the Creative Learning EXCHANGE

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SYSTEMS THINKING AND SYSTEM DYNAMICS IN K-12 EDUCATION

A study supported by The Waters Foundation—School Year 95-96—by Mary Scheetz

During the 1995-96 school year, a study was conducted in twelve school districts around the country that are integrating systems thinking and dynamic modeling into their programs. Educators were interviewed about their efforts to gain an understanding of systems thinking and dynamic modeling and the planning and implementation of instructional and organizational strategies that would incorporate the systems tools and concepts.

The settings for the projects involved in this study vary greatly. In each setting, the initial motivations for exploring potential uses of systems thinking and dynamic modeling were prompted by a variety of individual perspectives and circumstances. Some projects are just beginning and others have been in place for several years. Once the initial efforts were under way, continued efforts were varied and projects took on individual personalities. The summaries of the twelve projects involved in this study reflect one or more of the following types of applications of systems thinking and system dynamics:

- concentration on developing and improving classroom applications of computer modeling related to the dynamic concepts of systems thinking.
- development of formal training programs and the offering of workshops to teachers in their schools, their districts, their states, and even beyond.
- focus on a broad range of applications of systems thinking and dynamic modeling in both classes and in organizational planning, decision making, and reform.

No matter the approach taken or the amount of time that projects have been in place, there is a sense of purpose and commitment evident in all of the projects. All involved are convinced that the potential for systems thinking and dynamic modeling to affect learning is great and that we have just begun to scratch the surface of the possibilities. Given the uncertainties and the dynamics of the initial stages of innovation, the educators involved in these projects are working hard to maintain an attitude of respect for differing approaches as well as an eagerness to share whatever ideas, materials, and resources they have with anyone who is interested. The collegiality and collaboration that is demonstrated among the

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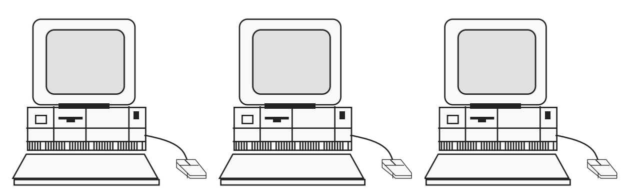
Bucks for Bytes: A model to explore strategies and ideas about Technology Acquisition

by Matt Hiefield, Sunset High School, Beaverton, Oregon



In the field of education, technology is being integrated in schools throughout the country. Students are being challenged to learn in new and innovative ways and are being exposed to whole other worlds outside of the classroom. However, computer technology itself is changing at a quick pace, and older computers (as a

***Technology** continued on page 11*

From the Editor . . .

As the school year winds down (or intensifies) to a close, we can look back on an active year for systems education in K-12. Many school systems are immersed in their first steps toward incorporating the concepts and practice of systems in their schools.

As you can see by the lead article, Mary Scheetz spent over a year chronicling the history and philosophies of many of the districts across the country which are involved. We have featured her introduction as well as a description of one of the sites, Carlisle, Massachusetts, in this newsletter. In future issues we will present the summaries of the other districts. In the meantime, we encourage everyone to download the whole paper from the Web or to order it from us.

As you can see from the other articles in this bountiful issue, there are schools systems we haven't heard from before who are actively pursuing systems education. It is exciting to get input from them—as well as to feature teachers such as Jim Trierweiler from Carlisle, whom we have known for years.

Enjoy your summer, get refreshed and rejuvenated, and most of all—learn something interesting.

Lees Stuntz *(stuntzln@tiac.net)*

Updates. . .

GIST

As we are ending the fifth year of our project, we have been spending time examining what has been done and planning for the next five years. Two years ago we became a Waters Foundation Grant program and added a full time Mentor. The funding and networking with other projects that has occurred because of this has accelerated our growth. This summer a group of teachers will be getting together to create a map of the Project's Desired Results and identify Leverage Points we need to concentrate on in the future. Our project currently serves three middle schools with a student enrollment of 2600 and an academic faculty of 98 teachers.

One of the major learnings has been that although the Learning Environments (LEs) created by the Core Team are good and provide ST/SD activities for the classroom, their use does not guarantee sustained or increased use of the tools in classrooms. For this reason our energy has been divided into four areas this year:

- Rewriting the LEs with the help of interested classroom teachers to make them more user friendly and flexible.

1. Rewriting the sixth grade interdisciplinary environmental unit, EATORDIE Island, to include an introduction to the tools and vocabulary of Systems Thinking and Systems Dynamics (ST/SD). Sixth grade teachers who use the unit have been involved in helping to rewrite it this year. Currently 7 of the 11 teams use this unit.

2. Rewriting Financial Dreams or Budget Nightmares (FD&BN) to add more ST/SD activities. Two of the seventh grade teams have field tested the new FD&BN this spring, rewriting and adding to it as they taught it. They will assist in training and supporting other teams who choose to use it next year. Currently 4 of the 8 teams use this unit.

- Assisting teachers in creating materials to enhance and assist with what they are already teaching in their classrooms. In this area we have been working with teachers who have taken the summer courses in ST/SD to help implement lessons they created this summer and to create new lessons. These materials are being field tested by the teacher who created them with plans for editing this summer. These materials are for single academic subjects and take less time, so we hope other teachers might be more willing to use them. Some of the larger units are:

1. The use of BOTG in the study of novels. Work has been done with at least one novel at each grade level.

2. The use of BOTG in helping the seventh grade gifted students prepare for Model UN. A study of each country was done using factors identified as leading to a country's success and BOTG were used to look at connections.

3. A Dynamics of Conflict (Why wars start) unit was designed and field tested with an eighth grade class. The students were divided into groups and each group looked at the factors leading to the beginning of each war the United States has been involved in. The class then created a generic map of the probability of war and decided on leverage points that could have been used to avoid each of the wars.

- Increasing the understanding and use of ST/SD by the Middle School Administrators and District Instructional Services staff. We feel that the more these people use the tools and processes in their work with teachers and in their planning, then more teachers will see the connections and uses of ST/SD in their classrooms. Mary Scheetz has been conducting training sessions with this group on her visits to Georgia. We believe that the Organizational Learning applications are a vital part of the project's growth.

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Summaries of ST/SD Projects in K-12, continued from page 1

projects is rare in the world of education.

One of the elements found in all of the projects studied is a process of learning that is consistently described as challenging. The process often begins with acquiring the skills necessary to build computer models that enhance curriculum and instruction.

Depending on an individual's technological expertise, model building can require a new set of skills and time to practice the skills in order to develop competency. However, the challenges seem to go beyond modeling skills and involve a realization that dynamic modeling is based on a "shift in thinking," a new paradigm for planning instruction and in many cases, a new paradigm for decision-making and problem solving within the school or school district.

The strategies used to address the necessary "shift in thinking" differ from project to project. However, there is always some type of task analysis of the knowledge, skills, and perspectives involved in dynamic modeling and a conclusion that instructional strategies can and should involve tools and concepts that lead to the type of thinking required in dynamic modeling. In addition, the conclusion of educators involved in this work is that systems thinking/system dynamic tools and concepts can be incorporated throughout a K-12 education. A prevalent goal among the projects is a desire to contribute to producing students who are not only better able to understand and create dynamic computer models, but also who are able to apply this understanding in a variety of ways to a variety of situations.

