

# Learning Activity A | Systems Thinking

## The Global Marketplace

### Targeted Learning Objectives

- 4.4 9 Know that they are amongst those with the highest income in the global marketplace (if they earn more than 9  
9 US\$20K per year they are in the 80% percentile of income in the global economic system.)9
- 4.9 9 Know that overcoming systemic problems requires collaboration amongst different parts/people within the system.9
- 5.2 9 View all disciplines as important for tackling challenges caused by the global economic system (i.e., as high 9  
9 human purpose);9
- 5.3 9 Be more interested in improving the health and welfare for all living beings;9
- 5.4 9 Value perspectives from other disciplines.9
- 6.5. 9 Practice the virtues of critical thinking when evaluating new information:1. Intellectual integrity; 2. intellectual 9  
9 humility; 3. confidence in reason; 4. intellectual perseverance; 5. fair-mindedness; 6.intellectual courage.9

### Activity

**Individual:** In preparation for the group discussion, read Prahalad, C. J., & Hart, S. L. (2002). *The Fortune at the Bottom of 9 the Pyramid. Strategy + Business(26), 2-14.*; Answer the following questions: **1** | When you earn a degree in engineering, 9  
9 you are likely to have an income of \$50-65K/year. In what approximate income percentile does this place you in the global 9  
9 marketplace? **2** | Given the global situation described in the reading, identify what disciplines are important to address the 9  
9 challenges caused by the global economic system? **3** | The design innovation company, IDEO, insists that their design 9  
9 teams have a range of technical and social science disciplines on a design team, regardless of the product. What is the 9  
9 value of having someone with a social science education when the product is an engineered product? **4** | Global economic 9  
9 systems are believed to accumulate wealth in powerful societies at the expense of less powerful societies. Use data from 9  
9 the reading (or other data) to support the truth (or untruth) of this statement.9

**Possible Group Discussions:** Discuss one or more of the following in your group. Capture your group response in the 9  
9 form of summary statements for each question. **1** | What rights and responsibilities do you have to the global society at this 9  
9 level of income? **2** | J.F. Kennedy said “a high tide raises all ships.” Does this apply to the global economic system? Why 9  
9 or why not? **3** | Throughout human history, there are examples that illustrate that extreme inequity within a socioeconomic 9  
9 system pushes the system toward instability. What is instability in this case and why does inequity cause instability?9

#### Objectives

6.5 (group discussion)

#### Criterion 9

Virtuous critical thinking in discussions

#### Standards

5 PROFICIENT Practices the five virtues of critical thinking with openness and 9  
9 respect for others' points of views;9

3-4 DEVELOPING Practices less than all five virtues of critical thinking or 9  
9 inconsistently practices them;9

0-2 BELOW EXPECTATIONS States own viewpoints as facts; Creates an 9  
9 unwelcome atmosphere for those with differing viewpoints;9

#### Active Learning Profile

information source: direct / indirect9

experience: doing / observing9

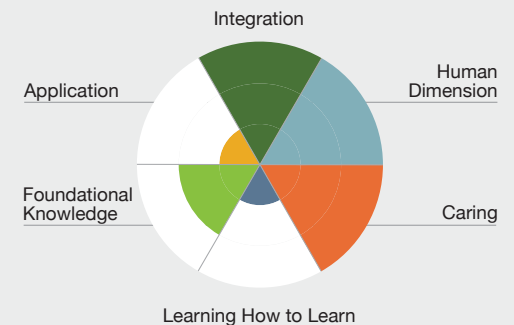
reflection: individual / group9

#### Time Investment Profile

individual: 90 minutes reading and reflection9

group: 30 minutes discussion9

#### Development Profile



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#### Objectives

6.5 (group discussion)

