System Dynamics in Primary and Secondary Education

What we're learning about how kids, and their teachers learn…

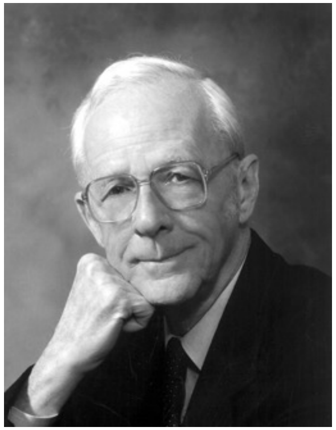
Lees Stuntz and Anne LaVigne

Creative Learning Exchange

ISDC 2018, Reykjavik, Iceland

Jay's vision for K-12 – always present as a challenge

On the shoulders of giants, who have consistently stood by K-12 efforts from the beginning…



…and John Bemis

1980s → **Today**

With gratitude to so many *beyond* K-12 education, who have supported K-12 work

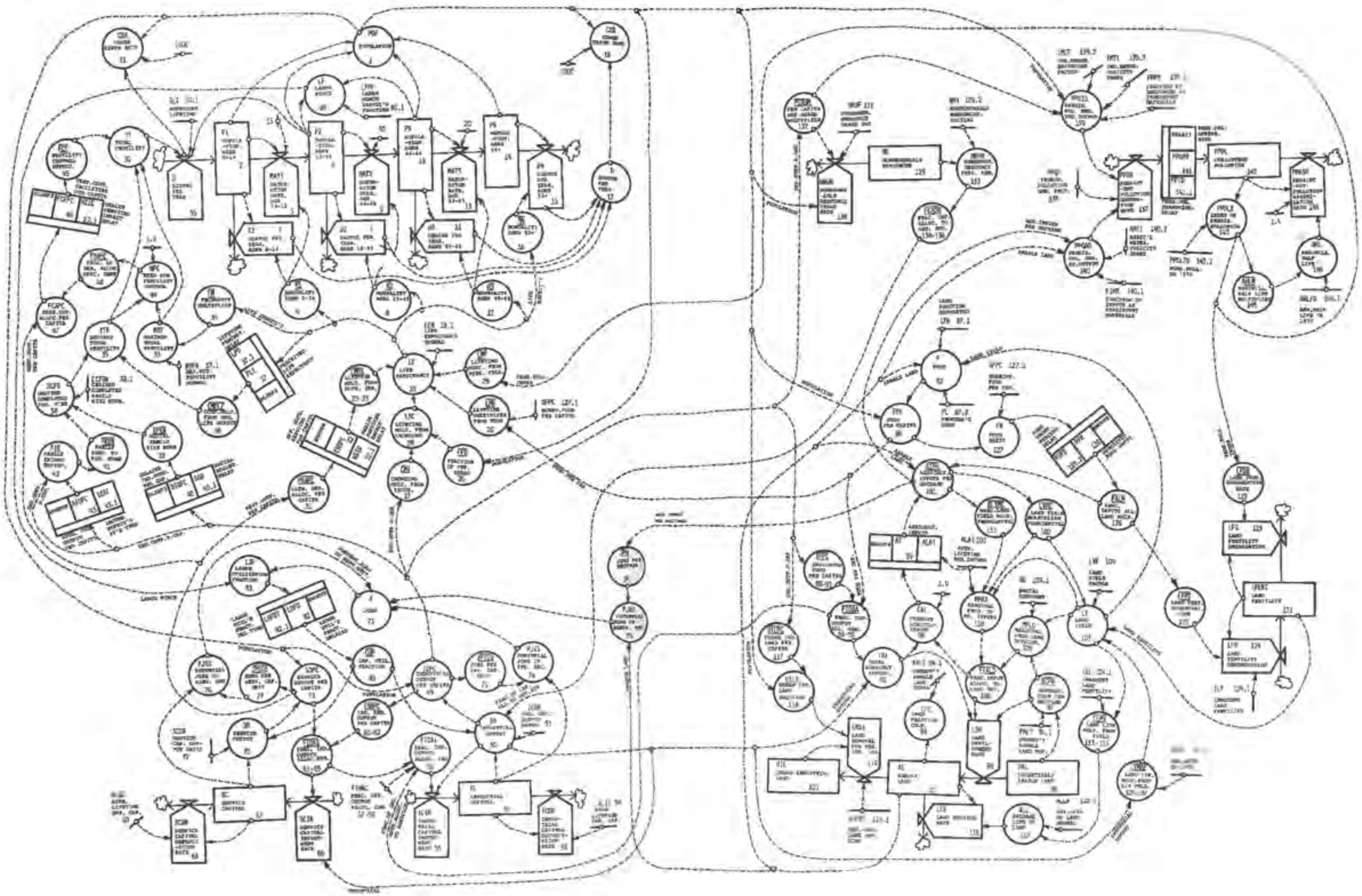
from the past

into the future...

System Dynamics is HARD – one reason why it's difficult to increase adoption.

Innovation Characteristics that influence Rate of Adoption		
1	Relative Advantage	Degree to which the innovation is superior to existing products
2	Compatibility	Degree to which the innovation matches the values and experiences of the individuals
3	**Complexity**	**Degree to which the innovation is relatively difficult to understand or use**
4	Divisibility	Degree to which the innovation can be tried on a limited basis
5	Communicability	Degree to which the beneficial results of use are observable or describable to others

Kids can't start here…and neither can most people, for that matter.



