DynamiQueST 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 Innovation Academy Charter School (IACS), and hosted by Worcester Polytechnic Institute, on March 16, about 45 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, Greater Lawrence Technical School, Innovation Academy Charter 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 12-18. Their project posters were diverse in nature, including topics ranging from The Use of Systems Thinking to Gain Perspective on the Holocaust to Simulating the Flight of Paper Rockets.

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

Again this year, students experienced the power of a large simulation. Led by experienced teachers, 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 DynamiQueST, 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.”

In the afternoon, George Richardson once again joined us to help develop systems insights from the World Climate Simulation experience of the morning. He, along with experienced teachers, developed a short goal/gap lesson based on various mitigation and adaptation policies that
EDITORIAL

This is a very busy and exciting spring here at the CLE. As you know, we have our biennial ST/DM conference coming up June 30-July 2. If that weren’t enough, we held, with tremendous help from the staff at Innovation Academy Charter School, another successful DynamiQueST hosted by the System Dynamics group at WPI. We played the World Climate Simulation and had a mind-stimulating debrief with George Richardson.

The ST/DM conference will once more be an event to learn with the best, see old friends, and create renewed enthusiasm and energy. Additionally, however, this year we have something really spectacular to showcase. Our new mobile app—Splash!—created in conjunction with BTN, will have its debut at the conference. We are very excited about it. Join us to see it, use it and help us make it better.

We hope you are finding time, amongst the end of school busyness, to enjoy the lovely spring reawakening of the earth and the plants. We are in the height of crocus season now, and the daffodils are budding and blooming as I write this. Enjoy!

Happy Spring,
Lees
(stuntzln@clexchange.org)

A New Kind of System Dynamics Software
Coming at the ST/DM Conference!

We will debut Splash! at the conference at the end of June. Join us to learn about this exciting app, and give us feedback so that we can make improvements.

Kids love to play and figure out how things work. They explore their world and create ways to share their understanding wherever they are. These kids create drawings to show how the health of the school’s garden can grow and decline over time.

Such drawings are useful, yet they are static, unable to move and actually change over time. How can we create a new way for kids to play and think—an engaging space where they can explore, create and test their ideas within a moving playground?

An Introduction to Splash!

Let’s build this playground, so anyone—whether young or not so young—can explore and learn in this new way. We’re giving the app away to everyone, everywhere, with no advertising, thus removing barriers to implementation for cash-strapped school systems throughout the world.

“Any fool can know. The point is to understand.” -Albert Einstein

Will you join us to provide a tool to students to increase understanding?

“Tell me and I forget, teach me and I may remember, involve me and I learn.” -Benjamin Franklin

Will you join us to help involve students in their own learning?

“Education is the kindling of a flame, not the filling of a vessel.” -Socrates

Will you join us to help kindle the flame

Let’s increase understanding. Let’s involve students in their learning. Let’s kindle the flame of inspiration and innovation.

We need only $4500.00 more to fully fund Splash! Please GIVE NOW! Join this worldwide group of concerned citizens to give our youth a tool to engage their minds and inspire them to build better futures for themselves and the generations to come.

To see more demonstration videos, design documents and benefits, visit Splash! and the Splash! YouTube Playlist.
Students at Innovation Academy Charter School in Tyngsboro, Massachusetts, learn physics in the context of systems thinking and modeling tools. Each lesson becomes a more authentic and engaging experience when the classroom moves outside.

In this project, students learn about the forces acting on a paper rocket. Using Insight Maker, a free online stock-flow modeling program, they model those forces over time during a simulated flight. Students then take the lessons they learned from the simulation and attempt to build a rocket that will fly as high as possible. On “Launch Day” students take their rockets outside and record their flight with an iPad. From the video, students can generate behavior over time graphs of height and velocity of the rocket and compare them to their predictive model. The last step is to go back and revise their model to get a better understanding of what actually happened during the launch.

