the Creative Learning EXCHANGE

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TUCK EVERLASTING

System Dynamics, Literature, and Living Forever

by Carolyn Platt, Rob Quaden, Debra Lyneis. Prepared with the Support of **The Gordon Stanley Brown Fund.**
Based on work supported by The Waters Foundation

In this lesson, sixth grade students use system dynamics tools to explore themes in a novel. *Tuck Everlasting* by Natalie Babbitt is an enchanting and suspenseful story about a child named Winnie who faces big decisions when she encounters the Tuck family and learns their secret about a spring whose water gives eternal life. After reading the novel, students use behavior over time graphs to discuss their own opinions on the story's major themes. They also use a simple system dynamics computer model to see what would happen to the population of the town in the story if people could live forever.

Using these system dynamics tools in a literature unit allows students and teachers alike to make connections across subject areas. Students use their mathematical intelligence in a language arts setting. They also learn that basic systems principles and tools apply across disciplines.

OBJECTIVES FOR STUDENTS

- Students will use behavior over time graphs to identify and explain what changes over time in the course of the novel, *Tuck Everlasting.*
- Using their graphs, students will discuss their opinions on issues in the story such as fear, courage, trust, maturity, and the acceptance of death.
- As a class and in teams at computers, students will build a simple model of the population of Treegap, the town in the story. They will use the model to explore what happens to Treegap's population if people can live forever. They will also relate this population growth to their own local area.
- Students will use evidence from their model to write about the consequences of living forever, relating it back to the novel.
- By using system dynamics tools in a literature unit, students will learn that systems principles and tools are transferable across disciplines.

PREPARING FOR THE LESSON

Time Requirements

- One class period for the behavior over time graphs lesson.
- One class period for the modeling lesson, plus a follow-up classroom or homework writing assignment.

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Johnny Appleseed

I am a classroom teacher of students in the Primary Grades. Last year, as part of my Masters in Ed. program through Lesley University, I began to use children's literature as a vehicle for demonstrating casual loops to my first grade students. Some of you may remember letters I posted about the work we undertook, mention of which can be found in Linda Booth Sweeney's <u>When a Butterfly Sneezes</u>..."

This year, I have a core of the same students in my second grade classroom, but have not, as yet, delved into the use of System Dynamics with my students.

Yesterday, as a part of our study of apples/Johnny Appleseed, I was modeling the creation of a 'flap' book that demonstrates the life cycle of an apple seed. As I outlined the seven steps of growth and how they could be drawn, Jack raised his hand to add these comments:
"Ms. McCarthy, that's a casual loop!" I asked him to elaborate for the other children. He said, "I remember that when something starts and ends at the same place, it's a circular model of cause and effect." "We studied that last year with the stories about <u>If You Give a Moose a Muffin</u>, and <u>The Cow That Buzzed</u>."

***Johnny Appleseed** continued on page 10*

UPDATES…

SyM· *FEST*
From Tim Joy
The Ides of March

Nichelle is a Sixth Grader from Tubman Middle School in Portland, Oregon. She wore a yellow dress and stood before her poster on Cicadas, announcing to me that "my model will show you what happens perfectly." In the few minutes I spent with her, she spun her story about the "bugs" and how some appear every 13 years and some every 17 years.

"See… look at my table," she said.

I knelt down so I could be closer to eye level with her, and then she showed me the model on her iBook—opened the model, described the wire connections and the two stocks.

"This one's for the 13 year ones, and this one's for the 17 year ones. I add them right here." She pointed at the "Total" converter placed between the two population strands; she was the unquestioned master of her story, and she had taken me in.

SyM· *FEST* witnessed a lot of variety—about 125 students, roughly 25 teachers, parents and guests. We saw models on transportation, stress, social change, biology, disease, history, sports, and more. There were brainy kids who were in second year calculus, kids who'd been modeling for four years, kids who spoke eloquently about what they had come to understand. Still, in my mind, it was about Nichelle who is at the front end of her learning, a yellow coil of enthusiasm and yearning and optimism. She was having a big day.

So were we.

Thanks to all the participating schools: Boeckman Creek, Tubman, Winterhaven, Westview, Franklin, De La Salle North Catholic, La Salle, Wilson, Roseburg, Central Catholic… and our special out-of-towners from Vermont, Champlain Valley Union.

We are grateful to Ron Zaraza, Scott Guthrie, Diana Fisher and Dave Hamilton for helping us organize pieces of the day.

Kudos to Barry Richmond and Wayne Wakeland for their tremendous Young Masters sessions.

A gracious bow to Lees for finding time amid the conference planning to join us and participate.

Very special thanks to Mike Collins, Lou Macovsky and Julie Bong for their extraordinary efforts to keep the event spinning forward.

Onward DynamiQue*ST*!

All the best and all my thanks,
Tim

EDITORIAL

As spring approaches here in the Northeast (after a very wimpy winter) we are really starting to get revved up about the Conference. Registrations are starting to come in at a steady pace, so if you have not registered, please do so soon if you want accommodations in the New England Center. The program promises to be interesting and packed full of learning for everyone. We are very excited to have outstanding keynote speakers, Peter Senge and Barry Richmond.

SyM· *FEST* (formerly SyMBowl) was a huge success this year. I was delighted to have been able to attend. The atmosphere was one of celebration and learning. The posters were excellent and the students did a wonderful job explaining their projects.

