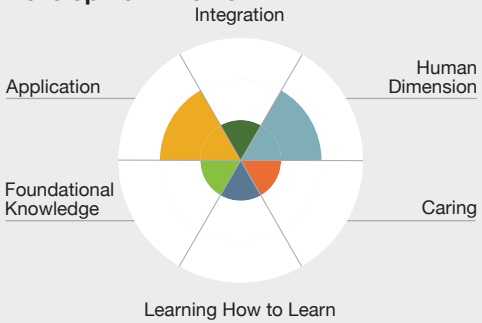
Active Learning Profile

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

Time Investment Profile

individual: 90-120 minutes reading and reflection
group: 40-160 minutes discussion

Development Profile



Notes to Faculty

This activity requires individual reading as well as group discussion. The discussion could really be something like "I would put together a class action lawsuit." The questions are meant to have them think through what it is they are trying to achieve in their solution.