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#### Active Learning Profile

information source: direct / indirect9

experience: doing / observing9

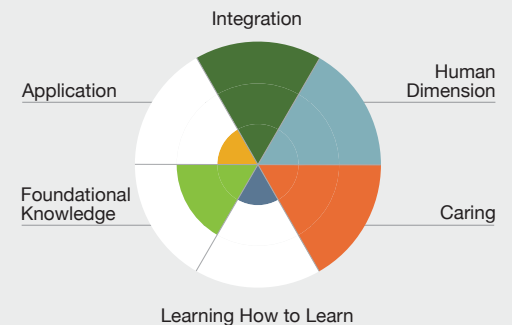
reflection: individual / group9

#### Time Investment Profile

individual: 90 minutes reading and reflection9

group: 30 minutes discussion9

#### Development Profile



#### Notes to Faculty

The important part of this activity is that it is completed, both individual and group activities There are no right and wrong answers. Students will be at different levels of development and this is okay. It is important to allow them to “be where they are.” The group discussion provides a venue for differing opinions to emerge. This is the process that causes growth or evolution of thought.

Group conversations are designed for growth in the targeted learning objectives, but may be hampered by poor social skills of individual group members. Effective conversations are more likely when the individuals practice the virtues of critical thinking. However, don’t be surprised if some students dominate the conversation or if others don’t participate. Allow students within the group to anonymously rate individuals’ performance after the conversation, without penalty. This provides you, the instructor, with feedback.



# System Dynamics

## Targeted Learning Objectives

- 1.1 9 Remember the concept of a dynamic system and the elements within a model of a dynamic system: system 9 boundary, surroundings;9
- 1.4 9 Know that all material or energy input to (or output from) the system must be created from existing material or energy;9
- 1.5 9 Remember that there are graphical tools that can be used to model a system and its behavior (interactions, 9 consequences);
- 1.6 9 Understand the relationship between events, patterns and system behavior;
- 1.7 9 Remember that the global economic/social system involves interactions between human behavior (society and economy) and the natural world (environment);
- 2.1 9 Identify components that make up a system by analyzing events and patterns;
- 2.2 9 Identify what events (or measures) serve as indicators for the behavior of the system;
- 2.3 9 From a list of possible factors, eliminate those that are likely to have negligible impact;
- 2.5 9 Create a schematic graph that depicts the behavior of a particular event (or measure) over time;
- 2.6 9 Using a causal loop diagram, evaluate the consequences of changes within a dynamic system (i.e., what happens 9 when those changes ripple through the system?)
- 2.7 9 Recognize the interdependency of components within a complex system;
- 2.8 9 From the knowledge of a system and behavior-over-time graphs, create a causal loop diagram involving the major 9 events (or measures) within a system;
- 2.9 9 Manage projects which requires system understanding (e.g., life cycle assessment, supply chain network analysis).
- 3.1 9 Connect the ideas of systems thinking to the rest of the modules (e.g., concept of sustainability, consequences of 9 population growth, material flow, energy flow, water system);
- 3.2 9 Recognize interdependencies of different systems (e.g., a nuclear power plant relies on a large reservoir of cold 9 water as does the local ecosystem within that same body of water);
- 3.3 9 Relate ideas of events and patterns of consumer behavior (including ones' own) to the larger global system.
- 3.4 9 Be able to make connections between events and patterns from very different areas, such as political, social, health 9 and safety, environmental, manufacturing, sustainability, economic;
- 3.5 9 Be able to construct causal loop diagrams that portray the behavior of a dynamic system.
- 4.1 9 Know that they are part of dynamic local and global systems ("society");
- 4.2 9 Know that their behavior (actions and inactions) can affect the systems;
- 4.6 9 Know that they share common resources with others in the global system;
- 4.9 9 Know that overcoming systemic problems requires collaboration amongst different parts/people within the system.
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### Active Learning Profile

information source: direct / indirect<sup>9</sup>

experience: doing / observing<sup>9</sup>

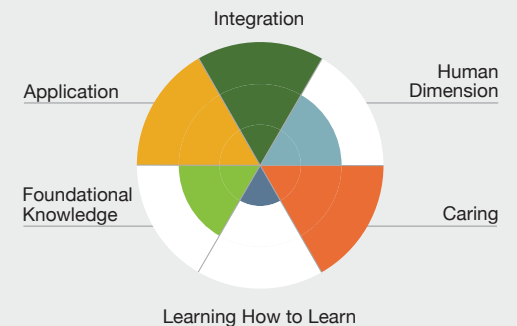
reflection: individual / group<sup>9</sup>

