Connected Wisdom: Living Stories about Living Systems

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*Connected Wisdom: Living Stories about Living Systems* is a book of twelve stories selected from ancient fables and folktales to illustrate twelve principles of living systems. Below is one chapter from the book.

**Chapter 10: Reinforcing Feedback**

Circular processes that create growth or decay by amplifying or reinforcing change

Have you ever heard someone say, “We’re on a roll!” when successes seem to build on themselves, or “We’re spiraling out of control!” when problems continue to pile up? When people use these kinds of phrases, they tend to be describing reinforcing feedback, a circular process in which a change builds on itself over time.

The expression *vicious cycle*, for example, suggests rapidly building momentum in a negative direction. A teacher might describe a student whose low self-esteem and poor performance are reinforcing each other as being in a *downward spiral*. A biologist might use a different term, such as *cascading*, to describe events that trigger other events in an ever-growing spiral, for example the growth of an embryo from a single cell. A climatologist might discuss the reinforcing effect of a slight rise in overall atmospheric temperature, which is currently occurring. This increase has caused ice to melt in polar regions; the now bare ground absorbs more heat, causing even more ice to melt.

Reinforcing feedback can also be a good thing. We experience this engine of positive growth in many situations, for example when learning builds on previous learning, or compound interest helps our bank account to grow, or when we see one act of kindness lead to another. Whether reinforcing feedback consists of an engine of growth or decay, we can work with it and even change the hidden forces that cause it.

In Aesop’s fable, “Hercules and Pallas,” mighty Hercules finds himself caught in an escalating spiral of aggression.

Hercules, once journeying along a narrow roadway, came across a strange-looking animal that reared its head and threatened him. Never daunted, the hero gave him a few lusty blows with his club, thinking he would set it on its way.

The monster, however, much to the astonishment of Hercules, was now three times as big as it was before, and all the more threatening. He thereupon redoubled his blows and laid about him fast and furiously, but the harder and quicker the strokes of the club, the bigger and more frightful grew the monster, and now completely filled up the road.
Here in New England, after a rainless May, we are enjoying beautiful summer weather, not too hot, with many days of clear skies interspersed with a few days of downpours. As a result, we aren’t too panicked about the water table here, as opposed to California. (See the lesson cited from Tucson.)

This is an unusual time for us to be sending out *The Exchange*, but we have so many interesting things going on that we thought you might like to take a look at them as you relax and enjoy the rest of summer.

As you can see, there is ample evidence across the country, from Tucson to Tyngsboro, that kids learn and can communicate significant critical thinking using the tools of systems thinking and system dynamics. Take time to peruse the original lessons on the CLE website, as well as what Ryan Keeser has done with them on BetterLessons, and gain inspiration from what even 3 and 4 year old children can do with BOTGs, as well as the expansive topics that middle and high school students can explore.

And above all, take the time to rejuvenate, relax, read and reflect.

Take care,
Lees Stuntz
stuntzln@clexchange.org

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**Updates…**

**Free, online version of *Fishbanks* now available in Chinese, Spanish, Portuguese and English**

The MIT System Dynamics Group and MIT Sloan have now launched the free, online version of *Fishbanks* in Chinese, Spanish and Portuguese, joining the English version. Simply go to [https://mitsloan.mit.edu/LearningEdge/simulations](https://mitsloan.mit.edu/LearningEdge/simulations). The online, web-based versions of *Fishbanks* are all freely available, and any teacher, including K-12 teachers, are welcome to use them at no cost.

Teachers, including K-12 teachers, can also be granted instructor access to Fishbanks and all the other simulations we have. Instructors gain access to instructional material including slides for briefing and debriefing, and written and video instructor guides. Simply go to [https://mitsloan.mit.edu/LearningEdge/simulations](https://mitsloan.mit.edu/LearningEdge/simulations) and click on the “Educator Register” button on the top right, then fill out the registration form.

In addition to *Fishbanks*, we offer many other simulations, including:

- CleanStart: simulating a clean energy startup company
- Eclipsing the Competition: simulating the solar photovoltaic industry
- Platform Wars: simulating the video game market
- Salt Seller: simulating competition in commodity markets
- World Climate: an interactive role play simulating global climate change negotiations, using the award-winning C-ROADS model


Please spread the word at the upcoming Systems Thinking Dynamic Modeling Conference, Camp Snowball, other conferences, and in your networks.