Early in the class, the modeling tools help students solve simple motion problems. A single flow leading into a stock can be used to solve problems involving how far an object travels while moving at a fixed speed. Students then learn that the same model can be used to solve acceleration problems involving how fast an object travels if it accelerates at a fixed rate. Students realize that velocity appears in both models and that the two separate models can be more useful if we connect them. Doing this results in a general accelerated motion model that can be used to solve most kinematics problems in Physics (Figure 1).

As students learn about forces and Newton’s Laws, they can add new variables for force and mass to their models to calculate the acceleration and improve their models even more. Since gravity forces are dependent on the mass of an object, yet another addition can be made. The gravity force is constant for objects close to the surface of the Earth which makes it simpler to analyze mathematically, but drag force is a highly dynamic force that both depends on and affects the speed of the object. This circular feedback relationship between drag force and speed makes it impossible to properly analyze with high school level mathematics, but adding this relationship to our model is no more difficult than adding any other force. The addition of the drag force completes the model, which is now able to accurately simulate a rocket flight.

In order to simulate the rocket flight, students are shown an example rocket and they discuss what can be changed while still keeping their rocket compatible with the launcher. They have the most control over the mass, frontal area, coefficient of drag, and initial velocity. They try several simulations with each of
these variables at high and low levels to determine which adjustments help the rocket go the highest. They then use what they have learned to inform their decisions in building their own rockets. For instance, many students try to streamline the fins of their rocket so they pass through the air more efficiently, while others focus on giving their rocket an airtight fit to the launcher to maximize the initial velocity. Once they have completed building their rockets, they go back to their models and attempt to predict how high they will go based on how they were made.

On “Launch Day” students take their rockets outside and launch them. A launcher made out of PVC pipe is used to store the air pressure from a bicycle pump until it is released by a valve sending the rocket up into the air. Students record the flight of their rocket on an iPad while their classmates sight the rockets through an inclinometer to determine the maximum height of the rocket. Video Physics by Vernier Software and Technology, aids in analysis of videos from the iPad. Using a known distance visible in the frame of the video, such as the height of a flagpole, students can track the rocket through its flight frame by frame to create graphs of height and velocity over time (Figure 3).

With their flight results in hand, students go back to their models and compare their predictions to the actual flight. Insight Maker can take in the data from their video analysis and present it on the same graph as their simulation results. This enables students to manipulate the inputs to the program to make a better fit with the data. In the process they learn a little more about the forces that govern its flight. Some inputs were well known, but others like coefficient of drag were not, so this was a good place to start in trying to get their model to mimic the actual data. When changing the values of the model inputs is not enough, students added to the model to account for something that they had not anticipated. For instance, one group had a typical straight flight going up, but on its way back down it spun sideways greatly increasing its frontal area and therefore drag force. These students were able to create another frontal area variable that was only active when the rocket was coming back down.

Figure 3: Results of Video Physics Analysis. Courtesy of Maya Hegde.
The visual nature of the graphs, models, and videos captured make this project a natural fit for a poster presentation of student work. Students summarize the steps of the project showing their simulation, building, testing and revising the model (Figure 5). Students present these posters at an open “Exhibition Night” at the school, giving students a chance to share their work with people outside the classroom. When the weather cooperates, exhibitors set up posters and launch rockets outside as part of the presentation.

Through this project students also learn a practical application of stock-flow modeling. They learn that while models can be used to make predictions, their accuracy is dependant on the inputs and structure of the model. Making a useful and accurate model is an iterative process that includes evaluation and revision. Modeling also requires a strong understanding of the underlying system and it can reinforce important curricular concepts with engaging content.

Figure 4: Comparison of initial model (left) and revised model (right) with measured position data. Courtesy of Maya Hegde

Figure 5: Student Work at Exhibition Night
Systems Thinking & Dynamic Modeling Conference for K-12 Education
June 30 – July 2, 2018
Babson Executive Conference Center
Wellesley, Massachusetts

Bring Your Skills to the Next Level

The Systems Thinking and Dynamic Modeling Conference for K-12 Education put on by the Creative Learning Exchange provides resources and opportunities for educators and interested citizens to explore what is current and possible in K-12 systems education. This conference is the longest running Systems Thinking Conference for educators currently in existence.

