Introduction to Systems Thinking
Wellesley, MA – June 24, 2016
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Introductions
✓ Name
✓ School/job assignment
✓ What do you hope to take away from today’s session?

Polling Question
A little about you…
Which of these most closely matches your work?
1. Teacher — Elementary
2. Teacher — Middle/High School
3. Educational support or Administration
4. Business and/or consulting
5. Non-profit organization
6. Other

Polling Question
A little about you…
Choose one statement below that best matches your experiences with systems thinking (ST):
1. I haven’t applied ST to my work.
2. I have applied ST with students and/or my colleagues with some success.
3. I currently apply ST with my students and/or colleagues on a regular basis with success.
4. In addition to currently integrating ST into my work, I have taught others ST strategies.

General Information
✓ Schedule
✓ Facilities
✓ Breaks/lunch
✓ Materials
✓ Other details

Food for Thought
“Having to know the answers puts us in terrible positions from which to learn.”
D. Kim

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Circles in the Air

Mental Models
Mental models are deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action.

Level 1 - Introduction

Big Picture of the Day

• Habits of a Systems Thinker
• Behavior Over Time
• Connection Circles
• Stock/Flow Maps and Models
• Application/Implementation Ideas

Resources We’re Using

• Habits of a Systems Thinker, Waters Foundation
• The Shape of Change, Rob Quaden and Alan Ticotsky.
• All materials in the book are downloadable from the Creative Learning Exchange website at http://www.clexchange.org/clexproducts/shapeofchange_lessons.asp
• The Systems Thinking Playbook, Meadows and Sweeney
• Systems in Motion, Andersen and LaVigne

Why Systems Thinking?
The world is made up of dynamic, interdependent systems. We have an obligation to provide students the skills and tools needed to be successful in this world.

Peter Senge – Schools That Learn, 2000
Habits Sort

✓ Sort your cards into 3 piles:
  o Habits I’m Using
  o Habits I’m Not Using
  o Habits I do not fully understand
✓ Share with 2 or 3 people at your table:
  o One of the habits you understand from the first pile OR one question you have about a habit from the last pile

Efficacy $n.$

✓ Power or capacity to produce the desired effect
✓ Ability to achieve results
✓ Effectiveness

Behavior Over Time

Stories to Graphs

✓ What is changing?
✓ How is it changing?
✓ Why is it changing?
✓ So what?

Stories to Graphs

✓ Prices are now rising more slowly than at any time during the last five years. (PRICE)
✓ After the concert, there was a stunned silence. Then one person in the audience began to clap. Gradually, those around her joined in and soon everybody was applauding and cheering. (NOISE LEVEL)
✓ In the spring, my lawn grew very quickly and needed cutting every week. But since we have had this warm spell, it needs cutting less and less frequently. (LENGTH OF GRASS)
Stories to Graphs (continued)

- When doing a jigsaw puzzle, I usually spend the first half hour or so sorting the edge pieces. When I have collected all the ones that I can find, I construct a border around the edge of a table. Then I start to fill in the border with the center pieces. At first this is very slow going but the more pieces I put in, the fewer there are to sort through so the faster I get.
- A “typical” season for your favorite sports team.

Practice Field: Macquarie Island

Graphs to Stories

System Dynamics Computer Models

The Habits of a Systems Thinker

Which habit(s) do you practice when you use behavior-over-time graphs?

Connections

What are some connections you can make...
- to curriculum and assessment?
- within your team, school, or organization?
- to your coursework?
Connection Game

- Materials:
  - Large open space to play the game
  - Easel pad or display board
  - Large number card for each student

- Goal:
  - Students will experience how “parts of a system are interconnected and changes to one element can cause far reaching effects.”

Connection Game – Debrief

- Let’s draw out what happened first.

Connection Game – Debrief

- What happened when you tried to stay equidistant from your two numbers?
- Was it difficult to achieve the goal of equilibrium? Why or why not?
- What strategy did you find most effective? If you played again, what would you do differently?
- How did one person’s change in position affect others in the group?
- Can you think of an example of one behavior causing many other unexpected things to change?

Guidelines

Draw cause → effect linkages between the variables. The arrow shows the direction of causality. The arrowhead is labeled to show the relationship between the variables.

Examples

- Sugar intake
  - New cavities
  - $ or +

- Brushing teeth
  - New cavities
  - $ or –

Adapted from materials provided by the Social System Design Lab at Washington University, St. Louis
Whale Video

• Watch the video.
• Write key words that you think are important variables in the system that go up and down over time, e.g., number of sea otters.
• Choose what you feel are the most important variables (no more than 9) and write these around the outside of the circle.

Connection Circles

Connection circles are thinking tools designed to help students understand complexity. Using connection circles as graphic organizers, students generate ideas about changing conditions within a system. They choose the elements they think are most important to the change and draw arrows to trace cause and effect relationships. Quaden and Ticotsky, The Shape of Change.