Scaffolding – an engineering <u>and</u> an educational methodology

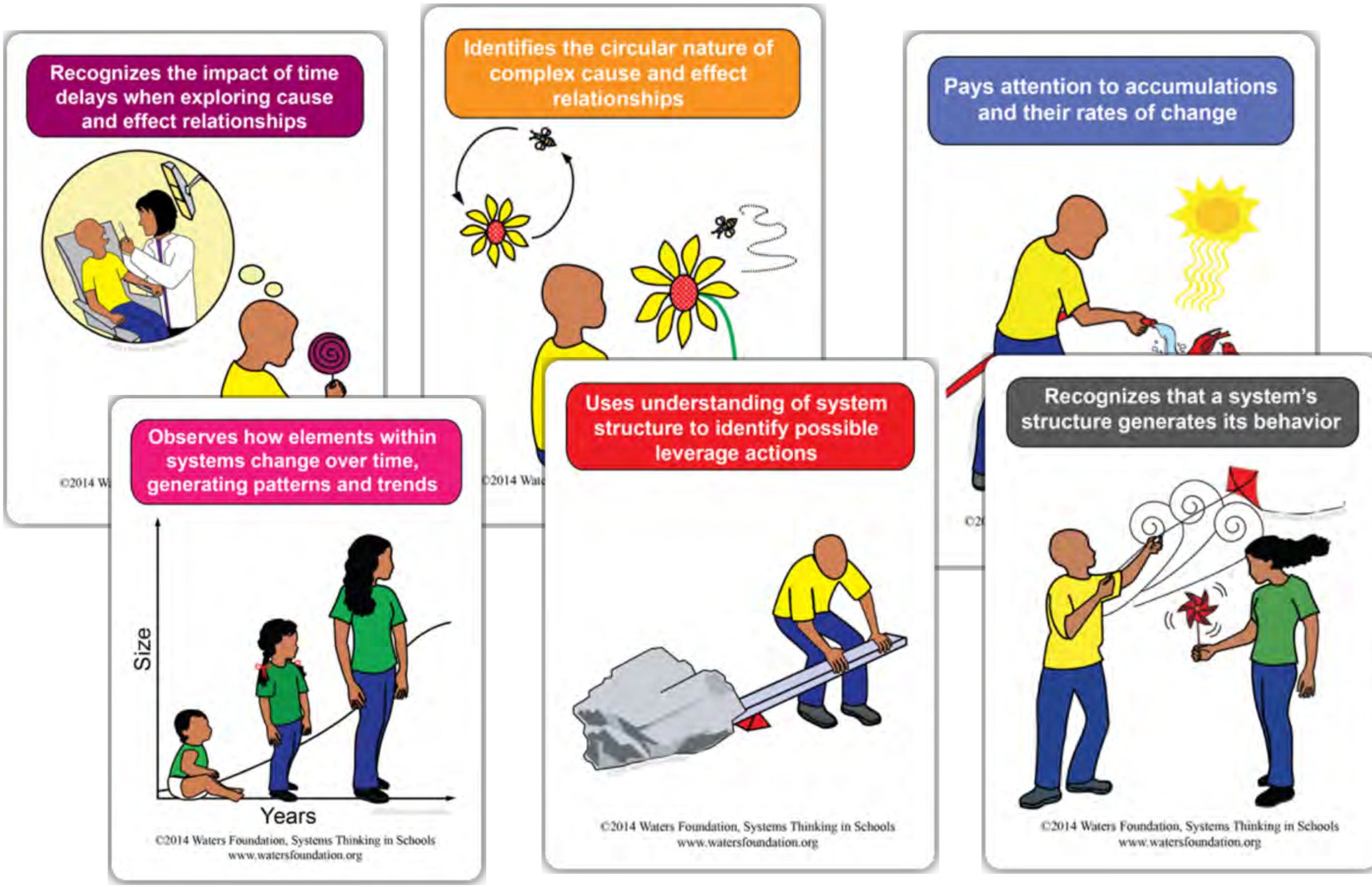
How do we scaffold the critical thinking skills generated by System Dynamics?

- **Creating interesting and engaging contexts:**
  - **Stories**
  - **Games**
  - **Simulations**
- **Using age appropriate, visual tools**

Barry Richmond's Eight Systems Thinking Skills

- **10,000 Meters Thinking**
- **System as Cause Thinking**
- **Dynamic Thinking**
- **Operational Thinking**
- **Closed-Loop Thinking**
- **Scientific Thinking**
- **Generic Thinking**
- **Empathic Thinking**

Habits of a Systems Thinker from the Waters Foundation



Scaffolding understanding of …

- Behavior over time
- Feedback
- Accumulation
- Modeling

Scaffolding understanding of behavior over time through stories, simulations, and kinesthetic experience