In the Boston area again in 2018, the 13th biennial ST/DM Conference will host an impressive slate of systems educators and system dynamics professionals. The focus for this conference will be to extend and expand the knowledge and practice of teaching using the tools and mind-sets of systems thinking and system dynamics.

An introductory workshop will be held at Babson Executive Conference Center on June 29th, the day before the conference. This training workshop will include 8 hours on Friday (9 AM to 5 PM), breaks and lunch. Mentorship time will be scheduled during the breaks in the conference, tailor-made to help integrate the offerings of the conference. Systems mentors with decades of experience will help integrate the stimulating material and discussion presented throughout the conference. We recommend that all beginners take this introductory workshop if at all possible.

For over 27 years, the CLE and the Waters Foundation have worked together to advance the use of Systems Thinking and Dynamic Modeling in K-12 education, through curriculum, training and support. Many educators have started down the road of utilizing the powerful tools and attitudes generated originally by the field of system dynamics. The previous twelve ST/DM conferences, workshops, and training have given a boost to many teachers and administrators focused on maximizing their students potential for critical thinking.

Keynotes

The conference is designed to build on that initial interest and training. This year we are lucky to have George Richardson, a consummate teacher and system dynamics modeler, and Anne LaVigne, an experienced teacher and systems educator, as our kickoff conference keynote speakers.

The grand finale of the conference will be a keynote by Brad Morrison, expert system dynamicist and teacher at Brandeis University, facilitating with Saras Chung, who has introduced group modeling to scores of K-12 students in St. Louis through the Social Science Design Lab from Brown School of Social Work.

Join us for another instructional and educational conference as we work together to bring our skills to the next level. 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 (lawtons@clexchange.org) at the Creative Learning Exchange, or call us at 978-635-9797. Scholarship applications and registration forms are available online at clexchange.org.

The CLE is proud to welcome two dynamic keynote pairs to the 2018 conference. With diverse experience in Systems Thinking, Systems Education, and System Dynamics, these four speakers are sure to inform, engage, and motivate us all to educate K-12 students in exciting and powerful ways.
SATURDAY
10:00-12:00 –**Keynote: Two Roads Converged in a Yellow Wood: Collaborative Journeys** - George Richardson (SUNY Albany) and Anne LaVigne (Creative Learning Exchange)
12:00-1:30 – Lunch
1:30-5:00 – Workshops
  - *From Connection Circles to Feedback Loops: Creating a Learning Organization in the Classroom*
  - *Using Systems Tools to Develop Literacy Skills*
  - *Using Systems Tools to Teach STEM*
  - *Introduction and Testing of Splash!*
5:30-6:30 – Meet and Greet with Student Posters from DynamiQueST
6:30-7:30 – Dinner
8:00-9:00 – Resources for ST/DM in K-12 Education, CLE and others

SUNDAY
7:00-8:30 – Breakfast
9:00-10:30 – Break-out Sessions
  - *Building Insights using Stella’s Online Simulation Software*
  - *Using Fishbanks and other Online Simulations to Teach Key Systems Concepts.*
  - *Teaching Humanities using Systems Tools*
  - *Integrating Systems Lessons into Early Childhood and Elementary Education*
11:00-12:30 – **Keynote: Lessons from Implementation of Systems Thinking and Dynamic Modeling in Schools** - Educators with experience from across the world. Three different models: Greg Orpen (Innovation Academy), Tim Lucas and Cathy Keegan (Milton PA Public Schools), Benjamin Chung (Korea and Thailand)
12:30-2:00 – Lunch
2:00-5:30 – Workshops
  - *How to Run the World Climate Simulation with Middle and High School Students*
  - *Systems Lessons through Games*
  - *The Beer Game Simulation*
6:00-7:30 – Dinner
7:30-8:30 – Breakout Sessions
  - *isee systems’ New Offerings: A Workshop For Experienced Modelers*
  - *Splash! Demonstration*