### Time Investment Profile

individual: 90 minutes reading and reflection<sup>9</sup>

group: 30 minutes optional sharing of answers<sup>9</sup>

### Development Profile



# Learning Activity B | Systems Thinking

## System Dynamics

### Activity

**Individual:** Read Hjorth, P & Bagheri, A. (2006). Navigating towards sustainable development: A system dynamics approach. Futures 38: 74-92.;

**Answer the following questions and discuss in groups:**

- 1 | Environmentalists argue that the health and welfare of non-human living organisms should be part of the sustainable development. Presuming that the models presented for sustainable development (e.g., Figure 7) are fairly accurate, what value would it have to achieve environmentalists' goals?
- 2 | Refer to Figure 4. Describe the stakeholders and disciplinary expertise that would be required to design sustainable solutions.
- 3 | In your view, what is missing from the model in Figure 4?
- 4 | Choose a habit in your life that you have been trying unsuccessfully to change (e.g., For me, this could be "Spending more time in nature."). Create a causal loop diagram that reflects major influences to this habit and how they are linked to it. Use the causal loop diagram labeling conventions. Identify three "high leverage" points that would enable you to change the habit in the way that you desire.

**Objectives**

6.5 (group discussions)

**Criterion 9**

virtuous critical thinking

**Standards**

5 PROFICIENT Practices the five virtues of critical thinking with openness and respect for others' points of views;

3-4 DEVELOPING Practices less than all five virtues of critical thinking or inconsistently practices them;

0-2 BELOW EXPECTATIONS States own viewpoints as facts; Creates an unwelcome atmosphere for those with differing viewpoints;

**Active Learning Profile**

information source: direct / indirect

experience: doing / observing

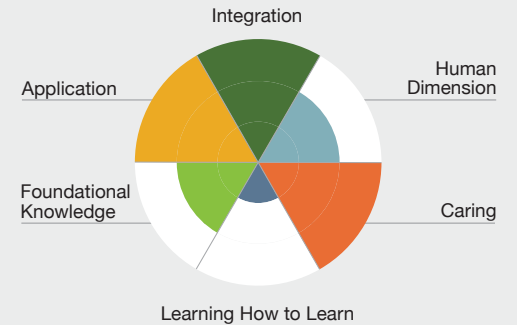
reflection: individual / group

**Time Investment Profile**

individual: 90 minutes reading and reflection

group: 30 minutes optional sharing of answers

**Development Profile**



# System Dynamics

## Targeted Learning Objectives

- 1.1 9 Remember the concept of a dynamic system and the elements within a model of a dynamic system: system 9 boundary, surroundings;9
- 1.4 9 Know that all material or energy input to (or output from) the system must be created from existing material or energy;9
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- 1.7 9 Remember that the global economic/social system involves interactions between human behavior (society and economy) and the natural world (environment);
- 2.1 9 Identify components that make up a system by analyzing events and patterns;
- 2.2 9 Identify what events (or measures) serve as indicators for the behavior of the system;
- 2.3 9 From a list of possible factors, eliminate those that are likely to have negligible impact;
- 2.5 9 Create a schematic graph that depicts the behavior of a particular event (or measure) over time;
- 2.6 9 Using a causal loop diagram, evaluate the consequences of changes within a dynamic system (i.e., what happens 9 when those changes ripple through the system?)
- 2.7 9 Recognize the interdependency of components within a complex system;
- 2.8 9 From the knowledge of a system and behavior-over-time graphs, create a causal loop diagram involving the major 9 events (or measures) within a system;
- 2.9 9 Manage projects which requires system understanding (e.g., life cycle assessment, supply chain network analysis).
- 3.1 9 Connect the ideas of systems thinking to the rest of the modules (e.g., concept of sustainability, consequences of 9 population growth, material flow, energy flow, water system);
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- 3.3 9 Relate ideas of events and patterns of consumer behavior (including ones' own) to the larger global system.
- 3.4 9 Be able to make connections between events and patterns from very different areas, such as political, social, health 9 and safety, environmental, manufacturing, sustainability, economic;
- 3.5 9 Be able to construct causal loop diagrams that portray the behavior of a dynamic system.
- 4.1 9 Know that they are part of dynamic local and global systems ("society");
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- 4.6 9 Know that they share common resources with others in the global system;
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### Active Learning Profile