We are looking forward to SyM· *FEST*'s spin-off and younger sibling, DynamiQue*ST* coming up at WPI in Worcester, MA on May 3rd. For those of you close by and able to participate, see the information on our website (http://clexchange.org).

Good luck to you all with your busy springs and the end of the school year. We hope to catch up with your news at the conference. As always, please send any news or articles here to me at the CLE for inclusion in the newsletter. We are always looking for good material.

Lees Stuntz <stuntzln@clexchange.org>

DynamiQue*ST* 2002

May 3, 2001
Campus Center, Worcester Polytechinic Institute
Worcester, MA

FMI: http://clexchange.org or call 978-635-9797

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Materials

- Copies of the book *Tuck Everlasting* by Natalie Babbitt, A Sunburst Book; Farrar, Straus and Giroux, 1975.

For the graphing lesson:

- Story chronology sheets to review the sequence of events in the story.
- Behavior over time graphs worksheets.
- Pencils, colored markers, paper.
- Easel pad and marker, or blackboard and chalk.
- Overhead projector and transparencies, or blackboard and chalk.

For the modeling lesson:

- One computer with a projection device or large screen, or an overhead projector, or blackboard and chalk.
- STELLA© system dynamics modeling software available from High Performance Systems, Inc., 45 Lyme Rd., Suite 200, Hanover, NH 03755. Tel. 603-643-9502. http://www.hps-inc.com. (There is a free run-time version of STELLA available from the website. You can use it to build the model; you just cannot save your work.)
- Computers at which students can work in teams. One computer for every two students is ideal, but use whatever you have.

LESSON 1: BEHAVIOR OVER TIME GRAPHS

Setting the Stage

Briefly review the chronology of events in the story. So that their graphs will be consistent, students should remember what happened on the first day, the second day, etc. Use the following chapter summaries to refresh their memories. (The chapter summaries are handed out as a work paper for the students.) Ask students to take turns reading the summaries aloud in their groups, noting on their copies when one day ends and the next begins.

TUCK EVERLASTING
By Natalie Babbitt

Chapter Summaries

1. Road to Treegap.

2. Mae Tuck sets out to meet sons.

3. Winnie Foster thinks about running away.

4. Man in yellow suit is looking for someone.

5. Winnie meets Jesse, Miles and Mae.

6. Tucks kidnap Winnie.

7. Tucks tell Winnie about living forever.

8. Man in yellow suit overhears the story.

9. Arrival at Tucks' home. Winnie meets Angus Tuck.

10. Winnie tours Tucks' messy house.

11. Silent pancake dinner.

12. Tuck explains dangers of living forever. Horse is stolen.

13. Man in yellow suit tells Fosters that Winnie is okay.

14. Bedtime. Jesse proposes to Winnie.

15. Man in yellow suit offers trade: Winnie for the wood.

16. Constable on his way to Tuck's.

17. Winnie goes fishing with Miles.

18. Man in yellow suit arrives.

19. Man wants Winnie. Mae hits him with rifle.

20. Constable arrives. Mae could be hanged if man dies.

21. Winnie home again. Man in yellow suit dies.

22. Jesse gives Winnie water. Winnie has idea to save Mae.

23. Hot night. Storm brewing. Midnight at last.

24. Mae escapes and Winnie takes her place.

25. Weeks later. Winnie pours Jesse's water on toad.

Epilogue. Many years later, Tucks return to Treegap.

What Changed Over Time in the Story?

Ask students to think about the scene at the beginning of the story and the scene at the very end, including the epilogue. What things changed during the story? Let students brainstorm as many ideas as they can as you write them down on the easel pad or blackboard. Changes can be concrete or abstract. They can encompass the entire story or just part of it. The only requirement is that you record the students' suggestions as *nouns—they must be specific quantities that can increase or decrease over time.* These are typical responses:

- The population of Treegap
- The size of the wood
- The amount of development in town
- Winnie's age
- The ages of Miles' children
- The ages of the Tucks (which did not change after they drank the water)
- Winnie's fear
- Winnie's trust in the Tucks
- Winnie's "prissiness"
- Winnie's independence
- Winnie's courage
- Winnie's maturity
- Winnie's acceptance of death
- The Fosters' trust in Winnie
- The Tucks' love for Winnie
- The "evilness" of the man in the yellow suit (as revealed to the reader)

How and Why Did It Change?

Students will draw graphs to describe how some of these variables changed over time. Start as a class with the age changes, because they are more concrete and because they will more closely relate to the graphs students have done in their math classes.

1. On the overhead projector or blackboard, draw a vertical and horizontal axis. Remind students that a behavior over time graph is just a rough sketch; it is a way to look at patterns of behavior rather than at exact numbers. Distribute a worksheet with three unlabeled graphs to students.

