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Using System Thinking Protocols To Improve Student Analytical Thinking And Foster Engagement In Rural Commons

Kristin Guin-Grosse

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WHAT MAKES IT A SLINKY?:

A SYSTEMS THINKING TOOL KIT FOR EDUCATORS

By Kristin Guin-Grosse

A capstone project submitted in partial fulfillment of the requirements for the degree of Masters of Arts in Education: Natural Science and Environmental Education.

Hamline University

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Project Summary

When I recall the first time I was asked to think about systems I recall my Masters class for Environment and Society. Our instructor asked us to think about systems and how we interact with them using the lens of our course title to interpret systems. There was complete silence. Not a person in the class had a relevant comment. I quickly discerned that most of us did not have any idea how to look at the world around us from a “systems perspective.” That began my education in systems thinking. Since I came to my degree pursuit with depth as an educator and a layman’s background in environmental science, I had a lot to learn.

The logic and elegance of understanding systems was immediately apparent. In this project, I sought to answer the questions, *how can systems thinking be applied through community engagement pedagogy to improve student higher-order thinking and foster student self-efficacy in their contribution to rural commons?* The time for this project seems particularly apt as the news of impending environmental, political, and social problems percolate daily. Systems thinking is now included as a cross-cutting concept in the next generation science standards. Integrating systems thinking across the disciplines is becoming an imperative (Next Generation Science Standards, n.d.). Teaching students to test assumptions, to understand and make predictions and to find points of leverage for meaningful change are expectations for 21st-century learners (Senge, 2000).

Systems thinking is not a new concept. In truth, it has made significant inroads into the collective consciousness. Conservatively, there have been concerted efforts to introduce and teach systems thinking and system dynamics computer modeling for several decades (Lyneis,
Forrester, a professor at the Massachusetts Institute of Technology - Sloan School of Business Management, was the founder of system dynamics (Richmond, 1993). Forrester developed computer modeling simulations to illustrate internal forces and decision making within a complex corporate system. Forrester’s models became the groundwork for system dynamics (Senge, 1990).

In the posthumously published book, Thinking in Systems: A Primer, Meadows (2008) described an elegant approach to introducing systems thinking to students. The instructor would grip a slinky in one hand suspended above the floor. The other hand was positioned underneath the spring-like toy. Meadows would remove the supporting hand and the slinky would bounce and spring above the floor still suspended in the other hand. Meadows would then inquire, “What made the slinky behave like that?” The students would respond that when the supporting hand was removed, the slinky fell. Still other students would suggest that gravity caused the slinky to bounce and spring above the floor. Meadows would then put the slinky down and pick up the box that the toy came in and hold it in the same manner as the slinky. One hand gripping the top of the box. The other hand supporting the box from the bottom. When Meadows removed the supporting hand - nothing happened. The box remained suspended above the floor. Through a dynamic conversation, the students would arrive at the understanding that the slinky’s behavior was within the structure of the slinky. It was not attributable to the supporting hand or an outside force. This would launch the class into an exploration of systems behavior and pattern modeling. Students would be prepared to examine the inherent behaviors and patterns within a system to explore what Richmond (1993) called “10,000-meter thinking” (p. 11).
Students can use the models of systems thinking to examine social and natural systems. They can learn to see global systems, explore the interaction of the elements of a system, and examine the interplay of events over time. Thus developing an image of the models and patterns of behavior that shape all systems. The educators tool kit is an entry point for educators who want to begin understanding and using systems.

Through the process of my capstone research, and development of the student unit, I saw merit in creating a set of supporting materials. An educator who lacks experience with systems thinking integration can benefit from the tools and examples included in the toolkit. In an effort to keep the scope manageable for the intent of the capstone, the materials included in the toolkit serve as an introduction to the basic concepts of systems thinking. Also included are examples that educators can use or model to create lessons for their students or staff development. The text portion of the toolkit includes brief descriptions with added graphic images to display the models used in systems thinking. There are also audio-visuals included to enhance understanding, accessibility, and engagement.

