



the Creative Learning EXCHANGE

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THE FIRST YEAR: INTEGRATING SYSTEMS THINKING AND STELLA INTO THE K-12 CURRICULUM

A review by Richard Langheim and Timothy Lucas, Ridgewood Public Schools, Ridgewood, New Jersey

This review of our first year with systems thinking is in rough form. We have been encouraged by Lees Stuntz and Nan Lux to share the work we have begun in New Jersey in a K-12 public school district. Our work is at a grass roots level based on staff development and teacher training. It is also based on three important beliefs:

- Children must be skilled problem finders and problem solvers as they enter the next century.

- Teachers must see themselves as curriculum designers, creating and mediating learning experiences for students. This constructivist approach to learning includes the innovative use of technology.

- To become part of a student's "way of thinking", systems thinking must be integrated into the elementary curriculum as a cognitive tool and academic competency.

We hope the information is helpful and understandable. It will stay in this rough form because we are putting our energy into our second year. The time we have invested working with systems thinking in our district has been more rewarding and meaningful than either of us ever expected.

*"took off for a weekend last month,
just to try to recall the whole year.
All of the faces and all of the places,
wondering where they all disap-
peared.*

*it's those changes in latitudes,
changes in attitudes,
nothing remains quite the same.
With all of our running and all of our
cunning,
if we couldn't laugh, we would all go
insane."*

Jimmy Buffett

Background

Ridgewood Public Schools:

Our district is located in Bergen County, New Jersey, 13 miles from New York City. The Village of Ridgewood is an upper/middle class community that has historically valued a quality school system. The school system includes six elementary schools (K-5), two middle schools (6-8), and a four year high school. There are approximately 4700 students in the district with a per pupil cost of \$8,500. The high school has been ranked as one of the top eight public high schools in New Jersey, with over 92% of its graduates attending college (14% attending the most competitive colleges). The

commitment to quality education is seen in the outstanding teaching staff, innovative programs, and community involvement in the schools. People tend to move to Ridgewood because of its schools and the programs they offer.

Rich Langheim:

Currently, Rich is Executive Director of Management Information Systems for the district. His work involves administration, staff development, using technology in the curriculum, and a range of central office responsibilities including assessment of the K-12 academic program. Rich has been a high school teacher and administrator, and serves on a neighboring town's school board.

Tim Lucas:

Currently, Tim teaches fourth grade and coordinates Special Projects for Curriculum and Instruction. His work involves staff development in problem solving and cognition, assessment of the K-12 program, gifted and talented programs, and state grants. Tim has taught middle school science and computer courses, and has been an adjunct graduate professor at two local colleges.

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UP-DATES...

STACI^N Project

The STACI^N Project held the winter training session at Stanford University the weekend of March 6-7. The eight schools were represented by more than 25 teachers in the two-day long intensive workshop. Ellen Mandinach, the Project's director from Educational Testing Service, and her assistant, Tony Cline, have moved into the research phase of this project, now in its sixth year.

The teachers involved have gotten many hours of systems training from High Performance systems in the use of STELLA. They have been using their expertise with modeling in their classrooms for a number of years. It was very evident that their training in systems thinking is now an intrinsic part of their whole style of looking at education. It was impressive to see applications of systems work on diverse projects. They ranged from using stocks and flows to describe simple narratives about wolves, caribou and hunters, to students building their own models of real world scientific problems in high school, to a discussion of setting up a system for a group of low-achieving students to start learning in an interdisciplinary way about the world they really live in.

System Dynamics in Education Project

This group, working under the able guidance of Jay Forrester and Nan Lux, has been concentrating their efforts on the Road Map project. The Road Map is a self study guide for system dynamics using the available texts and other informative materials. Road Map I has been available for some time through the Creative Learning Exchange. By the time of this printing, Sections II and III should also have been completed.

FROM THE EDITOR...

The Creative Learning Exchange is expanding its capabilities. You may be hearing different voices on the phones these days. Lisa Schleelein is now here part time to keep things running smoothly, and we have college students popping in and out on vacations who help us with the various chores of the office.

We are still looking forward to hearing from you about your experiences. How is it going? Did you do something in the classroom that you learned from? What did you learn? Is there material which you need which I do not have at the moment? What is it? The article on the First Year at Ridgewood is a good example of feedback which can help others. A simple model which you have used in a classroom with a short lesson plan would also be terrific. Let me hear from you.

You will notice that there is a questionnaire in this newsletter. If you have NOT filled one out before, and wish to remain on the mailing list, please fill it out. I would enjoy hearing from you.

Lees Stuntz, Editor

Some other current projects include a glossary of system dynamics terms and work on creating models of generic structures.

LEARNING OPPORTUNITIES...