Throughout the projects there are many people who love to learn, who are willing to test out new ideas, and who are extraordinarily willing to support the new ideas of others. Virtually every project began with one or more teachers who were introduced to dynamic modeling and who followed up by creating classroom applications. Classroom applications have often been accompanied by staff members utilizing systems thinking and system dynamics concepts in organizational situations as well. In some cases, teachers had to seek out training. In others, interested individuals or businesses in the community were supportive and provided opportunities for training. In all cases, a high level of commitment and a great deal of patience were demonstrated by the individuals who began the projects and who sustained their efforts over time in order to work through, and to help others work through, the challenges of change and learning.

Samples of Quotations From Project Participants

The first set of quotation samples reflects the degree to which people in these projects are living the concept of being lifelong learners and the idea that great benefits can come from learning together. There is a strong belief that educators can create classrooms and schools that work better for students and for adults as well.

"Using system dynamics must fit in a curricular context, not just added, but within a planned framework."

"To develop the capacity to create fundamental changes at the classroom, school, and/or district level, several kinds of support are critical: ongoing staff development, easy access to tools such as computer software, telecommunications, books, etc."

"By not rushing we have been able to experiment with 'how to' make systems thinking and system dynamics meaningful to students and teachers. We have attempted to demonstrate how systems thinking and system dynamics can enhance what is already going on in classrooms, not replace it."

"Learning is not easy, it takes time. It's not a workshop; you pick up some of the concepts and use parts of it as you continue learning, trying, adjusting."

"It takes a lot of work and time and teacher training is very important as well as consistent practice. Learning together builds trust; is refreshing. All of this 'together' feeling fosters a spirit of cooperation."

Those who use systems thinking and dynamic modeling in their classrooms are risk takers. They create environments and utilize instructional strategies in which there may not be one right answer and questions may be asked that surpass the teachers' immediate knowledge or understanding. They take these risks gladly because they see the short-term learning results for students and the potential long-term results of developing skills and attitudes that will help students deal with the complexities of the world in which they live.

"Young children can understand concepts of systems thinking. They enjoy building meaning from use of systems thinking tools."

"Using systems thinking and dynamic modeling has changed the way I ask questions as a teacher."

"When using system dynamics models, there is an immediate student interest and facility in learning. There is a willingness on the part of students to recognize and talk about complexity and interdependency of issues."

" This is like teaching someone to drive via 'What do you think will happen if . . .?' vs. 'Stop! Don't! Turn that way!!!' "

"It allows me to approach prob-

Summary *continued on next page*

Summaries of ST/SD Projects in K-12, continued from page 3

lems in classrooms that are beyond the normal scope of the course and the normal skills of high school students AND the results include greater student understanding."

"Students' thinking is shifting to a more analytical style. They are better able (and more inspired) to look for deeper meanings and cause and effect interrelationships."

"I now look at math as change over time. It connects the functions, and applications seem to be natural."

Many of the project participants don't seem to be able to use systems thinking and dynamic modeling in the classroom without seeing implications for needed changes in the way we structure schools and the way we operate within those structures. It's much like Deming's idea that we have to change the way we think before we can change the way we work.

"Breaking down the barriers is slow but we can begin by training people in cross-disciplinary groups so that they have the experience of seeing what is possible when people work together."

"Using organizational applications helps us to model behaviors we want from students, including being lifelong learners."

"Support for systems thinking/system dynamics should be reflected in overall mission statements and system-wide goals. There should be a coordinated effort to steer the overall system in the direction of systems education practices and experiences."

"Developing a common vocabulary through systems thinking is very powerful. . ."

"Prior to incorporating systems thinking, the administrators were clearly focused on their divisions, as opposed to their first focus being the school in its entirety."

"I think there is a greater willingness on the part of my fellow administrators to weigh the impact of their decisions on areas other than those for which they are directly responsible."

"This used to be a collection of classrooms - it's now a school community. There's a greater consistency, more shared ownership."

Participating Projects

The following projects participated in the 1995-96 study. Educators from these twelve projects have communicated, collaborated, and shared resources for several years. At least thirty more projects are known to have started over the past few years. Several of them have been motivated and/or assisted by representatives from the projects listed here. Based on informal communications, it is assumed that a number of other projects have also started or perhaps have been in existence for years but have not been a formal part of the network that has been developing.

- Acton Public School District and Acton-Boxborough Regional School District, Acton, MA
- Carlisle K-8 School District, Carlisle, MA
- Catalina Foothills School District, Tucson, AZ
- CC-STADUS/NSF Project, Portland, OR
- Concord Middle School, Concord, MA
- Concord-Carlisle Regional School District, Concord, MA
- Glynn's Integration of Systems Thinking, Brunswick/ Glynn Co., GA
- Harvard School District, Harvard, MA
- LaSalle College Preparatory School, Portland, OR
- Lawton Elementary School, Ann Arbor, MI
- Maumee Valley Country Day School, Toledo, OH
- Willard Elementary School, Ridgewood, NJ

Summary Format

Setting: Representatives of each project provided information about the community in which their school(s) are located. The purpose of this description is to provide a context for the project summary.

School/District Goals/Philosophy: Additional context is provided by the goals and/or philosophy of the schools involved in the projects. It should be noted that a great number of the school goals have direct connections with systems thinking and dynamic modeling.

Project Goals/Philosophy: The individual "project personalities" can be partially viewed through the project goals and philosophy. Each project has identified the goals that best suit the needs of students and staff at this point in time. The goals are also greatly dependent on the length of time that the project has been in place.

History of Project: The story of each project has been based on interviews and discussions with project participants. Evident in each of the histories are key people and events that stimulated the initial efforts and have served to sustain the projects over time.

Quotations: Participants from each project responded to the following survey questions: What do you believe have been the most notable results produced by the efforts to implement systems thinking or system dynamics in the classroom and/or the organization? For you, what have been the most important learnings that occurred because of the efforts to understand and implement the concepts of systems thinking or system dynamics in your classroom or your organization? From your perspective, what have been the most important challenges that had to be addressed and/or what are the most important challenges that still must be addressed? The responses reflect images and information about each projects that are not included in the more formal project history.

Acknowledgements

The projects described in these summaries have benefited greatly from the support that has been provided by many experts in the fields of systems thinking and system dynamics. Those experts and hundreds of K-12 educators owe a debt of gratitude to the pioneers of system dynamics whose belief in the value of systems thinking for all K-12 students and whose encouragement of the adults who work with those students have been crucial factors in both the beginning and sustaining stages of systems thinking and dynamic modeling projects in schools.

Dr. Gordon Stanley Brown (1907-1996), who pioneered the theory and practice of feedback dynamics and engineering control systems at the Massachusetts Institute of Technology in the 1940's. Brown went on to be head of the Electrical Engineering Department and Dean of Engineering at MIT. During retirement, he devoted energy and skillful leadership to bringing system dynamics into the Catalina Foothills School District in Tucson, Arizona.