The community project for the local historical society was developed using the principles of Universal Design for Learning (UDL). UDL principles include a researched-based lesson development approach focused upon inclusive participant experiences through multiple means of representation, action, expression, and engagement for learning (UDL Guidelines, 2018).

The unit design follows the model of backward design authored by Wiggins & McTighe (2000). The framework for Understanding by Design suggests an examination of ending objectives prior to lesson design (Wiggins & McTighe, 2000). Lessons are developed with clear expectations for student outcomes.
The culminating project included a student-led Prototype Expo where specialized student groups displayed and presented information and resources focused on their area of expertise. The Prototype Expo is modeled on the five themes of place-based projects suggested by Smith (2002): cultural studies, nature studies, real-world problem solving, entrepreneurial opportunities, and induction into community processes (p. 587). The project is the intersection of methods in system thinking integration with community-engaged, place-based projects, and service-learning in a rural community.
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Introduction

This tool kit is designed to be a resource for educators in applying systems thinking into the daily routine of classroom instruction. The news extols us daily of the complex problems we face in the 21st-century. Systems thinking teaches a process of modeling causality and problem-solving. The answer to what makes a slinky™ a slinky™ is noting that the characteristics of the object are inherent in the behavior of the object. The behavior within a system shapes the patterns and trends. Understanding the patterns and trends presents a path to finding solutions to problems in any system. For decades, many leaders of systems thinking have worked to promote early adoption of systems thinking modeling with K-12 students. These powerful thinking tools are indispensable for our future generations (Richmond, 1993). However the concepts of systems thinking still lag in the modern zeitgeist. It is my hope that this tool kit will help you start your journey.

How to Use the Tools in this Kit

Each of the strategies mentioned in the tool kit are stand-alone skills that can be used without the other strategies. Some of the models work well in tandem. As your proficiency in teaching and using systems thinking models grows you will see the wide ranging applications.

Where to Get Started

Below is a link to my website: Systems Thinking Ed

Use this link to access my introductory video on the ‘what is’ of systems thinking.

Then use this tool kit and the resources on the site to share these skills with your students.
Quick Start Video and Website

Below is a link to the website I developed for the tool kit for educators. On the website, you will find the explainer video that I created to help educators understand the dynamic potential of systems thinking. The video is intended to be a succinct introduction to the concept. From there the reader can watch another linked video and explore links to informational websites with more examples of systems thinking for K-12 instruction.

Systems Thinking Ed:

https://systemsthinkinged.com/

Systems Thinking Ed, a website hosting a quick-start explainer video designed to demystify systems thinking:
The Five Disciplines of a Learning Organization

Peter Senge (1990), a vocal advocate for systems thinking instruction in K-12 education, defined the five disciplines of a learning organization.

Each component is defined below:

**Personal Mastery:** According to Senge (1990), learning organizations are supported by individuals who place their own learning as a priority. Senge further asserted that learning is a calling; that having a vision for the future is not just a good idea but a constant pursuit by the
individual. “People with a high level of personal mastery live in a perpetual learning mode (Senge, 1990, p. 142).”

**Mental Models:** Are the ingrained habits, practices, and mental pictures of how we understand the world and perceive what happens (Senge, 1990).

**Shared Vision:** A learning organization has a collective understanding, a target. Senge identifies the shared vision as “a capacity to hold a shared picture of the future we seek to create (Senge, 1990, p. 9).” At the heart of that vision is a sense of a long-term perspective (Senge, 1990).

**Team Learning:** Team learning builds upon the personal mastery and the shared vision of the members of the organization. In a learning organization team learning involves members building capacity together (Senge, 1990).

**Systems Thinking:** According to Senge (1990) the foundation for the five disciplines of a learning organization rest on the fifth discipline - systems thinking. The power of systems thinking can be developed in students through the use of mental models for critical thinking and problem-solving. The objective is to look at a whole problem with deep understanding before seeking solutions. Through the discipline of problem-solving, looking at cause and effect and change-over-time, solutions can be focused on long-term systemic change rather than immediate, short-term fixes (Senge, 1990; Senge 2000).

