Toys and Games Review of Systems Theory
A-priori Knowledge – 4 Principles of Systems Theory

1) There are three levels of systems.
   A micro system is an independent individual.
   Meso (or messo) systems are made of multiple individuals or micro systems.
   Macro systems made of multiple meso systems, organized as social institutions.

2) Systems are connected to other systems.
   Boundaries separate each system.
      Permeability describes how strong the boundaries of a system are, and is a continuum from 0% permeable (i.e., totally closed) to 100% permeable (i.e., totally open). Most systems occur within these extremes and are referred to as "semi-permeable boundaries."
      Open systems have highly permeable boundaries. The system can have lots of interaction and interact with many other system. If the system is too open, the boundaries become too weak, the system may lose its own identity and become enmeshed with another system.
      Closed systems have highly impermeable boundaries. The system is set apart from and limits interactions with other systems. If the system is too closed, the boundaries are too strong, and the system will become isolated and estranged.

   Energy connects systems to each other. Systems use energy to maintain its own system functioning and to interact with other systems.
      Sustainability describes how well the system uses energy to maintain itself, measured on a continuum with both undesirable extremes (0% gain = death= loss of all energy) and (100% gain= exponential growth). Sustainability occurs as a balanced interaction of gaining and losing energy.
      Synergistic systems are those systems which use enough and the right types of energy to assure the system will continue. Systems that need to grow and have more gain of energy are also considered synergistic.
      Entropic systems occur in systems which lack enough or have the wrong type of energy to stay healthy. As systems lose energy they risk dying.

   Systems interact with other systems by exchanging energy.
      Interface is the place where the boundaries of each system meets the boundary of another system.
      Energy is the term used to describe the form of the resource that is exchanged among systems. What is considered energy is specific to the systems involved and will vary dramatically. Although we often associate energy with electricity, fuel and physical stamina, energy for particular systems could include the exchange of: money, labor, emotion, support and proximity, thinking, behavior or action.
      Interacting with other systems requires each system to monitor the direction and strength of energy that is exchanged. Each system risks entropy if it offers too much or the wrong form of energy to another system.

3) Systems seek to maintain a constant balance in the internal use and external exchange of energy.
    - Equilibrium
        - Homeostatic
        - Steady State
    - Feedback Regulating Exchange
        - Monitoring
        - Mechanisms
            - Breaking
            - Reinforcing
            - Balancing
        - Feedback Delay
            - Data Gathering
            - Responsiveness

4. Systems exist within and interact with their environment.
    - Context specific time and place.
    - Systems thinking requires simultaneous consideration of all four principles, and awareness of interactive effect between observations of each principle with others.

Instructions for Faculty

Fun and Games with Systems Theory is a guided experiential learning activity for students to begin to understand the application of systems theory to real world events. Building on science principles provided in the liberal arts foundation, the activity is conducted after students have heard the lecture material on the 9 principles and definitions of key terms for each principle.

Fun and Games with Systems Theory requires about 70 minutes of instructional time. The room is set up for "stations." Stations are set up as independent learning activities for small groups (ideally 4-5 students), each requiring approximately 5 minutes to complete. Each station is structured to facilitate independent group learning. At the station, student groups find instructions, a set of the materials, and an explanation of how the activity explains the principle of systems theory. Groups begin the activity at any station, and then progress as a group through the stations in sequential order, looping from station 9 to station 1.

Set up:
The room is set up as 9 stations, materials and instruction sheets for students are set out according to the station number.

Beginning:
Students are assigned to small groups (ideally 4-5 students) and assigned to a station. The activity begins when all students are assigned. Faculty- instructor provides initial instructions and monitors time to facilitate the eight transitions between stations, student-groups move between stations in sequential order, and looping from station 9 to station 1 to continue the process. Faculty–instructor strives to minimize direct involvement in activities of stations, favoring encouraging students to work with each other to clarify assignment and interpretation of meaning.

Initial Instructions:

Today, you will participate in 9 stations, one activity at each station. You will begin with the activity at your station, and then progress through the other stations. Please choose one member of your group to be the narrator of this activity. Each station will require a different narrator, so each of you should be prepared for your turn. The narrator reads the instruction for each activity and directs the group members to assure the activity is completed.

Stations transitions:

Repeat these instructions for the next eight transitions." Near the 5 minute mark: "In approximately 1 minute we'll be changing stations. Please complete the activity and return materials and organize your station for the next group to use. Take time now, to answer the questions on your review sheet and record notes from your experience at this station."

"Designate the narrator in your group for the next activity, collect your materials and proceed to the next station. Please begin the activity once your group has convened at the station. You will have 5 minutes to complete the task."

Parachute Play

Materials

Vinyl parachute with handles, folded in a box
5 plastic balls under the parachute

Instructions to narrator

Step 1: tell the group: "Use the parachute."
Comment on what you observe the group doing to use the parachute.

