The Creative Learning Exchange

VOLUME 26 • NUMBER 2 • SPRING 2017

Model Mysteries

An Exploration of Vampires, Zombies and Other Fantastic Scenarios to Make the World a Better Place

by Anne LaVigne and Lees Stuntz

Now complete and available online at www.clexchange.org/curriculum/modelmysteries/

We are thrilled to announce that the Model Mysteries book is now complete! It is available online at www.clexchange.org/curriculum/modelmysteries/. We introduced you to *Model Mysteries* in the Fall *CLExchange* newsletter, where we shared the introduction to the book and the first lesson. In this issue, we present the second chapter and just a brief introduction.

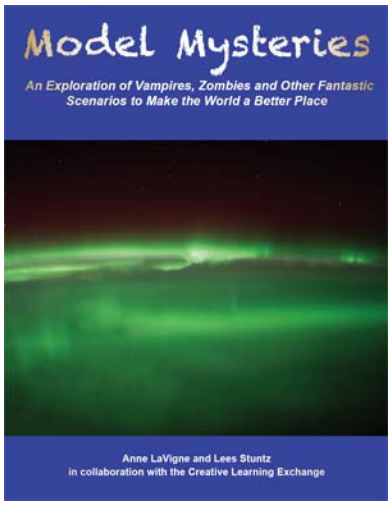
Who can use this book?

The modeling activities are intended for students from ages 10 to 110. In other words, if you're interested in thinking about how to solve mysteries and like the idea of creating computer models and applying them to real-world problems, this book is for you. You can use it independently as a student, work with a group of students, or if you're a teacher, share it with interested students to complete a guided or independent study project.

THIS ISSUE AT A GLANCE

Chapter 2: Energy Drink Mania

Dive in – How does your body process energy drinks?



Have you heard? Sleep is out of fashion. It's time to wake up and stay awake for as long as you can. You might have heard the phrase "burning the candle at both ends," meaning that people are trying to stay up late and get up early too, just to keep up with everything they need to get done. Energy drinks have created a way to accomplish this, but with costs, of course. This chapter does not address those costs – financial, physical or mental. Itdoes show one basic result of ingesting energy drinks – raising the level of caffeine in the body.

Model Mysteries *continued on page 3*

DynamiQue*ST* 2017
World Climate Simulation

DynamiQue*ST* is a showcase of the power of simulations and creative student projects that utilize critical thinking skills to analyze complex dynamic systems. Organized by the *CLE* and hosted by Worcester Polytechnic Institute, on March 17, about 70 students in grades 7-12 participated in this student-centered conference that celebrates the application of systems thinking in schools. This year's event brought together students and teachers from Arlington High School, Carlisle Public

DynamiQueST *continued on page 10*

EDITORIAL

It is always lovely to see the sun (and the rain) in the early spring here in New England. We are enjoying a breath of fresh air after the dark winter. The erratic weather here, including a warm winter, makes us ever more mindful of our climate, our environment, and our planet.

With that concern in mind, we modified our spring event, DynamiQue*ST*, to include the *World Climate Simulation*, created by Climate Interactive and based on a robust system dynamics model. The model is the work of some of the best minds in the system dynamics community, and has been instrumental in the last two climate negotiations. Of even more importance to the planet, the simulation and model are being used by countries outside the US, including China.

Climate Interactive has an excellent set of materials that can be used readily by teachers in middle school and high school. (https://www.climateinteractive.org/programs/world-climate/). I urge you to look at the material and see if you can run it at your school. If you would like tips, just ask and we can find you answers. Better yet, email and tell us about your experience so that we can put it into the newsletter! The more students experience this simulation, the more informed systems citizens we have helped to teach.

Happy Spring,
Lees
(stuntzln@clexchange.org)

A New Kind of System Dynamics Software

What is ***Splash!?***

Liquid Physics + System Dynamics = ***Splash!***

Whether it's managing our health, planning our retirement, or addressing climate change, System Dynamics can help us tackle the variety of dynamic problems we find in the world around us.