Image credits:

https://pixabay.com/illustrations/group-personal-feedback-confirming-3530357/


https://commons.wikimedia.org/wiki/File:Smycka3eng.png

https://commons.wikimedia.org/wiki/File:Diffusionofideas.PNG

https://oer.gitlab.io/oer-on-oer-infrastructure/Git-introduction.html
The Iceberg Model

One of the more universally recognized thinking tools used in systems thinking is The Iceberg Model. The concept is elegant and simple. As an iceberg floats in the water, we can see the top float along. What lies below the water is a large block of ice that can be a metaphor for problem-solving. In systems thinking, the iceberg can be viewed with four distinct sections.

1. The part floating above the water represents an event in our lives or in a system.
2. The section just beneath the water, which is somewhat visible, represents the patterns or trends that are happening over time.
3. The third section represents the structures within the system that contribute to the patterns of behavior.
4. The fourth section, the part of the iceberg that is deep in the ocean and invisible from the surface, represents the mental models, the ingrained beliefs, the values, and the assumptions that are held within that system.

Taking a deep dive into how a system is working or not working requires an understanding of its underlying patterns and trends. It also requires a look at the structures that support the system. When we examine the root beliefs and assumptions we have within in a system we can identify leverage points for change in the system. The deeper we go in our understanding the more effective we will be in finding leverage points that offer lasting change.
Here are four questions to ask when you want to use the iceberg model to examine a system:

Events - What just happened?

Patterns/Trends - What’s been happening? Have we been here before?

Systemic Structures - What are the forces at play contributing to these patterns?

Mental Models - What about our thinking allows this situation to persist?

Iceberg image: https://creativecommons.org/licenses/by-sa/4.0

Iceberg concept adapted from: http://donellameadows.org/systems-thinking-resources/
Using Feedback Loops

Definition and Example:

Feedback loops, or causal loops, demonstrate causality. As students learn how to create visual models of cause and effect, they can then examine patterns of behavior. Through the examination of causality students can achieve higher-level thinking skills in analysis and simulation.

There are many places where feedback loops can be found. The predator - prey relationship between a fox and a rabbit is a good example.

Students can quickly grasp the fundamental principle of a causal loop when they recognize that the interrelationship of predator - prey is not linear.

Rather it is a closed loop of cause and effect. The birth and death rate of the fox will affect the rabbit and the inverse holds true for the rabbit. This is a closed loop system where the behavior of one impacts the other.

Feedback loops can be reinforcing or balancing. A reinforcing loop has positive cause and effect inputs on both sides of the loop.
Money in a bank account and the interest accrued on the balance is a reinforcing causal loop. As the balance increases the interest increases. In a balancing loop the system is finding balance as one element increases the other decreases. These two types of feedback loops form a foundation for a wide range of systems modeling. Thus, student mastery of modeling using feedback loops is a valuable tool for 21st-century learning (CLE, 2014).

The example below depicts balancing closed loop behavior. Systems causal language uses an ‘s’ to symbolize a ‘+’ or an increase or an ‘o’ to represent a ‘-’ or decrease. Hunger and snacking behavior is a balancing causal loop in a simple system:

My hunger feeds my desire to snack. I buy a snack at the vending machine. I am no longer hungry. A thermostat attempting to return a room or home to a desired temperature is another example of balancing behavior in a system.

How to Start:
A common illustration for using feedback loops is in population dynamics. Students can use feedback loops to demonstrate population growth using birth rate data. This is a reinforcing loop: as birth rates rise population increases. Conversely, students could see the balancing loop in a feedback loop by graphing deaths and the effect on the population.

To draw these feedback loops, see the examples below:

The Creative Learning Exchange (2014) identifies the following critical thinking outcomes as students master feedback loops:

- Map the major influences on a system’s behavior;
- Identify the causality that shapes recurring behavior;
- Analyze multiple and competing feedback loops;
- Focus thinking about problems and solutions.

