About The Creative Learning Exchange

Our Mission

To develop Systems Citizens in K-12 education who use systems thinking, system dynamics, and an active, learner-centered approach to meet the interconnected challenges that face them at personal, community, and global levels.

The Creative Learning Exchange (CLE)

The Creative Learning Exchange was founded as a non-profit in 1991 to encourage an active, learner-centered process of discovery for 5–19 year old students that engages in meaningful, real-world problem solving through the mastery of systems thinking and system dynamics modeling.

Since its inception, the CLE has worked to encourage teachers and educators to use systems thinking and system dynamics in classrooms and schools throughout the United States as well as internationally.

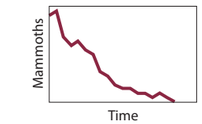
The CLE has done this through its website that offers free curriculum, its products that include books and games that promote systems thinking, and a biennial conference to help educators and students learn and utilize systems thinking and system dynamics in the classroom and the school organization.

How to be part of the CLE network:

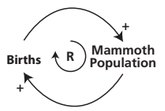
- **Register with the CLE online at www.clexchange.org.**
  You will start to get our quarterly newsletter, The *Exchange*, as well as email notifications of new curricula and upcoming events. These materials are available for download from the web.
- **Browse and download our free materials.**
  All of the curricula and other materials are in Adobe PDF format and the models are in STELLA®. A run-time version of STELLA is available from isee systems: www.iseesystems.com. Our newer curricula also has simulations which can be run directly from the CLE website.
- **Join the CLE K-12SD listserve** from the CLE website to make connections, find resources, and ask questions of experienced teachers and world-class system dynamics experts.

— System Dynamics Tools —

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.

Publications Available from the Creative Learning Exchange

The lessons in ***Dollars and Sense*** challenge students to use systems thinking and mathematical tools to develop a realistic and personal understanding of the dynamics of the economic system in which we live.

Healthy Chickens, Healthy Pastures is a game that has been created to help students think deliberately about living systems in a farm setting and give them a mental framework to take home and apply in other contexts.

Tracing Connections collects the experiences and thoughts of practitioners from education, business, public policy, and research to present the powerful applicability of systems thinking.

Critical Thinking Using Systems Thinking & Dynamic Modeling correlates critical thinking skills with the use of systems thinking and dynamic modeling. After creating a definition of critical thinking, it expands upon how to use the tools of systems thinking and dynamic modeling to improve this important trait in students. The why and the how of using systems thinking and dynamic modeling in education are the fundamental topics covered in this introductory text.

The Shape of Change, Including Stocks and Flows contains lessons with a variety of systems thinking tools that engage students in classroom activities that help them understand not only what but why things change over time.

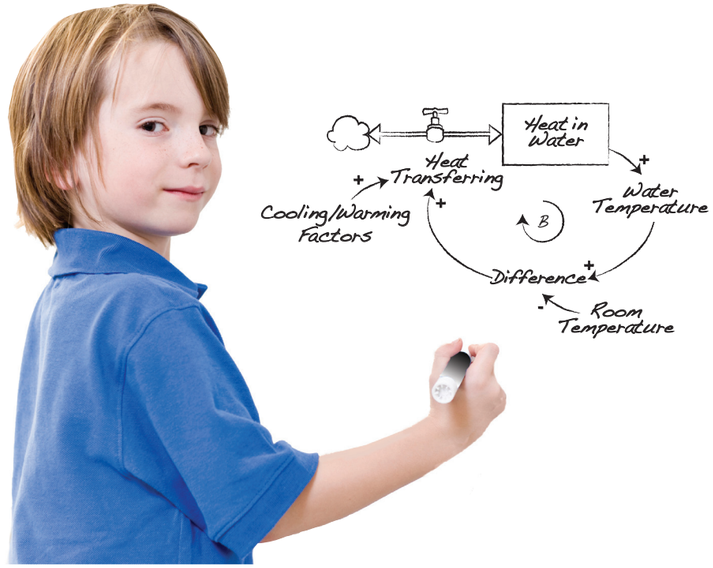
...that School in Tucson is a longitudinal study of systems thinking in K-12 education. Thirteen years ago, middle school students and their faculty in Tucson, AZ, pioneered a revolutionary new approach to learning—using systems thinking tools to engage in collaborative, real-world problem solving that honed their critical thinking skills.

Characteristics of Complex Systems—Oscillating Systems is a new series of lessons from the CLE that allows students and adults to play (using online simulations) with oscillating systems.

Many situations in a variety of contexts display up-and-down oscillatory behavior. By asking "what if" questions as part of an exploration, students discover that the structure of a system creates the variations.

CREATIVE LEARNING Exchange

System Dynamics & Systems Thinking in K-12 Education



System Dynamics Tools for Deeper Understanding

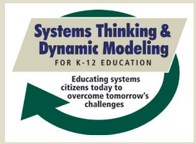
Allow students to express and communicate their mental models through graphic tools.

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.

Examine the elements of change over time.



Systems Thinking and Dynamic Modeling Conference

The CLE hosts a biennial conference on systems thinking and dynamic modeling. Speakers and presenters are teachers, administrators, and experts in system dynamics. For more information, go to **www.clexchange.org** or e-mail info@clexchange.org.

www.clexchange.org

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System Dynamics/Systems Thinking and the Common Core, STEM and New Generation Science Standards

Effectively addressing the Common Core State Standards, New Generation Science Standards and STEM strategies requires more than K–12 education as usual. One of the biggest challenges of STEM curricula and, in fact, all curricula, is creating opportunities for students to gain experience and practice in the process of critical thinking. The utilization of System Dynamics/Systems Thinking (SD/ST) offers a unique methodology for addressing these higher-order thinking skills in a way that creates a framework to gain knowledge, as well as the tools to communicate thought. SD/ST offers an integrated way of thinking, in practical and useful ways, about the complex, interconnected systems that surround us, and how they change over time.

Common Core Standards

English, Language Arts, and Literacy Across the Curriculum

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

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.

System Dynamics/Systems Thinking (SD/ST) Tools and Learning Strategies to Build Science, Technology, Engineering, and Math Excellence