There are several software products available in the market to create system dynamics models. These highly capable and flexible tools are often designed for advanced users and professionals, but they can end up being intimidating or boring for those who are just starting to learn system dynamics.

There is an evident need for a simple modeling software that's designed with beginners in mind – something that middle and high school students might use to learn system dynamics. If this tool existed, it would make system dynamics accessible to a much broader audience and help catalyze its use.

Splash! is exactly such a software. Designed primarily for tablets and mobile devices, Splash! combines liquid physics simulations with system dynamics in a way that emphasizes fun, delight, and ease-of-use as much as it does the core principles of system dynamics.

Learn more on the Splash webpage, http://www.clexchange.org/splash/

Camp Snowball

Camp Snowball 2017
July 10-14, 2017—Vernon, New Jersey

Join members of the Waters Foundation Systems Thinking in Education team at Camp Snowball this summer. Camp Snowball will take place in Vernon, New Jersey at the Crystal Springs, Minerals Hotel. Camp Snowball is a highly interactive (and fun) professional development program.

Visit campsnowball.org for all the details and for registration information!

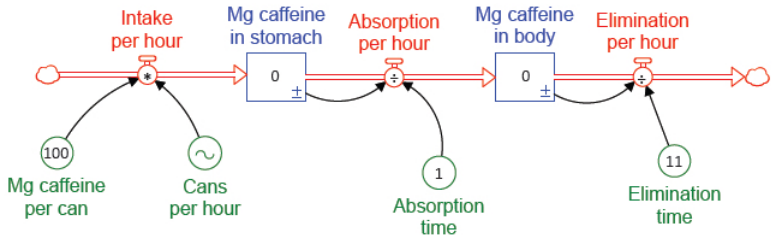
Model Mysteries

continued from page 1

Put Together the Pieces

Energy drink cans, Mark J Merry, Creatie Commons 2.0. [cropped version]

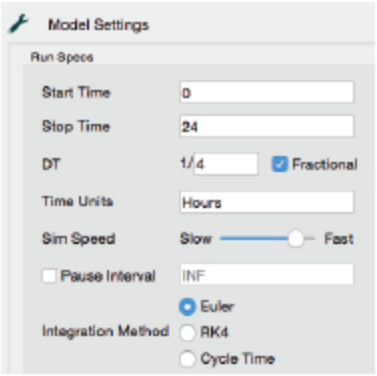
First, you need two stocks, one for "Mg caffeine in stomach" and another for "Mg caffeine in body." Note that Mg stands for milligrams. Energy drinks are consumed, land in the stomach, are absorbed by the body, and are eventually eliminated[1]. Create the following:



Input the numbers and equations as indicated in the diagram. See Appendix B: Equation Helper for assistance if needed. Note that "Cans per hour" has a squiggle sign (~) and needs a special equation called a graphical function. A graphical function allows you to decide when the individual will and won't be consuming energy drinks over an entire 24-hour period. The details for this are below.

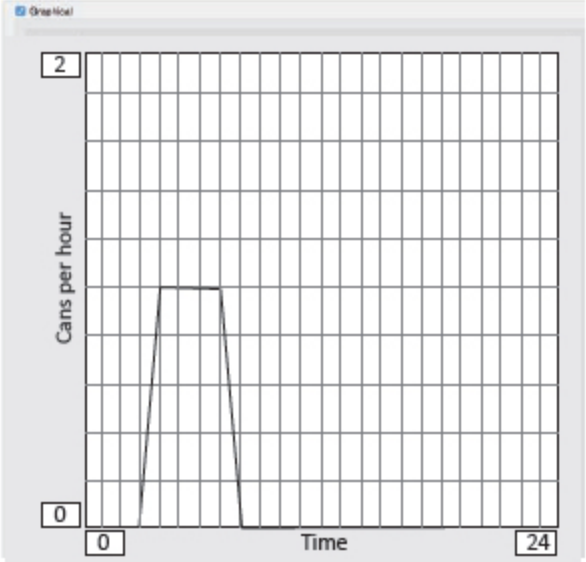
Set up the model's "Run Specs" as follows:

Start Time = 0
Stop Time = 24
DT = 0.25 or 1/4
Time Units = Hours
Integration Method = Euler

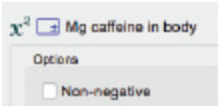


Create the graphical function:

1. Type TIME as the equation for "Cans per hour."
2. Click on the function icon.
3. Check the box for "Graphical."
4. Set the y-axis scale to be 0-2 "Cans per hour" and the x-axis to be 0-24 "Time," with time being hours in a day.
5. Create the line on the graph as shown, indicating that the person drinks no energy drinks for hours 0-3, drinks one can per hour for hours 4-7, and goes back to zero cans per hour starting at hour 8.



Also make sure that the stock is set to allow negative values. In other words, if you are using STELLA® software, you must un-check the "Non-negative" box for each stock you create.



1 Elimination time obtained from http://www.caffeineinformer.com/the-half-life-of-caffeine

***Model Mysteries** continued on page 4*

Model Mysteries

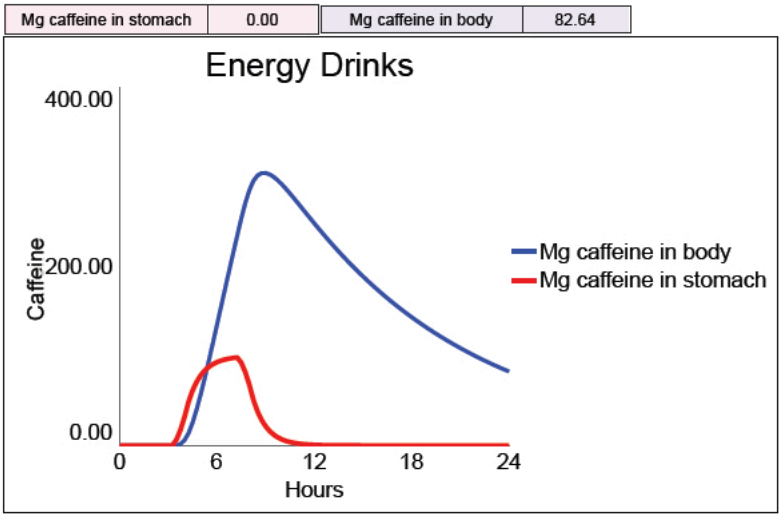
continued from page 3

Create a graph of "Caffeine in stomach" and "Caffeine in body". Run the model to see what happens. If all the initial values are correctly entered, you should see the following graph lines and ending numerical value. You may need to set the graph's scale to match the one below.

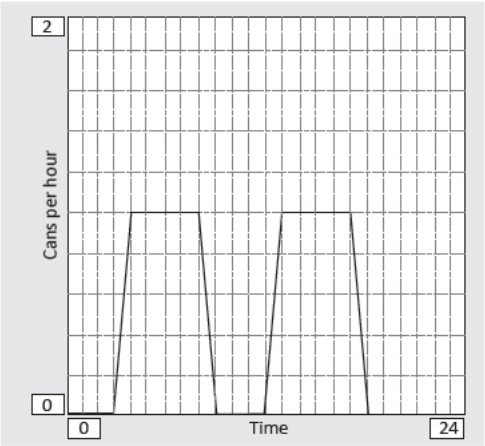
If the behavior is different, recheck your connections and equations. If the behavior is still not matched, check Appendix B: Equation Helper on page 59 for guidance.