information source: direct / indirect<sup>9</sup>

experience: doing / observing<sup>9</sup>

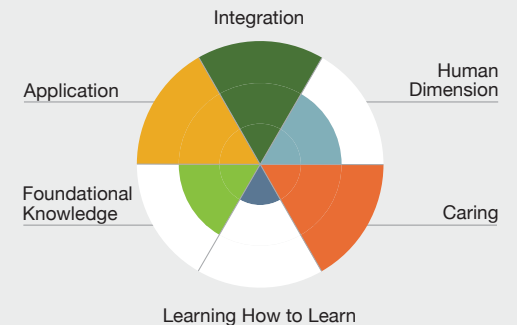
reflection: individual / group<sup>9</sup>

### Time Investment Profile

individual: 90 minutes reading and reflection<sup>9</sup>

group: 30 minutes optional sharing of answers<sup>9</sup>

### Development Profile



### Notes to Faculty

The important part of this activity is that it is completed, both individual and group activities. There are no right and wrong answers. Students will be at different levels of development and this is okay. It is important to allow them to "be where they are." The group discussion provides a venue for differing opinions to emerge. This is the process that causes growth or evolution of thought. You can collect students' response and evaluate for objective 6.5 if desired. An alternative would be to facilitate whole-class discussions on their responses. However, it is best to have students briefly share their responses in pairs or small groups before initiating a group discussion. The faculty member should then ask for group opinions? (This allows the students to feel less vulnerable when sharing their views).

Group conversations are designed for growth in the targeted learning objectives, but may be hampered by poor social skills of individual group members. Effective conversations are more likely when the individuals practice the virtues of critical thinking. However, don't be surprised if some students dominate the conversation or if others don't participate. Allow students within the group to anonymously rate individuals' performance after the conversation, without penalty. This provides you, the instructor, with feedback.

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## System Dynamics

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**Objectives**

6.5 (group discussions)

**Criterion 9**

virtuous critical thinking

**Standards**

5 PROFICIENT Practices the five virtues of critical thinking with openness and respect for others' points of views;

3-4 DEVELOPING Practices less than all five virtues of critical thinking or inconsistently practices them;

0-2 BELOW EXPECTATIONS States own viewpoints as facts; Creates an unwelcome atmosphere for those with differing viewpoints;

