the Creative Learning EXCHANGE

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The GIST of Systems Thinking

The Creative Learning Exchange wishes to salute the Glynn County School System, its teachers, and administration for developing and allowing us to distribute an innovative and creative curricula. From Total Quality Management to the American Revolution, through Hurricanes and Financial Dreams, the Glynn County School System is using Systems Thinking as their educational tool.

A brief history

In the spring of 1992, Glynn Integration of Systems Thinking (GIST), a partnership of the Glynn County School System, Georgia-Pacific, Inc., and High Performance Systems, was formed. The project plan was to develop a critical mass of materials to be used for instruction, combining both models and curricula. Learning Environments were created, field tested during the 1993-1994 school year, and refined the following year.

The Glynn County System, which consists of two high schools, three middle schools, and eight elementary schools that service a total of approximately 10,500 students, is an enthusiastic one which strives to improve quality of education for students. It has a diverse population, ranging from those who live on resort islands to those who live in government projects. The outlying areas of the county are rural. With this kind of diversity, teachers are faced with a challenging array of students every single day. The school system's efforts to decrease student underachievement have been extensive and the teachers have been exposed to many different programs and projects. From the outset, there has been determination that GIST not become just one more in a series of projects. The goal of GIST is to involve the entire district in Systems Thinking and remain viable for many years. The core team members were ten teachers from the three middle schools. Because of this, the curricula developed are for middle school programs. Although the program is now reaching beyond the middle schools, this focus has provided us with the lion's share of materials suitable for this age bracket.

In the original form, the learning environments were intended to be multi-disciplinary units which incorporate all major academic areas. Because some subject areas did not lend themselves naturally to certain themes or topics, the curriculum in those areas became somewhat contrived and did not fit into the flow of the unit. During testing and refining, the initial core team members realized that the learning environments did not have to be simulation driven; instead, they could become curriculum driven with the simulations used as enhancement. As a result of these realizations and changes, and for financial reasons, the emphasis now has taken a direction different from the original plan. Of late, the team has concentrated on creating smaller learning environments to insure that there is a natural connection in the subject areas involved.

Presently, the Creative Learning Exchange has 10 different curricula from GIST, some of which are complete, integrated learning environments involving multiple disciplines. The Cross-Curricular units are a refreshing change of pace for teachers and students alike, using the tools of systems thinking to teach the interdependence of all elements and to stress the importance of processing all available information. We are very excited about these units, and sing the praises of the curricula developers, Kathy Alexander, Cathy Eaton, Paula Ghiglieri, Jeff Giddens, Stephen Kipp, Jan Mons, Pam Sederholm, Pat Stanford, Dana Strickland, and Sherril Sumner.

A MATTER OF CHOICE
An Educational Approach to Total Quality Management
Developed by Pam Sederholm

When asked if getting a good education is important, most students will answer, "Yes." If asked what it takes to get a good education; students will answer, "Hard Work." When asked if they are working hard to get a good education, most will answer, "No." (Glasser, 1990, The Quality School: Managing Students Without Coercion) Why is it that children won't work hard for something they all claim that they want?

Dr. W. Edwards Deming, creator of the Total Quality Management movement adopted by businesses

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UPDATES. . .

News from Ridgewood
(via Tim Lucas, Principal of the Willard Elementary School)

Patti London had two visitors from Sweden who are rehabilitating adults with severe head trauma caused by accidents. Their patients are relearning how to learn using modeling software (VemSim). The similarities between our work with elementary students with ADD and their work with these special adults was amazing. The use of modeling and mapping to help focus and make connections was discussed at length. The use of systems thinking was seen as successful, especially when other typical educational strategies had failed.

Classroom teachers are becoming more sophisticated in their understanding of how children learn (4MAT, learning styles, cognitive research, understanding short and long term memory, constructive approaches to learning, mediated learning, input-elaboration-and output skills, etc.). As we introduce systems thinking and systems dynamics to teachers in terms of these topics and its impact on learning, they become very interested and want to know more. The process of encouraging teachers to teach systems thinking can begin by focusing teachers on a range of applications—from its specific use as a tool in an academic area, to its use as an interdisciplinary tool, to a tool that impacts the development of cognitive processes students will need as learners. (Elementary teachers know that the real fruits of their work with children will not be realized for many, many years.)

I do not believe we fully understand the total impact working with systems dynamics has on how children learn. By children, I mean ages 4 to 10 as they build their cognitive approaches and strategies for thinking, problem solving, and processing information. Obviously, we want to see them apply System Thinking skills, but it also offers them an opportunity to be better learners—though feedback loops, graphic organization of ideas, on-going "behavior over time" concepts that are part of everyday processing, ability to focus and refocus as they see problems from different perspectives, and a decrease in their episodic grasps of reality. As we gain in our understanding of cognitive functions, the use and appreciation for systems thinking will continue to grow also.

CC-STADUS
Tim Joy in Portland, OR sends this graphic example of the effect the CC-STADUS project is having in their area.

I am Tim Joy, teaching writing and literature for 13 years and always suspecting I was party to some intellectual crime. Why is it that so many students thought the world of language began and ended at the door of my classroom? This was generally true of my peers' classroom as well.