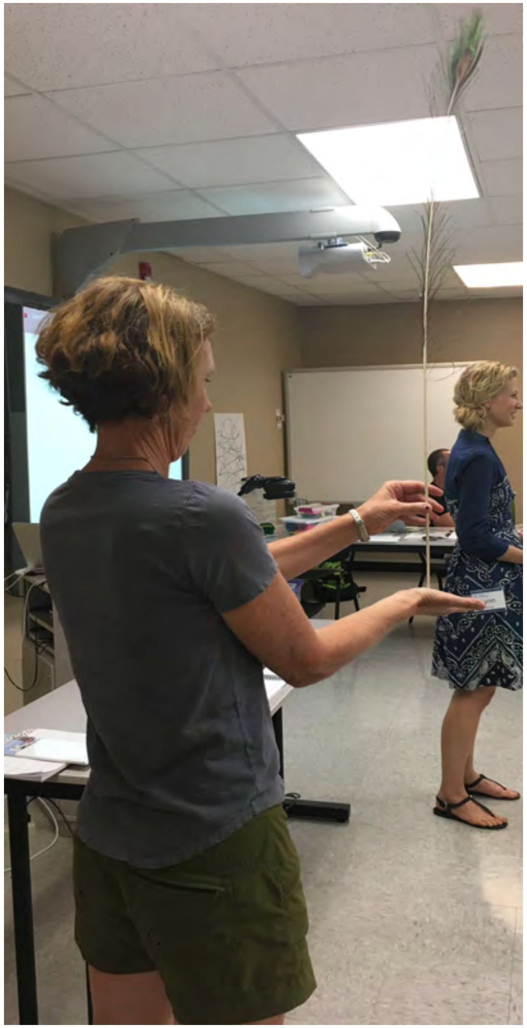
Student graphs for a story … up close

Representing continuous trends while playing the World Climate Simulation

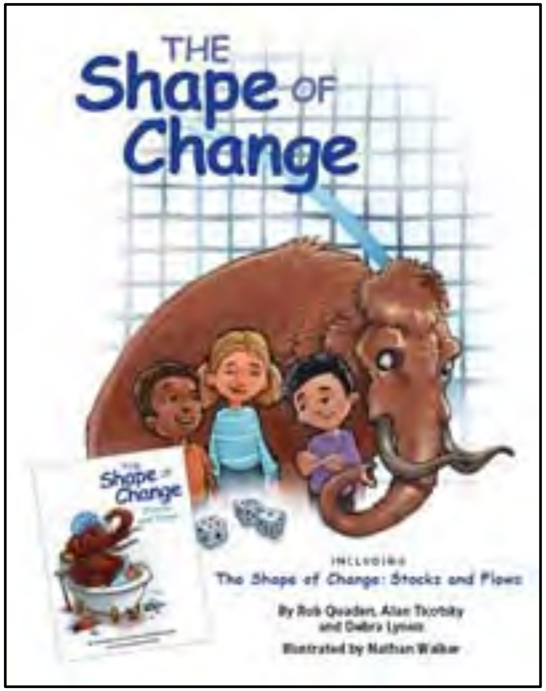
CREATIVE LEARNING Exchange
Making Thinking Visible

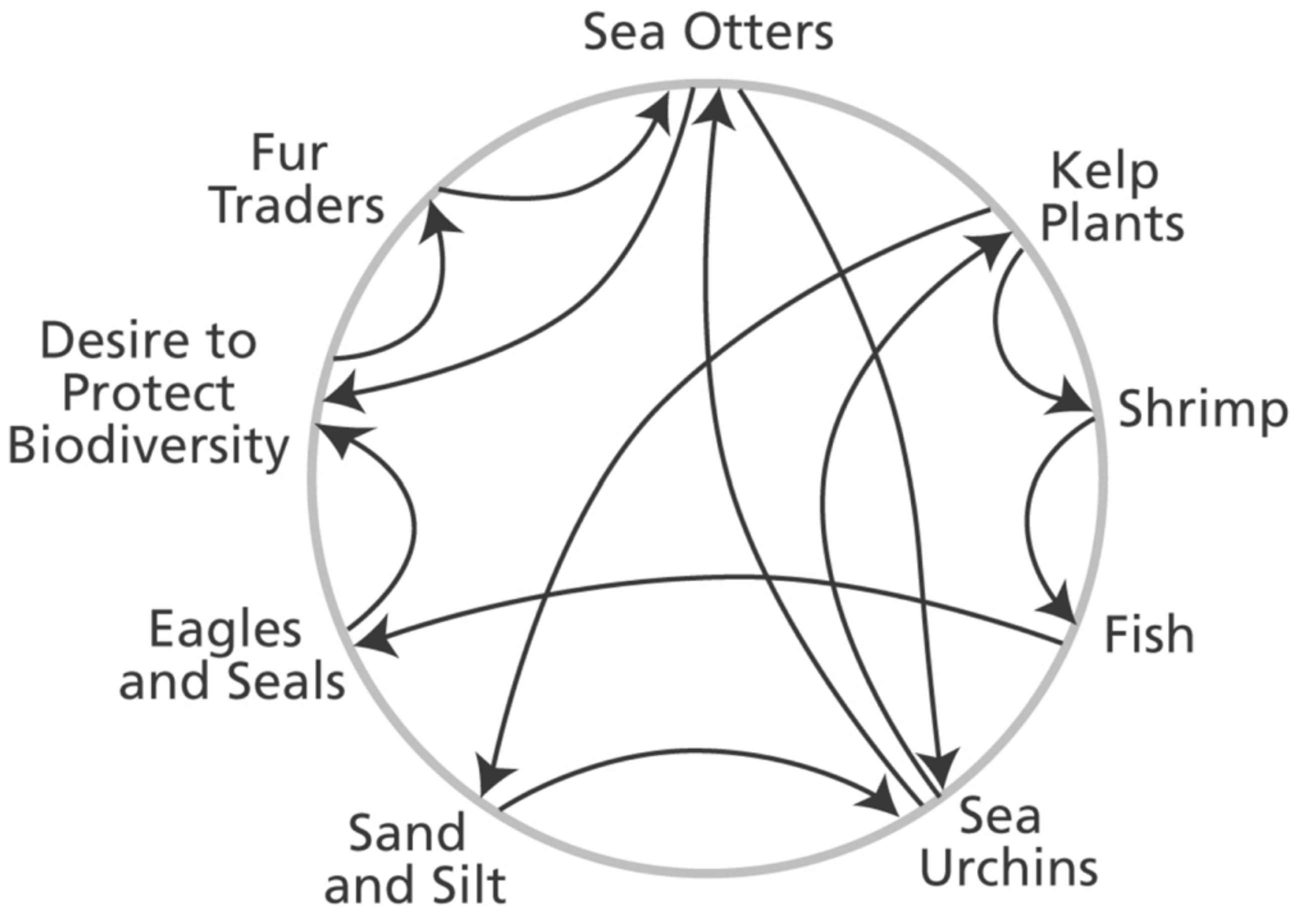
Scaffolding understanding of feedback through stories, kinesthetic experience, and connection circles