Creating your own CONNECTION CIRCLES

1. Draw a large circle.
2. List important elements around the circle.
   Restrict the number to between five and ten.
   All elements should be nouns or noun phrases.
   Elements can increase or decrease.
3. Identify an element that causes another element to increase or decrease.
   Draw an arrow from the cause to the effect.
   Make sure that the causal connection is a direct one.
   Identify polarity of arrow and label at the arrow head.
4. Continue to identify elements with causal connections.

How to Create Connection Circles

1. Draw arrows between graphs that have causal relationships.
2. Indicate the nature of the causality with a "+, s" or "-, o" next to the arrowhead.
3. ‘Tell the story’ of your connection circle.

A Connection Circle Template
Feedback Loops

Feedback shows circular causal relationships within a system.

Finding Feedback within a Connection Circle

Living Loops

From straight lines to loops

NOTE:
Left hand is “active”
Right hand is “passive”
+ = same direction
- = opposite direction

Living Loops

Trial 1
• Stand in a line.
• Hold the link in your left hand connect with the person next to you.
• Whatever happens to your right hand, repeat that same action with your left.

Living Loops

Trial 2
• Stand in a circle.
• Hold the link in your left hand connect with the person next to you.
• Whatever happens to your right hand, repeat that same action with your left.

Living Loops

Trial 3
• Stand in a circle.
• One person receives an “opposite” link.
• Hold the link in your left hand; connect with the person next to you.
• Whatever happens to your right hand, repeat that same action on your left; if you have the opposite link, do the opposite action.

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Things are getting out of control!
I can't keep up!

We are really on a roll now!
The change seems to be doubling.

The Habits of a Systems Thinker

Connections

What are some connections you can make...
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✓ within your team, school, or organization?
✓ to your coursework?

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Stocks and Flows

Stock and flow diagrams show the nature of change in a system (i.e. dynamics) and the interdependencies that influence the changes.

In and Out Game

Materials:
• Large display area (easel pad, display board, or chalkboard)
• Large easel graph pad
• Colored markers and chalk
• Rope or tape to mark out areas of the classroom floor

Goal:
Make predictions about dynamics, based on different rules and compare results.

In and Out Game – Debrief

• How are the lines for Game 1 and Game 2 similar? How are they different?
• Which line is steeper? Why?
• How would the graph be different if there were some players in the stock at the start of the game?
• What happens when an outflow is larger than the inflow?
• What happens when the inflow and outflow are equal, say, 3 in and 3 out each round?
• What experiences in life resemble the In and Out
Tree Game

Materials:
• Approximately 150 wooden craft sticks for each team of students.
• One container to hold the sticks for each team.
• One copy of two worksheets for each team (pages 71-72).

Goal:
Experience the effect of exponential decay on an accumulation.

Tree Game – Debrief

• How does the graph show what happened to the stock of trees in the forest over time?
• When did the forest grow? Why?
• When did the forest decline? Why?
• Did the forest ever stay the same? Why?
• Why did the forest grow and then start to decline?
• Why did the rate of decline increase as time went on?
• What caused the changes in the stock of trees?

Tree Game

Procedure:
1. Count 120 sticks into your container.
2. The container represents a forest that will undergo some changes.
   • Each year trees will be added and removed according to a certain rule.
   • The stick added represent new trees. The sticks removed represent trees that are cut down.
3. Each person on the team will have a job.
   • Forest managers plant trees (add sticks)
   • Lumberjacks cut down trees (remove sticks)
   • Record keepers record inventory.

Tree Game Rules

• Start with a forest of 120 trees
• Each year plant 4 new trees
• The first year cut 1 tree.
• The second year cut 2 trees; the third year cut 4 trees; and so on. In other words, the number of trees you remove from the forest doubles each year.
• Each year the managers add sticks and the lumberjacks take away sticks and the record keepers record the data on the Forest Inventory Table
• Be as accurate as possible. (MP 6)
**Tree Game – Extension**

http://www.clexchange.org/curriculum/shapeofchange/sec_6_TreeGame.asp

Some Questions to Ask When Creating Stock-Flow Maps

- What are the key stock(s) and flow(s) in the system?
- How can we name a variable (converter) to avoid qualifiers?
- Does a converter affect how much is added to or how much is subtracted from the stock (accumulation)?
- Does the converter directly affect the flow or does it connect to something else first?
- Look for feedback by asking, “Does the stock affect other parts (flow or converter) of the map?”
- How can we draw the parts and connections in a way that is visually clear?

**Stocks and Flows**

Adding another stock and elements

**Finding Feedback within a Stock/Flow Map**

Feedback shows circular causal relationships within a system.

**Practice Field: Macquarie Island**

Macquarie Island on a misty day. (Photo: Richard Stokoe)

**Finding Feedback within a Stock/Flow Map**

Feedback shows circular causal relationships within a system

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The Habits of a Systems Thinker

Which habit(s) do you practice when you use stocks and flows?

Connections

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✓ to your coursework?

Some Other Tools

Systems Archetypes

System archetypes use causal loop diagrams to capture “common stories” that occur repeatedly in diverse settings. They act as a lens, a perspective from which to see what creates behaviors in a system.
Implementation and Sharing

Closure

- What’s next?
  - Implement one idea
  - Explore websites, such as CLE and Waters Foundation.
- Exit Survey
- Certificates