And then I discovered STELLA and system dynamics. I still teach writing and literature, but it's changing radically. At La Salle High School, three teachers were trained in the CC-STADUS summer institute, and we use STELLA at all levels and in many disciplines: Physics, English, Government, Economics. This year we'll add models in Health and Biology. We're still hoping to convert the Religious Studies Department.

We have ambitions. Starting a dynamic modeling club. Implementing a two-year dynamic modeling core curriculum so students can model on their own when entering their Junior year. Producing a Sophomore project that utilizes STELLA as a component. Enjoining the local engineering, biological, political arenas with dynamic modeling experience to converse and exhort students on modeling. We now have two computer labs (one with 24 [whole school], the other with 22 Macs [science/math]) with all computers having STELLA, a direct result of Teresa Hazel's dogged efforts at grant writing, We will soon have a few in the library with STELLA as well.

***Updates** continued on page 11*

FROM THE EDITOR. . .

As the school year has started, it was my pleasure to get in a trip to Georgia to see the GIST project. Their work is featured in this newsletter. They have concentrated on middle school, but with the addition of funding for a full time mentor, there is the resource available to create inservice courses to reach out to both the elementary schools and the high school.

The conference for next summer is slowly taking shape. We have tried hard to keep the costs reasonable by holding the conference in a college setting, where both food and lodging are within a reasonable budget. The program is being formed by many people's thoughts on what would be beneficial to those attending as well as the exigencies of time and space. I welcome input in this process. If there is anything that you think would be particularly helpful for you or other potential attendees, please get back to me.

Lees Stuntz (stuntzln@tiac.net)

Gist Curricula, *continued from page 1*

worldwide, contends that individuals want to do their best. The problem is that management often does not create a system which will enable them to do so. His process for improving business involves giving workers responsibility for the quality of the products they create. The following learning environment uses Deming's plan to give children responsibility for their own learning, tapping into this intrinsic desire to learn that Dr. Deming and so many educators believe is present. It is my hope that by giving students control over what they learn, and how they learn it, we will motivate them to want to learn. By creating a system that forces continual evaluation of the process by which they are learning, perhaps they will also gain some insight and control over the way that they learn.

OVERVIEW

This unit does not utilize any particular content material; rather it is a plan to restructure your classroom. It may be used at any grade level and with any content material. However, it must be used with more than one class in order to establish competition between corporations. Due to the nature of the design, there are no particular day to day lesson plans. Instead, this unit will be presented in three parts: Preparation Materials, Planning & Teaching, and Evaluation.

To begin the unit it is fun to ask your classes if they feel that kids should be given more responsibility. You can imagine what their replies will be! Next, ask the students if they are given many opportunities to make decisions in school. Finally, ask if they would like to have the chance to make all the decisions in class; to determine what they will learn, and how they will learn it. Hopefully they will take the bait and run!

Explain to the students that they will be organizing themselves into a corporation. Their job is to successfully learn the content material you have planned. Each class will nominate and elect a CEO and Vice President. These roles will be to oversee operations and manage the corporation. Students will also elect a Quality Assurance department. These students will review all of the materials, create a test, grade homework, and monitor the teach-

***GIST** continued on next page*

The Second Systems Thinking and Dynamic Modeling Conference

July 17-19, 1996

Wheaton College
Norton, Massachusetts
(easily accessible to both Boston, MA and Providence, RI)

- Sessions focusing on:
  - Systems tools for use in the classrooms and in the educational organization
  - Organizational change using the systems approach
  - Curriculum examples and innovations utilizing systems tools and dynamic modeling
- Addresses by world renown figures in the fields of system dynamics and systems thinking.
- Time to talk, to learn from colleagues from across the country

Preceding the International System Dynamics Conference,
to be held in Boston July 21-26, 1996

Gist Curricula, *continued from previous page*

ing of the unit to insure that all pertinent information is taught. (Tests from the different classes involved will be randomly selected. Classes will not know which test they will be given. The test may or may not be their own.)

The next group to be elected will be Research and Design. These students will compile daily evaluations of the class's work to study the progress of how well the corporation is operating.

The remainder of the class will be organized into Production Management Groups. These groups will each be given a portion of the information to be covered. They will determine what material is important, design a way to present it to the class, and teach the lessons. As the teacher, you will act on behalf the Stockholders. You will be available for consultation and advice.

Each class should be given a fifteen day deadline in which to develop their lessons, teach, review, and take their test. On a daily basis, students acting as Quality Control will evaluate how well the class is working. Quality Control will give and take away "productivity points." There are incentives established for finishing ahead of schedule, and for having a high percentage of the class pass the test. There are also penalties for going over deadline. The class with the most productivity points, wins.

At this point it is wise to remind each class that they will be running things, not the teacher. This means that if they have a problem, the students will have to solve it together. Students who cause problems will now have to answer to everyone. This can be very scary. Any concerns regarding this should be confronted prior to beginning the unit.

