

System Dynamics Tools for Deeper Understanding

Allow students to express and communicate their mental models through graphic tools.

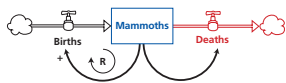
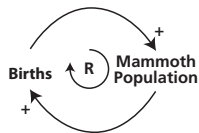
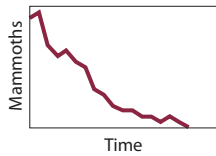
Explore patterns and structures rather than events.

Show connection between parts of a system.

Delineate basic differences in how parts of a system work together.

Surface the elements of change over time.

The most effective use of these tools is to utilize more than one in each application.



- **Behavior-over-Time Graphs:**
Show behavior of one or more elements of a system over a period of time, using line graphs.
- **Feedback Diagrams:**
Use words and arrows to map how elements of a system interact and affect each other.
- **Stock and Flow Diagrams:**
Draw stocks (accumulations of quantities) and flows (factors that change the stocks) to show the structure of a system.
- **Computer Models:**
Use equations and functions to simulate or replicate behaviors in a system.

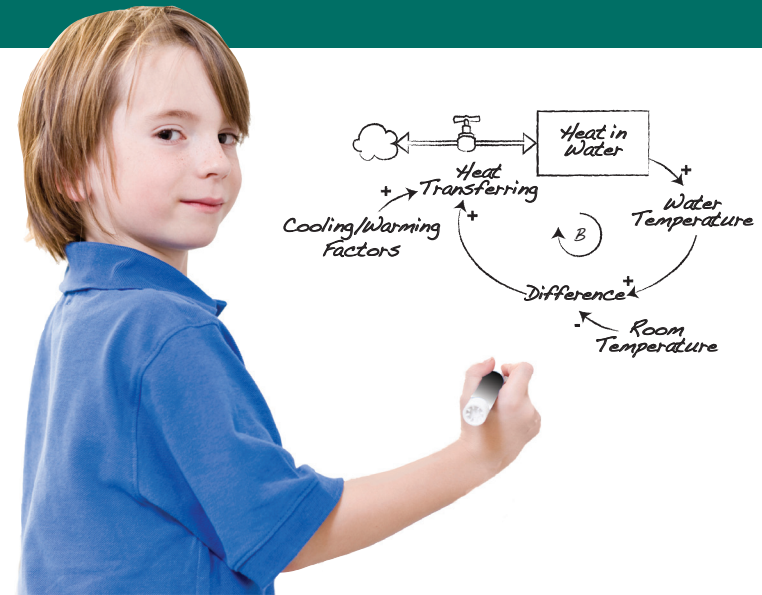
These tools have been used to:

- Explore patterns over time of plots and character development in literature
- Model the spread of infectious diseases, rumors, and cultural fads
- Simulate the declining population of mammoths and how humans may have contributed to their extinction
- Compare linear versus exponential growth with a game about making friends
- Learn how “keystone” species affect other animal populations

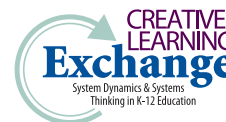
And much more...

Systems Thinking and System Dynamics

Moving Our Students Toward the Core Standards



Effectively addressing Common Core State Standards requires more than K–12 education as usual. It requires using techniques and tools that give students deeper understanding through multiple avenues for learning. System dynamics and systems thinking provide such strategies. System dynamics is a methodology to explore complexity, interconnectedness and change over time.



TEACHER TRAINING WORKSHOPS
E-mail Lees Stuntz (stuntzln@clexchange.org),
call 978-635-9797 or go to www.clexchange.org

For more examples and information, visit the
Creative Learning Exchange website at www.clexchange.org

www.corestandards.org

Characteristics and Skills of a Systems Thinker

- Critical thinking
- Understanding complexity
- Modeling
- Communication and collaboration
- Seeking and recognizing patterns and structures
- Quantitative thinking
- Testing assumptions
- Seeing the big picture
- Focusing on real-world issues
- Cross-discipline exploration

English, Language Arts, and Literacy Across the Curriculum

Correlation with the Common Core Standards

COMMON CORE STANDARDS	SYSTEM DYNAMICS (SD)
READING —develop staircase of increasing complexity to build comprehension in a diverse array of content.	DEALING WITH COMPLEXITY —SD helps students understand behavior systemically, seeing the big picture, with graphic tools for representing behavior.
WRITING —express logical arguments and opinions, using research skills frequently.	CLARITY —SD diagrams and models create visual examples that can be easily understood by readers.
SPEAKING AND LISTENING —employ a mix of one-on-one, small group, and whole class structures, emphasizing collaboration and problem solving.	LEARNER-CENTERED LEARNING —students using SD tools effectively work in teams to solve problems that arise from their studies.
LANGUAGE —build a precise and varied repertoire of vocabulary.	PRECISION OF LANGUAGE —describing systems requires concise and accurate wording. The use of SD visual tools helps students clarify and communicate their thinking.
SCIENCE, HISTORY AND SOCIAL STUDIES —apply English language arts skills across the curriculum to promote content area literacy.	INTERDISCIPLINARY LEARNING —students learn to recognize generic structures that occur across their curriculum. Understanding feedback provides insight into social issues and policies.
MEDIA AND TECHNOLOGY —integrate 21st Century skills throughout the curriculum, and use modern applications for varying assumptions, exploring consequences, and comparing predictions with data.	COMPUTER MODELING —from upper elementary grades through high school, students can use software to build simulations of situations in many content areas. SD tools and models give students the ability to change assumptions, compare predictions and explore consequences in powerful ways.

Mathematics

Correlation with the Common Core Standards

COMMON CORE STANDARDS	SYSTEM DYNAMICS (SD)
K-5 MATH —build a solid foundation in whole numbers, computation, fractions and decimals, negative numbers, and geometry. Emphasize hands-on learning, to continue through upper grades.	REPRESENTING DATA —graphing data over time requires students to use a wide array of math skills. Simulations, experiments, and other activities where data are analyzed reinforce quantitative thinking.
MATHEMATICAL REASONING —build solid conceptual understanding, as well as procedural skills. Enable 8th graders to understand algebra with an emphasis on linear expressions and functions.	QUANTITATIVE THINKING —SD promotes dynamic understanding through stock and flow thinking. Stocks are quantities that change because of flows, or rates of change. SD modeling creates a visual framework to understand mathematical functions.
MATHEMATICAL APPLICATION —guide students to apply math reasoning to real-world issues and challenges, and use math in novel situations.	GENERIC STRUCTURES —students learn to transfer insights across curriculum areas, connecting diverse topics as they identify behaviors caused by systemic structures.
MATHEMATICAL MODELING —use modeling to link classroom experience to empirical situations, leading to better understanding and decision-making.	MATHEMATICAL MODELING —using readily accessible, powerful software, students can model sophisticated situations and run simulations to test assumptions, create alternate scenarios and explore consequences.
APPLIED MODELING —model quantities and their relationships in physical, economic, public policy, social and everyday situations.	APPLIED MODELING —students can build and use models that allow “what if” simulations in most curriculum areas.