Activities that engage and teach feedback concepts



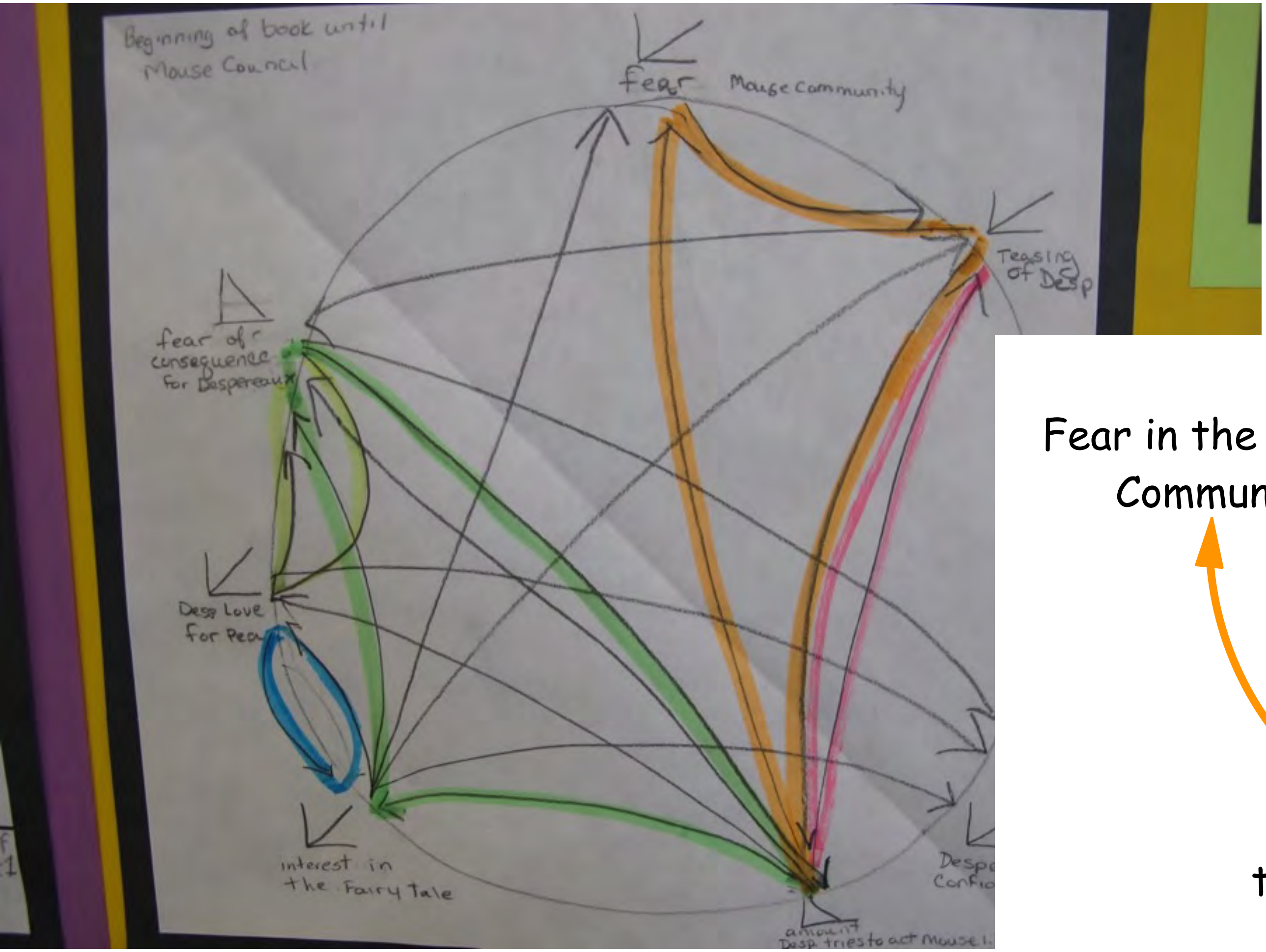
Connection circles …
a tool created by educators