Experiment, changing the numbers for "Mg caffeine per can" and the graph line for "Cans per hour" to see how it affects the amount of caffeine in the body over time[2]. Change only one variable for each run. Use the table below as a guide for changing "Mg caffeine per can." These are meant to show a selection of energy drinks with a range of caffeine amounts, but feel free to look up additional brands.[3]

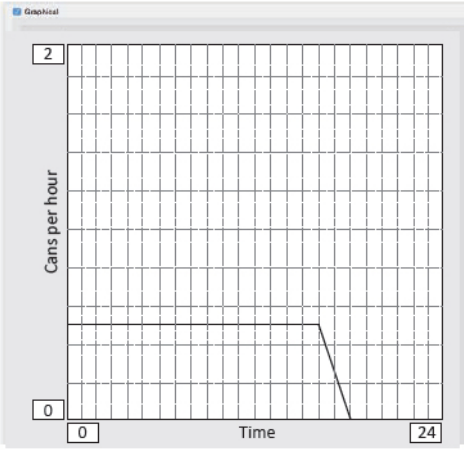
Try some variations for the "Cans per hour" graphical function and compare results.



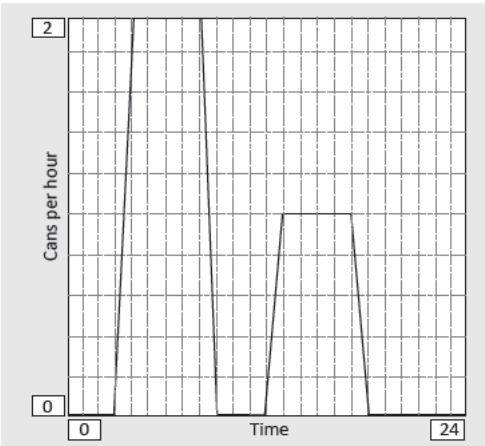
Option 1



Option 2



Option 3



What is the drinking pattern? What happens as a result?

What is the drinking pattern? What happens as a result?

What is the drinking pattern? What happens as a result?

2 This model is not intended to predict exact amounts of caffeine in any individual's body or to provide a guide for the maximum number of drinks to safely consume. The model, like all others can show general trends, but is by its nature, not an exact match for reality. It also does not take into account differences in age or weight.

3 Energy drink caffeine amounts obtained from http://www.caffeineinformer.com/the-caffeine-database

Dare to Dig Deeper

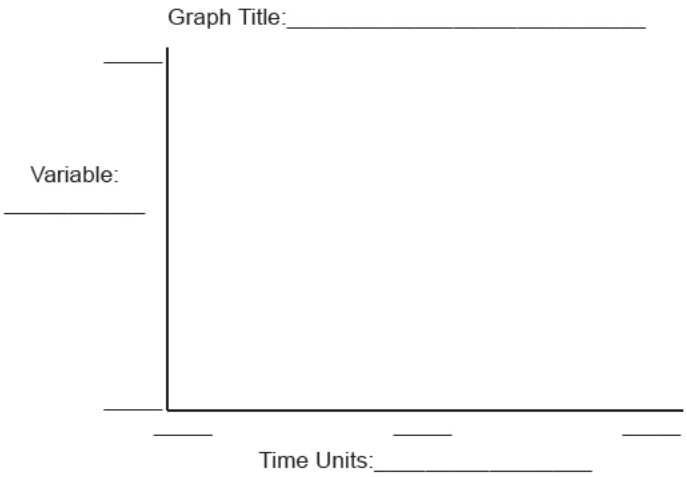
Dare yourself to find solutions, using the model you created to help. Key questions to dig into are:

1. How long does it take to fully eliminate caffeine from the body?
2. Based on consumption, what are caffeine levels in the body over time?
3. What should you consider when deciding on consumption of caffeine in energy drinks?

D Dare

1. Given the original settings, how long does it take for the caffeine to be eliminated, that is, less than 10mg remain in the body.