FINANCIAL DREAMS OR BUDGET NIGHTMARES

Developed by Jeff Giddens, Jan Mons, and Pat Stanford

Both students and teachers should understand the unit goals in order to learn from and enjoy the activities. By comprehending the unit goals, teachers using the Financial Dreams or Budget Nightmares learning environment will understand the importance of stressing various key activities, and students will recognize the relevancy of learning the skills taught within the activities. Each subject area has specific objectives that reinforce these broad goals; strategies for teaching the goals are included also.

Unit Goals: Students will be able to understand that:

1. The things that are taught in school are relevant in everyday "real" life—people actually use them on a daily basis.
2. Actions taken and decisions made now are very important because they affect what happens in the future—what is done now decides what can de done later.
3. People have some control over what happens to them.
4. People must be able to connect their actions and their decisions to the consequences resulting from them—people must take responsibility for the consequences of what they do.

This learning environment helps students to understand the connection between the actions and decisions they are presently making and their ability to achieve their goals for the future. It seems that many individuals feel as if they are "stuck" within the confines of an economic system that conspires against them. They habitually complain they have few or no options that will allow them to rise above low levels of income and debt. This is the issue that this integrated learning environment addresses.

The learning environment includes four modules which impact an individual's financial lifestyle: goal setting, job placement, decision-making, and evaluation.

A. The goal setting module includes activities such as a goal survey, research into goal related terms, and classifying and categorizing goals. In this part of the learning environment students come to understand that goals are the first step in the process of attaining what they want from life.

B. The job placement module of the curriculum uses activities such as writing a resume, applying for a job, conducting a job interview, researching the tax system, studying insurance/health related issues, and planning a budget. Here students begin to understand how the job market operates as well as how their performance and attitude determine what type of occupation is available to them.

C. In the decision-making module of the learning environment pupils simulate making real life financial decisions using a STELLA II model. The model simulates ten years of the students lives as they attempt to live within their means and deal with the consequences of their actions when they do not. Pupils use output tables to chart their progress and see the results of monetary decisions.

D. Within the evaluation module of the learning environment students write essays and narrative descriptions of the decisions that they made during the simulation, study the economic functioning of their community, and find the relationship between insurance cost and the benefits of personal maintenance. With this part of the learning environment students have the chance to evaluate their performance within the unit and change behaviors that they view as counter-productive to the attainment of their goals.

HURRICANE

Developed by Jan Mons and Cathy Eaton

Since 1989, the Glynn County area has had two devastating hurricanes hit within 350 miles. Hurricanes Hugo and Andrew have served to remind all of us that no one along the east coast of the United States is immune to the dangers of a major Atlantic storm. In addition, most of us have been made very aware of the uncertainty of predicting where these storms will go and of the overwhelming responsibility of managing the evacuation of areas most likely to be the targets.

There are no certainties in hurricane prediction. Too many factors combine to give each hurricane its unique characteristics. Meteorologists are among the first to admit that the science of hurricane prediction is "iffy" at best and may, at times, even fall into the realm of "best guess." But, meteorologists compile the data that are available from a variety of sources and make predictions about hurricanes with an amazing level of accuracy. It is upon the information from meteorologists at the National Hurricane Center that local area Emergency Management Agencies base their decisions.

The Glynn County Emergency Management Agency is responsible for the safe evacuation of the residents of Glynn County in case a hurricane threatens. Theirs is no easy task. To make decisions in an emergency situation, the GCEMA enlists the assistance of an emergency management team composed of representatives from other local agencies including local law enforcement, public works, utility companies, fire departments, and the emergency medical force. It is this body that recommends evacuation of the area for an impending hurricane, whether the order is for voluntary or for mandatory evacuation. Because prediction of the a hurricane's landfall is difficult, issuing evacuation orders is, in essence, a gamble. No one knows better than the emergency management personnel the importance of accuracy in recommending the evacuation of an area.

Most people have no idea of the many factors involved in hurricane prediction and in managing the evacuation of an area. While participating in this learning environment, students will assume the roles of both National Hurricane Center personnel and emergency management team members. Using computer simulations, students will make decisions very similar to the decisions made by the people involved in hurricane prediction and in emergency evacuations. It is not the intent of this learning environment for students to try to question the decisions of the officials in an emergency situation. Rather, our intent is to make students aware of the many elements that must be considered as a hurricane approaches our area. Although there is no way to control the course and strength of a hurricane, students can learn the importance of processing all of the available information and making informed decisions.

Learning Environment Objectives

Science: The students will:

1. Demonstrate skills needed in stress management
2. Demonstrate the importance of personal values and individual responsibility to self and others.
3. Identify how rights of individuals are protected.
4. Identify the layers of the earth's atmosphere and describes the importance of each
5. Describe the hydrologic cycle and related heat transfer concepts.
6. Investigate weather phenomena and the use of meteorological instruments and weather maps

Social Studies: The students will:

7. Locate a place on a map using latitude and longitude
8. Identify the location of a place relative to another using cardinal and intermediate directions.
9. Make a decision and identify the consequences of choices.
10. Make a decision and accepts consequences of choice.
11. Make a decision based on data.
12. Identify consequences of alternatives
13. Cite short and long term consequences of alternatives.
14. Cite short and long range positive and negative consequences of alternatives.
15. Draw inferences about a situation by conducting impartial observation.
16. Determine adequacy, relevancy, and consistency of information for justifying conclusions or generalizations.
17. Suggest responsible actions in a given situation
18. State reasons for advocated positions.
19. Formulate and defends positions on an issue
20. Present viewpoints to leaders, officials, etc.
21. Participate in planning for effective action in civic affairs