Feedback loops provide a visual representation of system interrelationships. Students can use these models to interpret causality (CLE, 2014).
Creating Behavior-Over-Time-Graphs

Definition and Example:

Behavior-over-time graphs (BOTGs) are a valuable tool to represent patterns or trends over time. Systems thinkers use BOTG models to examine patterns rather than focusing on isolated events. Proponents of systems thinking assert that improved pattern analysis strengthens problem solving capabilities for finding long-term solutions rather than quick fixes (Senge, 2000; Meadows, 2008; Booth-Sweeney, 2009).

The example of feeling hungry and seeking a snack is a relatable example to introduce the concept of behavior-over-time graphs to students. We can graph hunger throughout the day for five days. We can then look at the BOTG to check for trends.

![Stacked By Day Graph](image-url)
In the graph on the previous page we can see feelings of hunger felt throughout the day. This is an entry point to demonstrate to students how to carefully determine the information on each axis. The ‘x’ axis should always represent the time frame over which the behavior or change is being measured. In this example, the hours of the day are along the ‘x’ axis. The time frame should represent the information being graphed. If the behavior being graphed was practicing the trumpet weekly then the ‘x’ axis should reflect that measure. The vertical, ‘y’ axis should represent the behavior or event being measured. In this case, the graph depicts hunger level as a percentage from 0 to 100 percent with 0 representing no hunger and 100 representing maximum hunger.

When we examine the graph and observe the behavior-over-time, we can see that the subject feels hunger at three traditional meal times throughout the day roughly equivalent to breakfast, lunch, and dinner. Another trend emerges at the 3:00 PM time frame. Each day at that time there is a spike in hunger. Recognizing this trend presents a powerful decision making tool. Now we can examine behaviors and determine where change might happen throughout the day to address that 3:00 PM spike in hunger. After all, eating a bag of chips at that time might ruin my dinner and my waistline.

The graph on the next page offers another perspective of our BOTG for hunger throughout the day. In this graph, we can see the peaks and valleys for hunger throughout each day and over the course of the five days. This BOTG presents the same information as the previous graph but may offer a new way to identify leverage points for behavior change. In this graph the peak feelings of hunger appear more variable. In other words, it is likely that there is more than one factor affecting the rise or fall of hunger throughout the day.
Where and How to Start:

1. The BOTG is a line graph. Tools for building line graphs using spreadsheet data are widely available. Students can build simple line graphs using chart paper and markers.

2. Begin by demonstrating how to set up the variables using simple examples. Keep in mind that the X axis represents change-over-time and the Y axis represents the behavior or event being graphed.
The screenshot above, from Systems Thinking in Schools (2008), provides a one-page example of simple line graphs to teach change over time.

3. The application of BOTGs is endless. They are an effective tool to represent social-emotional growth, change in human migration patterns, or change in the character of a story.

4. Invite students to decide on the units of measure for a graph. Guide students to select units that convey the story their graphs will tell.
Appendix A: Engagement Education and Systems Thinking

Sample Unit

The following unit was developed to demonstrate how systems thinking strategies can be embedded into an integrated, cross-disciplinary unit. The Nutting Truck and Caster Unit was a 6-week plan that incorporated year-long learning. Throughout the school year, students explored interactive, engagement activities in metropolitan museums. They learned how simple machines were used in large-scale factories. Students used systems problem-solving to engage actively in the design iteration process. In small groups students examined a problem, explored causes, built a model, tested their model, presented and explained their construction and design process. Seventh grade content learning standards are integrated throughout the study. Research included a close-up lens on local industrial changes of the 19th and 20th centuries to help students connect nationwide industrial shifts to rural commons. Students explored local museums, historical societies, and municipal sites in their rural commons. They also investigated cultural, scientific and social changes wrought by industrial change through the urban museum installations designed to convey the experience of 19th and 20th-century industrial innovation, design, and change.

An additional concept that students uncovered, in learning about the history of the company at the center of their studies, introduced environmental stewardship. The company was designated a Superfund Site by the Environmental Protection Agency in 1980. Students interacted with their local water quality municipality. A representative from the Rice County Soil and Water Conservation District also taught the students about
soil quality. Students learned about the groundwater contamination at the site of the former factory, how the groundwater and surface containment was managed, and how the groundwater extraction and treatment system operated until 2004. The site was removed from the Superfund watch list in 2017.