MONDAY
7:00-8:30 – Breakfast
9:00-12:00 – **Keynote: Using Group Modeling and Systems Tools to Unpack a Complex Educational Problem** - Brad Morrison (Brandeis) and Saras Chung (SKIPNV)
Studying Homeostasis in the Skeletal System
Using Feedback Loops

by Ashley Young, High School Science Teacher at Innovation Academy Charter School

In this activity, students use feedback loops to discover how the skeletal system helps the body maintain balance in blood calcium levels. Students then make connections to the causes and treatments of the bone disease osteoporosis.

Background

This activity was used in a high school Anatomy and Physiology course within a unit on the skeletal system. Before the activity, students had learned about the anatomy of bone tissue including the parts of bones and the types of cells that make up bones.

Students can have difficulty with the study of bone anatomy, as many of the types of bone cells sound similar (osteoclasts, osteoblasts, osteocytes, etc.), and they can lose sight of how these cells work together to form and remodel bone tissue during growth and/or injury.

This activity was designed to help students better understand how the different cell types help our body maintain homeostasis in blood calcium levels, as well as make connections to a well known bone disease — osteoporosis. Connecting the study of bone anatomy to a disease most students have heard of helps student engage in learning the more difficult anatomy content and apply their learning to the outside world.

One benefit to using systems thinking tools such as feedback loops is that they can be easily modified to students at different levels. This activity has been modified for both honors students and students who need more support.

**Materials**

- Student handout (1 per student)
- Whiteboard and markers (1 per group)

**Time Required**

- Approximately 1.5 hours

**Activity outline**

**Part 1 - Feedback Loop Review**

At Innovation Academy, students frequently use systems thinking tools such as behavior-over-time graphs, feedback loops, and iceberg models in their courses. Anatomy and Physiology is a junior/senior level course, so students have been exposed to feedback loops before beginning the course. Nonetheless, a quick review was done as the first part of the activity, as this was the first feedback loop the class had completed in the course this school year.

To review, students were first reminded about the difference between reinforcing and balancing loops. A major theme of the course is the study of homeostasis in the body, and students were asked in small groups to discuss which type of loop describes body processes that maintain homeostasis (balancing loops). Next, students practiced writing a + (meaning same direction) or - (meaning opposite direction) on two example feedback loops.

**Part 2 - Draft Feedback Loops in Groups**

In the second part of the activity, students worked in groups of 2-4 to draft a feedback loop based on background information provided in the student handout. As beginning a feedback loop can often be the most difficult part, students were given a stock to begin with. Students were also instructed to think beyond a typical feedback loop only containing one loop.

Honors students were given more information to add to their loop. In this class, honors students could choose to work together on the entire loop, including the honors portion, or they could choose to work in another group and complete the honors portion on their own.

After groups finished drafting their loops, groups shared out their ideas, and a class version was developed which students wrote on their student handouts. (See the following 3 loops.)

**Part 3 - Individual Analysis Questions and Reflection**

Students completed and submitted the last portion of the activity individually for assessment. Analysis questions 1-3 require students to draw and explain the feedback loop, and questions 5-8 require students to interpret their feedback loop to describe causes and possible treatments of osteoporosis. Three of the questions (4, 7, and 8) also contain a research component.

As the final part of the activity, student were asked to reflect on their learning by creating an entry on their digital portfolio. At Innovation Academy, students keep a digital portfolio for each class in which they document work and reflect on their learning and growth.

Students who needed more support received an answer template to help with the reflection questions.
Class Feedback Loop

Example of Student Work

Feedback loop

Feedback Loops continued on page 10
Analysis Questions (5, 6, and 8)

5) When an overactive parathyroid releases too much parathyroid hormone (PTH) it can cause osteoporosis. When too much PTH is released, the number of active osteoblasts decreases. Since there are not enough active osteoblasts taking calcium from the blood to deposit to the bone, the bones are not getting enough calcium to stay strong. Therefore the skeletal system develops osteoporosis and the bones become brittle.

