Economics and System Dynamics for Young Students

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ABSTRACT: *Today's students need an understanding of economics and system dynamics to participate effectively and fully in our complex global economy, but very few K-12 schools teach either discipline. In Carlisle, Massachusetts teachers have developed several basic economics lessons using system dynamics for students in fourth to eighth grade. This paper will describe those lessons and how student response to system dynamics instruction has spurred the need to expand the system dynamics/economics curriculum.*

INTRODUCTION

Jay Forrester has often said that system dynamics could be the vehicle for integrating effective and desperately needed economic education into the kindergarten through twelfth grade (K-12) curriculum. Students need a sound understanding of economics in order to thrive in a global economy, yet very few schools offer economic education to K-12 students, and fewer still approach it through a system dynamics perspective. Although there are some successful lessons in the works, a comprehensive K-12 economics curriculum based on system dynamics is still an opportunity waiting to be developed.

Students and teachers at the Carlisle Public Schools in Carlisle, Massachusetts have experimented with a few system dynamics lessons in basic economic education. This paper will describe those lessons, how they were developed, and how the need for more such lessons has been evolving in recent years. Economics has been a late-comer to the system dynamics curriculum in Carlisle for many reasons. Only now is Forrester's advice beginning to sink in, prompted, as it turns out, by the very questions that students raise as they apply system dynamics to other areas of their study.

System Dynamics and Economics in Carlisle

Carlisle is a small suburban Boston school district with a total enrollment of 843 students in kindergarten through eighth grade. In 1994, a middle school math teacher and a middle school science teacher first experimented with system dynamics in their classes. Since then, system dynamics has slowly grown in Carlisle as a useful approach and set of tools to enhance the regular curriculum. This growth has been nurtured and nudged by a supportive administration, school board and community. Also, the Waters Foundation has generously provided funding for two systems mentors, Rob Quaden and Alan Ticotsky, teachers who help their colleagues learn and implement system dynamics in their classes.

In the early years, because there were few examples to follow or completed lessons to use, the mentors plied their system dynamics ideas and developed lessons with whichever teachers seemed to show an interest – usually math and science teachers, often in the middle school. These were the "early adopters," tolerant of the uncertainty that accompanies innovation. Gradually, with more training opportunities and encouragement provided by the administration, the circle of interested teachers expanded to include literature teaching and many elementary grade lessons. This year, now that the support and training structures have been laid, *every* teacher in the school is required to implement at least one system dynamics lesson each year as part of his/her performance evaluation. Because system dynamics had proven its worth for students, Superintendent Davida Fox-Melanson believed that the time had come to take this next step and bridge the gap to include the larger majority of teachers who are reluctant to embrace innovation at first. We do this because we believe that students will need system dynamics skills to deal with dynamic complexity.

Meanwhile, mentors Quaden and Ticotsky have been developing and assembling a growing list of successful lessons and gradually pulling together a sequential K-8 system dynamics curriculum. Throughout, system dynamics is never taught as a course on its own. It is infused into the regular curriculum as a way to make learning better for students. It is a set of tools in a learner-centered experiential approach to education.

Economics, however, has not been prominent in this curriculum, even though we have long had the sense, and Forrester's advice, that it should. There may be several explanations.

- Math and science teachers were the first to be drawn naturally to system dynamics. They were more comfortable with the equations and technology, they already used experiments in their teaching, and they were looking for "real" computer applications for their students. Also, system dynamics models of physical systems seemed easier to grasp at first. In the early years, the Carlisle mentors were busy with math and science applications.

- Unlike math and science, economics is not one of the core subjects taught in K-12 schools. There is not a ready curriculum to be enhanced with the use of system dynamics tools. Indeed, teachers, who are themselves products of the same system, do not have much background in economics unless they have sought it out in upper level elective courses. To introduce an economics strand in K-12 education would be to start from scratch (a perfect opportunity, according to Forrester.)

- Because economics is not part of the core curriculum, it is not measured in the high-stakes standardized tests which drive (and constrain) so much of K-12 instruction. School districts, and teachers, are forced to dwell on the tested subject matter, leaving little room for anything else. Schools, like Carlisle, where students already perform well on statewide tests, have some liberty to tinker with the curriculum, but the pressure is still there and time is precious.

- Social studies *is* a core subject. Economics could reasonably fall there. However, the traditional emphasis (and thus the standardized testing) has been on history and political science. Even so, system dynamics has made slower headway in K-12 social studies, partly because soft systems seem more difficult to model at first and because social studies teachers are not as accustomed to using models and computers in their teaching. In time, these will change. In Carlisle, we have had some good social studies lessons and we know that we need to do more if we are going to give students the essential tools and perspective to deal with the complex social issues facing them. Economics may just be our entrée.

The goal in Carlisle is not to teach a K-8 Economics course based on delivering the content of a typical high school Economics textbook. Rather it is to help students gain an understanding of basic economic concepts as they apply to their current curriculum and their daily lives. System dynamics forces education to be interdisciplinary. As students use system dynamics as a tool, their own questions lead them into areas of exploration beyond the usual curriculum boundaries. Economic questions are arising more frequently in social studies and science lessons, indicating a need to introduce more economic education into the K-8 curriculum. Several of the Carlisle economics lessons below grew from this need.