Over the course of several months students planned and implemented projects that asked them to distill and analyze their learning. Students created slide presentations and taught younger students the concepts of simple machines. They learned how simple machines were employed in even the most complex industrial settings. The presentations were part of the learning experience for state science standards for the younger students and to extend the service learning role that contributes to the middle school students’ sense of purpose and self-efficacy (Jacoby, 2014).

They also analyzed the use of interactive engineering toys as a way to model the design and engineering process used to solve problems that emerged in the manufacturing process. Students explored this concept at a large, urban museum and later developed methods to apply these strategies and created interactive materials for their local school and historical society. The students engineered interactive instructional tools to share with school-age students and adults who visit their local historical society.

To address the necessity to cultivate community assets, students presented interactive materials they designed and constructed. The interactive projects taught visitors to the local historical society about the industrial accomplishments in the local community. Students highlighted the accomplishments of a designer who created a new model of hand truck (dolly) in the 1890s. The company was established in the students’
hometown and continued production of their highly desirable products until the mid-1980s when the company was sold to another Midwestern manufacturing company.

Students worked in cooperative learning groups that were organized by student skills and interests. Students with an interest in mapmaking created display maps to include with the instructional materials to share with the historical society. Students who chose the technical and public speaking aspects necessary for the slide show presentations focused on that aspect of the research project. Still, others focused on the design and implementation of an interactive engineering project. The interactive activity was modeled to reflect the manufacturing design process used by the local company. In addition, students brainstormed strategies from their experiences at the larger metropolitan museum in an effort to streamline their design for the project for their local historical society.
Nutting Truck & Caster Unit

6 weeks - This unit is a culminating unit. Students will have been introduced to the concept of change-over-time and human impacts through reading and learning about the industrial revolution, Westward expansion, the U.S. Civil War.

### Stage 1 Desired Results

**Step 1: Understandings and Essential Questions**

Social scientists find connections between events, people, and accomplishments of the past and present to help understand our world.

Social scientists gather, classify, sequence, and interpret information and visual data in order to recognize how people, places, ideas, and events shape our world.

Systems thinkers solve problems using models to understand the events, patterns, structures, and beliefs that shape a system.

How can systems thinking help me to look at systems in my own life?

What do inventions from the past have to do with what we experience in our world today?

**Step 2: Content Unit - Meaning**

**UNDERSTANDINGS (create)**

- Students will understand that...
  - Students will understand the iteration process of engineering design.
  - Students will understand how events, thoughts, and creations of the past are connected to our modern experiences through systems learning.
  - Students will write for and present information for varied audiences.
  - Students will use systems modeling to infer how actions from the past impact the local community and environment.

**ESSENTIAL QUESTIONS (create)**

- Why does an invention from the past matter to us today?
- How can we share our understanding of the past with future, curious seekers?
- What can we do to make our exploration interactive?
- How can we improve our community through service to our fellow students and our local historical society?

**Step 3: Acquisition**

**Students will know...** (nouns)

- Students will know three models for systems thinking.
- Students will know what, when and where about the U.S. industrial revolution after the Civil War.
- Students will identify the technological advancements that led to industrial growth from 1860-1920.

**Students will be skilled at...** (verbs)

- Students will analyze informational text and determine important information to summarize the text.
- Students will write for different audiences and purposes and present in varied formats.
- Students will apply systems thinking models to analyze problems at the Nutting Company.

### Step 7: Evaluative Criteria

**Student journal rubric**

- Peer reflection forms
- Community assessment rubric
- A measure of community engagement at RCHS with student installed content.

**Key Qualities:**

- Student engagement and self-direction.