**Active Learning Profile**

information source: direct / indirect

experience: doing / observing

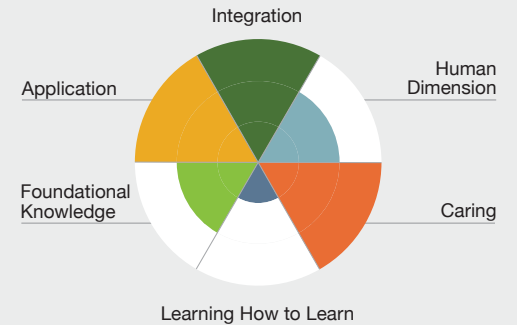
reflection: individual / group

**Time Investment Profile**

individual: 90 minutes reading and reflection

group: 30 minutes optional sharing of answers

**Development Profile**



# Learning Activity C | Systems Thinking

## Your Campus Systems

### Targeted Learning Objectives

- 1.5 9 Remember that there are graphical tools that can be used to model a system and its behavior (interactions, 9 consequences);9
- 2.1 9 Identify components that make up a system by analyzing events and patterns;9
- 2.2 9 Identify what events (or measures) serve as indicators for the behavior of the system;9
- 2.3 9 From a list of possible factors, eliminate those that are likely to have negligible impact;9
- 2.4 9 Create different system boundaries that lead to different systems solutions;9
- 2.5 9 Create a schematic graph that depicts the behavior of a particular event (or measure) over time;9
- 2.6 9 Using a causal loop diagram, evaluate the consequences of changes within a dynamic system (i.e., what 9 happens when those changes ripple through the system?);9
- 2.7 9 Recognize the interdependency of components within a complex system;9
- 2.8 9 From the knowledge of a system and behavior-over-time graphs, create a causal loop diagram involving the major 9 events (or measures) within a system;9
- 3.3 9 Relate ideas of events and patterns of consumer behavior (including ones' own) to the larger global system.9
- 3.4 9 Be able to make connections between events and patterns from very different areas, such as political, social, 9 health and safety, environmental, manufacturing, sustainability, economic;9
- 3.5 9 Be able to construct causal loop diagrams that portray the behavior of a dynamic system;9
- 4.1 9 Know that they are part of dynamic local and global systems ("society");9
- 4.2 9 Know that their behavior (actions and inactions) can affect the systems;9
- 4.3 9 Know that they are have great power ("self-authorship") as an engineer to improve or worsen the larger systems;9
- 4.6 9 Know that they share common resources with others in the global system;9
- 4.9 9 Know that overcoming systemic problems requires collaboration amongst different parts/people within the system.9
- 5.2 9 View all disciplines as important for tackling challenges caused by the global economic system (i.e., as high hu-9 man purpose);9
- 5.4 9 Value perspectives from other disciplines.9
- 6.5 9 Practice the virtues of critical thinking when evaluating new information: 1. Intellectual integrity 2. Intellectual hu-9 mility 3. Confidence in Reason 4. Intellectual Perseverance 5. Fairmindedness 6. Intellectual Courage 7. Intellectual 9 Empathy 8. Intellectual Autonomy9

#### Active Learning Profile

information source: direct / indirect9

experience: doing / observing9

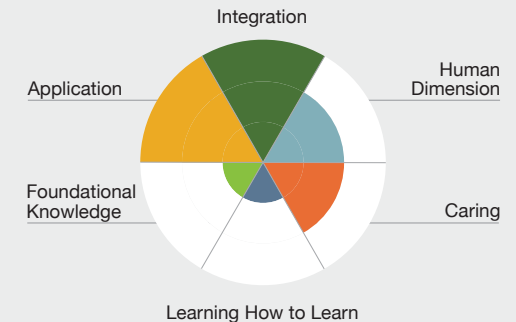
reflection: individual / group9

#### Time Investment Profile

individual: 60 minutes reading9

group: 90 minutes group work9

#### Development Profile



# Learning Activity C | Systems Thinking

## Your Campus Systems

### Activity

**Individual:** Must first be knowledgeable of causal loop diagram construction

**Group:** Choose a system on campus that results in waste that is landfilled (alternate: wasted potable water). Create a causal loop diagram for this system (begin by identifying the major components of the system, remember to consider both tangible and intangible components). Create a comprehensive strategy to decrease the flow of waste to the landfill (or alternatively, the flow of potable water). Your strategy should be based on the system components depicted in your causal loop diagram. (Hint: Choose 4-5 key indicators in your causal loop diagram and sketch schematic diagrams of how those indicators behave over time. This should help you develop a comprehensive strategy.)

#### Objectives

2.1-8, 3.3-5

#### Criterion

application, integration

#### Standards

5 PROFICIENT Systems and strategies that incorporate a broad range of approaches (behavioral, policy, political, social, technological);

3-4 DEVELOPING Systems and strategies that have a limited range of approaches or incompletely capture system complexity;

0-2 BELOW EXPECTATIONS Systems and strategies that have only one or two key factors or approaches.

