Most of us are familiar with Santayana’s famous quote that “Those who do not remember the past are condemned to repeat it.” But what does this mean, in practical terms, for how we teach history? Are there opportunities to help our students better recognize and apply lessons from the past to understand the present and what may happen in the future?

As systems thinkers and dynamic modelers, we have unique tools and perspectives with which to foster deep learning. Consider our “iceberg” (Figure 1). Some may apply Santayana’s warning to particular events (e.g., Neville Chamberlin’s 1938 appeasement policy granting Adolph Hitler’s demands, or the failure of the U.S. to anticipate the Japanese attack on Pearl Harbor). As systems thinkers, we look at longer-term behaviors over time to find recurring patterns (e.g., exponential growth, oscillations, overshot and collapse). These generic patterns appear as periods of economic boom and bust, war and peace, social and political upheaval. We recognize that underlying these patterns are closed networks of structured relationships or systems. Finally, we know that these systems continue to function in the present, informing patterns that impact today’s world and future events.

Professor Jay Forrester, in his paper Counterintuitive Behavior of Social Systems, observes that repeated public policy failures in U.S. history reflect an inadequate understanding of “complex and highly interacting systems,” and in particular the non-linear and hence non-intuitive dynamics of social change. Complex systems exhibit general and recurring behaviors that include: (1) large distances both in time and space between cause and effect; and (2) short-term solutions that only exacerbate problems and make them worse over the long term.

What is needed, he asserts, are systems tools, including models and simulations, to help American citizens and policymakers better understand how structures of relationships (complex systems) have produced past patterns of behaviors while also informing future possibilities. Actively reconstructing and simulating the past offers better possibilities for managing in the future.

As a first step in addressing Dr. Forrester’s concerns, the four simulations of the Population Dynamics series have been designed to supplement existing high school history curricula and be largely self-directed by students outside of class time. They are intended to introduce students to a variety of systems tools (behavior-over-time graphs, stock/flow maps, models/simulations) along with primary and secondary historical resources. This unique combination of tools offers students opportunities to actively reconstruct patterns of change in the past, based on structural relationships that continue to exist and influence the present and future.

Each of the four simulations examines an important period of development in American history.
EDITORIAL

As the weather folks have told you with appropriate fanfare, we in New England are shoveling out from the Blizzards of 2015. You have to like snow to live in this part of the world! We are cozily working away in our snow capsule here at the CLE. Several exciting projects are coming to fruition at the beginning of this year. The first is featured in this issue—a new, extensive curriculum delineating the effects of Population Dynamics on past and present events. This curriculum has four parts, the first two of which are introduced here. The next two parts will be up on the website within a week or two. We would, as always, appreciate feedback, input, and constructive criticism about any of our curricula. Please tell us what you think!

We are also pleased to have DynamiQueST revived. DQ showcases student work, and incorporates coaching and learning in a fun and interesting day for students and adults alike. All are welcome, either to present (students) or to come see what our kids can do. It is impressive. There is a video on the CLE website of a previous DynamiQueST, offering a flavor of what sorts of projects the students present.

I hope you all are enjoying the slowly lengthening days and increasing strength of the winter sun. We would love to hear from you.

Take care,
Lees Stuntz
(stuntzln@clexchange.org)

The Second Edition of the Habits of a Systems Thinker available through the Waters Foundation

The Habits of a Systems Thinker have been a valued resource available through the Waters Foundation for many years. Recently, a second edition of these habits was released and is now available at http://www.watersfoundation.org. The second edition includes revisions and also two new habits. To see the resources, visit: http://watersfoundation.org/product-category/cards/. To download a one-page version of the habits, visit: http://watersfoundation.org/resources/habits/.