EATORDIE ISLAND
an Integrated Unit on Interdependence

Developed by Kathy Alexander and Steve Kipp

When developing this unit, we tried to consider all that children of today need to understand. We kept coming back to the concept of interdependence and the role it plays in every aspect of our lives. We decided that this concept would be the central focus of our unit and we tried to create lessons and activities that would allow the students to apply knowledge to more familiar surroundings. We did this by looking at population growth (any type), its limits, and the issue of community development. Bringing this concept closer to home will make any learning experience more relevant.

GIST *continued on next page*

Gist Curricula, *continued from previous page*

This unit involves each discipline but is not dependent on the subjects being taught at the same time, which allows instruction in a self contained or subject specific setting. We worked to keep the unit on a sixth grade level, however, the lessons are easily adjusted to be appropriate for lower and higher levels of instruction. While these lessons are for a specific number of days, the instructional spin-offs are unlimited. This unit can be adapted to any geographic location and the class can follow-up with any number of individual or group projects about their local community. The idea was to teach the concept of interdependence using the tools of systems thinking and still be as flexible as possible. The rest of the paper will give a brief description of the instructional focus in each subject area.

SCIENCE - Students learn how plants and animals depend on each other for survival and stability. Through a series of activities, students are introduced to food webs, habitats, producers, consumers and feed back loops. They investigate the effect an action may have on the world around them and explore ways that effect applies to their personal lives. The culminating activity involves interaction with a computer simulation model developed by Kipp and Alexander. During this simulation, the students are given a choice of certain plants and animals and are required to use them to create a balanced ecosystem.

MATHEMATICS - The first part of the math unit involves graphing skills. We felt that for the students to be more comfortable with the simulation, they needed to have a working knowledge of how to read and interpret graphs. The unit ends with graphing the world population from 1650 to present. Then they experience a food distribution simulation based on current population density per continent.

SOCIAL STUDIES - The emphasis is on quality of life in various countries and the factors which make that quality high or low. Students research specific facts about each country and compare their findings with an ideal quality of life. There is ample opportunity for discussion about what may be causing some problems in each country and how that relates to our interdependence on each other.

LANGUAGE ARTS - There are not specific lessons for this subject, yet, a number of language skills are being used in each subject area. Students may also wish to involve themselves in their local community. They can identify interdependence between business and community and possibly do research on development in their area. A debate can then be held to present both sides of the issue. There is no limit as to how this concept can be used in any language class.

DON'T COVER YOUR TRACKS!
A Wellness Approach to Alcohol & Tobacco Education

Developed by Steve Kipp and Sherril Sumner

Wellness: A Matter of Choice

It is no secret that a large proportion of the health problems experienced by Americans are directly related to lifestyle. Health care professionals are constantly reminding people of the dangers of poor diet, lack of exercise, alcohol and tobacco consumption, and especially the use of illicit drugs. Although many have heeded these warnings and made healthy changes in their lifestyle, a large number continue to be crisis-oriented, not making healthy changes in lifestyle until after a stroke, heart attack, emphysema, cancer, etc. has struck. Perhaps this is due in part to the slow, cumulative nature of these problems. For instance, that first wine cooler seems anything but dangerous to the future alcoholic; smoking one pack of cigarettes poses no immediate threat to one's respiratory welfare. The challenge, then, is to let people experience the threat of lifestyle-induced health problems before they make unhealthy lifestyle decisions.

This Learning Environment is designed to allow middle school students to experience the cumulative effects of some unhealthy habits through computer simulations and a supporting curriculum. Using STELLA software run on Macintosh computers, students will experience their own premature death as a result of smoking, as well as seeing how much money they have wasted over the years on cigarettes. The ultimate objective, of course, is to positively influence the lifestyle choices that students make as they seek to define themselves in these crucial preadolescent years.

Day 1
"Actions Leave Tracks"—Students will learn that "actions leave tracks", meaning that what we do today can have powerful consequences in the future.
Day 2
Actions Leave Tracks: Tobacco and Your Body—Students will review the structure of the respiratory system and learn the effects of tobacco on the human body.
Day 3
To demonstrate to students the dangers of smoking on a nonsmoker and to show students the substances left by smoke.
Day 4
Students will learn about the some of the effects of alcohol by analyzing and graphing given information.
Day 5
Students will experience the simulated effects of drunkenness without the consumption of alcohol.
Day 6
"Wellness isn't sainthood, just feeling good."
1. Students will learn that wellness isn't a matter of trying to be better than someone else ("holier than thou"), but is just a matter of feeling better (while increasing your chances of living longer).

2. Students will differentiate between short-term and long-term "tracks" of various actions.

Day 7

1. Students will differentiate between short-term and long-term "tracks" of actions.

2. Using the information in the survey, students will calculate the total number of years that someone smoked and calculate the total number of cigarettes smoked per day.