Dr. Jay W. Forrester, Germeshausen Professor, Emeritus, at the Massachusetts Institute of Technology, directed the system dynamics program at the MIT Sloan School of Management until 1989. He is the founder of the field of system dynamics. He also holds the patent for magnetic core memory, which for many years was the standard memory device for digital computers. Since his retirement in 1989, Dr. Forrester has worked to bring system dynamics into classrooms through the Pre-College Education Project at MIT.

Excerpted for this issue is the summary from the Carlisle Public Schools.

CARLISLE PUBLIC SCHOOLS
Carlisle, MA

Setting

The K-8 Carlisle school district is located in a suburban community outside of Boston, MA. The three main buildings on campus house 230 students in grades K-2, 250 students in grades 3-5 and 210 students in grades 6-8. Beyond the eighth grade, students attend Concord-Carlisle High School.

District Mission Statement

The mission of the Carlisle Public Schools is to structure our school in order to promote student success by engaging them in meaningful tasks. When tasks are meaningful, students will invest their talents and energy and thereby gain the skills and knowledge which are valued by the larger society and which will enable them to thrive and compete in the 21st century.

Broad Objectives

- Commitment to the belief that all children can learn and that it is our responsibility to ensure that every child reaches his/her maximum potential.
- Develop a core curriculum and engage in instructional activities characterized by high expectations and quality student performance.
- Promote a learning environment that is respectful of diverse student needs, abilities, aptitudes, and learning styles.
- Create a system of continuous assessment and improvement of education for the student, teacher, and the community with the goal of developing a society of life-long learners.
- Facilitate professional growth and development of all members of the school community.
- Develop operational, planning, and management strategies that enhance instructional excellence.

Vision Statement

The mission of the Carlisle Public Schools is to develop a society of life-long learners who possess the behaviors, skills, and knowledge essential for contributing members of a democratic society and a global economy.

Project Goals/Philosophy

Initial ideas included moving students from data collection to plotting information to making predictions to system dynamics. The sequence was one of experience, model, predict. Models were used as a tool to get kids thinking systemically. Current goals are to expand the use of systems thinking and system dynamics in both the classrooms and the organization of the Carlisle School District. The expansion process will include the identification and implementation of elementary applications of systems thinking and system dynamics as well as additional middle school applications. Throughout the process, efforts will be made to clarify curricular and instructional goals, as well as overall school goals and to match the tools and concepts of systems thinking with those goals.

History of Project

Interest in systems thinking/ system dynamics for one Carlisle teacher began in the early 80's through a course taught by Nancy Roberts. Additional information about applications of systems thinking and system dynamics in schools came with the Systems

***Summary** continued on next page*

Summaries of ST/SD Projects in K-12, continued from page 5

Thinking and Dynamic Modeling Conference that was offered in Concord during the summer of 1994. Conversations following that conference included ideas from The Fifth Discipline and the potential of connecting systems thinking/system dynamics to the development of a learning organization. The concepts seemed appropriate for an approach to a vision for the school district. District teachers also attended summer workshops for more intensive training in computer modeling.

During the 1994-95 school year, applications of systems thinking/ system dynamics were started in middle school math and science with the development of models for use in the classroom. Two interested parents with system dynamics background became mentors for the project. A study group of interested teachers and administrators began to meet on a regular basis with the community mentors for workshops, dialogue, and practice of applications. The project was set up on a basis of learner-centered learning, letting educators learn to model when they were ready and needed to use it. The availability of the mentor as a resource and the time for teachers to really understand modeling were considered very important. Additional community involvement has been invited through the implementation of a yearly forum, the first of which included Peter Senge speaking on the topic of needed changes in schools in order to educate students for their future. Break out groups during that forum brought community members and teachers together for dialogue. The intent of the forum was to create a feeling among all participants that significant change could be created together. Teachers continued classroom applications and attended another summer workshop in computer modeling.

A new teacher in social studies helped to extend the applications during the 1995-96 school year. The study group described above has continued to meet and is beginning to acquire and develop examples of instructional materials and strategies for more and more subjects. Students are asking to use the models and other tools and concepts in a variety of units of study. Ideas for organizational applications are also being studied. The shared experience of the teachers, administrators and two interested community members in their efforts to learn about and create models has been very important. It has been a translation of verbal support into active support. In some instances, the group has analyzed existing models borrowed from other schools as a vehicle for discussion and learning.

In addition to in-district efforts, a consortium of local school districts has served to encourage applications of systems thinking and system dynamics and to provide and share ideas about a variety of applications. An offshoot of the consortium is a state grant for the 1996-97 school year to further develop applications of systems thinking/system dynamics for middle school mathematics.

Plans for the 1996-97 school year also include expansion of the project to the elementary classrooms. Administrators and several teachers from both the middle school and the elementary school will attend the Systems Thinking and Dynamic Modeling Conference during the summer and will meet in August and throughout the school to continue development and analysis of systems thinking and system dynamics and to plan for applications that seem to best fit the Carlisle School District.

Quotations from Project Participants

Notable Results

• *"It has begun to permeate the way in which we think even though we haven't figured out all the ways to get it into the classroom."*

• *"By using the models, it's possible to see the problem more clearly, have deeper understanding. It's an extension on lab experiences."*

• *"Showing kids the model gets them thinking about all the factors that affect one another. It requires really understanding instead of memorizing."*

• *"Using models can lead to recognition of patterns of behavior."*

• *"The district atmosphere is important - it's one of encouraging teachers to try things."*

• *"Flexibility of mind is one of our values."*

• *"People here are generous of spirit and time, willing to collaborate."*

• *"We used to make up things for interdisciplinary units, this is real. We are looking for universal patterns that transcend disciplines."*

• *"Using organizational applications helps us to model behaviors we want from students including being lifelong learners."*

• *"This used to be a collection of classrooms - it's now a school community. There's greater consistency, more shared ownership."*

• *"We're trying to question teachers to get at what they want to teach, what they want students to learn."*

• *"We're also asking ourselves, what makes classes work or not work? What are the variables? How could we use systems thinking?"*

Individual Learnings

• *"Understanding underlying structures gives students a sense of control."*

• *"K-12 articulation is essential, we need to learn about what's important at the early grade levels."*

WELCOME TO SYM BOWL 97!

Most of you know that we ran the first "SyM Bowl," (Systems Modeling Bowl), a competition among high school SD students in the Portland OR area, last April. Although we pretty much made it up as we went along, the event itself went like clockwork. This year's event will be almost a carbon copy, although including what we hope will be incremental improvements.

SyM Bowl evolved from the CC-STADUS (NSF) grant here in Portland, in which we have been training high school teachers in System Dynamics. Teachers are expected to build their own models (in small groups), with the ultimate goal of developing new cross curricular (CC) materials. In addition, they are encouraged to *use* SD models, tutorials, etc. in their classwork, to encourage high school students to build their own models, and as resources and expertise become available, to teach courses in SD modeling and simulation.

SyM Bowl 96 was held at (and co-sponsored by) Oregon Health Sciences University (OHSU) and the Portland VA Medical Center. (I am a Research Pharmacologist at the Portland VA Medical Center and Associate Professor at OHSU). My not-so-hidden agenda is to simultaneously increase the visibility of SD within the biomedical community. SD has tremendous potential in this realm, but so far is under-recognized.