John Sterman jsterman@MIT.EDU

**BetterLesson**

We are thrilled to announce that some of the great lessons the CLE has to offer are being used and adapted. Ryan Keser, a middle school science teacher in the Brookline, MA public schools is a Master Teacher in the BetterLesson: Share What Works Project. BetterLesson has partnered with outstanding educators across the country to run Master Teacher Projects and create over 16,000 rich lessons, covering Common Core Math, Common Core ELA, Next Gen Science and Blended Learning.

Ryan used the In and Out Game from *The Shape of Change* to inspire the two systems thinking lessons he has put up on the BetterLessons site. We look for more to come!

*Introduction to Change over Time*
*Reinforcing Feedback Causal Loops*
The goddess of wisdom, Pallas, then appeared upon the scene. "Stop, Hercules," she said. "Cease your blows. The monster’s name is Strife. Let it alone, and it will soon become as little as it was at first."

"Strife feeds on conflict."

Until Pallas appears, Hercules does not see how he and Strife are trapped in a reinforcing feedback loop. The greater Hercules’ aggression, the larger Strife grows, and the larger Strife grows, the greater Hercules’ aggression. Hercules is caught up in an escalation, a type of reinforcing feedback loop in which one party does something that is seen as a threat by another party, causing the other party to respond in kind and so increasing the perception of threat to the first party. This results in a rising spiral of aggression. It is only when Hercules realizes, with the help of Pallas, he must not respond, that the spiral is broken.

Balancing Feedback: circular processes that create stability by counteracting or lessening change.

Objectives
To explore reinforcing feedback, an underlying pattern in living systems that amplifies change, acting as engines of growth or decline.

To explore the question: how can a set of interrelationships cause a living system to grow or decline?

Literature standards
• Read fables, folktales, and myths from diverse cultures.
• Describe characters in a story and explain how their actions contribute to the sequence of events.
• Make connections between fables, folktales, and myths and relevant everyday situations.

Classroom management
• Students can complete this activity individually or in pairs.
• Materials
  • One printed copy of a photo
  • Paper
  • Pen or pencil

Student activity
This activity explores the effect of reinforcing feedback in social media. Over the past few years the term “go viral” has taken on a new meaning. It no longer refers to sickness, but to a picture, video, or comment over the Internet that has taken on a life of its own. This activity explores the potential power of posting information on social media, how that information can spread, and its relationship to the “Hercules and Pallas” story.

1. Select a photo to share with the students. The photo should be

Connected Wisdom continued on page 4
Population Dynamics

continued from page 3

something the students will think is funny, interesting, or unusual. Tell them you wanted to share this photo with them because you found it interesting and thought they would too. Talk to them about how sharing a photo in person reaches only them. They have no way to share this photo with friends or people at home if you have the only physical copy of it.

2. Ask students to list 10 people they know and interact with regularly. Discuss what might happen if they were to share this photo with those 10 people. Ask if they think any of the 10 people would think the photo was interesting and would want to pass it on? Would this be possible to do if you only had the physical copy of the photo? What would be an easier way to share it?

3. Students will probably agree that sharing the photo on the Internet, through e-mail, Twitter, Facebook, or other social media outlets would be much simpler. If they shared this photo on day 1, 10 people would view it. What would happen if on day 2, each of those 10 people shared the photo with 10 people they knew?

4. Ask the students to continue the pattern of people sharing with 10 more people for four days. At the end of four days, how many people would have seen the photo? Have students create a data set and chart that represents the amount of views the picture would have over four days. Here is our example:

5. Take this idea further by having students continue to add up the potential exposure the picture would receive if people continued to share it. In the story, Hercules tried to fight the monster he encountered. When he fought it, it grew three times its size. The more he fought it, the more it grew. The same idea can happen in social media. For each person who shares a photo or video, the audience grows exponentially because every friend of that person has the potential to share it as well. Challenge students to create a feedback loop that represents the system that is occurring.

6. Discuss with the students the positive and negative repercussions of media going viral. What are the important safety considerations? Do the benefits of social media outweigh any negative effects?

Take it a step further

Ask students to share (appropriate) examples they have seen of media going viral.

Challenge students to create an appropriate video or photo that could possibly go viral. What social media outlets should they use to promote it? Have them develop a plan to aid in the success of the video or photo. If you want, allow them to follow through with the plan.
Teacher’s Guides and the Books on which They Are Based

How do we learn to live sustainably – or within the means of nature? Through this book, readers from 10 to 110 explore, through 12 timeless folktales and modern examples, how the laws that guide living systems can also guide how we live and learn.

The beautiful book was designed by renowned graphic artist Milton Glaser and illustrated by award-winning artist Guy Billout.