#### Active Learning Profile

information source: direct / indirect

experience: doing / observing

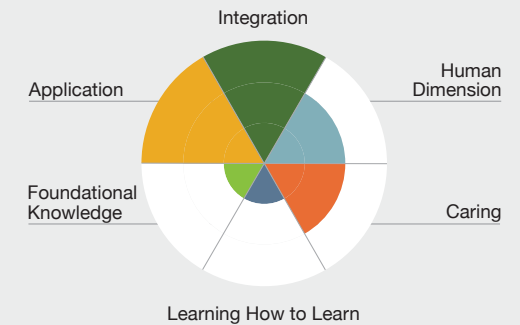
reflection: individual / group

#### Time Investment Profile

individual: 60 minutes reading

group: 90 minutes group work

#### Development Profile





# Learning Activity C | Systems Thinking

## Your Campus Systems

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experience: doing / observing9

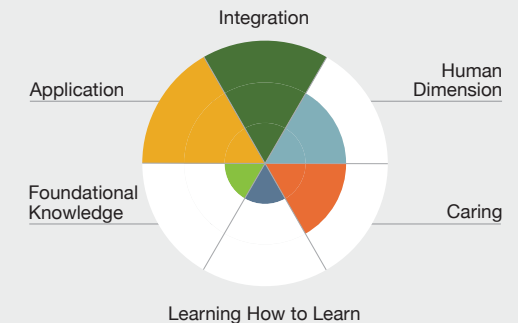
reflection: individual / group9

#### Time Investment Profile

individual: 60 minutes reading9

group: 90 minutes group work9

#### Development Profile



#### Notes to Faculty

This activity is best completed through group work. On individual is not likely to have a broad enough view to develop a causal loop that depicts the complexity of the system. Teams should be no larger than 5 people. It is best if teams have a large space on which to write (whiteboard/chalkboard/table-sized paper). It is very important that there is a large space on which to develop ideas of how to construct the causal loop diagram. There is no "right answer" to this activity, but typical campus systems are likely to involve multiple sources (food service, campus facilities operations, dormitory, administrative operations, parking and transportation services, bookstore and associated services). The best depictions of the system should capture both the complexity of the system and its critical components. The best depictions only depict those with major or potentially major impacts on the behavior of the system. For example, components that contribute on the order of 1% to the behavior would be considered negligible. **Modification:** If the groups are unfamiliar with one another, a good way to start the causal loop is with a silent brainstorming activity. Each individual should get a stack of post-it notes. Give people up to two minutes to *silently* and individually write down all the major components of the system that they can think of. Only one item should be on each post-it and it should be large and legible. Then in the following 5', they should silently group like items. After that, they can refine their solution through group dialogue.

# Learning Activity C | Systems Thinking

## Your Campus Systems

### Activity

**Individual:** Must first be knowledgeable of causal loop diagram construction

**Group:** Choose a system on campus that results in waste that is landfilled (alternate: wasted potable water). Create a causal loop diagram for this system (begin by identifying the major components of the system, remember to consider both tangible and intangible components). Create a comprehensive strategy to decrease the flow of waste to the landfill (or alternatively, the flow of potable water). Your strategy should be based on the system components depicted in your causal loop diagram. (Hint: Choose 4-5 key indicators in your causal loop diagram and sketch schematic diagrams of how those indicators behave over time. This should help you develop a comprehensive strategy.)

#### Objectives

2.1-8, 3.3-5

#### Criterion

application, integration

#### Standards

5 PROFICIENT Systems and strategies that incorporate a broad range of approaches (behavioral, policy, political, social, technological);

3-4 DEVELOPING Systems and strategies that have a limited range of approaches or incompletely capture system complexity;

0-2 BELOW EXPECTATIONS Systems and strategies that have only one or two key factors or approaches.