2. Sketch the graph.



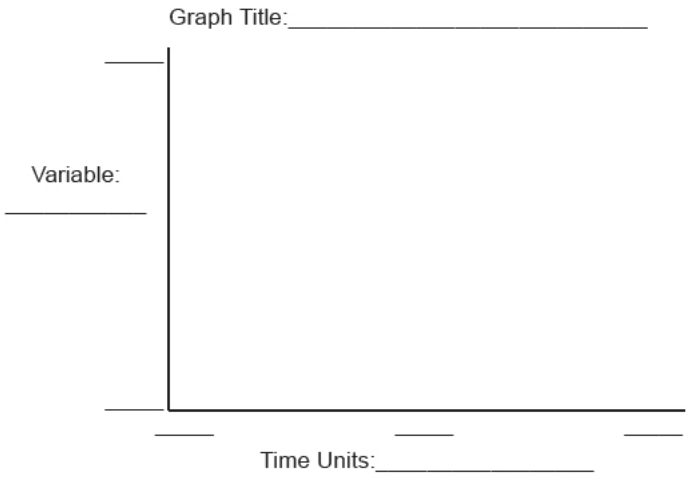
D Double Dare

1. Think about a situation in which a person wishes to remain alert for 16 hours and then feel tired enough to sleep well at night. Using the model, what is the maximum caffeine s/he should consume in order for levels to drop below 50 mg before going to bed?

Consider recommended caffeine amounts[4] for children, teens, and adults. Although rare, there are documented deaths from caffeine overdoses. For healthy adults, this would be a lot of energy drinks (perhaps dozens of cans that add up to thousands of milligrams caffeine consumed), but for younger people or people with health issues, a lethal dose can be much lower[5].

Age	Recommended Maximum Daily Caffeine intake
12 and under	50 (although none is more desirable)
13-17	100
18 and over (healthy adult)	200-400

2. Try some different ideas, and then sketch your best graph.



Reflect: What did you do to create this result?

4 Recommended caffeine information from http://www.caffeineinformer.com/caffeine-safe-limits

5 Documented deaths by caffeine, http://www.caffeineinformer.com/a-real-life-death-by-caffeine

Model Mysteries
continued on page 6

Model Mysteries

continued from page 5

Triple Dog Dare

1. What are the maximum number of energy drinks a person can consume without having the caffeine level in the body go over 400 mg at any given moment?

Dare to Reflect:

Think about the changes that were most effective and also realistic in deciding on caffeine intake. For example, if someone drinks energy drinks now, is it reasonable that they would totally give them up?

Thoughts and Insights from this Model:

Connect to Other Stories

Many other situations (real and fictional) behave in a similar way as this simple model does. Modify the labels and numbers for the energy drink model to explore one or more of these stories. You can even make up your own stories that have behaviors similar to those seen in this model.

Story 1: Tree Disappearance

Overview

In a local forest, trees are planted by foresters and harvested by lumberjacks. The trees take years to grow from immature saplings to mature trees ready for harvest. The problem is that the number of trees has been declining. Use this model to consider the basics of how the trees grow, mature, are harvested as well as how to create a healthy forest over time.

Details

1. Time units_____
2. Cutting rate_____
3. Saplings (stock)_____
4. Number of foresters_____
5. Mature trees (stock)_____
6. Trees planted per forester_____
7. Time to mature_____

Forest, by Jon Sullivan, Public Domain

Dare

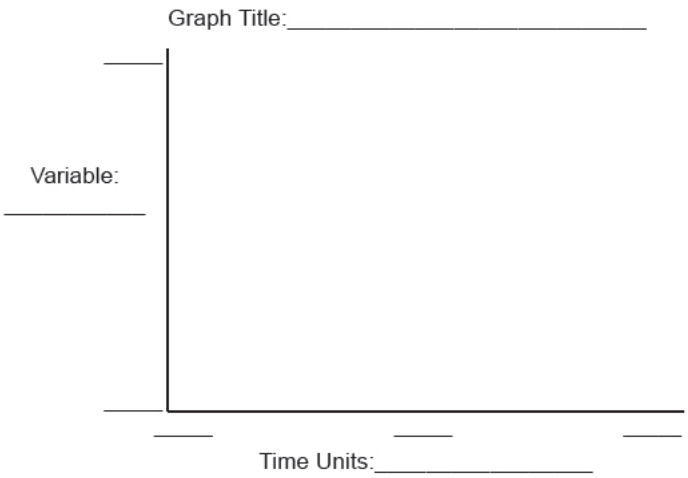
1. Re-label and change the numbers in the previous model to make sense for this situation. Make sure to show a scenario in which the trees are declining.