The SyM Bowl Concept

Teams of 2-4 students identify a problem (any area), identify reference behaviors, find experts and reference materials, build a model (simple to start with!), state assumptions, discuss parameter values, conduct sensitivity analyses, consider loop behaviors, and draw conclusions.

Wayne Wakeland, Ph.D., Systems Science Dept., Portland State University, is the judging supervisor. Six judges are drawn from PSU, OHSU, local SD consultants, and teachers.

We have worked long and hard at developing what we feel are appropriate criteria. However, we will be actively seeking evaluations and suggestions from many of you in the next few months. We want to be sure that this program encourages good modeling practice, and does not evolve into a flashy competition with no underlying substance.

The Event Itself

A paper (50%) is required (1 week in advance). The writing, formulation of the problem, etc. provides 25% of the score; modeling expertise provides 25% of the score. Papers are evaluated before the day of the event.

Poster presentation (25%). On the day of the event, teams present their models in an open-house forum (9:00-

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Summaries of ST/SD Projects in K-12, continued from page 6

• *"We would like to create a model for each archetype."*

• *"It's like learning to read, it gives you another lens, another way of looking at things."*

• *"It makes math and science a part of everything else."*

• *"It's a useful way for getting people to check out assumptions."*

• *"It's a vehicle for working with other disciplines. It opens up conversations."*

• *"It's a forum for talking objectively about complex and/or controversial subjects?"*

• *"It helps you to get underneath the language. What are you really thinking?"*

• *"We value ways to make learning connected."*

• *"An incomplete model can be an effective learning tool."*

• *"There's value in some of us being good at modeling, it keeps us from being fuzzy."*

• *"It's like music, few people are virtuosos, but lots of people enjoy playing an instrument at their own level."*

Challenges

• *"Learning it is not easy, it takes time. It's not a workshop, you pick up some of the concepts and use parts of it as you continue learning, trying, adjusting."*

• *"In reality, systems thinking is the difficult part, it's changing behavior. System dynamics is the discipline to get there."*

• *" . . . working with adults and students who are new to systems thinking/system dynamics and remembering how it was to not think that way and trying to bridge the gap ."*

• *"We have gone from 40 early release days to 9 or 10. We are trying to synthesize professionalism and budgeting realities. It's a shared responsibility to find the time to continue learning together without release time."*

The entire text of this article is available from the CLE and the web site (*http://sysdyn.mit.edu/*). The 8-character title is SUMMARMS.

THEME PARK DYNAMICS

St. Louis, Missouri

This came to us through the K-12 list (see box below for sign-up information). I have included it here, as well as the reply from George Richardson. We hope to have a follow-up in the next newsletter with the models the students are actually creating and their insights gained from the models.

I am doing a unit on theme park dynamics using STELLA to model systems inside the park—such as the flow of people in and out of gift shops, game booths, etc.

We are currently in the process of analyzing the systems (rides, game booths, restaurants, shows, and gift shops) to determine what elements are variable and constant. Knowing this will assist them in determining what elements (as a park designer) they have control over.

We also surveyed over 1000 people at Six Flags to gather data to support the decisions they make for their final projects—innovative parks for the year 2015—which solves the flow problems we see in parks today. booths, rides, restaurants, and shows.

The kids (5th grade gifted) did really well setting up the models, collecting data at Six Flags, and writing the equations (with some help from me).

Question: Any ideas of how we can use these models now to redesign each system to make it more efficient? For example, one group experimented with two elements in their system (rides)—first, the number of seats in each car, and second, the length of the ride cycle.

They concluded that the number of seats impacts the length of each queue the most. They figured that they should redesign the system by designing a coaster that has more seats per car.

It seemed difficult to get the kids to do the experiments. I challenged them to choose two constant elements in the system and change each one one at a time. They looked at how the flow of people change: did the number of people waiting in each queue change? did the amount of time waiting in line change? did the number of people exiting each hour change?

It was really hard for them to support their conclusions about which element affected it the most. Anyone have any ideas of how to help facilitate this better?

Art Schneiderheinze
Gifted Education Teacher 5th grade Center for Creative Learning
cct18@mail.rockwood.k12.mo.us

On redesigning the system to work better

The kids would probably have to enlarge their system boundary to get good answers on system redesign. For example, if one put more seats in the cars (or more cars per ride), then waiting lines might initially be shorter, but that would attract more people to this ride, and waiting lines would get long again. Presumably waiting lines are the result of the overall relative attractiveness of the ride, relative to the others in the park, and waiting lines are part of that relative attractiveness.

If the kids redesign the system to have more cars but don't have the relative attractiveness idea in there, or the notion that people attracted to the ride per unit time is a variable, then they would miss this compensating effect.

In the long run what we're after is habits of thought that seek out and identify effects that will tend to compensate for policy initiatives. I'm not sure how one would work with the kids on this modeling project to get them to this sort of thought process, but it's the goal nonetheless.

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Opportunity for Neo-Renaissance Person

Democratic, alternative high school in Seattle, is expanding over the next couple of years, with openings in several curriculum areas. See *http://www.novaproj.org/*

Currently interested in math and science, particularly. Interested parties please contact Chuck Estin at: *cestin@cks.ssd.k12.wa.us*

Anyone with Systems in their blood interested in exploring a Seattle connection?

K-12 DISCUSSION GROUP

A lot of information comes to us from the K-12 Discussion Group Listserve, such as the above discussion of theme park modeling. You, too, can become a part of the K-12 Discussion Group.

k-12sd@sysdyn.mit.edu

To join contact Nan Lux: ***nlux@mit.edu***

JIM TRIERWEILER, CARLISLE, MA

Jim Trierweiler, an eighth grade science teacher in the Carlisle, Massachusetts, schools, has an interesting approach to teaching and grading. I talked with Jim for an hour or so and thought a description of his approach might give other teachers ideas and start them thinking about their classroom as a whole.

Although his science class is heterogeneously grouped, he teaches honors plus eighth grade science. Jim uses Investigations in Physical Science(IPS) with additional challenges added to every lab and test. He sets high standards and gets high results. In order to do so, he teaches over the top of the highest achievers. (Incidentally; he says when they come in he really doesn't know who they are. The highest achievers are not necessarily those who have been labeled the smartest.) He treats all students as geniuses and hopes for the best.

Jim's philosophy of education is to get as many students as he can close to their highest achievable functioning, the top of their intelligence range. He feels that this is the duty of the educational system for the good of the society as a whole. He wants students to realize that it is the effort they put in which determines what they get out of the class. He tries to break down the internalized stereotypes held by students. Students who think that they are smart think that's why they get good grades. Students who think that they are dumb think that the only grade they can get is a bad one. He wants students to understand that the harder they work, the better they become.

Jim believes that if a teacher sets high standards and the students do not take ownership of their work and responsibility for their learning, then the teacher's standard will not be met by half the class. In order to create the atmosphere where the students assume responsibility, he has the students keep track of their own grades. It is their education. He wants to move the locus of control from external control to internal control.

The students have portfolios of their work in the classroom. In them, the students keep track of their own grades on their own grade sheets. Jim just keeps his eye open to possible cheating. All their work is on file in their portfolio, which makes it easy to check.