Days 8 & 9

Students will use a ©STELLA simulation model to learn about the health and financial consequences of smoking.

Day 10

Summary Assessment

Students will demonstrate comprehension of the content of this unit by reading short stories and answering questions in terms of:

1) "Actions leaving tracks" (short- and long-term effects)

2) The known effects of tobacco use and alcohol abuse on the human body,

THE AMERICAN REVOLUTION
A Systems Thinking Unit for 8th Grade Social Studies

Developed by Cathy Eaton & Paula Ghiglieri

The American Revolution is one of history's most pivotal events. This one revolution set off a chain of events that has changed the course of history. However, all too often, the events leading to the Revolution are simplified. Our history has presented the patriots as heroes and the loyalists as tyrants. In fact, the patriots were discontented rebels who resented Britain's reawakening interest in the colonies, and Great Britain was a nation attempting to recoup the cost of war. Taxes and prohibitions passed by the English Parliament were intended to recover some of the losses incurred during the French and Indian War. Prosperous colonists stirred the emotions of other colonists to encourage their participation in the resistance to English rule.

The following are points that are to be stressed during this unit:

• Revolution is a fundamental change—it in no way implies war even though war does often break out as a result of or as a precursor to revolution. In this unit, the signing of the Declaration of Independence is considered the revolution.

• No revolution occurs suddenly. Even though the change may seem an overnight thing, it is one that occurs over a long period of time. The American Revolution actually took from 1763 until July 4, 1776 to evolve.

• Four elements have been identified for almost every major revolution. These elements include a need or very strong desire for change, the support of the people that the revolution will affect, a set of circumstances that make the time ripe for change, and a leader or leaders who orchestrate/instigate/propagate the change—a spokesman who tells the supporting populations what they really need. All four of these elements can be identified for the American Revolution.

• A reinforcing feedback loop is put into motion when one element of a system reinforces or encourages the behavior of another element of the system. Consequently, both elements are moving in the same direction. In the case of the American Revolution, the acts passed by the British Parliament elicited anger from the colonists. The colonists' anger, in turn, served to evoke an angry response from the Parliament. These actions and reactions created a pattern which continued until the signing of the Declaration of Independence.

Learning Environment Objectives

8th Grade Social Studies: Students will

1. analyze attitudes in Georgia toward independence from England and Georgia's role in the Revolutionary war.

2. define the terms Whig, patriot, Tory, and loyalist.

3. explain why Georgia did not become actively involved in colonial revolutionary activities until 1775-1776.

4. describe the events of 1775-1776 that led to the polarization of the Whig and Tory attitudes.

5. explain why families split into Whig and Tory factions.

6. compare and contrast the attitudes of the Whigs with those of the Tories.

7. develop a timeline of events in 1775-1776 that led to Georgia's involvement in the Revolution

8. evaluate the Whig and Tory positions on the issues of 1775-1776.

9. explain the causes of the Revolutionary War.

10. define revolution

11. identify the major events which led to the signing of the Declaration of Independence.

12. analyze and explain the implications of the Declaration of Independence.

13. identify the primary leaders of the American Revolution.

14. identify current revolutions and compare them with the American Revolution.

Systems Thinking: Students will

1. identify reinforcing feedback loops and the elements that create them.

2. identify specific causes of an event or a series of events.

3. identify specific results of an event or series of events.

4. identify which individual or group actions influence an event or series of events.

5. identify how individual or group actions have influenced an event or series of events.

6. list actions within the control of an individual or group that may affect an event.

7. identify how past actions affect the present and how present actions affect the future.

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Gist Curricula, *continued from page 7*

DISASTERS

Developed by Cathy Eaton, Pam Sederholm, and Sherril Sumner

A Matter of Balance

Balance is defined as a state of equilibrium or the conditions that lead to the state of equilibrium. Too often when considering balance, one overlooks balance as a necessary force in systems. In the natural world, the struggle for balance creates prey-predator relationships and the diffusion of water from outside of a cell to inside of a cell. Social systems involve a balance between the needs of the diverse members within the society and the needs of the society as a whole. Political systems within the society are a result of trying to balance viewpoints and attitudes. Our personal lives are motivated toward the need to balance time, finances, and relationships. Balance, or a lack of balance, is a force that drives many types of systems.

As elements within a system become imbalanced, something within the system attempts to reestablish equilibrium. Too often, this adjustment may be quick and uncontrolled or even delayed. This unmanaged or postponed adjustment may create an outcome which is violent or, in social and personal areas, one of anger, discouragement, or disillusionment. If not brought under control, this situation may lead to additional imbalances which, in turn, may create the need for further adjustments. This cycle may continue indefinitely if not regulated in some way. The adjustment to the imbalance causes a disaster, worsens an existing disaster, or creates a sequence of related disasters.

At times, balance may not be the desired outcome. Maintaining a level of imbalance may improve performance within a system. For example, the imbalance between the air pressure on the top of an airplane's wing and the air pressure under the airplane's wing is the force which keeps the plane airborne. If the air pressure should equalize, the plane crashes. An imbalance is also necessary as athletes "psych" themselves up by stimulating the production of an uncommonly large amount of adrenaline in the blood. The increased volume of adrenaline leads to enhanced performance on the playing field. The energy produced by adjusting to imbalance creates positive outcomes in limited circumstances.