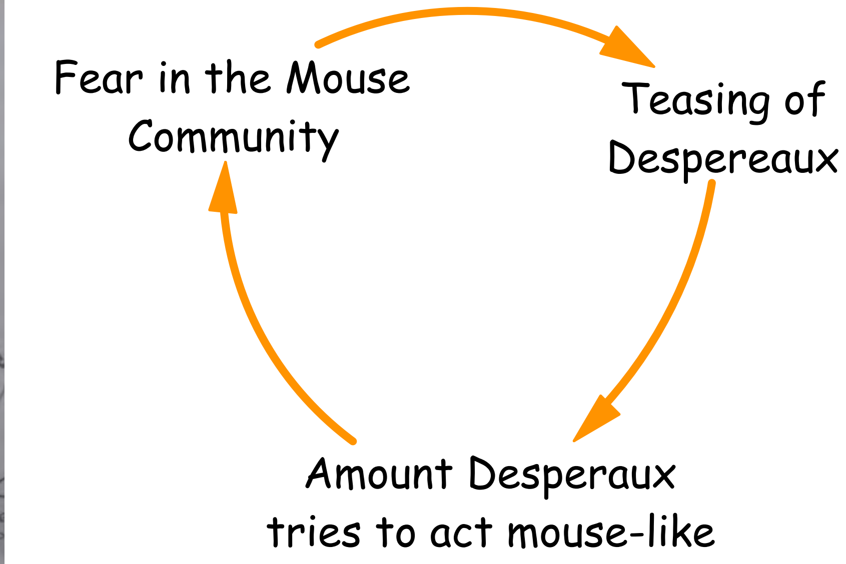




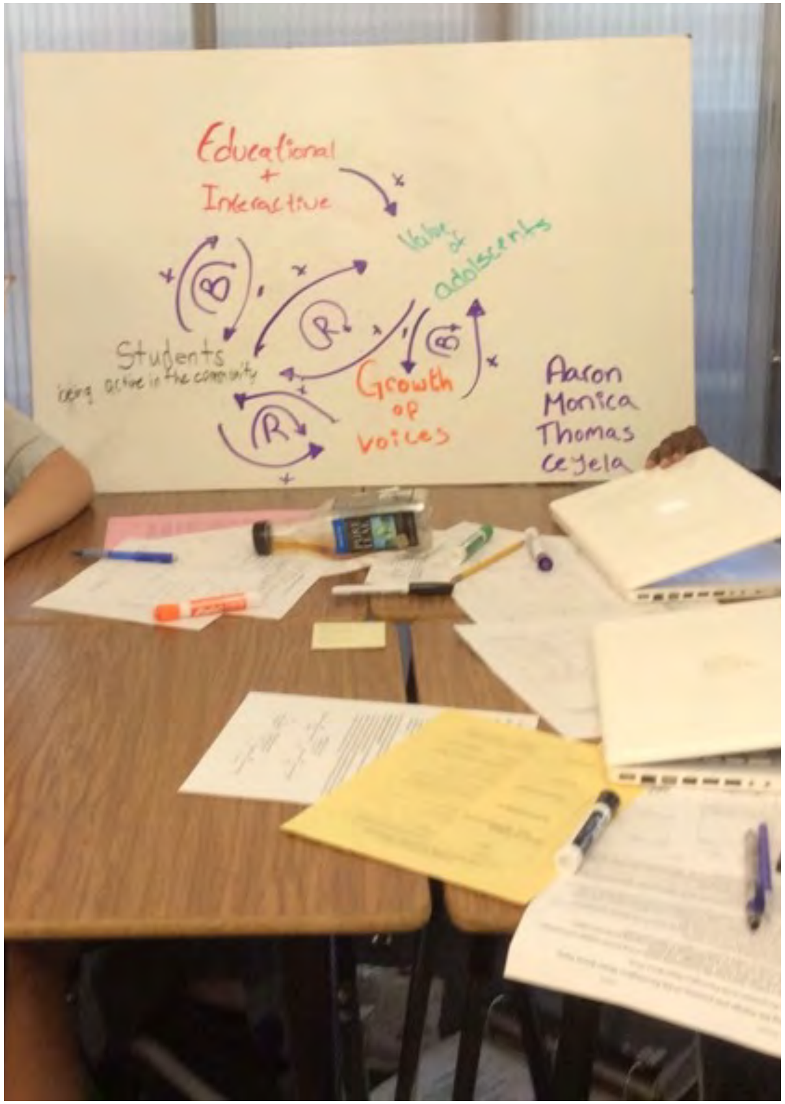
From using connection circles to find feedback…

Students identified feedback loops.





…to drawing loop diagrams



Scaffolding understanding of accumulation through kinesthetic experience, games, simulation, and models

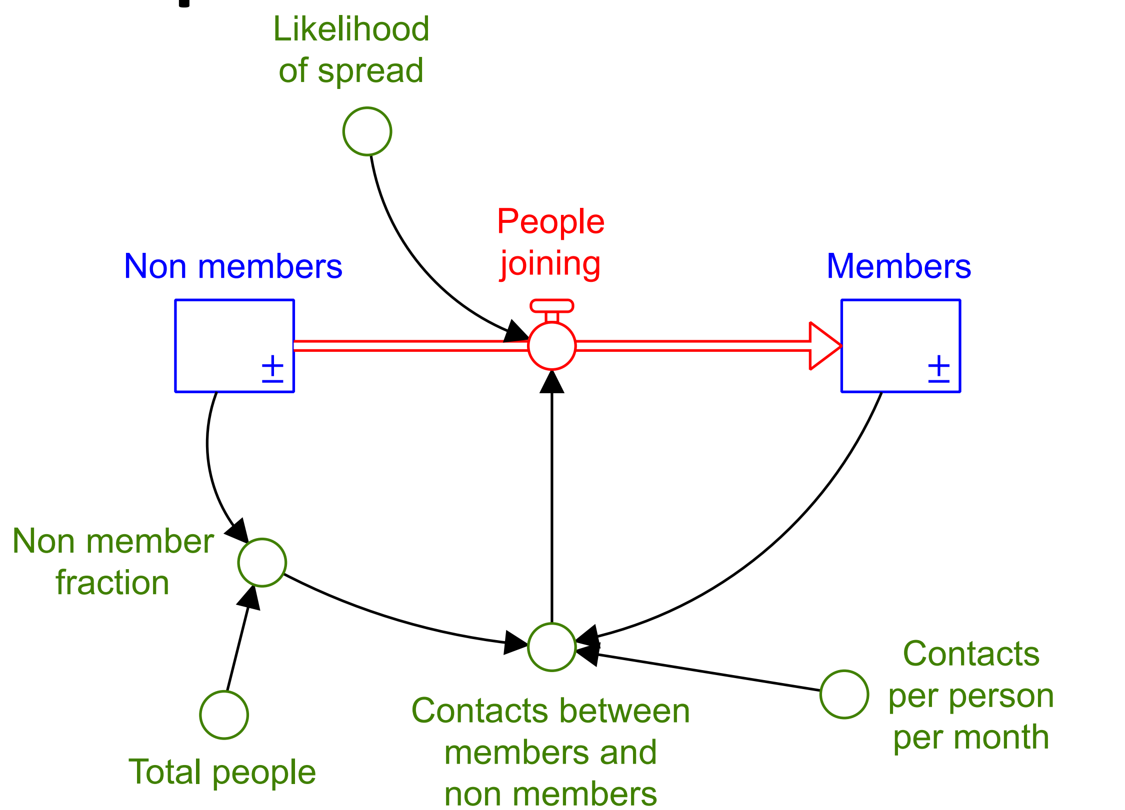
Thinking about their garden's health, variable names are painted on rocks, so kids can "play" anytime.