Another place for basic economic lessons is in the teaching of system dynamics itself. In order to use system dynamics, students need to learn about stocks and flows, but system dynamics skills are not taught in isolation as a separate course. Lessons in saving and spending money, interest rates, credit and other money management issues provide a good context for learning basic system dynamics concepts along with economic concepts. (Students then transfer the same structures to other areas of study. That way, math, system dynamics and other formerly distinct subjects are woven together.) The series of bank balance lessons below began as system dynamics lessons through which students became engaged in thinking about economic decision-making.

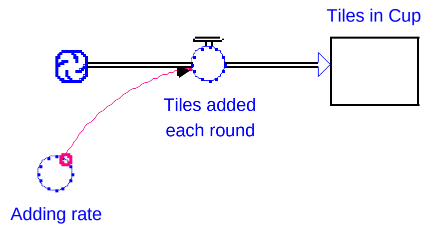
In Carlisle, system dynamics is built into the curriculum for all students across the grades and subject areas. It is not only for gifted students or students who are interested in math. This is not a problem. Teachers are often pleasantly surprised at the enthusiasm and depth of understanding that even young students can achieve across a class. (Sometimes students who have had difficulty with other approaches find a new chance for success with the systems approach.) If there is any constraint, it is that some teachers are more reluctant to plunge in to unfamiliar areas than their students are.

BANK BALANCE LESSON, SIXTH GRADE

One obvious and useful system dynamics application to the study of basic economics is the modeling of bank balances. Carlisle students do bank balance lessons in fourth, sixth and eighth grade. With increasing complexity and independence they build basic system dynamics models to understand how money accumulates with simple and compounding interest. They learn about deposits and withdrawals as flows into and out of their stocks of money. They are introduced to the ordinary business of living.

Several years ago, Rob Quaden began teaching students to build bank balance models in sixth grade math classes (eleven year olds.) Students always have difficulty understanding percentage, interest rates, and the formula: *Interest = Principal x Rate x Time.* The modeling lesson was an attempt to help students grasp the concept more intuitively. It was also a way to let students "play" with the idea on the computer while also building their system dynamics skills.

Students begin with a constant inflow to the stock. Before they can consider the concept using numbers and money, however, they begin with a very concrete tactile activity using little tiles in paper cups. For example, to figure out how many tiles would accumulate in the cup over a certain time at a certain rate, they physically place the tiles in the cup, count them and record their findings on a table of values.



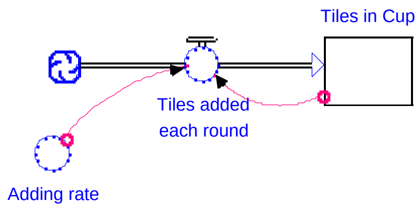
Next, they draw stock/flow diagrams and in teams build STELLA models of the tile problems, producing straight line graphs. Only after they can see that the computer model produces their same table of values are they ready to start thinking about money, one more level of abstraction. It is important not to skip this step. Even young students today are computer savvy. They can click and drag and fiddle with numbers in order to make their graphs "work." The point of this math lesson, however, is to help them understand exactly what the computer is *doing* and, beyond that, to understand exactly how simple and compound interest *work*. System dynamics provides the chance to move beyond mindless computer games and the rote application of formulas, *if* students are given the means to understand just what they are doing.

Students are then given a list of piggy bank problems. With discussion, they observe that the structure of the tile problem is just like that of the money problems. They change the labels on their tile models and get to work. This is fun.

- John has $8.75 in his piggy bank. He adds $1.75.week. How much money does John have after 4 weeks? When will John have $42.00?
- Mike has saved $78.00 and saves $4.00 per week. Melanie has saved $124.00 and spends $3.00 per week. When will Mike and Melanie have the same amount of money?

(By the sixth grade, Carlisle students are already familiar with basic system dynamics and the mechanics of STELLA. Students are introduced to stocks, flows, and graphing in the primary grades. See "The In and Out Game," by Ticotsky, Quaden and Lyneis, "Graphing the Friendship Game," by Ticotsky and Lyneis, and "The Mammoth Game," by Stamell, Ticotsky, Quaden and Lyneis. In the fifth grade, they use those skills in curriculum applications like "It's Cool" a science lesson by Quaden, Ticotsky and Lyneis, and "Tuck Everlasting" a literature lesson by Platt, Quaden and Lyneis. All are available online at the Creative Learning Exchange website: www.clexchange.org.)

Once students understand constant flows, they are ready for compounding flows, but again, they still need the concrete activity before they are ready to leap to interest rates at the bank. Once again they count tiles into paper cups, but this time the number added depends on the number of tiles already in the cup. Starting with 8 tiles in the cup, they are given the "rule" to "add one half as many each time," recording their results on a table of values. As 8 tiles become 12, then 18, then 27… students notice a difference in the accumulations from the earlier constant flow tables.