In recognizing elements that are imbalanced, one may direct efforts at rebalancing these elements or at using the energy produced by the imbalance. The identification of the imbalanced elements is vital to maximize the positive effects from an imbalance or to minimize its negative effects.

Our purpose in developing this Learning Environment is to bring students to the understanding that they can make a difference when imbalances occur in their lives. If they can identify the imbalanced elements, then students can manage the adjustment to the imbalance or take advantage of the energy produced by the imbalance and avoid or lessen disaster. Of course, within a natural disaster, students must realize that, even though they cannot manage the imbalance, they can, to some extent, manage the additional imbalances which it generates. Students may gain control of their personal "systems" as they become more astute at differentiating those elements that they can change and those that they cannot.

Learning Environment Objectives

Language Arts: The students will:

1. Interpret semantic relationships
2. Recognize explicit and implicit main ideas, details, sequence of events, and cause-effect relationships.
3. Draw conclusions and makes comparisons, predictions, and generalizations.
4. Recognize relevance of data.
5. Recognize persuasion techniques, bias, and stereotyping.
6. Use the writing process: prewriting, drafting, revising, editing, proofreading, and publishing.
7. Use various modes of discourse (personal).
8. Respond to literal, inferential, and critical questions about literature.
9. Describe cultures and values represented in literature.
10. Recognize that literature reflects human experiences.

Mathematics: The students will:

11. Understand the methods followed by good problem solvers.
12. Determine solutions to sentences by trial and error.
13. Determine whether a number is prime or composite.
14. Make a table to find patterns and make generalizations.
15. Work with a special case to determine whether a pattern is true.
16. Use special cases to determine that a property is false or to give evidence that it is true.
17. Use simpler numbers to answer a question requiring only one operation.
18. Use drawings to solve real problems.
19. Draw a diagram to find the number of diagonals in a polygon.
20. Draw a diagram to aid in solving geometric problems.
21. Interpret bar graphs.
22. Display numerical information in a bar graph.
23. Interpret coordinate graphs.
24. Display information in a coordinate graph.
25. Know reasons for having graphs.
26. Plot and name points on a coordinate graph.
27. Graph equations for lines of the form $2 + y = k$ or $x - y = k$.
28. Make presentations from prepared materials.

Science and Health: The students will:

29. Demonstrate skills needed in stress management.
30. Identify health problems associated with obesity.
31. Describe causes and effects of contagious diseases peculiar to the adolescent.
32. Use newspapers, periodicals, and vertical files to obtain current information about environmental health
33. Demonstrate the importance of personal values and individual responsibility to self and others
34. Recognize major symbols, series, scales, and colors conventionally used to represent features on topographic maps and various earth models.
35. Recognize weather phenomena and their effect on the earth's surface.
36. Investigate weather phenomena and the use of meteorological instruments and weather maps.
37. Identify the impact of the physical environment on living things.
38. Examine how human beings affect the environment.
39. Select and use multiple types of print and nonprint sources for information on science concepts
40. Use a grid system to find exact locations.
41. Interprets the key or legend for map reading.

Scoial Studies: The students will:

42. Determine sequence of events and identifies cause and effect relationships.
43. Identify and define a problem related to Georgia Studies.
44. Formulate possible alternatives and solutions to a problem
45. Collect evidence using appropriate, reliable data
46. Cite short- and long-range consequences of alternatives.
47. Choose a reasonable solution from among the various alternatives.
48. Identify areas for future study.
49. Change the solution if new data warrants.
50. Work with others using democratic principles.
51. Use alternative methods of managing conflict.
52. Recognize the right of others to hold differing positions.
53. Present viewpoint to others.
54. Formulate generalizations and conclusions about time in studying the development of human affairs.
55. Relate the past to the present in the study of change and continuity in human affairs.

COMMUNICATION

Developed by Pam Sederholm & Jeff Giddens

Why is it that people—especially students in the middle grades—often have trouble understanding each other? Why is it that very few people ever set out to confuse others but often end up being misunderstood? Just what is it that humans have to do so that they can clearly transmit information to one another? These are a few of the major issues that were addressed in creating this Systems Thinking learning environment.

In exploring the topic of communication, this LE has been designed to promote the following concepts:

1. The world is full of systems.
2. Communication is a system.
3. If any of the components of the system is missing or fails to work properly, the whole system will be affected (i.e., the best possible communication will not occur).
4. To communicate effectively, individuals must be operating within the same system (or at least understanding the procedures that guide another's system).
5. Communicating in verifiable terms promotes clear communication.
6. Clear communication increases humanity's chances for peaceful coexistence with others.

Every attempt has been made to make the LE user-friendly for those teachers who want to give their students a better understanding of how to express themselves. Toward this end, copies of all transparencies, activity sheets, and other curriculum materials have been included in the booklet. The LE was purposely designed as infotainment (or information that entertains). The authors hope that the students who participate in the LE will enjoy learning about the content while simultaneously increasing their communication skills. We also hope that those who use the material will find them both useful and engaging.