The *Connected Wisdom Teacher’s Guide* is a new resource designed to accompany the *Connected Wisdom* book. Co-written with Carolyn Finely at SEED/Schlumberger, the 12 chapters are packed with activities designed for ages 10-18. It’s useful, though, to anyone interested in learning more about living systems principles. Find it on the CLE website.

There’s also a *Connected Wisdom* on-line training module (also free) designed for educators and facilitators. [http://www.planetseed.com/course/connected-wisdom-online-training-course](http://www.planetseed.com/course/connected-wisdom-online-training-course).

See more at [http://lindaboothsweeney.net/blog/?m=201408#sthash.HqKbyGhz.dpuf](http://lindaboothsweeney.net/blog/?m=201408#sthash.HqKbyGhz.dpuf).

**When the Wind Blows**, by Linda Booth Sweeney (2015)
When wind chimes start singing and clouds race across the sky, one little guy knows just what to do—grab his kite. But as the kite soars, the wind picks up even more, and soon he and his grandma are chasing the runaway kite into town.

As they pass swirling leaves, bobbing boats, and flapping scarves, breezes become gusts and the sky darkens. Can they squeeze in one more adventure before the downpour? Scenes rich with springtime details for little eyes to follow and lyrical verse that captures the changeable mood of the weather make this perfect for spring story times.

Jana Christy did much of the art for this book during hurricane-force winds on a small island off the coast of Nova Scotia where flags flapped and walls shook in a house that looks remarkably like the house in this story.

*When the Wind Blows Teacher’s Guide* is a new classroom resource based on the story. Written by Marie Colleen for K-3 students, it offers activities to help teachers integrate *When the Wind Blows* into English language arts (ELA), mathematics, science, and social studies curricula, introducing systems thinking and Biomimcry as well. Find it on the CLE website.

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**Systems Thinking & Dynamic Modeling Conference for K-12 Education**

June 24 – June 27, 2016
Wellesley, Massachusetts

The Systems Thinking and Dynamic Modeling Conference for K-12 education provides resources and opportunities for educators and interested citizens to explore what is current and possible in K-12 systems education.

Back in the Boston area in 2016, the 12th biennial ST/DM Conference will once again host a slate of impressive systems educators and system dynamics professionals.

Join us for another instructional and educational conference as we explore effective methods of improving learning. System dynamics and systems thinking provide strategies and methodology to explore complexity, connections and change over time. The ST/DM conference will provide attendees with examples, vignettes, and materials to help educators further learning using systems thinking.

For more information, contact Bunny Lawton at the Creative Learning Exchange, call us at 978-635-9797. Scholarship applications and registration forms will be available late 2015 or early 2016. SAVE the DATE!
The CLE and the Boston Area Systems Thinking Educators hosted the eighth DynamiQueST, an exposition of K-12 student learning, on Friday, May 29, with the support of the WPI System Dynamics Program. The day featured 21 students presenting projects to expert system dynamicists and knowledgeable K-12 teachers, as well as to their peers. A rendition of *The Infection Game* was run—with liquid in cups—for the whole group, and the afternoon session featured a guided group discussion run by a dear friend of K-12, George Richardson, featuring a NY Times article about the unintended consequences of the distribution of mosquito nets to prevent malaria.

**Innovation Academy**, a school with system dynamics in its charter, brought multiple groups of students, and was joined by students from the Lawrence Elementary (K-8) School in Brookline, MA. The project titles included:

*Population Growth and Energy Efficient Innovation*—Sam Cain, Jesse Viola, Yuichi Watanabe

Our model is meant to help understand the elements that drive energy efficient design.

*The Simplicity of Catapults*—Sankalp Bhoyar

Visitors will learn the significance of the location of a fulcrum when designing a catapult. A causal loop will help to highlight the development of the design process. This assignment was used for a lab in science class.

*The Systems of Rome 1*—Abbie Lyna, Surabhi Keesara, Hannah Goldthwait

Students created stock and flow diagrams that illustrated the positive and negative impact of military expansion on ancient Rome.

*The Solar Oven Modeling Project*—Alexandra Reed, Lee DiMatta

Students use stock-flow model to predict temperature of solar oven over time. Solar ovens were tested and then the model was recalibrated with the data from the test.

*A Taste of Hollywood: Expressing Character Development and Theme with the Support of Systems Thinking Tools*—Rian Benoit

Students read a novel of their choice, analyzed relationships between characters, and used a Behavior-Over-Time Graph to express the influence that characters had on each other. They then used observations from their BOTG to determine a theme for each relationship.
Systems of Rome 2—Ira Libby, Alex McLaughlin
Students created stock and flow diagrams that illustrated the positive and negative impact of military expansion on ancient Rome.