Jim developed this technique because he didn't like the fact that students were constantly coming to him and asking how they were doing. He felt that that exhibited the wrong attitude. The students should know how they are doing and what to do to improve. He utilizes a traditional grading system. He tests knowledge via tests and quizzes. The labs are based on applying what they are learning to the real world. A lab score is in addition to a knowledge score on the report card.

If a student gets below a 90, the student may make that up. Jim feels a second chance is part of his basic philosophy. Very few things in life, for adults or for students, are learned the first time through, and yet how many of our structures in school are designed around the one and only chance to prove what the students know?

If a student does poorly and panics when taking a test, where is the learning for the student? Sometimes the second chance is written and sometimes it is oral, especially for poor readers. When the students really understand and can demonstrate it, it is a big boost to self-esteem. Jim feels since he has instituted this, students work even harder to do their best the first time.

In classes with a full range from Special Education students who are virtual non-readers to the very gifted, he no longer has discipline problems with his integrated approach. His approach goes beyond a grading system which encourages students to take control of their own learning.

He feels that if he gave his course, individually, to any of the students in it and they had to do it all on their own they would each fail. He utilizes the variety of gifts which students have. He finds boys, girls, and students with different interests all have different ways of looking at problems. They ask different questions, all of which are needed to solve the problems Jim proposes to his cooperative teams.

He assigns four person teams and always has one of the highest achievers and one of the lowest in each group. The teams work together for a minimum of two units, so that they can learn to work as a group.

Jim tries to propose questions to the teams which none of his students, even the most gifted can answer right away. He feels he is successful if he has done that. He tries to make it so hard that everyone on the teams is dependent on each other to come up with the solution. He finds, when he proposes such questions, by the end of the period the heterogeneous cooperative groups have constructed the answer from their combined strengths.

One of his techniques to promote individual accountability in the cooperative teams is asking questions of different students every time. In his teaching, while the teams are discussing the problem and afterwards when they have their solution, Jim is very careful to continually rotate the students he calls on to answer questions. In traditional classes one or two students routinely answer the bulk of the questions. This encourages most students to sit back and let those few students do it.

At the end of every unit this talented teacher asks his students and himself the question, "And how could I have done it better?" He maintains the feedback from students and parents is invaluable in his never ending process of improving the learning in his classroom.

SyM Bowl '97, continued from page 7

11:30). Each team has a table and a computer, and they develop a background poster to illustrate their project. This session is open to the public, and students are encouraged to circulate and observe other projects. We had 16 teams (42 students) last year. (Ideal size = 15-20 teams.)

Formal presentation (25%). Five finalist teams are selected during lunch. Each team then presents a 15-minute talk (overhead transparencies) to the whole audience in an auditorium. After a 30-minute break we conclude with an awards ceremony.

Awards include certificates for every participant, plaques for each individual on the five finalist teams, STELLA for each individual finalist (generously provided by HPS), and cash prizes for each individual on the top 3 teams ($250 1st, $150 2nd, $75 3rd). (Note that prizes go to each individual, not to teams, to avoid encouraging a team of 1 or 2 to increase the share; these kids are not dumb!)

SyM Bowl Foundation

As a result of SyM Bowl 96, and presentations at the K-12 System Dynamics and Systems Thinking meeting at Wheaton College (June 96) and the International SD Meeting (Cambridge, MA, June 1996), we have received offers for several donations. Unfortunately, we did not have the infrastructure required to accept these donations. This led to the establishment of a non-profit corporation (SyM Bowl Foundation), with an initial Board of Directors, and a pending application for non-profit 501(c)(3) status from the IRS.

Our intention is for SBF to serve as the umbrella for similar events elsewhere. We hope to provide materials, schedules, judging criteria, etc. for other interested academic or community groups. Future groups will need some semblance of organization (as a chapter of SBF, for example), but will *not* have take on the burden of IRS approval, etc. This structure will allow us to seek donations and apply for grants.

(If anyone has the irresistible urge to send a donation, checks should be made out to SyM Bowl Foundation, and mailed to:
SyM Bowl Foundation
12140 SW Merestone Ct.
Tigard, OR 97223)

Scheduled Visitors to SyM Bowl 97

- Nan Lux (MIT) will attend. Nan is going to work with our local VA and OHSU video people to collect footage of this event. We would like to see this evolve into a program suitable for teachers, administrators, and perhaps local cable access (ours and yours).
- Lees Stuntz, Executive Director of the Creative Learning Exchange, Acton, MA.
- Allen Boorstein (NYC), a friend to SD and education and an enthusiastic supporter of SyM Bowl.
- Mom (Seattle, WA).
- Will Costello will be bringing a team of students from Vermont! We are delighted at the chance to see their work, and to let them participate in this event.
- Steve Peterson, of High Performance Systems, Inc., will attend and will serve as a judge.
- Various teachers and student visitors will be attending from around the NW (from Seattle, WA to Roseburg, OR, etc.).

Invitation

If anyone has an irresistible urge to come see what is happening, please feel free. (Don't wait for the video!)

SyM Bowl '97 April 25, 1997
OHSU - 9:00 p.m. - 4:00 p.m.

Ed Gallaher, Ph.D.
VA Research Pharmacologist
Assoc. Prof., Physiol/Pharmacol and Behavioral Neuroscience
OHSU
gallaher@teleport.com

1998 Systems Thinking and Dynamic Modeling Conference

June 28-30
New England Conference Center
University of New Hampshire
Durham, New Hampshire

The summer conference for 1998 will be held on the lovely wooded campus of UNH. Durham is just a little more than an hour north of Boston. The Center itself affords excellent meeting facilities with comfortable rooms and delicous food. Registration for the conference will start in the late fall of 1997.

Technology Acquisition Model, continued from page 1

capital expenditure) are quickly becoming outdated. With a finite supply of funds, educators are trying to figure out the best use of technology and are wrestling with several vexing questions:

1. What is the best way to employ technology and at what grade levels? For example, should a school district on a limited budget buy cutting edge technology at the high school level and pass down older machines to middle and grade schools?

2. If a district is purchasing technology, should it try to buy enough for every classroom in the district at the same time or should it stagger its purchases? What are the advantages and disadvantages of each strategy?