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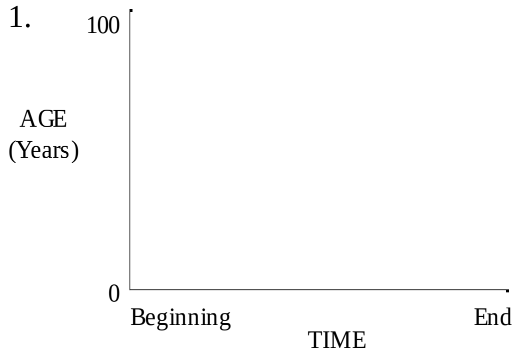
- As you label the axes together, remind students that *time must always be on the horizontal axis* on a behavior over time graph. On this first graph, time goes from the "Beginning" of the story to the "End" (including the epilogue).
- The vertical axis is for the variable you are studying. Label it "Age in Years," 0-100.
  (Do not label every point on the scale—focus on the patterns, not the details.)

2. Ask students to graph Winnie's age from the beginning of the story (age 10) to her death in 1948 at the age of 68. (This can be somewhat confusing to students, since the action in the story covers only three days and Winnie's death many years later is revealed only in the epilogue. Ask students to consider how Winnie's age changed from year to year throughout her lifetime, similar to their own grandmothers' ages.) Mark a starting spot on the vertical axis representing 10 years. (If students need more guidance, also discuss where Winnie's final age might be.) Allow students to finish their own graphs before discussing their ideas as a class.

3. Graph Jesse's age. (If students are confused by the concept of age, discuss that aging means to grow one day older every day. After the Tucks drank the water, they may have lived for many years, but they never aged. Their ages remained unchanged forever.) Together mark a starting spot on the same graph for Jesse's age, 17, and let students draw their lines before discussing them as a class. Note the spot where the two age lines intersect—this is when Jesse hoped that Winnie would drink the water and marry him. Note also that Winnie's line ends at 68 years, while Jesse's continues forever.

4. If students need more practice, quickly graph other ages. Miles and his children are similar to Winnie and Jesse. Students are especially intrigued by the frog's age: It grew until Winnie sprinkled the water on it; then it ceased to age. If students consider the Tucks' ages starting when they were born, their patterns are similar to the frog's.

1.



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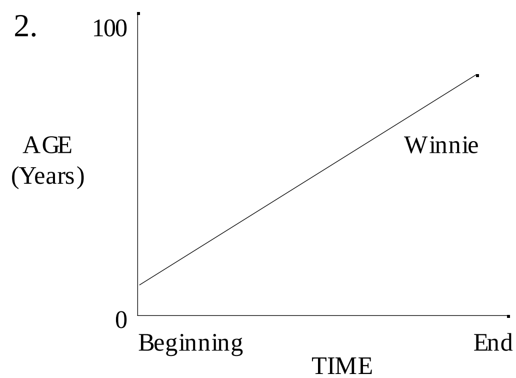

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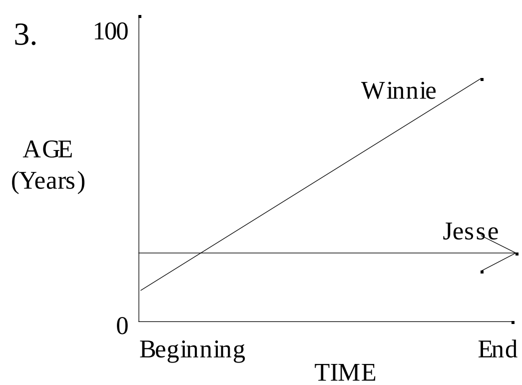
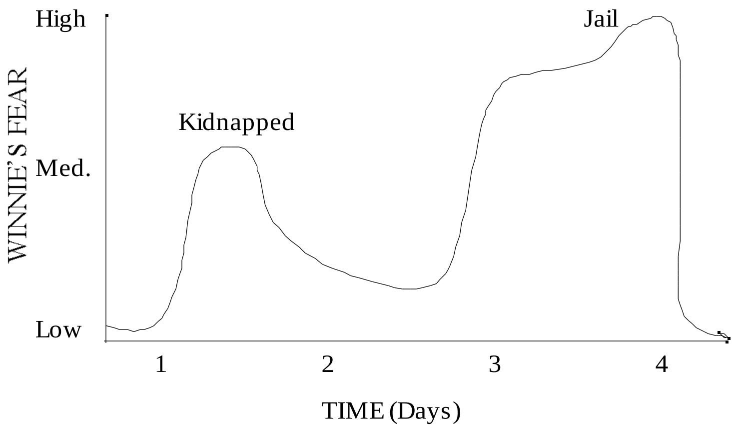


5. Students are now ready to graph some of the more complex changes in the story. Start with Winnie's fear.

- On a new graph, label the horizontal axis with the days of the story. The story opens one evening and takes place over the next three days. Label the vertical axis "Winnie's fear," ranging from "Low" to "High." Define these in discussion. "Low" means no fear at all. "High" means "scared to death," terrified.
  - Ask students to work in their groups to produce larger graphs with markers, so that the graphs can later be displayed, compared and discussed.
  - Students should decide how frightened Winnie was at the beginning of the story and draw their graphs to show how they think her fear increased or decreased as the story unfolded. They do not need to be particular about details—this is just a quick graph. (Limiting their time to just a couple minutes forces them to draw quick rough graphs rather than focusing on details.)

Students may label important points on the graph. They may refer to the chapter summaries worksheet to recall when events took place.