2. Determine how long it would take for the trees to disappear.

Double Dare

1. Using the model, think of at least two ways to slow the decline of the trees, ideally creating a stable number of trees over time.

2. Choose one idea and change the number for that part in the model to achieve slower decline. Make sure that your number is realistic. Sketch your best graph.



Reflect: What did you do to create this result?

Triple Dog Dare

1. Can you add something to the model to show how the forest has a limited amount of space and still show a scenario that stops the forest from declining? You'll need to show that when the space runs out, the foresters stop planting as many trees.

Story 2: Hungry Sheep on the Commons

Overview

A small town has a commons, a large grassy area, where local farmers can bring their sheep to graze. The grass grows and the grass is eaten by the sheep. This is great for the farmers, since their sheep get free food, and great for the town, since the area is naturally maintained by the grazing sheep. However, there's a problem. The grass is becoming sparse over time. Use this model to consider the basics of how the grass grows and is eaten by the sheep.

Details

1. Time units_____
2. Mature grass (stock)_____
3. Grass sprouts (stock)_____
4. Spreading new seed_____
5. Time to sprout_____
6. Eating rate_____
7. Time to grow_____

Sheep, Public Domain

Dare

1. Re-label and change the numbers in the previous model to make sense for this situation. Make sure to show a scenario in which the grass is declining.

2. Determine how long it would take for the grass to disappear.

***Model Mysteries** continued on page 8*

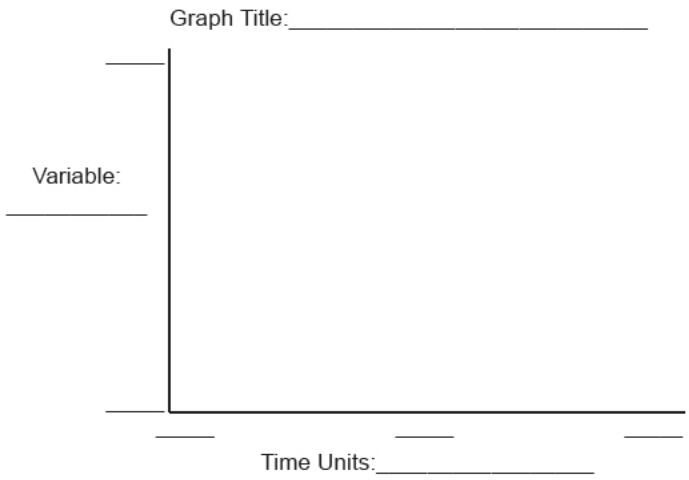
Model Mysteries

continued from page 7

Double Dare

1. Using the model, think of at least two ways to slow the decline of the grass, ideally creating a stable amount of grass over time.

2. Choose one idea and change the number for that part in the model to achieve slower decline. Make sure that your number is realistic. Sketch your best graph.



Reflect: What did you do to create this result?

Triple Dog Dare

1. Add an element to show that the space to plant grass is limited while still keeping the grass levels high. Also consider adding sheep and a maximum amount each sheep can eat.

Story 3: Medicine in the Body

Overview

In a hospital, doctors are working to get the correct dosage of medicine to a patient. It's important that the drug be delivered so that the levels remain stable in the blood. The doctors are using a time-release oral medication that takes about two hours to move from the stomach into the rest of the body. Use the model to consider how often the patient needs to take the medicine in order to maintain a level between 200-400 mg in the body by the end of day 2.