3. When does technology become obsolete? How does one define obsolete?

4. What are the ramifications of purchases on district budgets for upkeep and repair?

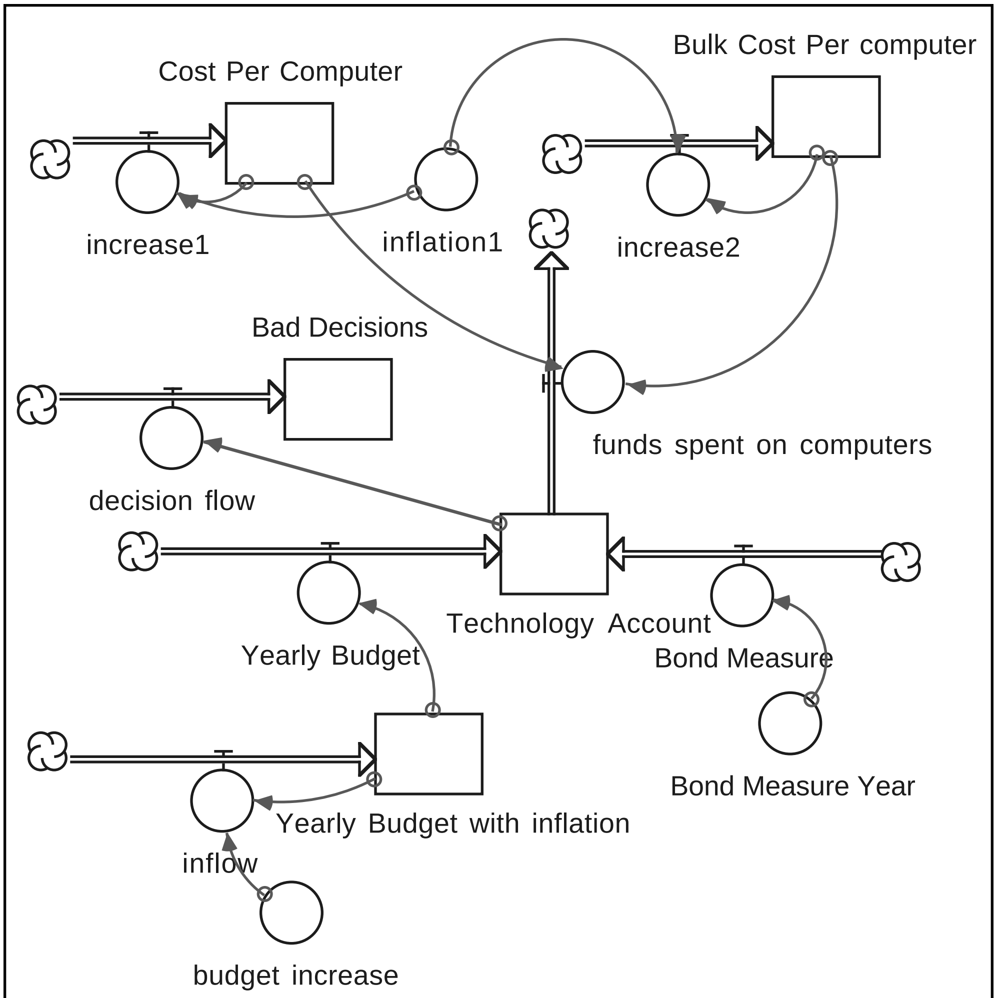
As a high school educator who has seen our district pass a technology bond and buy over two thousand new computers, I wondered about some of the underlying assumptions of technology and education and wondered if there were better ways to think about purchasing technology over the long run. Technology, of course, encompasses many things. The model that I undertook, however, looked specifically at computer purchases over a 20 year period. After consulting with our computer repair shop, I estimated that the average computer would be in our inventory for 12 years. This figure is high for the private sector but fairly realistic for education. The model first lets you in on your present inventory of computers and their ages. Then the model transforms you into the head of technology for the district and you are greeted with the following instructions:

Congratulations!!! You have just been put in charge of all computer purchases for the district over the next 20 years. In the simulation on the following page, you will be controlling a budget and can purchase computers at yearly intervals. Your budget will start at 150,000 and will increase by 2% yearly. Also, you will be able to pass one technology bond measure in the next 20 years worth 10 million dollars. To pass a bond, set the year in which you want to pass it. If you purchase more than 500 computers in any one year, you get the bulk discount price. If you purchase fewer than 500, you get the regular price. Computer prices are shown on the upper right hand side of the simulation.

As head policy planner, your ultimate job is to make sure that at any one time at least 20% of the district's computers are 1 to 4 years old. (A common standard in the business world is to have at least 50% of your computers from 0 to 2 years of age). With new programs and upgrades, the assumption is that at least 20% of the computers in a school district should be cutting edge.

Finally, don't let your budget balance drop below 0 or you will hear from the accountants!!!

Scroll right to the simulation, adjust the gauges, hit run, and then continue to adjust. Good luck!!



This is part of the model. It does not include "Acquisition and Aging of Computers" which factors into "Funds Spent on Computers." The entire model is available from the CLE

***Technology** continued on page 16*

Updates. . ., continued from page 2

• **D.** Restructuring the project design to meet future needs. Next year, Steve Kipp, an original Core Team member, will become a second mentor. Jan Mons, who has functioned as a full time mentor, will also assume responsibilities as Project Manager in the future. Additional teachers are needed to become leaders and trainers in the use of ST/SD. We have been using the Trinity Tutorial to train additional teachers in modeling. This summer, six teachers will attend a modeling workshop. A program of Learning Clubs will be added at each of the three Middle Schools so that teachers can meet on a least a monthly basis to share activities and learning.

Although the use of ST/SD has not increased as much as we had hoped in the original five year plan, we feel that we have a established a firm base to build upon in the next five years.

CC-STADUS

The question has been asked: "Does anyone have evidence that kids and teachers in schools where STELLA (or other system dynamics tools) is used exhibit systems thinking outside of classroom problems? In other words, are systems ideas and methods internalized by kids and teachers and used to think outside of school?"

Not only is there evidence, the evidence continues to be so exciting that I have not lost my enthusiasm for teaching high school students to create systems models. On the contrary, I believe it should start in the middle school when students learn first year algebra.

I teach math, programming, and a system dynamics modeling course at Franklin High School in Portland, Oregon. I have used system dynamics in my math classes since 1991 and have taught the modeling class since 1992. The modeling class is a math elective not applicable against the required credits in math for graduation. In spite of this the course has grown from 11 the first year to 40 students this year.

Students in the modeling course begin by completing exercises that build their skill in using STELLA, designing simple models, analyzing models they create via tutorials, and explaining what they understand in all processes. In the second semester they create more sophisticated original models for which they must collect data, work with an expert who understands the problem they are trying to model, and write a 10 to 12 page technical paper explaining their model and the results. Students have gone on to teach college professors what they learned in the class. I have had professors express admiration for the models the students have designed, some exclaiming that they have graduate students who could not do as well. One group of students designed a model of a pronghorn population near central Oregon, with spreadsheet data faxed to them by a wildlife biologist who had just modeled the same population. The biologist also faxed the observed population data and the results of his model. The high school juniors created a model with less error, compared to the observed data, than the professional biologist's model displayed. Other students have been requested to create models for administrators and teachers in the school. The Oregon Land Management Office hired two of my students to do a wetland model for them one summer. Currently we have two student groups working on models related to the school funding problems we are having in Oregon, requested by an administrator in the central district office. I have had a student tell me that having taken the modeling class his senior year in high school helped him (significantly) understand Calculus his freshman year at Reed College. Another modeling student created a STELLA model for an economics paper he did in college, only to have the professor grade him down, claiming he was using the model as a page-filler. The student went in and explained the model to the professor, who subsequently gave him full credit for his paper. I have had other modeling students tell teachers at Franklin that some of their environmental science classes were easier to understand because of their exposure to some of the complex issues that arise in environmental management situations.

Our main problem is lack of exposure regarding what the students are doing. Those adults who take the time to see what the students actually create are, without exception, very impressed by the quality of work, the thought, the understanding of the complexity of the issues they are modeling, and the models they create. (Franklin is an inner city high school serving primarily a blue collar population.) And Franklin High School is not the only place this is occurring.