- Emphasize that there are no right or wrong answers; this is a way to express their own opinions. Graphs may vary from group to group.
- A typical graph might look like this:



6. Display the graphs so that students can observe and discuss the differences. (Another option is to have students superimpose their different lines on the same graph in different colors on the overhead projector or blackboard, explaining their reasoning as they draw their lines.) Issues like these come up:
- How could students all read the same book and reach different conclusions on how frightening events in the story are?
- Why do most students think that taking Mae's place in jail is more frightening than being kidnapped? What makes those events frightening? How would they feel?

7. Deepen the discussion by asking students to draw a related line on the same graph.
- For example, ask students to graph Winnie's courage on the same graph as her fear and observe how students view the relationship differently. How is courage different from fear? How did Winnie become more courageous? Once you gain courage, can you lose it? Does facing your fears cause you to become more courageous? Can you be courageous and frightened at the same time? What does this mean to you?
- Another interesting variable is Winnie's maturity. Use a graph to explore how and why it grew. What happened to make Winnie more mature? What does it mean to be mature? Graph another variable such as Winnie's independence or her acceptance of death on the graph of her maturity to discuss how these are related.
- Use the graphs to explore any variables, to help students express their views explicitly, and to focus the discussion. Whenever possible, graph related variables on the same graph to help students think about interrelationships and the causes of change. Expect and accept that individual student graphs may differ widely. Use these differences to help students express, clarify and defend their own views in an objective way.

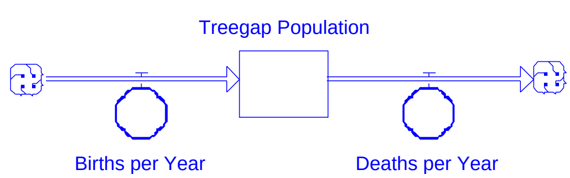
LESSON 2: BUILDING THE MODEL

In earlier class discussions while reading the book, students have weighed the idea of living forever, the novel's main theme. Now, using a system dynamics model, students will examine what would happen to the population of Treegap if everyone could live forever.

1. Decorate a box as a time machine and explain to students that they will be writing letters to send back in time to either Winnie or the man in the yellow suit. They will use the information that they will learn from their modern computer models to write their letters.

2. Ask students for the big decision in the story: whether or not to drink the secret water and make it available to others. The model will help them explore what would happen to the population of Treegap over time if everyone drank the water and lived forever.

3. Using a computer with a projection device, build the model together as a class. (Complete models in STELLA versions 5.0 and 7.0 are also provided with this lesson.) Prompting students to review what they have learned about STELLA modeling, drag a stock onto the screen and label it "Treegap Population." This is the number of people in the town.
- Does the number of people always stay the same? What makes it change?
- Births increase the population. Add an inflow for "Births."
- Deaths decrease the population. Add an outflow for "Deaths."
- Ignore migration for simplicity in this model.



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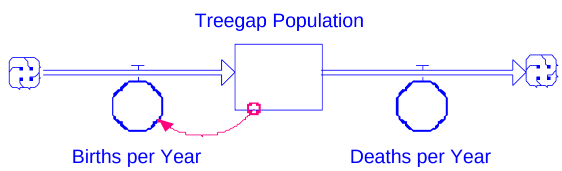
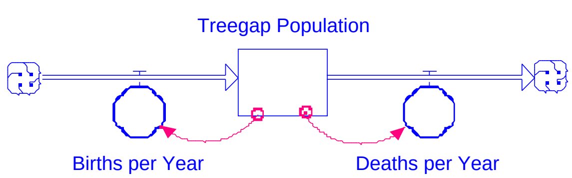
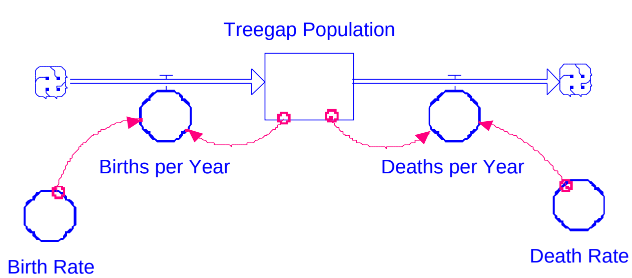
4. Ask students to consider how births increase the population? Does the size of the population have an effect? Are there more births in a larger population? Discuss how the number of babies born depends on the number of people and draw a connecting arrow from "Population" to "Births." This is called *feedback* because the size of the population influences the birth rate. Trace this loop and read it aloud: the more people, the more births, therefore the more people, etc. This is a *reinforcing loop* because the growth builds on itself. (Be sure to spend enough time on this important point.)



5. Similarly, how do deaths change the population? Does the number of deaths depend on the number of people? Draw the arrow from "Population" to "Deaths." Trace and read aloud this loop: the more people, the more deaths, the fewer people, the fewer deaths, the more people, etc. This is also a *feedback loop*. This one is a *balancing loop* because the change works around the loop to restore the first change—it balances out.



6. Ask students what else affects the number of births and deaths. Students will suggest factors such as the ages of the people, how many are female, health care, etc. Explain to students that people who study populations often group all of those factors together and call them "Birth Rate" and "Death Rate." These rates determine what percentage of the population is born or dies each year. Add converters for these and draw arrows connecting them to the "Births" and "Deaths" flows.



7. Now it is time for equations. Remind students to click on the globe icon in the upper left corner of the screen to change it to x^2. Question marks on the model indicate that we need to supply more information there.