WIZ KID MISSION
an introduction to running models on STELLA

Developed by Jan Mons

Welcome. Your team of WIZ KIDS has been hired by The Company to undo a case of industrial sabotage at its factories. Since they work on Government contracts you are not allowed into the factory. The following is an explanation of how the factory operates and special conditions which must be met.

Your team's challenge is to bring the factory up to the desired production within 48 hours. Each factory is a production line with the output form one machine feeding into the next Each machine performs an operation on its input. The operation from each machine is preset but you control the machine's dials, each of which must be set correctly for the whole factory to run at the desired production level. Each machine takes one hour to perform its task, the empties by sending what it has produced to the next machine. The input from inventory into machine 1 is 10. The dials can be set from 1 to 9. You must discover what operation each machine performs and set the dials to get the desired production.

In WIZ KID I each factory has one machine; in WIZ KID II each factory has two machines, and in WIZ KID

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III each factory has three machines and the dials must be set so that production is 100. Less than that and inventory is wasted; more than that for a long period and the machines will burn up.

Purpose:

The purpose of this "game" is to allow the students to see how changing one number in a problem can effect the results. As they begin to study Systems Thinking this "game" will be referred to. It is not necessary however to use this "game" in it's relationship to Systems Thinking.

It can be used as a problem solving activity. Students can use the trial and error method as well as applying what the learned in solving Mission 1 and 2 to solve Mission 3 and the Ultimate Mission.

Prior to going to the computer lab:

The Mission series can be explained using function machines. You will need to do a couple of examples with the whole class. You will also need to explain how to use the worksheet.

Procedure:

1) Talk about a function as a machine in a factory that does one job - say punching 3 holes in a sheet of metal. When you put in a sheet of metal you know what the machine will do to it. In the Mission game every machine adds, subtracts, multiplies, or divides the number put into it by the dial setting.

2) Put the FUNCTION overhead up and do the following example.

Example a)

Machine 1 — adds

Machine 2 — multiplies

Ask the Students to choose Dial settings from 1 to 9. Ask students the following questions and go through the example to find out the Production.

"If we start with 10, what comes out of Machine 1 and goes into Machine 2"

"What comes out of Machine 2 into Production?

Try several Dial settings until the students understand.

Example b)

This time do not tell the students what the Machines do. Let them set the Dials and you just give them the Production. Give the students as many hints as you think necessary. They need to keep changing the Dial settings until they see a pattern. You might suggest that they change only one dial at a time if they don't think of it first. You play the role of the computer and do the operations to get the Production. Use x,- as the operations. You will also need to explain how to use the worksheet as you do this.

SLOPE
a model for algebra 1

Developed by Jan Mons

Purpose:

The purpose of this activity is to give the students some feel for the concept of the slope of a line and the y-intercept of a line without having to do any computations and graphing themselves. The model can be used in the classroom with an overhead screen or in the computer lab with pairs of students at each machine. The worksheets can be done by pairs of students or as a class.

Prior skills and discussions:

Before using the model the students should have been introduced to:

1) The co-ordinate plane.

2) The x and y co-ordinates of a point.

3) The definition of a line without going into formulas.

4) The idea that each line has a slope and a y-intercept.

5) optional - A linear equation in slope intercept form. The tables in the model are set up in "function" form and students are asked to look at the relationship between x, y, and the slope. This should make the introduction of a linear equation easier, so it would be better to wait to introduce the formula.

Procedure:

note: If you are taking the students to the computer lab hand out all the sheets prior to going and answer questions in the classroom first. Step 1 is for the computer lab only.

1) Have students open up the slope model. Allow them to read the first screen and then slide to the right. It is best to do this as a class so that each student feels comfortable using the bottom slide bar. On SCREEN 1 have them go to RUN on the menu, slide to run and release. This first line has 0 slope. Now guide them to move the red slide bar to 1 and do another run. This second line has slope 1. Now the students should be able to complete activity 1 by themselves and move on to activity 2,3 and 4 independently.

2) Included are copies of the student screens in the model and the purpose of each screen.

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We have tried to select the overviews, goals, and a little of the teaching procedures from each of the ten "working" GIST curricula. We hope that your interest has been piqued by the excerpts from these varied learning environemts and that you are as excited about them as we are.

We also hope that any readers who have developed other programs will share them with us and others. In this way we can widen the base of systems thin king materials available to all educators.

The GIST materials are available in disk format from the Creative Learning Exchange. Disks are $5.00 for the first, and $3.00 for subsequeent ones. The materials are also accessible on the internetat the ftp site (sysdyn.mit.edu) or the SDEP World Wide Web page (http://sysdyn.mit.edu).

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If you have stories, ideas, obstacles to avoid, disasters to sidestep, please help us. Seems like we're putting our feet down into some foggy marsh and hoping we land on something solid. There's dampness everywhere.

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Trinity College

A report from John Hienbokel on the systems project at Trinity College in Burlington, Vermont, supported by grants from Jim and Faith Waters.