Wilson High School in Portland also has a modeling class whose students do excellent work. One of their students gained early admittance to Harvard University using a STELLA model he created in the modeling class at Wilson. Scott Guthrie teaches the modeling class at Wilson. Ron Zaraza, my partner in our NSF CC-STADUS grant, uses STELLA throughout his physics classes at Wilson as well. Ron has been instrumental in developing systems study at Wilson. He has brought most of the social studies teachers on board by teaching lessons in their classes, so they can see how it would be useful to them. Both of these teachers could offer more examples of student application of systems ideas outside the classroom.

La Salle High School is also making great strides. They do not have a modeling class yet but they have been the most successful in getting systems thinking to permeate multiple departments. The students build or work with models in English, science, religion, social studies, health, and math classes. They have made systems a strand in their school and continue to expand its use. Tim Joy, an English teacher, is the director of this effort. He could tell you more about student experiences at La Salle.

At Franklin I have used system dynamics via STELLA and the motion detector in every math class I have taught since 1991. It is such a natural method for understanding the functions that are traditionally taught in Algebra through Calculus classes that I cannot understand why math teachers are not jumping at the chance to use it in their classes. (Of course, I should not be surprised, since we have found from our summer SD training of high school math, science, and social science teachers that math teachers are the most resistant to change. I think this is because our training has included so little experience with applications. This needs to change!!!) The use of system dynamics has significantly altered the way I look at the mathematics I teach and the way I now teach math. I require my students to create simple models of some of the problems we study during the year. One year I tried to collect some statistics regarding the use of systems versus a traditional approach to teaching second year algebra. I collected information on the number of students who successfully completed the first year of pre-calculus from my Algebra II classes and those of two other Algebra II teachers. I know this is statistically flawed, but, for what it's worth, the difference was a success rate of 78.9% for the systems students verses a 60.6% success rate for the other students.

The evidence of what students can accomplish via systems studies using STELLA and other software has prompted the Portland Public School District (the largest in the Pacific Northwest) to allow both Franklin High School and Wilson High School to offer System Dynamics "Magnet" Programs starting next year. Franklin will require Systems students to take 4 years of math and 4 years of science and two system dynamics modeling classes. Each year students will be required to create models that coordinate their current math and science classes. Wilson's project focuses on science and social studies. They have created a special "Science, Society, and Technology" course team-taught by the modeling teacher and a social studies teacher. Their Systems students will also be required to take 4 years of math and 4 years of science, and the special new SST class they have created. Franklin and Wilson will share their developing curricula over the next few years to expand each program.

Additionally, Ron Zaraza and I will direct our second NSF grant to train high school math, science, and social science teachers to create cross-discipline system models using STELLA for three more years. We are also working with Portland State University and University of Portland, as both have become interested in incorporating systems training in their teacher education programs. (By the way, we have had multiple teachers, trained in our summer program, requested by organizations such as Bonneville Power to create systems models for some problem they want to study.) Another participant, a social studies teacher in Tillamook, Oregon was discussing the political ramifications of a ballot measure to build a new building in Tillamook. Three of his students modeled the problem and, much to the consternation of the principal and some local businessmen, publicized their findings, ultimately defeating the measure. We have had other participants work with science professionals around the state creating system models.

Our experience with students and teachers has been that we have seen barely the tip of the iceberg in the growth of system dynamics use in and outside of education in the Portland area. We have a critical mass of trained teachers, students, and other interested professionals and expect the growth to continue exponentially.

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NSF CC-STADUS Project Director
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Oyster River High School

The discussion on the use of systems thinking in k-12 classrooms is a current concern in our district. We began a three-year project to integrate STELLA as a learning tool within our district. Approximately 18 teachers (mostly high school science with some elementary and middle school) have worked within this project. Our goal was to become familiar with the software and basic modeling/model use during the first year and then integrate the use of models within the current curriculum during the second year. We began with a two-day basic modeling workshop that was intensive, exhausting, and overwhelming. Monthly meetings continued our efforts to improve our own proficiency with modeling. Guest speakers were imported, and then we also tried working on group modeling projects. As teachers, we were feeling frustrated with the lack of personal time necessary for working on models. A summer workshop brought us together for five days with new participants and students paid to work with us. This workshop was most successful. All participants left with models they had created and could work within their own classrooms (including 3rd and 5th grade teachers).

(To further clarify the experiences we had with our two-day intensive workshop: Exhausting and overwhelming were the words used by our teachers. . .but they also thought the

Updates. . .*continued on next page*

Updates. . ., Oyster River, continued from page 13

workshops were valuable. The condensing of systems thinking, basic use of STELLA, and work on constructing our own models [on a Thursday & Friday] was perhaps too intensive for new modelers. Excitement for classroom use coupled with trying to build "first" models promoted "webs" that overwhelmed our expertise. I would strongly suggest a more show & tell, activity & construct approach. By initially focusing the group on a particular experience and pushing for the group to construct a simple model, our groups have demonstrated considerably more progress in ownership of the modeling techniques. Part of the difficulty was our own upbringing. . .considering the details of the parts as more important than the relationships between the parts. We had to stop, reflect, and relearn systems we thought we understood. Team approaches helped us to see how others might model the same activity in a different way. If one team was "stuck," one might look over the shoulder of others to see how they maneuvered the system. This type of experience was less frustrating for some, and promoted wonderful discussions to clarify relationships. From here, individual teachers felt confident in trying to model on their own. Unfortunately, there doesn't seem to be a lot of "development" time available during the school year.)

This year we have pushed for implementation. The need for activities and an on-going, articulated use of STELLA in previous courses seems to be an area of concern. How much time can one teacher put aside for teaching students how to use STELLA? What types of activities promote systems thinking and thus create problems that STELLA models can help us to understand? Computer access has also been a problem for our classes. One computer cannot afford learning opportunities for 24 students. Developing the methodologies for integrating this wonderful tool will take more time, but we've started, and continue to identify means to achieve the goals we had set 2 years ago.

I have accomplished a basic CO_2 cycle model with my students in the hope that some of them might be attracted to STELLA's use in modeling the behavior of the systems they will choose to study in their personal research projects. Many students have already stayed to "play" with STELLA. Just this small glimpse of a very powerful tool has enticed many students to want to learn more. I just wish I had been braver in turning it over to the "kids". Next year we'll have a little more confidence—and the word is out with the students! I think we're progressing.

We did interview a UNH student who had used STELLA in high school and felt that it made a world of difference in how he approached his studies. A little more "chunking" of information (less memorization) and an ability to see connections most of his peers would miss were some of the skills credited to his past work with STELLA. One of our high school students remarked that the opportunity to see a graphic animation of the model along with the graph suddenly made graphing seem so much more valid to him. Evidently, the numbers connection to a graph were just as complicated (and uninteresting) as the graph itself. He became a very valuable communicator of student perceptions of our present curriculum.

More on k-12 use of systems modeling .. .