Details

1. Time units_____
2. Mg drug per pill_____
3. Drug in stomach (stock)_____
4. Pills per day_____
5. Drug in body (stock)_____
6. Elimination time_____
7. Absorption time_____Details

Taking a Pulse, Amanda Mills, USCDCP, Public Domain

Dare

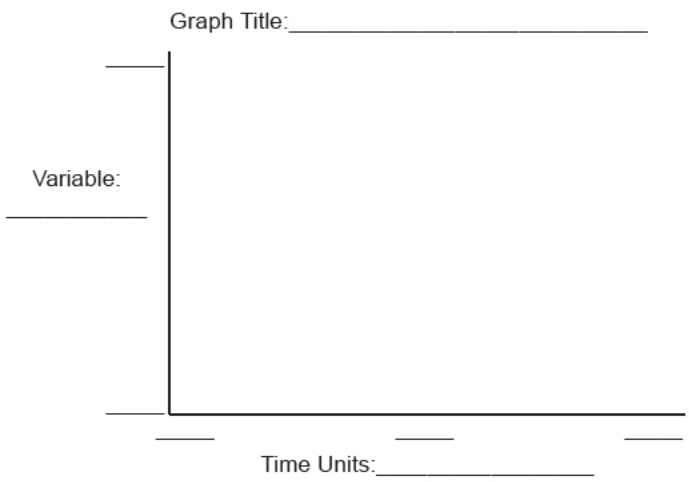
1. Re-label and change the numbers in the previous model to make sense for this situation.

2. Determine the best plan for "Pills per day" to achieve the correct levels in the body.

Double Dare

1. Using the model, think of at least two ways to increase how quickly the medication reaches the correct level.

2. Choose one idea and change the number for that part in the model to achieve the correct level more quickly. Make sure that your number is realistic. Sketch your best graph.



Reflect: What did you do to create this result?

Triple Dog Dare

1. Change the model to show how to best maintain therapeutic drug levels over the course of a week.

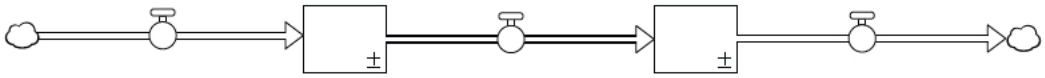
Story 4: Make up your Own

Create your own story with details, using an issue that behaves in a similar way. Modify the model to match your story, and use it to solve the problem(s).

Dare to Reflect:

One story I tried was_____

How did you adjust the model to solve the problem(s)? Create labels for the diagram and add any new part(s).



What would these model adjustments actually mean is happening in the real world?

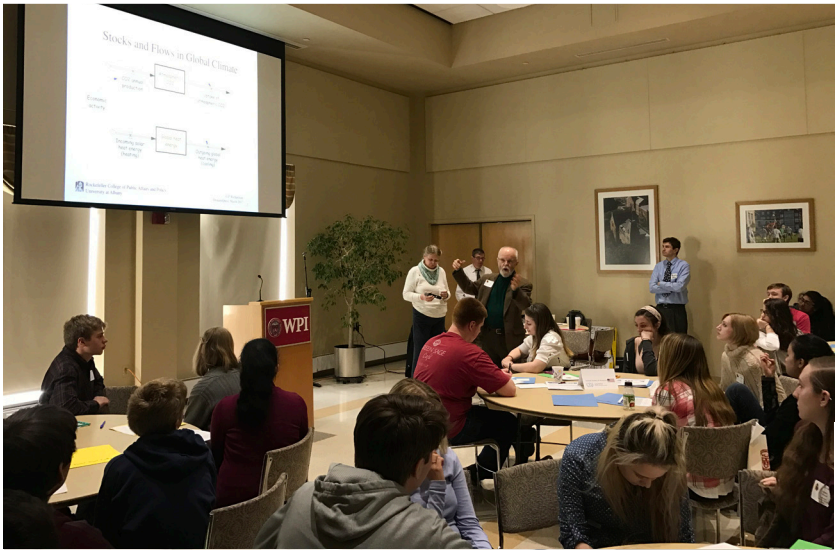
Other thoughts and insights:

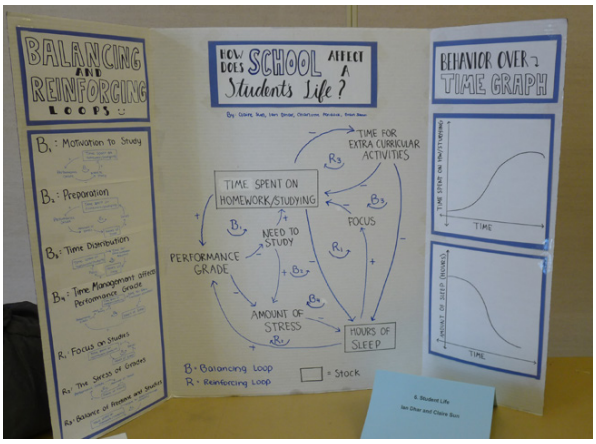
The complete *Model Mysteries* book is now available at www.clexchange.org/curriculum/modelmysteries/

continued from page 1

Schools, Innovation Academy Charter School, Lincoln-Sudbury High School, and Francis Parker Essential Charter School. Students participated in *The World Climate Simulation*, a large-scale climate change activity.

In addition to the group activity, students presented their own work using system dynamics. This combination fostered an energetic learning environment, as they learned the global power of system dynamics and experienced what challenges their peers explored. The day-long event at WPI was a success, with a variety of student projects, lively conversation and learning.





STUDENT WORK

The students ranged in age from 10-18. Their project posters were diverse in nature, including topics ranging from *Crime in Batman Movies* to *Marijuana Impact on Recovery from Opioid Addiction*; from *Slavery* to *Mushroom Materials: An Eco-Friendly Styrofoam Replacement*.

With these presentations and posters, students learned from each other and shared the challenges that their peers were tackling. This cross-school interaction fosters the growth of systems thinking in K-12 education.

WORLD CLIMATE SIMULATION

This year, for the first time, students experienced the power of a large simulation. Led by experts from *Climate Interactive*, students learned about the challenges facing us today. Applying systems thinking and working as a group, students tackled the climate change crisis in the *World Climate Simulation*, a group role-playing exercise of the UN climate change negotiations. The participatory activity creates a Model UN environment, using a system dynamics model. The interactive computer model rapidly analyzes the results of the mock-negotiations during the event. At DynamiQue*ST*, the World Climate Simulation built climate change awareness and enabled students to experience some of the dynamics that emerge in the UN climate negotiations. Students did a great job engaging in negotiations between groups as well as speaking to the "General Assembly."

Innovation Academy Charter School Principal Greg Orpen shared some thoughts from a few participants about their experiences at DynamiQue*ST*. The comments from these high school seniors are on the next page.

***DynamiQueST** continued on page 12*

DynamiQueST

continued from page 11

"It was a good eye opening experience that showed that not every school does systems thinking and how useful it is to get a deeper understanding of hard topics like climate change. It was the perfect IACS field trip—Systems Thinking and Public Speaking." - *Josivett Lopez (Grade 12)*

"I am definitely going to be more involved in being green because this mock summit really opened my eyes. It's so important for people to understand what is happening and what is going to happen without change. It is also important for countries to set aside conflicts and differences and to recognize that this is something threatening all humans from all across the world and it is our duty to try and prevent more harmful things that happen to the environment." - *Mary O'Flaherty (Grade 12)*

"I learned that climate change isn't going to be easy to solve. There are so many contributing factors that we need to change a lot of things. It won't be a quick fix, but if we all work together and pay attention to how things are connected, we will be able to solve it eventually. I also realized how well IACS prepares us to think systematically." - *Kaitlyn Willgohs (Grade 12)*

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Your financial support of our effort here at *The Creative Learning Exchange* is always 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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