Shoe stockroom – A variation of the In-and-Out Game from *The Shape of Change*.

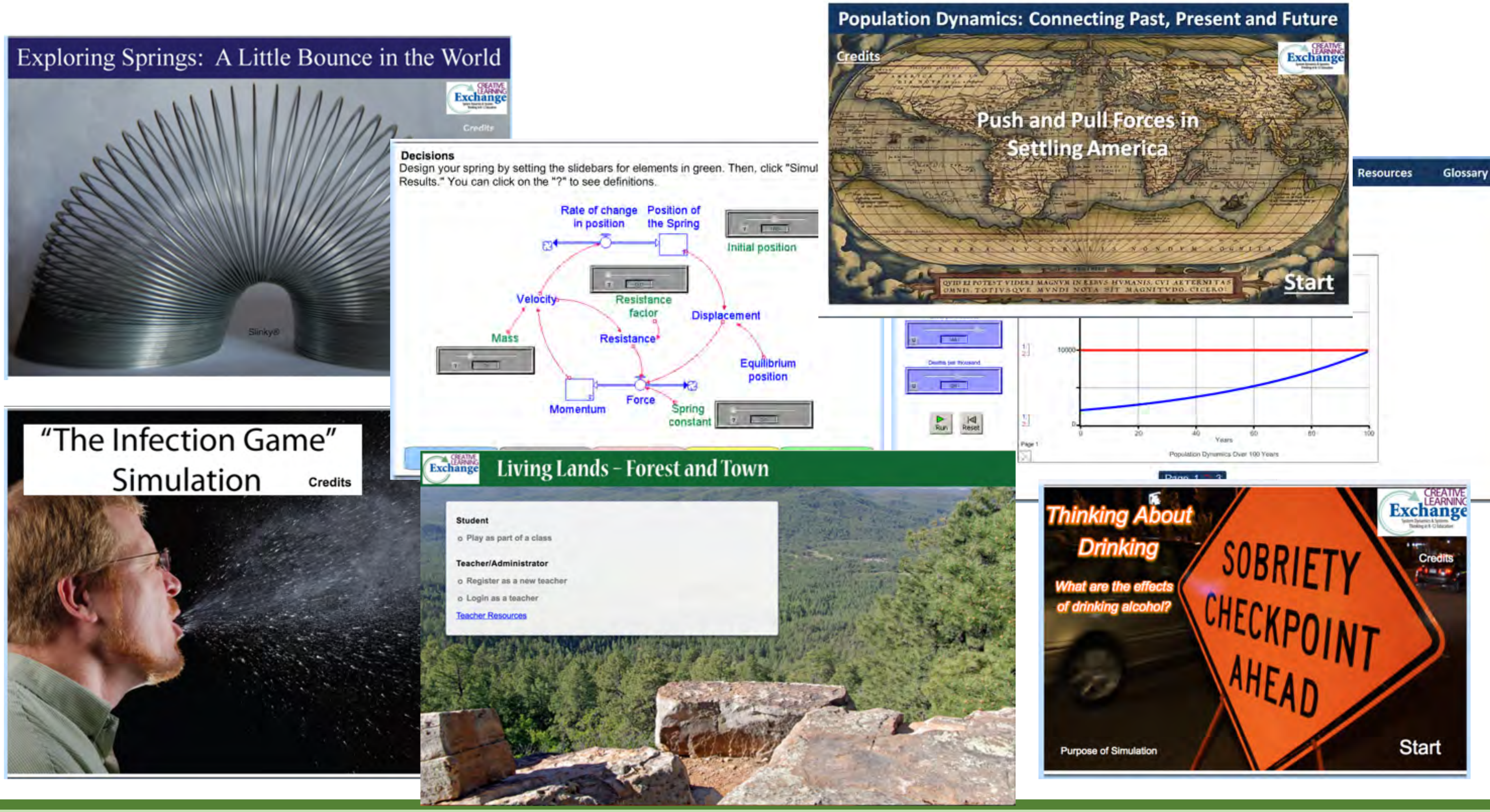
Play a game, then use simulation or modeling software to explore related models.