**TRANSFER TASK(S):** (performance assessments)

- Students will complete a written reflection journal of their project.
- Students will reflect upon their own work and critique the work of their peers.
- Students will present to peers, staff, and community members.
- Students will create materials that teach about their new learning and understanding and display this learning at school and at the local historical society in Fairbault, MN.
- Students will apply systems modeling (iceberg model, causal loop diagrams, behavior-over-time graphing) to events in the unit.
### Stage 3 – Learning Plan

**Summary of Key Learning Events and Instruction**

**Pre-Assessment:**
- Students will generate a class list of local businesses unique to their community.
- Students will apply the iceberg model to analyze a social-emotional issue in middle school.
- Students will draw causal loop diagrams and behavior-over-time graphs of simple systems they experience in their own lives.
- Students will collect and cluster brainstorming using a sticky note small group activity.

<table>
<thead>
<tr>
<th>Learning Events:</th>
<th>Progress Monitoring:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Entry Point:</strong> Students will explore the question, How do inventions of the past still influence us today?</td>
<td>• Students will respond to journal prompts to show the transfer of knowledge.</td>
</tr>
<tr>
<td>1. Students will access prior knowledge when they are re-introduced to previous learning - simple machines. During this unit, students will be extending their understanding of a. Simple machines in use in everyday experience. b. How simple machines can be used to solve complex problems. c. How to create models of simple machines for design and problem-solving. d. Create a model for demonstrating the use of simple machines. e. Teach peers and younger students models and applications for simple machines.</td>
<td>• Students will select how to individually demonstrate mastery and share learning on presentation day.</td>
</tr>
<tr>
<td>2. Begin with whole class generating a list of locally established businesses. Work with students to discuss the contributions of the local businesses.</td>
<td>• Students will receive instructor, local asset, and peer feedback forms.</td>
</tr>
<tr>
<td>3. Re-visit the museum exploration trip: Solving Problems with Design Thinking. During this experience, students learned the six simple machines: lever, screw, wedge, inclined plane, and pulley. Students visited a converted flour mill and learned how designers solved problems on the shop floor. Students then used design iteration and problem-solving strategies in order to model with K nex building toys and solve an example problem at the museum.</td>
<td></td>
</tr>
<tr>
<td>4. Select the local business Nutting Truck and Caster as a model for applying our previous museum experience to a local business.</td>
<td></td>
</tr>
<tr>
<td>5. Use jigsaw reading strategies and two-column notetaking strategies to read primary source and secondary source material pertaining to Nutting Truck and Caster.</td>
<td></td>
</tr>
<tr>
<td>6. Students will work in cooperative groups to transfer key findings onto sticky notes. Students will look for examples of design thinking, problem-solving, modeling, simple machines, and environmental impacts.</td>
<td></td>
</tr>
<tr>
<td>7. Using the systems thinking strategy of mind mapping, students will continue in cooperative groups to compare and cluster information.</td>
<td></td>
</tr>
</tbody>
</table>
8. Whole group discussion: as a class, discuss the results of the notetaking and mapping. What are the examples of design thinking, modeling, problem-solving, and simple machines? What did we learn about environmental impact? How does that take us back to our essential question? - How do inventions of the past still impact us today?
9. Introduce the causal loop as a tool to explore the problem Nutting discovered. A = Need to move lumber and furniture using hand trucks. B = Turning radius for hand trucks is as long as the cart - too long.
10. Teach or reintroduce problem-solving with The Iceberg Model.
   a. Ask small groups to discuss how we can apply The Iceberg Model to solving a problem?
   b. Look at the process of problem-solving through the story of Elijah Nutting, founder of Nutting Truck and Caster. What problem did he solve? Discovered how to cut in half the turning radius of a hand cart to move furniture more efficiently.
   c. How could we use modern techniques to demonstrate design problem-solving? Solicit responses from students. Students can recall the presentations they built earlier in the year explaining simple machines. Students will refer to their museum experience at the flour factory.
   d. Small groups will plan a demonstration for problem-solving hand carts using The Iceberg Model.
10. Students will work in project groups to continue researching the company, its products, its history, and its place in the local community. Each group will focus on a specific area: historical record, videography and/or photography, project-model for teaching simple machines through Nutting Co. problem, ‘finding our place’ - mapping the company in our local community; fundraising and grant writing for project development.
11. Working as a whole class, develop a presentation plan to demonstrating the problem-solution model to our school community and local community members.
12. Prepare model activity (Knex) and prototype kit.
13. Present prototype experience to 5th and 6th-grade students learning about simple machines.
14. Invite local community, school community to prototype project expo.
15. Collect and share feedback forms. Debrief and plan for additions and changes to learning.
## Appendix B: Project-based Learning Rubric