At Trinity we have experimented with a number of activities within our college curriculum and in out-reach activities to pre-college educators:

1. A STELLA TUTORIAL: this is an interactive (hypercard-based) Tutorial that:

a) guides the modeling rookie through the nuts and bolts of model construction by engaging him/her in the actual construction of a series of progressively more complex models of human population growth, and

b) provides an extensive Glossary feature to serve as an "electronic users' manual". This has been available for a while for the old STELLA II 2.0.x versions; we have just completed the STELLA II 3.0.x edition and are exploring translating that to a comparable Windows application.

2. A STELLA TUTORIAL COMPANION: This is a combination of paper and electronic documentation, illustration, and expansion for the TUTORIAL. It was built in recognition that the support provided by the TUTORIAL for nuts and bolts model construction is necessary but not sufficient to stimulate educators to actually develop or utilize models in their teaching. Each Chapter of the COMPANION is focused on a comparable Lesson in the TUTORIAL and provides a summary of what was presented and how that specific Lesson can be expanded beyond the population growth theme of the TUTORIAL to other systems (ecological, disease, economic, historical, etc.). In addition different ways to present and use models in the classroom are illustrated in the COMPANION. In our experience both the TUTORIAL and its COMPANION are most effective when they serve as adjuncts within a well-organized training program.

3. Training Workshops: We have conducted modeling workshops (at both beginning and experienced levels) for educators from Vermont, Massachusetts, Maryland, Arizona, Ohio, Georgia, and Oregon, have participated in the CC-STADUS program in Oregon the past two summers, and have begun working with a group of New Hampshire teachers this fall. The approaches we use with the two levels of workshops are quite different and, indeed, are currently evolving to new, and hopefully more efficient and productive, forms:

a. "Rookie Workshops": These traditionally have been conducted over an intense one-week time span during which we guide the teachers in working through a progressive series of human population growth models, in illustrating how the lessons of those human models can be extended to or connected to other fields of study, and in modeling through example how the computer models can be used to support enhanced learning in the classroom. With the availability of the TUTORIAL and its COMPANION, we now believe that we can realize some significant economies of time and energy in this process. We are planning to offer a significantly modified training program in the summer of 1996 to support groups of teachers from interested schools and districts who wish to develop their modeling expertise.

b. Experienced Modelers: We have convened groups of experienced modelers from the middle and secondary teaching ranks on two occasions to explore how to support the development of enhanced modeling skills and to encourage individuals to develop models that effectively cross traditional disciplinary boundaries. The most recent workshop brought together high school and middle school modelers for two weeks at Trinity in August 1995. This was a productive experiment not least because it has pointed us in a somewhat different direction for the summer of 1996. We are not planning to convene a single workshop but a set of workshops (separate ones for high school, middle school, and perhaps elementary school teacher). We anticipate that the groups would overlap a bit in their presence at Trinity, but that each group would be committed to the development of one or more ambitious models that would have immediate and significant applicability at their grade level.

4. Curricular Experiments at Trinity College: We have several underlying beliefs that color many of our college-level experiments:

a) entire curricula can and should be based on systems modeling;

b) systems modeling can admirably support the breaking down of traditional disciplinary boundaries. Everyone talks of this as being beneficial, but relatively few college and high school programs are actually moving in this direction (for all sorts of good and not-so-good reasons!); and

c) by beginning with small, simple, but significant models and building progressively more detail and realism as a course proceeds, you can eventually engage the students in the actual building of models, not just their ma-

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nipulation. In the hierarchy of things, building your own model is better than manipulating someone else's which is better than just talking about the system. Our two major experiments have been:

1) "Plagues and People" — a look at how disease (epidemics, specifically) have influenced the course of human history. We finished with a month-long exercise to model the spread of AIDS in the US.

2) "Population Growth and the Human Experience" — last spring (1995) we chose this topic so that we could productively tie the course to our TUTORIAL (which is population-based in its progression of modeling exercises). By this mechanism we managed to provide modeling training to our students while still covering relevant content material early in the semester. In the course we explored the dynamics of human population growth in a number of historical contexts; examined the interaction of population growth and the development of US agriculture; and tried to transfer our resulting understanding of the historical dynamics of the US to a scenario of a currently developing country, Malawi. In both this course and the preceding Plagues and People the predominant student learning stimulus came from the students need and desire to explore or create appropriate models of the interdisciplinary suite of topics that comprised the course.

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Please join the K-12 Discussion Group

The Internet discussion group at **k-12sd@sysdyn.mit.edu** has been rather inactive. Professor Forrester hopes in the next few weeks to establish a much more useful flow of communications. Part of the weakness so far comes from the small fraction of participants who are teachers. We need more people who are active in K-12 education.

The following are among the topics that should be exchanged:

1. Reports of experiences—successes, interesting vignettes, problems, failures.
2. How best to introduce systems and modeling to students.
3. How to encourage colleagues to use systems education.
4. What organizational structures contribute to learner-centered learning.
5. What classroom techniques work best.
6. When does the learning curve steepen for students and teachers.
7. What materials are most effective.
8. What research would help systems education and learner-centered learning.
9. What assessment techniques are effective.

Send request to join to: **nlux@mit.edu** (Nan Lux). When contacting Nan Lux, please send the following for the database: First Name, Last Name, Title, Organization, Street, City, State, Zipcode, Country, Day telephone, Evening telephone, Fax number, Email address

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