Infection handshake game

The spread of a social media site

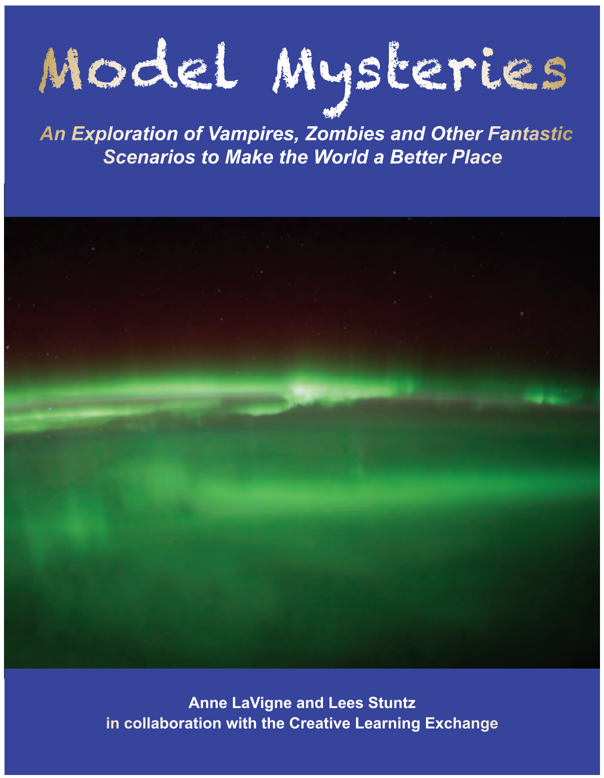


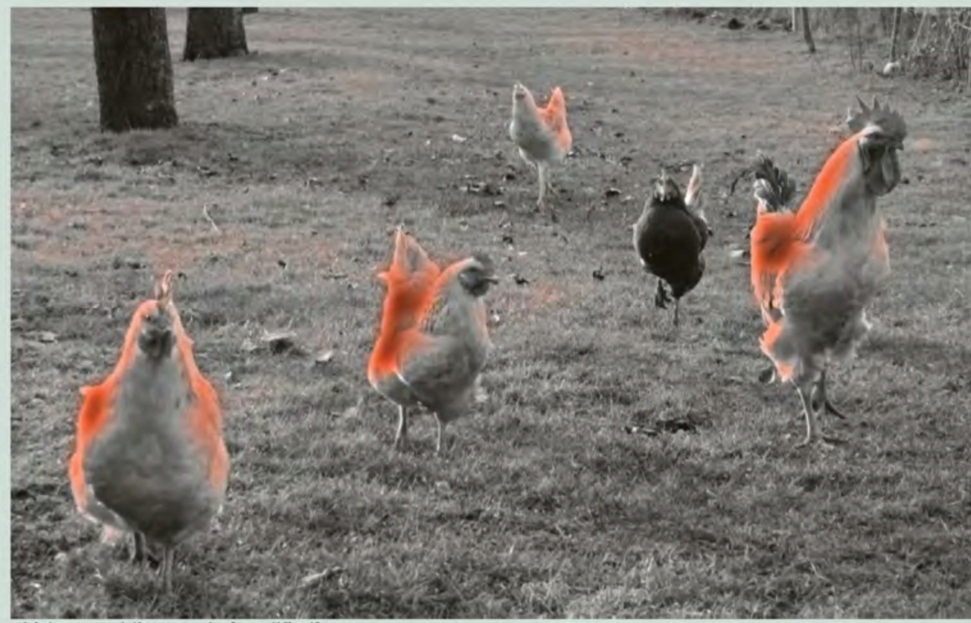
Simulation that engages within curricular contexts



Copying simple models within engaging topics and challenges

Dive in – How can you stop zombie chickens from over-populating planet Earth?





Chickens, Public Domain [modified].

… then connecting the same model to other contexts.

Story 1: Dodo Disappearance

Overview

In the 1600s, the dodo, a type of bird went extinct. Use this model to consider the basics of why this animal became extinct and how that extinction might have been stopped.

Details

1. Time units__________
2. Dodos (stock)__________
3. Birth fraction__________
4. Death fraction__________

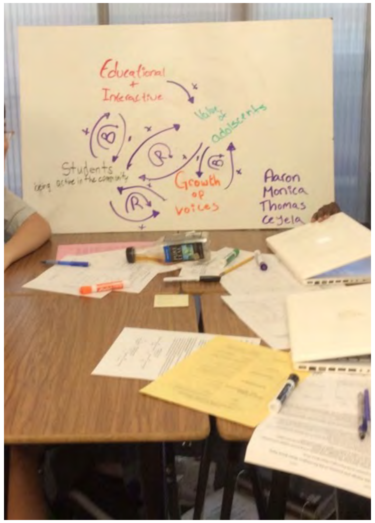
D Dare

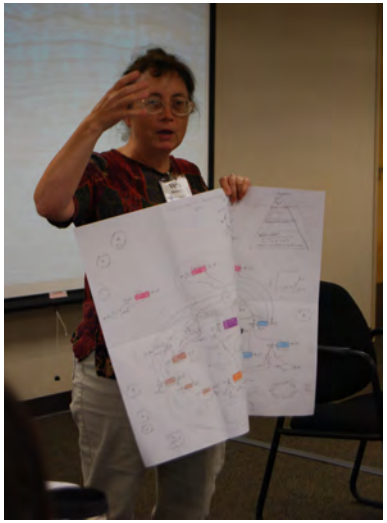
1. Re-label and change the numbers in the previous model to make sense for this situation.
2. Determine how long it would take for the population of dodos to disappear.

Dodo, by Christian Friedrich Stölze. Public Domain

In summary…

With scaffolding, students (and their teachers) can draw BOTGs, identify feedback, create S/F maps, and copy/modify models BUT… it's still difficult for them to build their own original models.





What now?

- How do we make the “leap” for students and teachers from simulations and copying models to creating models?
- We needed a visual, attractive and easily understandable bridge between current effective K-12 methodologies and the abstract modeling software available.

From water in an MIT basement.....