6) Osteoporosis is more common in older women because they have gone through menopause, which causes the ovaries to release less estrogen. Since estrogen stimulates osteoblasts, when less estrogen is released, fewer osteoblasts are active. When there are not enough active osteoblasts, there is no calcium being taken from the blood and deposited into the bone. This causes there to not be enough calcium in the bone, which results in osteoporosis.

8) For post-menopausal women, taking estrogen supplements can help treat osteoporosis because estrogen stimulates osteoblast activity, creating more bone and bone calcium. The risks include a much higher (up to 75% increase) chance of getting breast cancer, and it being discovered at a more advanced stage. However, some ways to keep this risk at a minimum are to exercise regularly, keep a healthy body weight, limit alcohol and stop smoking completely.

Digital Portfolio Reflection

I really enjoyed this assignment because it contained a systems thinking aspect to it and a follow-up analytical component. I am proud of the feedback loops I created and am the most proud of my responses to the analysis questions. For all of the questions, I worked hard to provide detailed and thorough responses, making sure to use my feedback loops as a means of explaining my analysis and to utilize information learned previously in the skeletal unit to make further connections. For the questions which required additional research, I explained what I had learned from my research to answer the question and made sure to cite the source in the APA format.

As mentioned previously, this assignment helped me better understand osteoporosis and rickets, two diseases of the skeletal system. For instance, Questions 4 and 5, which required me to use my feedback loops to understand how hyperparathyroidism (the excessive release of PTH) can cause osteoporosis and understand why osteoporosis is more common in postmenopausal women (i.e., how
menopause can cause osteoporosis, knowing that after menopause women's bodies release less estrogen, helped me understand two causes of osteoporosis. In the process, I had to think about how osteoclasts and osteoblasts respond to excessive PTH release, as well as how osteoblasts respond to lower amounts of estrogen. Questions 6 and 7, which required me to research how bisphosphonates work and the consequences (both benefits and risks) of hormone replacement therapy, helped me understand two treatments of osteoporosis. The Honors question, which required me to use my feedback loops to understand how a vitamin D deficiency affects the blood calcium level, amount of PTH released, and consequently, osteoclast and osteoblast activity, helped me analyze how a vitamin D deficiency can cause rickets, and therefore, better understand the cause of rickets. This question was also an opportunity to think back to what we had learned in class about childhood bone growth.

I found this assignment to be extremely interesting and enjoyable, and look forward to continuing to learn about organ systems of the human body, and throughout those experiences, use systems thinking to understand and analyze the body's ability to maintain homeostasis.

**Osteoporosis Feedback Loops Handout**

Name: _______________________________

*Each of our body systems helps us maintain a constant internal environment in response to environmental changes, which is termed homeostasis. In this activity, you will draw a feedback loop showing how the skeletal system helps our body maintain homeostasis in blood calcium levels. You will then use your feedback loop to make connections to the disease, Osteoporosis.*

**Part 1 - Feedback Loop Review**

A feedback loop occurs when a change in something ultimately comes back to cause a further change in the same thing.

- If the further change is in the same direction, it's a positive or reinforcing loop.
- If the further change is in the opposite direction, it's a negative or balancing loop. (From: http://www.thwink.org/sustain/glossary/FeedbackLoop.htm)

*When drawing a feedback loop*

- Items in the loop have to be stocks that can either increase or decrease. These items should each be in their own box.
- Boxes should be connected by arrows. At the end of each arrow, draw a + (meaning “same direction”) or - (meaning “opposite direction”).
- Classify each loop as reinforcing or balancing. Reinforcing loops have an even number of negative links and balancing loops have an odd number of negative links.