   - For "Treegap Population," click on the stock and enter an initial population of 500. The units are "people." (This model uses population figures from our town, Carlisle, Massachusetts, which had a population of approximately 500 in 1880, the time of the story. We are guessing that this number is reasonable for Treegap too. Relate this to a local small town or to another area familiar to your students.) Click OK.
   - The birth rate is 6%. Discuss that this means that there are 6 births for every 100 people every year. Written as a decimal, this is .06. Click on the converter and enter .06 for "Birth Rate." The units are "people/year." (Again, these figures approximately match Carlisle's growth.)
   - The death rate is 4%. This means that there are 4 deaths for every 100 people every year. Enter .04 for "Death Rate." The units are "people/year."
   - Ask students to derive the "Births" and "Deaths" flow equations. If there are 6 births for every 100 people every year, and you have 500 people, how many births will there be? What is the operation? Births = Population x Birth Rate. Likewise, Deaths = Population x Death Rate. Click on the flows and enter the equations by highlighting the required inputs.

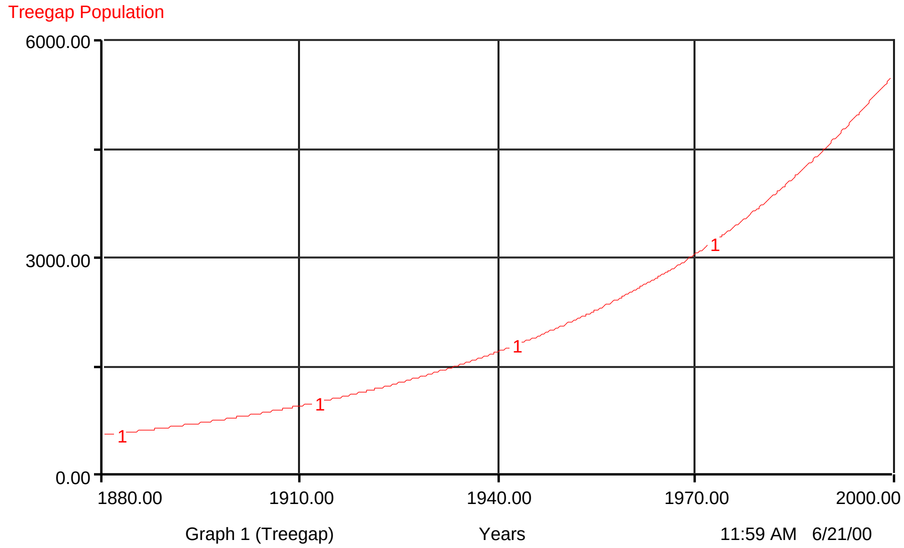
8. Set up the graph. Drag a graph icon onto the screen and click to open it. Double click on the graph, highlight 'Treegap Population," and click on the arrow to select it. Click OK.

9. From the "Run" menu, select "Time Specs." Enter the length of simulation from 1880 (the beginning of the story) to 2000. Label the time units "Years." This labels the horizontal axis. Click OK.

10. The model is complete, but there is one last *essential* step before running it. Ask students to draw a behavior over time graph labeled from 1880 to 2000 and predict how they think the population will grow and what final value it will have in 2000. Students should discuss their predictions and reach a consensus in their teams. This is just a prediction, a quick *best guess* that will help them think about their own model results later.

11. After students have committed their estimates to paper, send them to their computers in teams to build the model and run it themselves. Students can usually do this very quickly, but there are a few common technical mistakes.

- If there are "clouds" where the flows should join the stocks, students need to "dynamite" the flow and draw it again making sure to drag the flow completely *into* the stock before releasing it.
- The birth flow arrow must flow *into* the stock; the death flow arrow must flow *out*. They are computed in the direction they are drawn, regardless of labels.
- Be sure that all red connecting arrows flow in the correct directions.
- The graph should look like the one at right:



12. As you circulate among the teams of students at the computers, ask them questions to stimulate their thinking about the model. Building the model itself is just the beginning—students need to probe what they can learn from it. Tailor the difficulty of questions for different students and use their findings to lead an ensuing class discussion. Some questions might include:

- How does your prediction compare with the model results? Why are they different?
- What is the Treegap population in 2000? (They should estimate this from the graph, *not* from a table. Graph reading is an essential system dynamics skill.)
- What is the population at other specific points on the graph?
- Why does the line curve up? Why is it "flatter" at first and "steeper" at the end?