Workshop in STELLA modeling Concord-Carlisle Schools, Massachusetts

This workshop will be offered for one week during the last weeks of July or first two of August. It is open to any teachers or administrators who wish to learn how to model with STELLA for use in the classroom. The goal is that each person will finish a model or two which will be useful to them in the classroom or as an administrator. 3 hours of credit through Trinity College will be available at a very minimal fee, with completion of requirements.

The workshop is open to anyone who wishes to participate, space available. There will be minimal or no fee required to attend. For more information, please call Al Powers (508)369-0009.

Systems Thinking Course

This course will be offered this fall by the Boston Area Educators for Social Responsibility. It will provide teachers with an overview of the systems thinking initiative in middle and high school; an introduction to system thinking, principles and methodology; and hands-on experience using systems thinking processes and computer modeling to gain insight into the dynamics of real world program. Graduate credit for this seminar will be available through Lesley College Graduate School. More information will be in the next newsletter, or please contact Dessa Dancy (508) 456-8385.

FIRST YEAR AT RIDGEWOOD PUBLIC SCHOOLS

A Brief History:

We have worked on district projects together for the past six or seven years. About a year and a half ago, we became interested in Peter Senge's book **The Fifth Discipline**, and at the same time started to play with **STELLA II** from High Performance Systems. We have both always worked from the position that it is easier to ask for forgiveness than to ask for permission, so we started collecting resources, attending conferences, establishing a network, and began the staff development courses outlined in the following pages. At this point our district goals include systems thinking as an area of importance that needs continued effort.

Timeline of Activities for Year One

Summer of '91:

- Develop a plan for the first three years.
- Build up library and resources, and discuss range of applications of systems thinking.
- Write grant for local funding group to support district systems thinking work. (Grant not given.)
- Apply systems thinking to our district work and perceptions of how our district works.

Fall of '91:

- Teach "Systems Thinking 101 - An Introduction" as an inservice course.
- Demonstrate STELLA II to principals and computers coordinators.
- Attend New Jersey Science Teachers Conference and meet Barry Richmond from High Performance.
- Build maps and models of systems that involve daily classroom activities and problems that can be used with teachers.

Winter of '91/'92:

- Teach "Systems Thinking 102 - STELLA" as an inservice course.
- Teach "Systems Thinking 101" as a lunch time course at one of our elementary schools.
- Attend M.I.T. intersession workshop on systems thinking for one day - played the Beer Game.
- Build computer library of simulations that can be used with systems thinking.
- Purchased SemNet for building semantic networks on the Macintosh platform.
- Work with teachers from first course to develop curriculum for their classes.

Spring of '92:

- Teach "Systems Thinking 101 - An Introduction" again.
- Lead full day workshop on Fish Banks, for teachers, administrators, and other guests.
- Continue to network with other educators and M.I.T., collect articles, and start relationship with Creative Learning Exchange and Lees Stuntz.
- Work with teachers to develop curriculum and STELLA models.

Summer of '92:

- Revise three year plan and assess work started in year one.
- Attend High Performance Systems Training Conference in Vermont for four days.
- Quick visit in M.I.T. to share curriculum work.
- Finalize plans for the fall of '92 and schedule presentations on systems thinking through local and state education groups that we know.
- Continue to broaden the network.

Staff Development Courses

The district supports its staff through an on-going staff development program that involves in service courses each fall and spring. The courses are offered over 5 of 6 weeks and are taught by teachers and administrators from the district. During our first year we offered two different courses for our staff. The courses were taught during each semester and at lunch time workshops at one of our elementary schools. The courses included:

Systems Thinking 101 - An Introduction

This was an introductory course on using the concepts of systems thinking in the classroom. The class was designed to build on the problem solving program we have designed into K-12 curriculum that reinforces high level thinking skills. Teachers understood that the course was an extension of our four other problem solving courses and that this course stressed a macrocognitive approach to problem solving and problem finding activities. Teachers were introduced to learner-directed learning as another curriculum design tool that supports a constructivist approach to learning.

During the six sessions, the class was introduced to the concepts of systems thinking, reviewed current literature, and determined uses for systems thinking in their curricula. The teachers worked with causal-loop diagrams and structured diagrams in a range of applications and subject areas. The software STELLA II, was introduced during our last session.

Systems Thinking 102 - STELLA II

This course offered teachers an opportunity to work with STELLA II and build models that could be used in a specific discipline or in an interdis-

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FIRST YEAR AT RIDGEWOOD, continued

disciplinary setting. During our five sessions, the class worked with models that explored the ozone problems facing our planet. The teachers worked with readings, videos, diagrams, charts, and other STELLA models as they explored the power of the software through weekly projects. Each teacher was also required to work on one independent project during the course.