<table>
<thead>
<tr>
<th>CRITICAL THINKING RUBRIC for PBL: for grades 6-12</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Below Standard</strong></td>
</tr>
<tr>
<td><strong>Launching the Project</strong></td>
</tr>
<tr>
<td>• Uses only superficial aspects of, or one point of view, the Driving Question</td>
</tr>
<tr>
<td><strong>Developing and Revising Ideas and Products</strong></td>
</tr>
<tr>
<td>• Accepts arguments for possible answers to the Driving Question without questioning whether reasoning is valid</td>
</tr>
<tr>
<td>• Uses evidence without considering how strong it is</td>
</tr>
<tr>
<td>• Integrates evidence to evaluate and revise ideas, product prototypes or problem solutions based on incomplete or invalid criteria</td>
</tr>
</tbody>
</table>

**pblworks.org**

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Appendix C: Universal Design for Learning Fact Sheet

Classroom and community projects were created using the principles of UDL.
Appendix D: Cooperative Learning Group Roles

Cooperative Group Role Cards

<table>
<thead>
<tr>
<th>LEADER</th>
<th>RECORDER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makes sure that every voice is heard</td>
<td>Compiles group members’ ideas on collaborative graphic organizer</td>
</tr>
<tr>
<td>Focuses work around the learning task</td>
<td>Writes on the board for the whole class to see during the presentation</td>
</tr>
<tr>
<td><strong>Sound bites:</strong></td>
<td><strong>Sound bites:</strong></td>
</tr>
<tr>
<td>• “Let’s hear from ___ next.”</td>
<td>• “I think I heard you say ______; is that right?”</td>
</tr>
<tr>
<td>• “That’s interesting, but let’s get back to our task.”</td>
<td>• “How would you like me to write this?”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TIME KEEPER</th>
<th>PRESENTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encourages the group to stay on task</td>
<td>Presents the group’s finished work to the class</td>
</tr>
<tr>
<td>Announces when time is halfway through and when time is nearly up</td>
<td><strong>Sound bite:</strong></td>
</tr>
<tr>
<td><strong>Sound bite:</strong></td>
<td><strong>Sound bite:</strong></td>
</tr>
<tr>
<td>• “We only have five minutes left. Let’s see if we can wrap up by then.”</td>
<td>• “How would you like this to sound?”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ERRAND MONITOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Briefly leaves the group to get supplies or to request help from the teacher when group members agree that they do not have the resources to solve the problem.</td>
</tr>
<tr>
<td><strong>Sound bites:</strong></td>
</tr>
<tr>
<td>• “Do you think it’s time to ask the teacher for help?”</td>
</tr>
<tr>
<td>• “I’ll get an extra graphic organizer from the shelf.”</td>
</tr>
</tbody>
</table>
Appendix E: Habits of a Systems Thinker

The Habits of a Systems Thinker

1. Makes meaningful connections within and between systems
2. Seeks to understand the big picture
3. Changes perspectives to increase understanding
4. Considers how mental models affect current reality and the future
5. Observes how elements within systems change over time, generating patterns and trends
6. Surfaces and tests assumptions
7. Recognizes that a system’s structure generates its behavior
8. Identifies the circular nature of complex cause and effect relationships
9. Recognizes the impact of time delays when exploring cause and effect relationships
10. Considers short-term, long-term and unintended consequences of actions
11. Considers an issue fully and resists the urge to come to a quick conclusion
12. Pays attention to accumulations and their rates of change
13. Uses understanding of systems structure to identify possible leverage actions
14. Checks results and changes actions if needed: “successive approximation”

Adapted from, The Habit Forming Guide to Becoming a Systems Thinker, Tracy Benson and Shari Marlin, 2017, Systems Thinking Group, Pittsburgh, PA.
Appendix F: Script for Audio of Quick-Start Guide to Systems Thinking for Educators

2 - You may have heard of systems thinking. You’ve certainly experienced systems - because they are everywhere. They’re in nature, they’re in social interactions, they’re in our cities. You’ve probably used the word systems often: transportation SYSTEM, health care SYSTEM, belief SYSTEM.