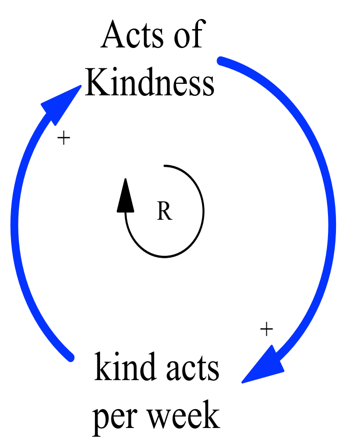
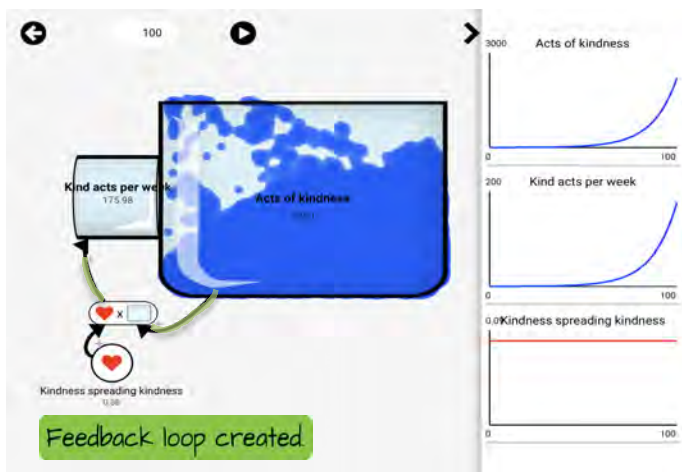
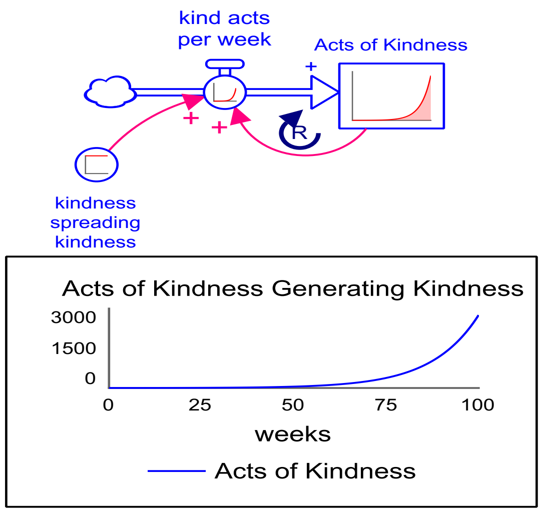
"In 1968, Jay started a student-run System Dynamics Laboratory course. The lab part was a room in the basement of the Sloan School. The purpose of the lab course was to give students some hands-on experience and physical, intuitive feel for some systems behavior. I was asked to design the course and stock the empty room with slow-moving, intuitive physical systems. I procured tanks of water, plastic tubing, valves and clamps for hydraulic experiments, and also springs, weights, and electrical devices."

David W. Peterson

...to “Tubs & Pumps”

The "Tubs and Pumps" activity, developed by Chris Browne, Barry Newell and Katrina Proust

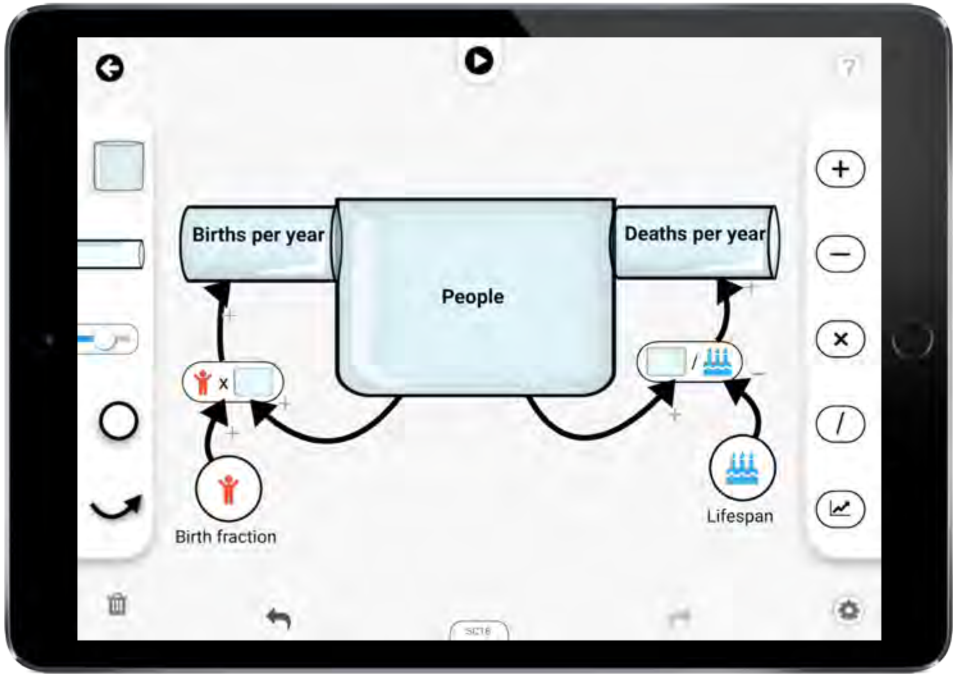
...to *Splash!*

Systems Thinking Tool Causal Loop Diagram	System Dynamics Tool **Visual** Stock/Flow Model – Splash!	System Dynamics Tool Traditional Stock/Flow Model
		

Quotes from students at BETA testing

- "The animation of the particles in ***Splash!*** makes it much easier to see the relationships between different variables, as well as the making of Systems Thinking models much more interactive." *8th grader*
- "It is easy to use and the colorful liquid physics simulations make the modeling process fun and exciting. I think ***Splash!*** does a great job of making systems dynamics modeling intuitive." *12th grader*
- "The app is fun to use, the fluid is beautiful to look at! and it teaches you system dynamics without you knowing." *10th grader*

Splash! and *Splash*Cards



A creative collaboration between

BTN VISUAL INTERFACES FOR SERIOUS SIMULATIONS & CREATIVE LEARNING Exchange Making Thinking Visible

Going Forward

We need experienced SD professionals to reach out and motivate pre-college educators and students.

We are here to help, to cooperate with you, to support you in your efforts.

Going Forward

Resources available through the Creative Learning Exchange

- ***Splash!***
- Simulations
- Books
- Curriculum
- DynamiQue*ST*
- Capacity Building Workshops

Help us create systems citizens of the world who can handle complexity.

from the past

into the future…

Your Picture Here

?

CREATIVE LEARNING Exchange
Making Thinking Visible

Stay connected http://www.clexchange.org

www.twitter.comCLEK12

www.facebook.com/clexchange

stuntzln@clexchange.org and lavignea@clexchange.org

Donate to ***Splash!*** *clexchange.org/splash*