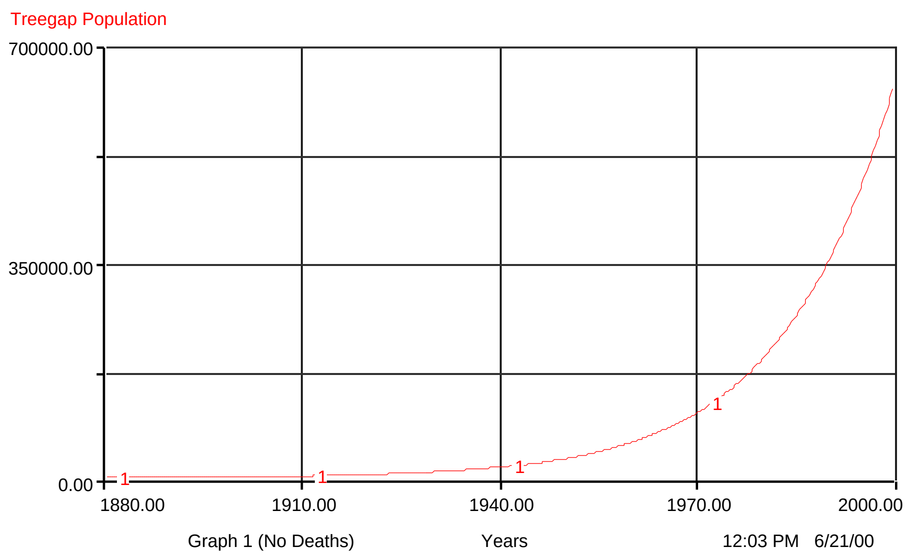
13. Bring students back into a class discussion.

- How did their estimates compare with their model results? What population did they find for 2000? This number approximately matches Carlisle's current population. Relate this to a local area familiar to your students.
- Why does the line on the graph curve up? Ask students to discuss this in their teams. They eventually express the idea of exponential growth: Because the growth rate applies to a larger and larger population, the population grows more and more quickly over time. There are more births than deaths each year. A larger population has more babies.

14. Return to the story, *Tuck Everlasting*. What happens to people if they drink the water? How could students use the model to find out how this would affect the population of Treegap? What would happen to the death rate if people lived forever? Let students see that the Death Rate would become zero. Before allowing students to run the model again, ask them to *predict* the change in the population in their teams on a behavior over time graph.

15. Examine and discuss the results of the model again, in teams and then as a class.

- What happened to the population and why?
- How accurate were their predictions?
- Why did the population on the model grow so fast?



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16. Relate what students have learned to the real world. In Carlisle's case, the population in 2000 was about 5000, approximately the projected size of Treegap in the first run of the model. In the model with no deaths, however, the population grew to nearly 700,000, which is approximately equal to today's population of the city of Boston (not including the greater metropolitan area). What would it be like in our rural town if that many people lived here? What about schools, roads, water supply, sewage, forestland, etc.? Let students discuss the consequences and limits of over-population, relating these same issues to your town or neighborhood.

17. Finally, relate what students have learned back to the novel. For their follow-up classroom or homework assignment, ask students to write a letter to either Winnie or the man in the yellow suit explaining what they know about living forever. In addition to explaining what they have learned from earlier class discussions, they should also be sure to include current information learned from the model. They must give either character their best advice, trying to convince Winnie or the man in the yellow suit to make a good decision about distributing the water. Place the finished letters in the "time machine" for their delivery back in time to Treegap.

CONCLUSION

This lesson uses a very simple population model. In Carlisle, students use similar models in a third grade science/social studies lesson about the extinction of ice age mammoths, in their fifth grade endangered species projects, and in a seventh grade biology lab on the growth of yeast in test tubes. They also see similar exponential growth patterns in math models of bank accounts. Through these lessons, students begin to recognize and discuss the familiar patterns. Each lesson reinforces the concept that the structure of the system produces the behavior, and that the same basic structures are transferable across disciplines.

BACKGROUND

Carolyn Platt is a sixth grade language arts teacher in Carlisle, Massachusetts. She developed this population-modeling lesson with the help of Rob Quaden, a Carlisle systems mentor supported by the Waters Foundation. She developed the behavior over time graphing lesson with the help of Rob, his fellow Waters systems mentor, Alan Ticotsky, and Debra Lyneis.

These lessons are simple and mostly self-explanatory. However, the Carlisle sixth graders had been previously introduced to behavior over time graphs and basic modeling. If you or your students need more information on these skills, consult the following lessons, free on-line from the Creative Learning Exchange at http://www.clexchange.org. (Use "Search" to find them.)

- "Getting Started with Behavior over Time Graphs: Four Curriculum Examples," by Gail Richardson and Debra Lyneis. The beginning of this paper provides general guidelines for drawing behavior over time graphs, including graphs of soft variables.
- "The In and Out Game, A Preliminary System Dynamics Modeling Lesson" by Alan Ticotsky, Rob Quaden and Debra Lyneis. This lesson explains stock/flow diagrams, graphing and the basic mechanics of STELLA modeling.
- "Everyday Behavior Over Time Graphs" by Gene Stamell with Debra Lyneis. This paper shows how this tool can be used throughout an elementary curriculum.

YOUR FEEDBACK

We would appreciate your comments or any suggestions for improving these lessons. Please send them to us at LyneisD@clexchange.org. Thank you.

This lesson, with accompanying model and worksheets, is available from the CLE and the Website clexchange.org catalogued under Language Arts as EN2002-03TuckEverlasting.

System Dynamics and Student Leadership

The following activity is the game presented at DynamiQueST last year, and reported on by Dan Barcan, Murdoch Middle School, Chelmsford, MA, in the Fall 2001 issue of the Exchange. *This description of the game has been included in the document SE2001-09-SDStudentLeadrship, available from the CLE and the website <clexchange.org>, catalogued under Systems Education.*

Activity: The S.S. Murdoch

Systems principles: After sailing with the S.S. Murdoch, students should understand:

1. Optimizing the parts of a system does not necessarily optimize the whole, and can even prevent the whole system from working effectively.
2. Groups of people working together are systems. As such, they need to have specific rules or policies in order to build the system the way they want and get the desired result.
3. Systems behave as they are designed to behave, though sometimes we believe we have designed them one way when, in fact, we have created something that will surprise us.
4. Solutions sometimes create new problems.