3 - But what is a system? And how can learning how to use systems thinking be a tool for problem-solving?

4 - A system is two or more parts interacting together. Systems thinking looks at the interaction using standardized models.

5 - The result is a tool for:

  1. Understanding the world around us
  2. Using a common language for communicating about systems
  3. Recognizing and modeling interrelationships

   Educators can equip students with the skills to confidently find lasting solutions using a vernacular recognized around the world.

6 - This quick-start video is designed to help you understand the basics behind systems thinking and to help you get started with models right away.

   We’ll look more deeply at:

   What is systems thinking?

   Why you should use these strategies with your students.

   How to get started with some basic models.

   Let’s look at...
7 - What a system is and what it is not?

A soccer team is a system; people standing on a soccer field is not.

The roots of a tree is a system; a pile of wood is not.

The human body is a system; as are many of the internal organs. These organs represent a system within a system.

8 - Why You Should Use Systems Thinking. The power of systems thinking is in the modeling tools you will gain; allowing students to test assumptions, understand and make predictions, and find points of leverage for meaningful change are expectations for 21st-century learners.

9 - How to Get Started. Getting started is as easy as learning a few universally recognized models.

10 - One of the more widely recognized tools is the Iceberg Model. An iceberg floats, we can see the top along the water. What lies below can be a metaphor for problem-solving.

11 - In systems thinking, the iceberg can be viewed with four distinct sections.

1. The part floating above the water represents an event in our lives or in a system.
2. The section just beneath the water represents the patterns or trends that are happening over time.

3. The third section represents the structures within the system that contribute to the patterns of behavior.

4. The fourth section, the part of the iceberg that is deep in the ocean and invisible from the surface, represents the mental models, the ingrained beliefs, the values, and the assumptions that are held within that system.

15 - Here are four questions to ask when you want to use the iceberg model to examine a system:

   Events - What just happened?

   Patterns/Trends - What's been happening? Have we seen this before?

   Systemic Structures - What are the forces at play contributing to these patterns?

   Mental Models - What about our thinking allows this situation to persist?

(An excellent example, with a free downloadable file, can be found on the Academy for Systems Change site. Find the link at the end of this video.)

16 - Feedback loops (or causal loops) are another systems tool. With a causal loop, you can examine patterns of behavior and analyze cause and effect.

17 - Students can grasp the principle of a causal loop by understanding events in a system and recognizing that the interrelationship of A to B is not linear.

   A ---------------> B

   It is a closed loop of cause and effect:

   What happens to A and B will effect the outcome of the other.
There is more to learn about feedback loops that go beyond the scope of this quick-start guide.

18 - Cause and effect can also be graphed as behavior-over-time. In a BOTG X is always the time and Y represents the event/behavior being graphed.

Behavior-over-time can increase, decrease, or oscillate (show three graphs)

19 - Examining behavior-over-time is a powerful problem-solving tool for a systems thinker. The graph represents specific points in the system where solutions can be found. Those are called leverage points. You can graph any behavior in any type of system. This isn’t just for math and science class.

20 - Understanding events in our lives and our world equips us to find real, long-term solutions rather than quick fixes.

And yes, some systems are fraught with complexity. All the more reason to teach our next generation of thinkers and doers to use a powerful set of models for seeking solutions.

I hope this video helps you get started with systems thinking. There are many excellent tools and I’ve included links at the end of this video if you want to go further in learning using systems thinking.
References


Systems Thinking. (n.d.). Retrieved from https://www.thwink.org/sustain/glossary/SystemsThinking.htm#F1