Technology availability is improving at our school. . .but I only have one computer in my classroom on a regular basis. I have borrowed 3-4 others on occasion to offer more students greater access at one time. Often in my classes we are working either in the lab with experiments or utilizing other literature. Student teams range from 2-4 students depending upon the activity. Equipment constraints are not new to teachers. Many times we develop lessons that engage students in a variety of activities. . .that do not have to be used in any certain order. Students share, wait their turn, and sometimes utilize free periods to access computers. I do not expect all of my students to become modelers. . .but they should all know the types of technology that are accessible to help them obtain data, analyze data, and communicate what they understand. STELLA has become an optional tool in my classroom this year. I plan to develop more use of this software-one byte at a time!

I would appreciate any ideas you folks might have to help make this a successful program. We are especially interested in attracting other disciplines and encouraging student use of STELLA. I would be happy to share more of our work with anyone who might be interested. Thank you.

Barbara Hopkins
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Durham, New Hampshire 03824
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University of Klagenfurt, Austria

Greetings and best wishes from Guenther Ossimitz

For almost ten years I have been engaged in the promotion of teaching system dynamics and developing systems thinking skills in the Austrian secondary educational school system. Since 1992, SD is an integrated part of the math-curriculum of natural-science-oriented gymnasiums (grade 11).

In the last years I have investigated the development of systems thinking skills of students aged 14-18 using system dynamics software (POWERSIM).

The design was the following:
1) Instruction of the teachers concerning the basic ideas of systems thinking, system dynamics (SD) and the SD-Software.

2) The teachers designed a sequence of lessons (of about 20 hours) about the basic ideas of system dynamics modeling and systems thinking.

3) Before and after the lesson-sequence all students were tested by me about their system thinking skills. (The test was not known to the teachers). Some students were also interviewed about the tests. The design of these (written) tests was the critical issue of the whole investigation. The tested issues of pre-test and post-test should correspond to each other, so that an increase in systems thinking skills could be somehow measured or concluded. The test did not simply check what students had learned in the SD-lessons (it would be rather trivial to define "systems thinking" as that what students learned in the SD-lessons). I tried to give the students a fair chance to express some level of systems thinking skills without having heard anything about SD or SD-modeling and simulation.

One of my main findings was that students without any SD-teaching were able to grasp a rather complex "systemic" issue given as a text. But before being taught about causal loop diagrams and flow diagrams they had serious difficulties to make a pictorial summary of the given situation. After having seen some simple causal loop diagrams students aged 14 and 15 were easily able to denote rather complex situations given as a text.

Another main finding was that the development of systems thinking skills (according to the indicators I have used) mostly depended upon the teacher. Age, gender, math skills or computer experience had far less influence—*by far* the most important variable for explaining the increase of systems thinking skills was simply the teacher.

Until now the results of my investigations were only available in German. I am about to summarize the main results in English within the next weeks. You will find this paper on the web-site mentioned below.

http://www.uni-klu.ac.at/users/gossimit/eng/sdyneng.htm

I have also done extensive theoretical consideration about what systems thinking and systems thinking skills are like, how it can be measured and how it can be developed (especially in the context of "ordinary teaching" at school). I would be very glad to find people in the worldwide SD-community to discuss these issues.

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http://www.uni-klu.ac.at/users/gossimit/main.htm

Jay W. Forrester *sent us the URL for Dr. Ossimitz's SD related web site, cut from a posting to the listserve. He writes that there are many interesting links given in the web site listed below.*

"Greetings SD community! If you are interested in a comprehensive list of SD-related web sites (English and German), please try

http://www.uni-klu.ac.at/users/gossimit/links/bookmksd.htm

Any comments are welcome!
Dr. Guenther Ossimitz"

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Trinity College

Thought I might let you know what we're thinking of here at the Waters Center for on-campus programs next summer.

Jeff and I are looking to organize a pair of "Institutes for Curricular Innovation" (our third year of these) at Trinity during July '97. We haven't actually gotten around to giving either one an official name yet but here are thumbnail descriptions:

1. (7-11 July) Focused on relative newcomers to educational system dynamics. Each participant will already have a basic understanding of STELLA modeling and come to the Institute with one or two relatively simple system dynamics classroom activities in mind. We will provide support and facilitation in helping the educators bring their ideas to a reasonable conclusion for SY 97-98 application.

2. (14-25 July) Focused on more experienced educational modelers, in this Institute individuals or teams of educators will engage in designing and constructing more elaborate curricular units, including entire courses, founded on a systems dynamics approach.

The primary audience for these Institutes is folks from the various Waters-supported projects. We anticipate, however, that space will be available for other participants, by application.

Hope that little teaser whets some appetites!

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Technology Acquisition Model, continued from page 11

I tried out the model with both teachers and our district technology gurus and it gave rise to some interesting ideas not only about technology but about some of the wider implications for education. In working through the model, it is becomes obvious that the timing of passing a bond is critical as well as how that money is spent. When many districts pass bonds, the money is usually spent soon after it is received. The model, however, helps explore some alternative spending strategies and gives rise to further discussion about the nature of technology. In addition, it gives rise to discussions as to how and where technology is implemented in a school district which in turn leads to questions of curriculum.

Using a systems approach to conceptualize these difficult issues was helpful in identifying the crucial points in the process and helped in formulating many critical questions which I had not even thought about previously. It substantiated the idea that technology planning entails much more than just buying the latest computer model and plunking it in a classroom or lab. Rather, planning encompasses several issues and fields and should be done in the context of at least a 5 to 10 year time frame (if not more).

If you happen to have any insights or questions, please feel free to e-mail me at *Matt_Hiefield@bsd.beavton.k12.or.us*

❖

THE SYSTEMS THINKING PLAYBOOK

We have had a number of requests for information about/references to *The Systems Thinking Playbook*. Below is the information we requested from Linda Booth.

The Systems Thinking Playbook is a lively resource, ideal for teachers aspiring to develop systems thinking skills. The book is a collection of exercises designed to enable people to learn basic systems dynamics and systems thinking concepts (from reinforcing and balancing loops to archetypes to stock and flow diagrams, which we'll have in Vol. III).

Packed with enjoyable, hands-on exercises, the Playbook features "Voices from the Field," well-written debriefs and causal loop diagrams. *The Systems Thinking Playbook* abounds with practical advice on how teachers and facilitators can maximize each learning experience. Includes Volume I and II. (The Turning Point Foundation, 1996). Volume III will be available December 1997.

It is available through The Turning Point Foundation:

Turning Point
PO Box 1108
Framingham, MA 01701-0206
USA
Fax: 508-650-0184
Tel: 508-650-0138
Educator's Discount Price: $47

Linda Booth
boothli@MIT.EDU

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If you would like to invest in our effort here at the Creative Learning Exchange, your contribution would be appreciated. You may donate any amount you wish; perhaps $50 is a reasonable amount for a year. All contributions are tax-deductible.

I am sending ________ to *The Creative Learning Exchange* to help invest in the future of systems education.

Name____

Address____

Thank you!!

The Creative Learning Exchange, 1 Keefe Road, Acton, MA 01720

The Creative Learning Exchange
1 Keefe Road
Acton, MA 01720
Phone (508) 287-0070
Fax (508) 287-0080

The Creative Learning Exchange is a trust devoted to encouraging exchanges to help people to learn through discovery. It is a non-profit educational institution and all contributions to it are tax-deductible.