#### Active Learning Profile

information source: direct / indirect

experience: doing / observing

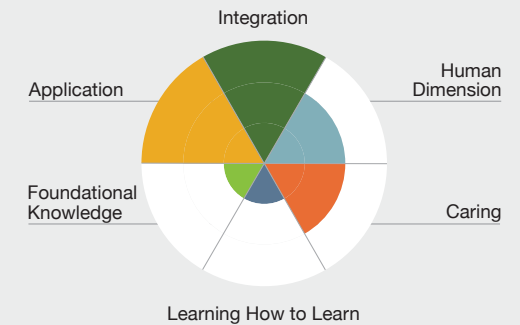
reflection: individual / group

#### Time Investment Profile

individual: 60 minutes reading

group: 90 minutes group work

#### Development Profile



# Learning Activity D | Systems Thinking

## The Global Economic System

### Targeted Learning Objectives

- 1.6 9 Understand the relationship between events, patterns and system behavior;9
- 1.7 9 Remember that the global economic/social system involves interactions between human behavior (society and 9 economy) and the natural world (environment);9
- 2.7 9 Recognize the interdependency of components within a complex system;9
- 3.3 9 Relate ideas of events and patterns of consumer behavior (including ones' own) to the larger global system.9
- 3.4 9 Be able to make connections between events and patterns from very different areas, such as political, social, 9 health and safety, environmental, manufacturing, sustainability, economic;9
- 4.1 9 Know that they are part of dynamic local and global systems ("society");9
- 4.2 9 Know that their behavior (actions and inactions) can affect the systems;9
- 4.4 9 Know that they are amongst those with the highest income in the global marketplace (if they earn more 9 than US\$20K per year they are in the 80% percentile of income in the global economic system.);9
- 4.5 9 Know that others are also participants and/or victims of the global system;9
- 4.6 9 Know that they share common resources with others in the global system;9
- 4.7 9 Social injustice (or inequity) pushes systems toward instability (social and political) and eventually collapse;9
- 4.8 9 Global economic systems often accumulate resources in one sub-system (powerful societies) at the expense 9 of another part of the sub-system (less powerful societies);9
- 4.9 9 Know that overcoming systemic problems requires collaboration amongst different parts/people within the system;9
- 5.1 9 Feel they are personally important in term of overcoming our global society's sustainability challenges;9
- 6.5 9 Practices the virtues of critical thinking when evaluating information.9

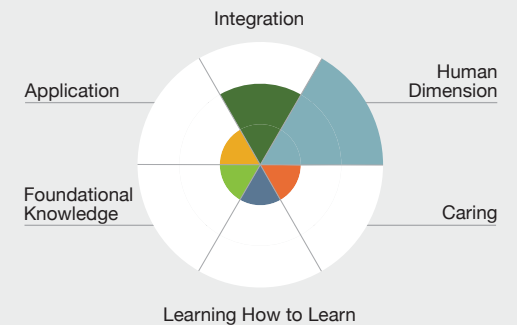
#### Active Learning Profile

information source: direct / indirect9  
experience: doing / observing9  
reflection: individual / group9

#### Time Investment Profile

individual: 90-120 minutes reading9  
group: 40-60 minutes discussion9

#### Development Profile



# Learning Activity D | Systems Thinking

## The Global Economic System

### Activity

**Individual:** Read “The Fortune at the Bottom of the Pyramid,” by C.K. Prahalad, S.L. Hart, *Strategy and Business*, 26(First quarter): 2002, 1-14. 9

- 1 | Fast forward to your post-college career. You are likely to be making a salary of 50-60 thousand US\$/year. According to the global market pyramid presented in the article, in approximately what income percentile does this put you in this global marketplace? What kind of responsibilities do you feel come with occupying this position in the global marketplace? 9
- 2 | Describe the impact that you, as individual, have on the global system. 9
- 3 | Prahalad and Hart make the case that multinational corporations have more power and will to alleviate income disparity (“poverty”). What are their arguments for this? What is your view about their position?9