Updates

In 2012 Jon Darkow received an educator’s scholarship from the Creative Learning Exchange to attend the Systems Thinking and Dynamic Modeling Conference in Wellesley, MA. Since that time he has been creating system dynamic models for his AP Biology, Anatomy and Physiology, and Biology students to investigate biological systems. Inquiry and investigation of cause and effect relationships are central goals for science education, but designing laboratory experiences that expose students to complex biological concepts can be unattainable. To circumvent this challenge of providing students with open-inquiry and rigorous content, Jon Darkow has designed many virtual laboratory simulations. Whether his students are manipulating the amount of thyroid stimulating hormone to investigate negative feedback loops in the endocrine system, or inducing and treating virtual cancer cells with Taxol, the simulations are designed to drive scientific curiosity.

Many of the simulations use random functions to produce variation in experiments, and allow students to analyze data using statistical tests. For each simulation, a worksheet is included to help students guide their investigations. Many of the themes of system dynamics are woven throughout the simulations, like thresholds, feedback loops, nonlinearity, optimality, and leverage points. Darkow has his students run the simulations during class to answer questions, address misconceptions, and help stretch his students’ inquiries. What his students enjoy the most is that they can run 50 experiments in an hour, manipulating several variables. “It is like a game,” he has heard his students say.

To see Jon Darkow’s models, visit tinyurl.com/darkow-models. For an introductory video on using his models, visit Jon’s YouTube

The underlying models are variations of small population models, such as the one shown in Figure 3. Models for Parts C and D contain additional structure to allow for richer behavior, yet the focus remains on population dynamics—births, deaths, immigration and emigration. The models are used to investigate historical patterns of population change. Let’s look at Part B, the simulation on New England’s Colonial History, as an example. There were many important events that happened in New England from 1620–1770, while its population grew dramatically (Figure 4). How might these and other events be related to a pattern of population growth?
Population Dynamics

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Topics include:

A. Settlement of New England (1620-1630)
B. New England’s Colonial History (1630-1776)
C. U.S. Urbanization (1820-1920)
D. America’s Baby Boom and Global Youth Bulges (1945–present)

How do the simulations work? Each begins with a conceptual frame to help students organize ideas across three broad sectors (Figure 2). Students learn that changes occurring within each sector are likely to be connected, through cause and effect, to changes in the other two sectors.

The simulations encourage students to think in terms of systems or structured relationships. At the simplest level, populations change as a result of people being born and people dying. Within a particular setting or population, there are the added factors of movement, comprising immigration and emigration. A growing population suggests that the combination of people being added to the population (through births and immigration) exceeds the number dying and emigrating.

But New England’s population did not operate in a vacuum. What factors allowed the population to grow exponentially? The environment and social systems of New England played important roles. In broad terms, “environment” spans a variety of factors – water, soil, trees, and so on. During the time period of interest, arable land was an essential ingredient for generating food. Similarly, “social systems” is a broad concept, but we can surmise that small farm communities within which residents could both feed and govern themselves, shaped both the numbers of people (impacting births and deaths) and their environmental needs (land). A systems approach adds perspective to what can be a confusing presentation of historical names, dates and facts.

Without spilling the punch line, the exercise of asking students to use a simulation to reconstruct population growth, within the context of known local and regional environmental and social systems, illuminates a wide array of events, including the Salem Witch trials, King Philip’s War, and even the American Revolution. Environmental conditions and resources, plus the social structures created by New England’s founders, shaped the dynamics of New England’s population.

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Population Dynamics

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England growth. As populations changed, spreading from initial settlement to more distant land, pressures grew to change the New England environment and its social systems.

How Did Population Dynamics Shape New England’s 18th Century History?

Why did the American Revolution begin in eastern Massachusetts?

(1) What was happening at the time in small agricultural communities like Lexington and Concord? Click on 3 starred towns to see historical graphs.

(2) Use that information, together with recent scholarship (below), to hypothesize how population dynamics in these eastern Massachusetts towns made this area a powerful starting point for the American Revolution.