Step 2: say
"Stop. Now each person holds a parachute grip, position the parachute flat parallel to the floor at waist level, and move the parachute." (comment on how the group is moving the parachute)
Say "move it in a different way (comment on how motion has changed) …
Say "move it a different way (comment on how motion has changed) ….

Step 3:
Say "Stop. Now, the goal of this activity is to keep the balls moving and on the parachute for a long period of time."
(If a ball falls off, return it to the parachute, and remind the group of the goal to keep the balls on the parachute.)

After awhile, ask, "Anybody getting tired?" When someone says yes, offer to take their spot so someone can have a break…

Step 4:
The person who is not holding the parachute now becomes the group recorder and tells what he/she observes happening…
Without telling the group, slow down your shaking of the parachute so the balls pile up at your spot. Continue with this slow shaking and don't respond to their encouragement to move at their pace, continue until other members talk among themselves about what to do or individuals change their shaking to align with yours to meet the goal.

Then say: "Stop! Why did you change your shaking motion?"

Then "Let's try again."
Without telling the group, slowly increase your shaking faster or larger shakes so the balls become more erratic, don't respond to the group's remarks, and wait to see what the group does to regulate the balls' motion or the group activity disintegrates .

Say "Stop. What do we need to do to meet the goal? What do we need to do to meet this goal over a long time?"

Group members record notes on what they observed.

Parachute - Systems Theory Principles Explained

The parachute activity illustrates several principles of systems theory.

In this activity, the narrator serves as the macro system, the individuals in the group holding the parachute are the meso system, and the balls are the micro system.. (#1, 2)

Step 1 – With little direction, the system is poorly identified… Individuals act only as holons, not as a system so boundaries are too open.(#3) The parachute is the interface, however the energy use is chaotic with no clear goal, energy form, direction and strength of energy is not occurring for the system. (#4)

Step 2: With explicit direction of how to manage the materials, the system becomes organized- (#5) roles and functions emerge in the shaking of the parachute.

Step 3: Adding a clear goal, individuals can observe the outcomes of the parachute system and alter their behavior to equi- or multi-finality. As the group succeeds in meeting the goal, a homeostatic balance (#7) in the behavior of individuals emerges, and a seemingly natural process of accommodating other group members creates the perception of a synergistic system (#4). The narrator role serves as a feedback mechanism (#6). The group will naturally assume the narrator provides internal, ongoing, and negative monitoring and reinforcing feedback. Watching until an arm appears tired interpreting the risk of system entropy (#4), and providing positive feedback is to change the system by stating "Anyone tired?'

The assumption that the narrator's role serves as internal feedback allows the group to let keep open boundaries, assume parallel structure and the sustainability of the system, and allows the replacement of a member by the narrator.

Step 4: The group's assumption of the narrator role will fulfill a homeostatic balance (#7) holds until someone notices the balls all collecting at the narrator's spot. As this person comments a hierarchical structure emerges with the narrator with less power in the group (#5), and the others will challenged the erratic behavior and turn quickly to internal control mechanisms (#6) to motivate the narrator to comply with the system's existing synergy (#4) and permeable boundaries (#3).

As the narrator resists the pressure to comply, the group will then try a strategy seeking a steady state balance (#7). Failing to change the narrator, members of the group will change their behavior to assure the goal is met, requiring all the individuals to reset the systems boundaries, energy exchange and structure to compensate.

Although seeming extreme actions in the two situations, the narrator's behavior to create small motion and large motion are both "breaking feedback mechanism" and resistance to becoming part of the system suggest that the narrator is an external located mechanism (#6). The group must eliminate the narrator from the system, assimilate or accommodate the narrator's presence or risk goal failure and system entropy (#4).

- It is possible for the group to recall the previous member and dismiss the narrator to re-establish the system. However, this option is rarely recognized by the group in the parachute activity.
- Most groups act at this point as individuals, each alter their behavior independently of one another which increases the risk of entropy but makes the boundaries and structure stable.
- Sometimes, the group realizes the realizes the entire system must change to assure the goal – Group members talk among themselves with a mutually influencing balance (#7) and plan what to do leads to a system wide plan change that is implemented all at once. The moment of transition is very unstable in structure and boundaries, but the outcome substantially reduces risk of entropy. The group will achieve "innovation" as improved system functioning such that the work of individuals reinforces the relationships of the group increasing the energy exchange so that the group is synergistic to itself and to the original goal.

Obstacle Course

Materials

10 pop bottles, set on the floor in 2 rows of 5 each, each bottle offset on either side of an 18" space creating a pathway, preferably a J shaped path. The pathway is marked with an x on either end created with the wide tape.