#### Possible Group Discussions:

- 1 | Discuss your response to individual reflections. 9
- 2 | Social justice advocates describe some indigenous communities as being “victims” of the global marketplace. 9 What does it mean to be a “victim” of the global marketplace? Do victims exist in the current market? Who? and why? 9
- 3 | From 1500’s to 1800’s, the world demand for sugar resulted in 300 years of slavery, as many indigenous people were enslaved by westernized societies for the purpose of working on the labor-intensive sugar farms. What parallels to this historical situation exist today as a result of the global market demands?9

#### Objectives

6.5 (group discussion)

#### Criterion 9

virtuous critical thinking

#### Standards

**5 PROFICIENT** Practices the five virtues of critical thinking with openness and respect for others’ points of views;

**3-4 DEVELOPING** Practices less than all five virtues of critical thinking or inconsistently practices them;

**0-2 BELOW EXPECTATIONS** States own viewpoints as facts; Creates an unwelcome atmosphere for those with differing viewpoints;

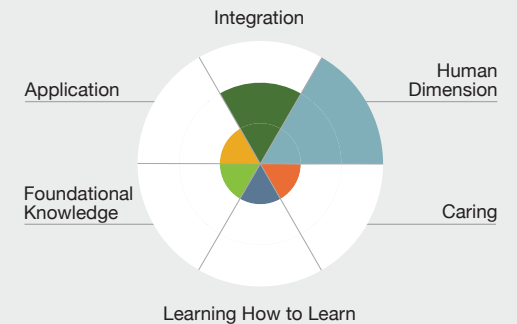
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# Learning Activity D | Systems Thinking

## The Global Economic System

### Targeted Learning Objectives

- 1.6 9 Understand the relationship between events, patterns and system behavior;9
- 1.7 9 Remember that the global economic/social system involves interactions between human behavior (society and 9 economy) and the natural world (environment);9
- 2.7 9 Recognize the interdependency of components within a complex system;9
- 3.3 9 Relate ideas of events and patterns of consumer behavior (including ones' own) to the larger global system.9
- 3.4 9 Be able to make connections between events and patterns from very different areas, such as political, social, 9 health and safety, environmental, manufacturing, sustainability, economic;9
- 4.1 9 Know that they are part of dynamic local and global systems ("society");9
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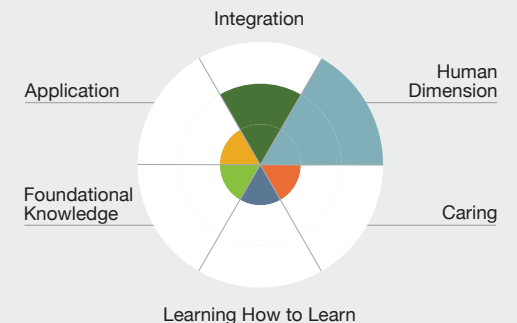
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#### Notes to Faculty

This activity is largely designed to promote students' thinking across domains (technological, economic, social, political). For the individual reflection, students should put themselves at or above 80 percentile. Regarding the responsibilities of being at 80 percentile, there is likely to be a wide range of answers. Again, there is no right answer, but this is based on the doctrine of *Noblesse Oblige* (Those who are privileged have an obligation to society.) This particular doctrine is a motto of the engineering honor society, Tau Beta Pi and others, such as the National Honor Society. **Dialoging about their answers with others 9 enables them to both grow and practice the virtues of critical 9 thinking**, so it is important to create time for the students to discuss their responses in small groups. The group discussions should be in groups no larger than five people. It is best not to isolate students who are in the minority in group. For example, if there are only two women in the class, these women should be in the same group, rather than distributed into the groups. The idea is to promote safety for their viewpoint by grouping them with at least one other who is likely to see things similarly. "Also, this may be a good time to invite a colleague from the social sciences to facilitate a class or group discussion." It is important not to impose your views, but allow students to express their own and model the virtues of critical thinking (6.5)

# Learning Activity D | Systems Thinking

## The Global Economic System

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