More than illuminating the past, the dynamics of changing populations can be transferred to consider future prospects. Across the globe there are a variety of patterns. In some cases, countries and regions are subject to accelerating rates of population growth, with accompanying issues of environmental sustainability and social instability (including, as a subsequent simulation illustrates, “youth bulges”). In other countries, social pressures involve net population decline generated by rapidly falling birth rates. In still others, the issue of aging populations, due to healthcare advances that extend life spans and reduce death rates, worries governments and citizens alike.

The four simulations are designed to illustrate how systems thinking and dynamic modeling could support and supplement deeper and more meaningful student learning. While we chose to focus first on demographic patterns in U.S. history, it would be equally valuable to start in one of the other sectors. What happens, for instance, when there is a sudden or dramatic environmental change or a social or political development? What questions might students surface to better understand how the other sectors fit in structural relationships of cause and effect? And how might models and simulations help reconstruct past patterns or hypothesize future possibilities?

The possibilities are truly exciting. As teachers and systems thinkers, we recognize the potential for engaging and empowering our students to actively reconstruct the world around them. Searching for and then identifying patterns is every bit as important as learning civics or acknowledging the important role of particular individuals and events in shaping a particular past.

The power of past experience rests in its capacity to provide lessons and insights for managing the future. This small curricular experiment provides an illustration or prototype for how students can connect their study of the past with an understanding of science, math, and systems thinking, to harness the genius of Santayana or Forrester and, in so doing, confidently contemplate and manage the future. The entire unit is available on the CLE website at http://clexchange.org/curriculum/complexsystems/populationdynamics/. On the following pages, we present the overview and teacher instructions for Parts A and B.

We welcome feedback! Your comments and suggestions will both allow us to make improvements on our future efforts, and encourage others to join us in imagining a far more wide-reaching set of simulations and other materials.
Teacher Instructions and Overview

While the settlement of New England is seen as a beginning for American history, it is also a part of the history of England, which, in preceding centuries, had been subject to dramatic changes in population. Together with environmental and social factors (e.g., economy, religion, culture, identity), these patterns help us understand major developments in America's past. Similar dynamics, involving changing birth and death rates, are occurring in many countries across the globe today, raising important implications for the future. This lesson asks students to evaluate the relative importance of PUSH factors that cause people to leave their homes (e.g., war, disease, limited job opportunities) and PULL factors in the settlement of the Massachusetts Bay Colony (e.g., better opportunities, self-determination, friendly locals, or beautiful scenery).

Following guided handouts, students use three computer simulations to investigate the significance of population change in United States history and on the modern world. The computer simulations are supplemented with a variety of primary and secondary sources, and students are challenged to reconstruct and experiment with long-term patterns of population change (based on births and deaths). Additionally, students can apply the principles of historical population dynamics to current and possible future events.

These lessons can be done either during or outside of class time, or within a flipped classroom context. They provide a frame to help students conceptualize how populations change, and how those changes affect social systems and environments while also being affected by them. Using multiple resources and structured problem-solving, these lessons encourage students to connect historical trends, structures, and relationships with real-world present and future challenges.

Introductions to Simulations/Student Activities

http://clexchange.org/curriculum/complexsystems/populationdynamics/popdynA.asp

Simulation 1: How Do Populations Change over Time?

In this introductory Sim, students explore the implications of different birth and death rates on long-term issues of population growth and sustainability within a fictional, present-day community.

Note: We highly recommend completing this Sim before undertaking Sim 2 or 3.

Students will:

1. Use a simple demographic simulation to create scenarios of their own choosing (varying initial populations, birth and death rates).

2. Analyze and interpret graphical output to demonstrate full understanding of different patterns of long-term population change.

Simulation 2: Were English Puritans Pushed Out of England or Pulled to New England?

Students work through a simulation exercise reconstructing how changing death rates in England impacted the English population in the period leading up to the settlement of New England. A diverse collection of primary and secondary sources relating to environmental, economic, cultural and religious themes challenges students to reconstruct how these factors interacted to shape events in England and in Colonial America.

Students will:

1. Use a timeline of important events and a graph of England’s changing population between 1300-1650 to discuss possible factors that may have influenced the colonization of New England (1620-30).