Besides the in service courses, a one day workshop was held in the late spring reviewing the simulation **Fishbanks**. Elementary teachers, administrators, and interested educators outside of Ridgewood attended the workshop and played the simulation. We debriefed the game, reviewed the concepts of systems thinking, and offered suggestions for integrating the game into our existing curriculum. Each elementary school was supplied with a copy of FishBanks and on-going support was offered. Plans are underway this year (Year Two) to use FishBanks as a fifth grade enrichment problem solving program. The program will be held on a Saturday in late winter, for all fifth graders in the district.

We were also able to share the use of systems thinking with the entire staff through **Connections**, our in-house staff development newspaper that is published two to three times a year. Each issue focuses on a specific topic (whole language, multiple intelligences, cognition, etc.). The final issue of the school year reviewed the use of technology in the curriculum and was a perfect platform for highlighting systems thinking. (see appendix)

By the end of the first year, we were able to work with 15% of our total teaching staff through courses and workshops. Several teachers began to write curriculum for their programs before the end of the school year, the administration had a better understanding of the concepts, and the term "systems thinking" became part of the educational jargon heard throughout the district.

Systems Thinking and Current Educational Trends

The district staff development program and courses, mentioned in the previous section, cover a wide range of current educational trends that are supported by research and current practice. It is accepted in the district that "the way we taught five years ago, is not the way we teach today - and the way we teach today is not the way we will teach five years from now". Teachers are encouraged to be curriculum designers. Therefore, rewriting curriculum and following current educational trends is the norm throughout the K-12 program, not the exception.

This created a unique challenge for us as we started discussing systems thinking with teachers and administrators. We had to show the relevance and importance of the underlying concepts of systems thinking in terms of the current educational practices that were already being used by the staff. We had to show how systems thinking supported and reinforced the following educational trends:

- Problem Solving and Teaching Cognition;
- Working with High Order Thinking Skills;
- Cooperative Learning;
- Whole Language;
- Literature-Based Curriculum;
- Using Technology as a Tool for Learning;
- Learning Styles and the 4MAT System;
- Multiple Intelligences and the work of Howard Gardner;
- Alternative Assessment;
- The New National Council of Teachers of Mathematics Standards;
- and a Constructivist Approach to Learning.

During our courses, in discussions with staff, at faculty meetings,

through workshops and at district articulation meetings, we showed the relevance and importance of a learner-directed learning approach using systems thinking. Here is a short review of our staff's reaction to the training we offered:

The teachers involved with problem solving and cognition recognized it as a natural extension of their curriculum work. The use of models as graphic organizers have been used in teaching problem solving throughout the district.

The supporters of cooperative learning saw immediate applications for the group processes they reinforce through daily activities.

We were able to show teachers involved with whole language and literature based instruction STELLA models of Romeo and Juliet and worked with them to design new maps and models for current grade level literature.

The teachers working with the technology program realized that STELLA could be used as early as fourth grade and additional Macintosh computers were ordered in several schools.

The teachers focusing on learning styles and multiple intelligences felt the drawing of the models, verbalizing the interrelationships in the models, and applying the mathematical components to the models, required students to use a range of skills and thinking processes that supported their curriculum work.

The advocates for alternative assessment and a constructivist approach to learning realized that the learner-directed learning approach using modeling and simulations helped students build understanding and knowledge.

Finally, the mathematics teachers enthusiastically found the graphing abilities of STELLA II and the higher level of mathematical thinking required in systems thinking in agreement with the NCTM Standards.

The versatility, adaptability, and technology aspects of systems thinking and STELLA made it easy for us to introduce systems thinking to a wide range of teachers who had already focused on an approach or method for instruction and assessment. The concepts of learner-directed learning are not new, but the practical strategies for using models throughout the curriculum appealed to many teachers.

Implementing Systems Thinking into the K-12 Curriculum

Systems thinking should be seen as **another tool** we can use to teach problem solving and cognition. Our district has been involved with teaching problem solving in all areas of the curriculum. For the past ten years, teachers have been working with analogies, sequences, and verbal reasoning skills throughout the K-12 program. These conceptual tools are the building blocks of cognition.

Events and facts are organized into patterns using analogous and sequential thinking. These skills are used to organize facts and events so that relationships can be understood. In turn, verbal reasoning and systems thinking are used to understand the structure of systems which generate patterns of behaviors.

There are a range of activities and experiences you can design for children that strengthen their understanding of systems. These activities are based on learner-directed learning experiences that encourage students to share their ideas with other students as they map and model their understanding of the curriculum and the world around them. The following chart sug-

gests a reasonable scope and sequence that would allow for the integration of

systems thinking into the K-12 curriculum.