Materials:

- A room at least 60' x 25' or outdoor space.
- If you are outdoors, you will need rope or chalk to mark the sections. Inside, masking tape will do nicely.
- 8 pieces of wood, roughly 1" x 6" x 2'. *Using two-by-fours proved dangerous, since they are more prone to rolling over. If you can find any sort of sturdy foam material to use in place of wood, you will protect your floors. We used cardboard for a while but it did not hold up very well. Also, eight boards worked for us. You may need to experiment with more or fewer boards to achieve the proper level of challenge.*

Time:
Allow at least 40 minutes for directions and playing the game with a class of 20-25, and make sure you have at least 20 minutes to debrief. If you have to cut somewhere, cut the game short rather than the debrief.

Set up the room like so:

Section 1 (water to be crossed with stones)	**Section 2** (island)	**Section 3** (water to be crossed by ship)
Begin here.		*End here.*

Description:

This game requires students to use small pieces of wood as stepping stones, get an entire class standing on a small wooden "boat" that they construct, and cross a section of the room without allowing any parts of their boat to separate from the others.

Students begin as survivors of a shipwreck. They are able to snag a few of boards from the ship and first must use those as stepping stones to get to the island (Section 2), where they can work safely. In this section, students enter the "water area" one at a time and can only stand on stepping stones. If they fall off, they exit the game. The most important rule for moving through Section 1 is that any board that is not being touched by a shipwreck survivor gets washed away by the current.[1] In the debrief, help students connect this part of the game to the parts vs. whole principle. In other words, one student leaping from the last stone to the island (Section 2) may make himself safe, but he loses a stone and endangers all the others. This is also a good way to access the idea that solutions create new problems—moving quickly may help us get more people to the next area within the allotted time, but it also increases the chance someone will leave a stone unattended and lose it for the group.

Once the group makes it to Section 2, where they can touch the floor again, they need to put together whatever pieces of wood are left from the stepping-stones crossing to make a boat on which all students can fit. Once everyone is standing on the "boat," they move the boards carefully to cross to the end of the room. In this activity, all students are moving together, as opposed to the stepping-stones activity, in which some waited at the beginning for others to get partway across. While boards can be left untouched here, they all must be touching at least one other board at all times—they can be stacked or laid end-to-end or side-by-side—but they need to remain in contact as the kids move the boat across Section 3. It is important to note here that the greater the number of students who "perished" in Section 1, the easier the boat crossing becomes. While you may decide to re-include them to make management of the game smoother, it is also a worthy topic for debrief to ask the students if losing people early on is a good or bad thing. This can help them get at the idea that a system does what it is designed to do, and if theirs was designed to allow for only 10 survivors out of 20, then so be it—the question is whether they designed the system they actually set out to design. If their answer is "no," perhaps new policies are in order.

Miscellaneous tips:

- If you play outside on blacktop, the wood can splinter around the edges.

***SS Murdoch** continued on next page*

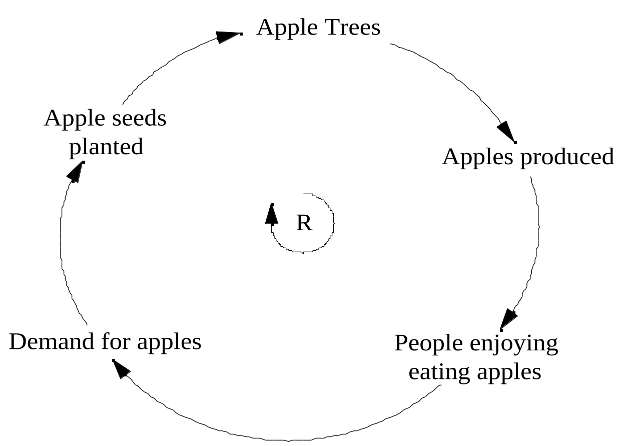
Johnny Apppleseed continued from page 1

Pretty amazing coming from a second language student, who had only a bare bones grasp of the English language last year, huh? The rewards of teaching!!!!! I would love to connect/re-connect with others who are using System Dynamics in the early elementary school grades.

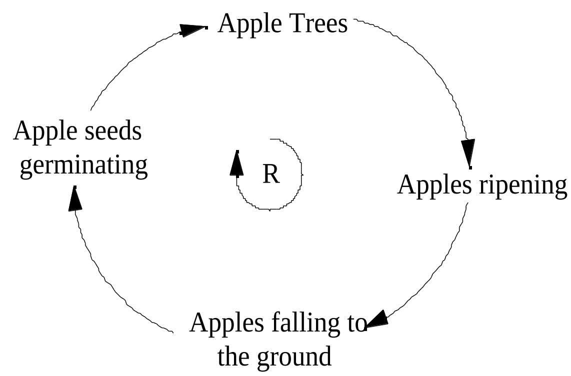
Terry McCarthy
Tacoma Public Schools
Tacoma, WA

From the CLE Staff:

This causal loop diagram might help students discuss the story of Johnny Appleseed. As Johnny planted trees, there were more apples for people to eat and enjoy, causing people to want even more apples and plant more trees.