2. Use a demographic simulation to identify death rates at three critical moments in English history (1300, 1400, and 1500) that account for England’s changing populations throughout the 350 year period between 1300 and 1650.

3. Use primary and secondary historical sources to describe how changes in the English population were connected to environmental and economic transformations.

4. Explore issues of globalization, religion, culture, the colonization of New England and the creation of an American identity.

Simulation 3: What Population Challenges Do Modern Nations Face?

Students use current UN data on birth and death rates in countries around the world to explore and compare possible future population developments.

Students will:

1. Examine and select current demographic data (populations, birth and death rates) from countries across the world.

2. Apply their understanding of
Population Dynamics

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demographic change to explore current demographic developments and their implications on possible futures.

Note: Each of the three simulations includes a student handout with instructions and prompts for written responses intended to challenge students to document and explain their learning.

Standards and Methods

This lesson strives to address three important sets of standards:

1. Content:
The College Board identifies twelve major themes that encourage students to think conceptually about the American past and to focus on historical change over time.¹

A. Sim 2 (Were English Puritans Pushed or Pulled to New England) highlights the following themes: demographic changes, economic transformations, environment, globalization, religion, culture and the American identity.

B. Sim 3 (What Challenges Do Modern Nations Face?) further connects themes of past demographics with future issues involving globalization.

2. Method:
The Common Core Standards stipulate that students learn to integrate information from both primary and secondary sources to forge a coherent understanding of an idea or event, noting discrepancies between sources.²

A. Sim 2 includes graphs, together with diverse primary and secondary sources, for students to reconstruct multifaceted elements of change that contribute to the decision of English Puritans to settle New England. Students actively reconstruct a past where population change is both the result of and the agent for change in other areas including the economy and environment.

3. Relevance:
The National Council For Social Studies specifies the need to empower students to make connections between learning and their world, to support active citizenship.³ This lesson encourages students to explore their changing demographic world and to assess impacts of change on their lives.

How does the simulation model work?

Each of the three simulations uses a system dynamics model similar to the one below.

Much like a demographer, the model starts with a TOTAL POPULATION (box in the center). That population changes annually with New Births (people flowing into the population) and New Deaths (people flowing out).

The model calculates these flows based on two factors shown as arrows leading into new births and deaths:

1. One is the demographers’ so-called “Birth Rate” and “Death Rate.” These rates are numbers, typically between 5 and 50, that refer to the number of births or deaths per thousand people in the total population.

2. Multiplying this rate by the total population determines the specific number of new births and new deaths.

New Births = Birth Rate (#/1000) x total population
New Deaths = Death Rate (#/1000) x total population

As a result of these core structures, populations change in nonlinear and often explosive ways. Where a birth rate exceeds a death rate, the total population grows at an ever-rising pace. That’s because new births and the total population work in a cyclical relationship called a “reinforcing feedback loop”: more births cause more people, which causes more births, which causes… Understanding this pattern, one of many oft-repeated in history, further informs what is happening in many places today with further implications for the future.

² http://www.corestandards.org/ELA-Literacy/RH/11-12/ for 11-12th Grade English/Language Arts standards involving teaching History
³ http://www.socialstudies.org/standards/execsummary
Teacher Instructions and Overview

The history of Colonial New England, characterized by growth and prosperity, also incorporates major episodes of social upheaval, as evidenced by such disparate events as King Philip’s War, the Salem Witch Trials, and the American Revolution. All of these events are connected, in some form, with changing population dynamics, as New England’s birth rates, death rates, and migration are shaped by its environment and social systems. This lesson asks students to reconstruct the causes underlying New England’s changing populations, and to assess their impact on PUSH factors (diminishing conditions or circumstances) versus PULL factors (relative benefits or attractiveness of a different location) that contributed to the larger set of events that shaped Colonial New England.