*Practice*

1. Write in a + or - on each arrow.
2. Classify the loop as either reinforcing or balancing.

---

**Feedback Loops continued on page 12**
Part 2 - Draft Feedback Loop in Groups

Aside from helping to build strong bones and teeth, calcium is used to help blood clot, assist in sending nervous system signals, and help muscles contract. Therefore, it’s important to maintain the right amount of calcium within the bloodstream. Our body maintains blood calcium levels in several ways:

Osteoclasts are cells that break down minerals in bone cells to release them into the bloodstream. One of these minerals is calcium. Parathyroid hormone (PTH), released from the parathyroid glands (these are found in your neck), stimulates osteoclasts to break down bone tissue and release calcium into the blood. Parathyroid glands release PTH in response to low blood calcium levels. HINT: one stock in this loop could be “number of active osteoclasts.”

Osteoblasts are cells that build bone, and in the process take calcium from the blood and deposit it into the bone. PTH inhibits (stops) osteoblasts from being active. Estrogen, mainly released from the ovaries, stimulates osteoblasts.

Honors students - also add to your loop

Vitamin D is needed to help our body absorb the calcium from the foods we eat. Without vitamin D, our small intestines would not be able to absorb as much calcium, meaning less calcium would make its way into our blood. When blood calcium levels drop, our body is able to make vitamin D. Note: Remember in a previous unit that we discussed how sunlight is necessary for our bodies to make vitamin D. You don’t need to include sunlight in this feedback loop.

Draw a feedback loop showing how our body maintains blood calcium levels. Do not draw one giant loop — start with the stock Blood calcium levels in the middle, and build loops off of this stock.

Part 3 - Individual analysis questions and reflection

Please type the following questions and staple to this packet.

1. Redraw the final feedback loop we drew as a class.
2. In your own words, describe how the different stocks are related. Be sure to discuss each stock as well as the meaning of the + or - on each arrow.
3. In your own words using your feedback loop, describe what your body does when blood calcium gets too high. Also describe what happens when blood calcium gets too low.
4. How much calcium does someone your age need daily? What are some examples of food rich in calcium? Research your answer and cite your source.
5. One disease of the skeletal system is osteoporosis, in which the bones become brittle and easily break due to low levels of calcium in the bones. One cause of osteoporosis is hyperparathyroidism, an overactive parathyroid that releases too much PTH. Using your feedback loop, explain why this could cause osteoporosis.
6. Osteoporosis is more common in women that have gone through menopause. After menopause, less estrogen is released from the ovaries. Using your feedback loop, explain why osteoporosis is more common in older women.

Digital Portfolio Requirements

<table>
<thead>
<tr>
<th>Introductory paragraph</th>
<th>Discuss what homeostasis is. Introduce this assignment, and how it fits into our current unit (the skeletal system).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your work</td>
<td>Upload your feedback loop drawing and analysis questions to your digital portfolio page.</td>
</tr>
<tr>
<td>Reflection paragraph</td>
<td>What aspect of this work are you most proud of? How did completing this assignment help you better understand the causes and treatment of osteoporosis? Give specific examples from your work.</td>
</tr>
</tbody>
</table>
this treatment, though. Research and describe these risks (be sure to cite your sources).

Honors students - also answer this question:

Another disease of the skeletal system is rickets, which is the softening and weakening of bones in children because of a vitamin D deficiency. Because the disease softens the growth plates at the ends of a child’s bones, it can cause skeletal deformities such as bowed legs. Using your feedback loop, explain why a vitamin D deficiency could cause weakened bones.

Analysis Questions Template

Please type the following questions and staple to this packet.

1. Redraw the final feedback loop we drew as a class.

2. In your own words, describe how the different stocks are related. Be sure to discuss each stock as well as the meaning of the + or - on each arrow.

A + on the end of an arrow means…

A - on the end of an arrow means…

When blood calcium decreases, the amount of PTH released increases/decreases. This then causes the number of active osteoclasts to increase/decrease. Osteoclasts are cells that… [describe the function of osteoclasts]. This could cause osteoporosis because…

3. In your own words using your feedback loop, describe what your body does when blood calcium gets too high. Also describe what happens when blood calcium gets too low.