5 feet of wide tape
1 bean bag
1 large lightweight ball
2 room chairs

Instructions to narrator:

Step 1: Hold the ball and your bean bag in your hands and tell group members: "Please line up single file at the marked x." Once the group is lined up, ask each person, "Please describe your plan to get this bean bag to the X on the other side of the pathway." Once the plan has been stated, say "Please implement your plan."

When the person has reached the X, say "Please record what was necessary to be successful achieving your goal." Collect the bean bag from one end and return it to the first marked x…(repeat this conversation with each group member.)

Step 2: Continue to hold the ball and your bean bag in your hands and tell group members: "Please line up single file at the marked x." Once the group is lined up, ask each person, "Please describe your plan to get this bean bag to the X on the other side of the pathway." Once the plan has been stated, say "Please implement your plan." As the person walks toward the marked X, roll the ball into their path, intending to stop their motion briefly.

When the person has reached the X, say "Please record what was necessary to be successful achieving your goal." Collect the bean bag from one end and return it to the first marked x…(repeat this conversation with each group member.)

Step 3:

Continue to hold the ball and your bean bag in your hands and tell group members: "Please line up single file at the marked x." Once the group is lined up, ask each person, "Please describe your plan to get this bean bag to the X on the other side of the pathway." Once the plan has been stated, say "Please implement your plan." As the person walks toward the marked X, move the chairs to block the pathway in such a way that the person can not climb over the chair nor move around it, and the beanbag can not reach the x unless the person leave the pathway. Allow the person as much time as necessary to solve the problem, if necessary, allow the person to return to the original spot and develop a new plan

Note for narrator alone: there are no rules about group members helping one another, and there is no expectation that members stay on the pathway set by the bottles, although each will assume these to be the rules of habit. To be successful the person must leave the path and develop another route, but internal concern for breaking implicit "cultural rules" will restrict this type of creative thinking. Once the innovation is made and no reaction occurs, everyone will follow.

When the person has reached the X, say "Please record what was necessary to be successful achieving your goal." Collect the bean bag from one end and return it to the first marked x…(repeat this conversation with each group member.)

Step 4: Remove the chairs, and ask group members to do the task one more time, and do not provide obstacles. Notice if the final path fits the original or the created short cut.

Activity concludes with reflections on what happened.

Obstacle Course - Systems Theory Principles Explained

The obstacle course activity illustrates several principles of systems theory. In this activity, the narrator serves as the macro system, the X serves as the goal, and the beanbag symbolizes energy exchange. . (#1, 2)

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Yo-Yos

Instructions to Participants:
"Take a yo-yo and play with it"
"Now yo down without pulling it back up. Record what you observe"

Reflection Directives of Activity

"Speculate on the behavior of the yo-yo when you stopped pulling it back up. You may also want to comment on what it takes to get the yo-yo going again.

Narrative Explanation of Systems Theory Principles Illustrated

Puzzle

Instructions to Participants:

"Look at the pieces piled up in the box. Construct the puzzle. Now observe the linked pieces."

Reflection Directives of Activity

"Which observation of pieces showed more details/meaning? The pile or the finished product?"
"What gave the finished product more meaning?"

Narrative Explanation of Systems Theory Principles Illustrated

Slinky

Instructions to Participants:

Play the slinky game according to directions. Note the energy of the slinky as it picked up the balls from the steps.

Reflection Directives of Activity

Consider the movement of the slinky, and the balls it contained. Discuss this interaction in terms of different levels of system. Can you comment on equifinality through watching this?

Narrative Explanation of Systems Theory Principles Illustrated

Tinker Toys

Instructions to Participants:

Reflection Directives of Activity

Narrative Explanation of Systems Theory Principles Illustrated

Principles of Systems Perspective as Demonstrated by Toys and Games

Principle	Principle 1	Principle 2	Principle 3	Principle 4
	There are three levels of systems. Micro, Meso, Macro	Systems are connected. Boundaries, Energy, Exchange	Balance Equilibrium, Feedback	Systems exist within and interact with their environment. Context, Integration
Parachute				
Yo Yos				
Slinky				
Obstacle Course				
Tinker Toys				
Engine Governor				
Puzzle				

Toys and Games Review of Systems Theory

A-priori Knowledge – 4 Principles of Systems Theory

1) There are three levels of systems.
    - Micro
    - Meso (or messo)
    - Macro
2) Systems are connected to other systems.
    - Boundaries separate each system.
        - Permeability
        - Open systems
        - Closed systems
    - Energy connects systems to each other.
        - Sustainability
            - Synergistic
            - Entropic
        - Systems interact with other systems by exchanging energy.
            - Interface
            - Energy form
            - Direction and strength
3. Systems seek to maintain a constant balance in the internal use and external exchange of energy.
    - Equilibrium
        - Homeostatic
        - Steady State
    - Feedback Regulating Exchange
        - Monitoring
        - Mechanisms
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