ELEMENTARY SCHOOL	
Grade/Topics and Concepts	Possible Activities
K-1: Introduce and reinforce the concepts that everything is connected, events can occur in cycles, several causes can lead to one effect, and that you can draw a map of an event or system. Students should be able to explain stocks and flows in a map and simple causal-loop diagrams. <i>We are encouraging an understanding of systems they already have in terms of family, nature, and patterns.</i>	Share books that highlight a cycle (If You Give a Mouse a Cookie), write your own cycle stories, draw pictures of cycles, discuss and draw current events including events that led up to them. Students brainstorm mind maps with the teacher on the board or using SemNet. Drawings (maps) placed around the room showing simple systems.
2-3: Continue to show the inter-relationships that occur in literature, social studies, science, current events and class dynamics. Students should draw simple causal-loop diagrams and structured diagrams, including converters and connectors, as they model curriculum concepts and situations. <i>We are encouraging students to see the "big picture"—that writing, reading, language, social studies, science, and mathematics are all connected.</i>	Cooperative groups should draw simple maps as they share their understanding of events and relationships in the curriculum. Students write explanations for different maps drawn by themselves and the teacher. Students include themselves or peoples' perceptions in the maps, as they work with point of view. Introduce and illustrate how people apply leverage and leave traces of their actions on other people and situations.
4-5: Work with structured diagrams as maps and teacher-made models. Stress the effects of actions on a system, using all areas of the curriculum. Force explicit definitions and explanations, as students share ideas and mental images. Use simulations and graphing applications of systems thinking wherever possible. <i>We are encouraging the use of mapping as a natural tool for students to use as they explain the world around them and define real-life problems.</i>	Students should discuss maps in all areas of the curriculum through drawing, writing, and discussions. (Left brain-right brain experiences) Use the simulations in the MECC Software and other simulations, e.g. FishBanks, Sim City, as a starting point for mapping. Stress higher level thinking skills involving reading and predicting graphs. Students should create maps of social interactions and controversial topics. Introduce STELLA.
MIDDLE SCHOOL	
6-8: The use of systems thinking should be integrated into the interdisciplinary activities designed by the team of science, social studies, math and English teachers. Specific units the involve research, field trips, and literature can be created., The "big picture" shown through maps and models can be strengthened through an interdisciplinary approach.	Study an area with an environmental problem, e.g., the Hudson River Project. Students look at the history, science, literature, and numerical data that show the challenges that face this wetlands area. The power of models can be shown across academic areas. Once the models are created, students can discuss where to apply leverage, and can directly impact the problem with working solutions (writing letters, making a video, working with student environmental groups, etc.)

HIGH SCHOOL	
<p>9-12: At the high school, work with systems thinking is limited to individual classes and teachers. This is a challenging group to change. Science and history offer an easy introduction to the use of maps and models. A specific course on systems thinking is possible and student created models are the ultimate goal. Applications of systems thinking for Advanced Placement curricula and courses is needed.</p>	<p>The list of possible high school activities is endless. You can model character development and plots in English; science models of theories and concepts are possible; and models of events in history and the social sciences can easily be created. The biggest factors are teacher training, flexibility of the curriculum and course content, scope and sequence of the course in the department, and teacher creativity.</p>

Final Thoughts

Our efforts during our first year have been, in part, a learning experience for us as we read and met the people involved in systems thinking. It has also been an adventure to talk to colleagues who were interested in exploring the potential of systems thinking for our students. In every instance it has been rewarding, both personally and professionally.

The reward stems from the intimate involvement of grass roots practitioners, whether they are individuals like Nan Lux from M.I.T., Lees Stuntz from the Creative Learning Exchange, or Barry Richmond and Steve Peterson from High Performance Systems. The interaction with colleagues from our own district, from neighboring districts and more recently from around the country has also been rewarding.

We're available to discuss further our experiences in Ridgewood and are interested in hearing about the experiences of others in the field.

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*"Looking back at my background
Trying to figure out how I ever got here.*

*Some things are still a mystery,
And others are much too clear."*

Jimmy Buffett

*The appendices to this article, Introducing Systems Thinking to Kindergarten Parents, Lesson Plan for Drama Unit, Lesson Plan for Lemonade Stand, and **Connections**, are available from the Creative Learning Exchange. Please write if you are interested in copies.*

INTERESTED IN INVESTING?

All of us are interested in promoting the use of systems education in our schools. A number of you have asked if there is a charge for the services of the Creative Learning Exchange, or what you can send to help defray the costs of printing and mailing to you.

The Creative Learning Exchange will continue to send out materials free of charge to all those on the mailing list, regardless of their desire to invest at this time. However, 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 \$25 is a reasonable amount for a year. All contributions are tax-deductible.

I am sending _____ to *Trust in Diversity* to help invest in the future of systems education .

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Thank you!!

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