Another loop might explain how apples produce seeds, which fall to the ground, germinate and grow into more trees.



These are both reinforcing loops suggesting that the number of apple trees would grow forever. Students could discuss the limits to such growth. In the first loop, the number of people wanting their own apple trees might grow quickly at first, but after everyone had planted trees on their property, the demand would slow down in that town.

Johnny could move to another area until trees are eventually planted everywhere. (Students might recognize this as s-shaped growth on a behavior over time graph.) In the second loop, many things prevent hundreds of trees from growing beneath every apple tree. Students could think more about how fruits grow as they discuss why this loop tells only part of the story. Why doesn't every seed become a tree? What happens when a person or an animal eats an apple and transports the seeds to another place? There are limits in every link in the loop.

Students can generate other causal loop diagrams to spark discussions about the story. The easiest way to start is to determine what might be increasing or decreasing with time. Then try to identify what might be causing that change. Sometimes a behavior over time graph can help clarify what is changing and why. Also, in a causal loop diagram, every arrow should represent a causal relationship between the variables. An increase in the number of apple trees causes an increase in the number of apples produced, for example.

✧

S.S. Murdoch Activity continued from previous page

- Fingers can be crushed while kids are moving boards. This is one large plus of using cardboard or foam.
- Generally, students will do one of two things. Some groups talk about a plan for 35 minutes, which can be debriefed once, but tends to just make kids frustrated after that. Be attentive to when they need a push to get going. Other groups leap onto the boards and aim for speed rather than caution. Both of these scenarios are fertile ground to talk about how solutions can create problems.
- Debrief, especially for younger students, can be focused on planning strategy to be more successful in another attempt at the game. Sometimes this line of discussion can be more engaging than talking about abstract principles.

[1] We learned a version of this "stepping stones" activity at the Browne Center in Durham, NH. www.brownecenter.com.

2002 Systems Thinking and Dynamic Modeling Conference

The 2002 Systems Thinking and Dynamics Modeling Conference, sponsored by the Creative Learning Exchange, will be held at the New England Conference Center at the University of New Hampshire, Durham, NH, from 8:30 Saturday morning, June 29, to Noon on Monday, July 1.

The Systems Thinking and Dynamic Modeling Conference provides opportunity for educators and interested citizens to explore what is current and possible in K-12 systems education. The Conference is designed to involve experienced individuals as well as novices in K-12 systems education.

· Teachers
· Administrators
· Curriculum coordinators
· Citizen advocates
· Business partners for schools

Keynote Speakers

Peter Senge (Author of the *Fifth Discipline)*

Barry Richmond (Developer of the STELLA and iThink modeling software)

Special Evening Session

A fireside chat with J**ay Forrester**, moderated by **George Richardson**

Highlights from the Draft Program

On-going sessions throughout the conference

- Action Research updates by the Waters Foundation Groups
- Help and discussion about modeling and simulation

Workshop sessions

- Introduction to Computer Modeling
- Introduction to Systems Thinking: Visual Tools for Increasing Student Learning
- Simulating a Disease Outbreak in Your Home Town
- The Art & Science of Storytelling with STELLA
- Paper, Scissors and Glue: Making Sense of Systems: A hands-on approach to ST/SD when computer technology is scarce
- Hands-on Systems Applications in Elementary Classrooms
- Lessons from the Systems Thinking Playbook
- Advanced Modeling Workshop

Parallel sessions

- Connection Circles—Students' Precursors to Causal Loops: What are connection circles and how can they be used in class?
- Can School Reform Get in the Way of Reforming Education? A Simulator for Exploring Reform Strategies
- System Dynamics Primer, Introducing SD to Elementary Students
- Topic Discussions in Science-Technology-Society/World Issues: Scope and Sequence
- Learning Science and Other Subjects with a Semi-Qualitative Computer Modeling Tool
- Integrating System Dynamics with the Visual Arts: A Feast for Both Sides of the Brain
- Systems Tools in the Social Studies Classroom: Meeting Challenges through Systems Thinking and Dynamic Modeling
- Pencil Simulation
- Uncharted Territory: Facilitating Systemic Change in Public School Districts
- Using the World3 CD for Teaching Limits to Growth
- History and Biology of Smallpox: Large-Scale Integrated Curriculum for High School Application
- The Thoughtful Integration of Systems Technology in K-12 Education Using a System Dynamics Tool Set to Enrich a 9th Grade Course in Human Geography
- Business Connection
- Bathtub Dynamics
- Year-Long Integration of Systems Thinking in a Language Arts Class: A Case Study
- Design and Use of a Unitless Multiplier
- Creating Content Specific Lessons Incorporating System Dynamics Models
- Using Dynamic Simulation as a "Real-World" Laboratory to Better Understand Physics
- Systems & Society Course: Simulating Society
- Traffic Safety: Marrying Systems Modeling & Risk Analysis
- Butterfly Sneezes Workshop
- Beyond Boxes and Spreadsheets: Facilitating Administrative Decision Making Using Dynamic Modeling
- Northwest Rhythms: Understanding a World of Change
- Large Scale Integration of System Dynamics into Secondary Courses: A Case Study—Environmental Science/Ecology

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