Rocket Modeling Project—Alissa George, Rosalie Toupin
Students model flight of a paper rocket using a stock-flow model. Rockets were then launched using compressed air and the flight was recorded using a stationary camera. Video data was then used to recalculate the model.

Systems of Rome 3—Amy Clements, Emily Green, Shayla Lee
Students created iceberg models that illustrated the positive and negative impact of military expansion on ancient Rome.

American Revolution: Causes and Reflections—Anika Burliilo
Students identified various factors leading to the start of the American Revolution reaching back to the end of the French and Indian War. Students considered cause and effect, escalation, and changing soldier morale over the course of major battles.

Fish Banks Policy Project—Marc Printz, Alex Contardo
Students create a stock-flow model of the Fishbanks game and use it to test and combine policies in an attempt to make the fishery more sustainable.

Every time, one of the remarkable features of DynamiQueST is the participation of system dynamicists and doctoral students in system dynamics who give generously of their time to come to coach the students who bring their projects. They, with the help of the experienced teachers, give practical feedback, using the system dynamics rubrics, to the students on what they have done well and what they could improve. This year, many of the system dynamicists stayed to join in the discussion on the mosquito nets and the complicated reality of introducing a first world solution in third world countries. Our thanks go to: Oleg Pavlov (WPI), George Richardson (University at Albany), Saeed Langarudi (WPI), Michael Radzicki (WPI), Jeff Potash (CIESD), Rebecca Niles (Leverage Networks and ReThink Health), and Raafat Zaini (WPI).
Late this spring I had a whirlwind tour of some of the wonderful lessons happening in the Tucson area. A full range of ages was represented, showing that teachers can utilize ST/SD tools to teach thinking skills at all levels. At Valley View Early Learning Center, I saw three- and four-year olds discussing BOTGs and stock/flow diagrams from the books they were being read in Jennifer Dooley’s room. Shown is an example of going from a BOTG about *Why Cowboys Sleep with Their Boots On* to a stock/flow diagram.

This year’s visit to Borton Elementary School (now expanded to 5th grade) was a delight. As always, there was ample evidence that this school has taken systems thinking seriously and made it an integral part of their pedagogy. The examples were numerous and these three are just a few of the exhibits adorning the hallways:

I saw examples of the use of the iceberg, Behavior-over-Time Graphs, and causal loops in literature in Julie Stigler’s 5th grade class in the Catalina Foothills district. The students were preparing to make presentations about the books they had read, and it was a joy to listen to their thinking and watch their burgeoning grasp of balancing causal loops as well as the easier reinforcing loops. The room was papered with results of class discussions on the
In Daniel Murphy-Cairns’ middle school classroom (again in the Catalina district), students were wrestling with the knotty and very timely issue of the California drought. Daniel used various resources, including an article appearing on timeforkids.com that had a germane discussion of the problems facing California—and much of the rest of the world. He posed four questions to the students:

A. The Governor of California, Jerry Brown, has proposed the following steps to help deal with the water crisis:
   - Make water conservation a mandatory part of the K-12 schooling.
   - Build 3 desalinization plants in California to turn salt water into drinking water.
   - Will this work? Why or Why not?

B. Is it possible to deal with the drought in California without attempting to deal with the causes of climate change?

C. What would you do to deal with the water crisis? Why?
   (Make sure to address long-term and short-term solutions.)

D. What are the mental models (the beliefs, values, and assumptions that drive our actions) that affect how Californian’s think about and use water?
   - Do any of these mental models need to change?
   - Do you have the same mental models?

The students were asked to use systems thinking tools to help them elucidate their thinking. One of the stock/flow diagrams that came out of class discussion was evident on the board the day we visited.

Finally, a trip to City High School yielded a rich discussion of the issues of the relationships of police with their communities, both in prison and without. In Brett Goble’s classroom, the students had used the simulation Beyond Closed Gates (available on the CLE website), in which the students can use system dynamics modeling to explore the relationships of groups where one set of people have power over another. This causal loop came out of the class discussion.

The whole visit was just plain fun. It was delightful to see all those students working hard, building their understanding and communicating their learning!
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If you would like to invest in our effort here at The Creative Learning Exchange, your contribution would be appreciated. You may donate any amount you wish; perhaps $50.00 is a reasonable amount for a year. All contributions are tax-deductible.

Enclosed is _________________ to The Creative Learning Exchange to help invest in the future of K-12 systems education.

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