Following guided handouts, students use two computer simulations to investigate the significance of population change in United States history. The computer simulations are supplemented with a variety of primary and secondary sources, and students are challenged to reconstruct and experiment with long-term patterns of population change (based on births, deaths, in- and out-migration). Connecting changes in population dynamics with environment and social systems (e.g., economy, religion, culture, identity) helps students see patterns that inform major developments and events in America’s past. Additionally, students can apply the principles of historical population dynamics to current and possible future events.

These lessons can be done either during or outside of class time, or within a flipped classroom context. They provide a frame to help students conceptualize how populations change and how those changes can affect social systems and environments while also being affected by them. Additionally, simulations encourage students to explore the conditions under which populations grow due to different birth and death rates, together with migration, and to experiment with managing sustainable long-term scenarios. Using multiple resources and structured problem-solving, these lessons encourage students to connect historical trends, structures, and relationships with real-world present and future challenges.

Introductions to Simulations/Student Activities

http://clexchange.org/curriculum/complexsystems/populationdynamics/popdynB.asp


In the simulation, students actively and progressively reconstruct important dimensions of New England’s colonial history in three ways:

- by comparing New England’s pattern of population growth with a timeline of important events and a table showing migration rates (in and out of New England);
- by learning HOW populations change over time; and
- by connecting patterns of population change to environmental, economic, political, and cultural developments.

Students will:

1. Use a timeline of important events, a migration table, and a graph of New England’s changing population between 1620-1780 to discuss possible factors that may have influenced the population growth of New England over time.

2. Use a demographic simulation to determine the extent to which New England’s economy and environment altered birth and death rates from those in England. They then use that information, together with data on immigrants, to assess the relative importance of natural growth (births exceeding deaths) versus immigration.

3. Use primary and secondary historical sources to describe how the particular pattern of population dynamics in New England throughout the 17th and 18th centuries contributed both to changing environment and economic transformations and, subsequently, to major events.

4. Explore issues of globalization, religion, culture, the planting of New England and the creation of an American identity.

Simulation 2: How Can Population Dynamics Shape Local and National Borders?

Students explore the implications of different birth and death rates, together with immigration rates and physical limits on growth (that, when activated, trigger emigration), on long-term issues of population growth and sustainability within a fictional, present-day community and beyond.

Students will:

1. Use a simple demographic simulation to create scenarios of their own choosing (varying initial populations, immigration, birth and death rates, specified...
Population Dynamics

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population “limits” under which quality of life is compromised).

2. Analyze and interpret graphical output to demonstrate full understanding of different patterns of long-term population change.

NOTE: Each of the two simulations includes a student handout with clear instructions and specific prompts for written responses intended to challenge students to document and explain their learning.

Standards and Methods

As with Part A of this lesson, Part B strives to actively engage students in putting pieces together to develop problem-solving skills and apply their learning in identifying the relevance of historical processes in the modern world. These processes address three important sets of standards:

1. Content:

The College Board identifies twelve major themes that encourage students to think conceptually about the American past and to focus on historical change over time. This lesson challenges students to integrate eight of those Advanced Placement (AP) themes while reconstructing the story of New England’s colonial history: demographic changes, economic transformations, environment, globalization, religion, war, culture and the American identity.

2. Method:

The Common Core Standards stipulate that students learn to integrate information from both primary and secondary sources to forge a coherent understanding of an idea or event, noting discrepancies between sources. This lesson uses primary and secondary historical sources, incorporated with demographic simulations. Students actively reconstruct a past where population change is both the result of and the agent for change in other areas including the economy and environment.

3. Relevance:

The National Council for Social Studies specifies the need to empower students to make connections between learning and their world, to support active citizenship. This lesson encourages students to explore their changing demographic world, and to assess impacts of change on their lives.

How does the simulation Model work?

Each of the two simulations uses a system dynamics model similar to the one above.

Much like a demographer, the model starts (box in the center) with a total population. That population grows annually as people flow into the population with New Births and Immigration. The population is reduced as people flow out of the TOTAL POPULATION by New Deaths and Emigration.