When blood calcium levels in your body get too high, your body will decrease the amount of PTH, which causes…

When blood calcium levels in your body get too low, your body will increase the amount of PTH, which causes…

4. How much calcium does someone your age need daily? What are some examples of food rich in calcium? Use this website (https://www.helpguide.org/articles/healthy-eating/calcium-and-bone-health.htm) for your research.

Someone my age needs ______ mg of calcium a day. Some examples of food with lots of calcium include…

5. One disease of the skeletal system is osteoporosis, in which the bones become brittle and easily break due to low levels of calcium in the bones. One cause of osteoporosis is hyperparathyroidism, an overactive parathyroid that releases too much PTH. Using your feedback loop, explain why this could cause osteoporosis.

If the parathyroid releases too much PTH, this will cause the number of active osteoblasts to increase/decrease. Osteoclasts are cells that… [describe the function of osteoclasts]. This could cause osteoporosis because…

6. Osteoporosis is more common in women that have gone through menopause. After menopause, less estrogen is released from the ovaries. Using your feedback loop, explain why osteoporosis is more common in older women.

After menopause, less estrogen is released from the ovaries. If less estrogen is released, the number of active osteoblasts decreases. Osteoblasts are cells that…. [describe the function of osteoclasts]. Therefore, osteoporosis is more common in older women because…

✧
came out of the simulation. He first illustrated a classic goal/gap map. He then used the example of reforestation of the rain forest to start the students working on their own issues and policies, such as industrial growth and water availability.
**Rain Forest Example**

Goal: Large and sustainable rain forests

- Efforts to halt rain forest destruction and allow rain forests to regrow
- Striving to maintain rain forests
- Increase in rain forest area
- Gap important to environmentalists

Rain forest area existing

Goal: Large and sustainable rain forests

- Efforts to halt rain forest destruction and allow rain forests to regrow
- Striving to maintain rain forests
- Increase in rain forest area
- Gap important to environmentalists

Rain forest area existing

Decrease in rain forest area

- Striving to increase agricultural production
- Gap important to agricultural producers
- Efforts to convert rain forest to agricultural land

Competing goal: Use of rain forest for agriculture

See how the World Climate Simulation works with students. Join the IACS teachers at the ST/DM conference and learn how to do it with your students.

Innovation Academy Charter School Principal Greg Orpen shared some thoughts from a few participants about their experiences at DynamiQueST. The comments from these high school students follow.

“"I had an enriching experience, participating in systems thinking activities with students from other schools, and got to learn how different people's skills can come together to form something unique.”

Spenser

“"It was helpful making the systems thinking diagrams and speaking with the systems dynamicists. When the topic of climate change came up in my Earth and Space Science and Botany classes I had a lot of useful background information.”

Nate
Scholarships for Systems Thinking and Dynamic Modeling Conference

The Creative Learning Exchange is pleased to offer scholarships for the upcoming conference. These are scholarships designed to encourage the use of systems thinking and dynamic modeling in K-12 education.

Some or all of the following criteria will apply. You do not need to meet all the criteria:

• Evidence that the recipient has done his/her own learning in the area of SD in K-12. The recipient has explored the basics and knows why ST/SD is relevant, and why there is more to learn.

• The recipient is willing to write a report on how he/she has used ST/SD in the classroom or organization in the 2018-19 school year.

• The recipient is involved with others who are also interested and committed, either in their school or nearby.

The application is the same for all of the scholarships. Any questions concerning scholarships should be directed to Lees Stuntz, director of the Creative Learning Exchange.

Invest in Education!

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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Address____________________________________________________

__________________________________________________________

E-mail_____________________________________________________

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The Creative Learning Exchange, 27 Central Street, Acton, MA 01720

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info@clexchange.org

The Creative Learning Exchange

27 Central Street
Acton, MA 01720
Phone 978-635-9797
Fax 978-635-3737
www.clexchange.org

Trustees
Davida Fox-Melanson
J. Bradley Morrison
George P. Richardson
Stephen C. Stuntz

Executive Director
Lees N. Stuntz
stuntzln@clexchange.org

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