The model calculates each of these four flows based on two factors shown as arrows leading into each flow:

1. In the case of new births and new deaths, demographers use a “Birth Rate” and “Death Rate.” These rates, typically, are between 5 and 50, referring to the number of births and deaths per thousand people in the total population.

2. Multiplying this rate by the total population determines the specific number of new births and new deaths.

New Births = Birth Rate (#/1000) x total population

New Deaths = Death Rate (#/1000) x total population

The same logic is used for calculating annual rates of immigration and emigration.

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DynamiqueST: A showcase of student projects

DynamiqueST is a showcase of student projects that utilize critical thinking skills to analyze complex dynamic systems in a relaxed environment, free from “winner/loser” constraints. Students ages 8-18 will showcase their work using their ability to analyze and to clearly communicate critical thinking using the tools and methods of system thinking and system dynamics.

WHAT ARE THE GOALS OF DYNAMIQUEST?

- Give students the experience of being coached on their projects by experts in the systems field, teachers, and other students, in a helpful and supportive manner.
- Permit teachers from different schools to see evidence of student work communicating critical thinking using systems thinking and system dynamics (ST/SD).
- Provide a venue for teachers and kids to network and learn from each other.
- Showcase student work for the wider community.
- Have some fun and celebrate with kids!

DO STUDENTS NEED A LOT OF EXPERIENCE TO PARTICIPATE?

No! DynamiqueST creates a venue for celebrating what has been done, informing those who wish to start, and providing encouragement for all!

WHO ARE THE COACHES?

- Professionals well versed in analyzing complex systems using the tools and methods of ST/SD
- Teachers who have used ST/SD in their classrooms for years.
- Other participating students

JOIN US!

- Students and teachers with projects/presentations
- Educators who wish to see what students are capable of thinking and communicating
- Community members who are curious about better ways to help students learn about the complex systems that are everywhere.

HOW DO I SIGN UP?

- Identify project(s) about topics that change over time. Look at the Rubrics for Projects and Tips on Using System Dynamics Tools or email Lees Stuntz for a free copy of Communicating Critical Thinking: Visual Tools for Student Projects.
- Check Creative Learning Exchange for information or email the director, Lees Stuntz. If you are new to learning systems thinking, get in touch with the CLE. We have both the resources and the willingness to help you get ready for DynamiqueST.
- If you are new to thinking critically about systems and don't have any projects this year, just come and join us to experience the day, and mostly enjoy what students can do.

For more information, visit DynamiqueST. Download the brochure.
Population Dynamics

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As a result of these core structures, populations change in nonlinear and often explosive ways. Where growth factors (birth rate and immigration rate) exceed a death and emigration rate, the total population grows at an ever-rising pace. That’s because new births and the total population work in a cyclical relationship called a “reinforcing feedback loop”: more births create more people, which in turn gives rise to more births, which causes… Understanding this pattern, one of many oft-repeated in history, further explains what is happening in many places today, with implications for the future.

It’s time! Spread the word! Register now for Camp Snowball! Join us in Portland, Oregon, July 13-17, 2015 at the Red Lion Inn, Jantzen Beach, for another great week of capacity- and community-building.

This year’s theme will focus on Teaching and Learning for the Future. As Gordon Brown, former Dean, MIT School of Engineering, so aptly put it, “To be a teacher is to be a prophet. You are not preparing children for today’s world, but for the world of the next 50-75 years—a world we can barely imagine.”

Join teams of educators, students, and business and community leaders at Camp Snowball to explore how to build everyone’s capacity for learning and leading in the 21st century. Camp Snowball focuses on empowering educators and students to think deeply and critically, manage high complexity, work collaboratively, communicate effectively, and achieve academically so that together we can contribute as co-creators of a sustainable future in the context of our local and global communities. FMI, visit http://www.campsnowball.org

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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THANK YOU!
The Creative Learning Exchange, 27 Central Street, Acton, MA 01720