As before, students draw stock/flow diagrams of the tile activity, this time with a good discussion on the new feedback loop. They build their own STELLA models of the tile problem in teams and follow that with problems involving money. This is a difficult step, however, because it takes an extended explanation of percents and interest rates to make clear their connection to the "add half as many" rule in the tile problem. Using their own bank balance models, students solve problems such as:

- Elena deposits $640 in a bank account. After each year, the bank adds interest to her account at a rate of 4%. Build a model of this situation and answer the following questions:
    - How much money will be in Elena's account after one year?
    - How much will she have after five years?
    - How long will it take for her money to double in value?
- Jim has a credit card bill of $246.00. The credit card company offers to let him wait six months before paying back any money, but they will add 1.5% to his debt each month. If Jim agrees to the deal, how much will he owe after the six months are up?

Many good questions arise out of this lesson:

- What is the difference between the graphs of the constant flow and the linear flow (where the stock is multiplied by a constant)?
- Which yields you more money in the end? Why? Which would you rather have?
- Why is the line curved when the bank balance accumulates interest? Why is the other line straight?
- Why does the curve have the same shape no matter how much money you have or what interest rate you use?
- How long does it take your money to double in different examples?
- What is "2*e* + 115" on the vertical scale? Students *always* test the limits of their models and are so pleased at how fast they can become gazillionaires at 100% and higher interest rates! Discussions ensue about whether this can actually happen. Students are also introduced to scientific notation in a practical application.
- How many years does it take to accumulate a certain amount of money at one interest rate? At another interest rate? (Saving for college, for example.)
- What interest rate do you need in order to accumulate a certain amount of money in a set time? What interest rates are reasonable returns these days?

Sixth graders can get their minds around all of these questions, and they love doing so. The bank balance lesson is intrinsically appealing to them because it involves playing with computers and money. Meanwhile, they are learning a great deal of math and basic preliminary economics.

BANK BALANCE LESSON, FOURTH GRADE

Two years ago fourth grade teacher Bill Gale saw a good place for system dynamics in his curriculum. He had participated in system dynamics training sessions held in Carlisle by the mentors, and he had attended an energizing High Performance Systems workshop for businesspeople and teachers led by the late Barry Richmond. Because Gale had come to teaching from a career in the computer industry, he was comfortable with the approach and eager to use it with his students. He decided to build bank balance models with his students.

Gale definitely pushed the standard for Carlisle. Until then we had thought that only sixth graders were ready to build models and understand bank balances with interest. Gale showed that younger students (9 year olds) were ready too.

The first time Gale tried the lesson two years ago, he gave his students some preliminary classroom instruction on the mechanics of STELLA and the concepts of simple and compound interest. When he loosed the students onto the computers in teams, they did surprisingly well. They were able to solve piggy bank problems and interest problems, accumulate enormous amounts of money and have fun. Yet, there lingered among the teachers some doubt about the real depth of the students' understanding.

Last year, with the help of the systems mentors, Gale used the concrete tile-counting activities with his students to lay the groundwork for the computer modeling. This worked much better. Barry Richmond was in Carlisle on the day that the students built their STELLA models. He got right in there and coached these little kids with the same enthusiasm and respect he would offer to much more sophisticated modelers. He was impressed with the students; they were awed with him.

This year (2002-3), Gale has further refined the lesson. Students did the tile activity and piggy bank problems in the early fall. They will do the compounding interest problems in the spring after they have had more background in math and system dynamics. Gale will continue to fine-tune the lesson. Sharper students have always grasped it easily, but Gale wants to make the concepts accessible to every student in the class by weaving it into the curriculum.

Fourth graders are able to answer many of the questions put to the sixth graders, but at a simpler level. They require more time to manipulate the tiles and record their results. They also need more help with using STELLA because this is their first exposure to building their own models. More of the questions directed to them focus on honing graph-reading skills: How much money do you have at a certain time? How long does it take to save a certain amount? If they can get all this background in fourth grade, they will eventually be able to go further in later grades.

EIGHTH GRADE LESSONS

By the eighth grade, students have had considerable exposure to system dynamics. They have worked on the math underpinnings, the concepts of feedback loops and stocks and flows, and the mechanics of STELLA. They have applied these tools to problems in various areas of the curriculum, and they are beginning to see the transferability of structures in different applications. There are several established system dynamics lessons built into the eighth grade curriculum, but there are also times when issues pop up and system dynamics tools seem to provide the best way to address them. Again, economics is not a core subject. There is not yet an explicit thread of economics lessons in the curriculum. There are, however, system dynamics lessons that include economic concepts and raise economic questions. As these lessons accumulate, it becomes clearer that we need to focus more on economics in our curriculum.

Bank Balance Lessons

Building on their earlier experience, eighth graders revisit the bank balance problem. This time they do not need the concrete tile activity and they are ready for more sophisticated real-world problems. The bank balance lesson takes three different forms in eighth grade.

Exponential Growth

One major focus of the bank balance math lesson at the eighth grade level is the concept of exponential growth/decay. Now that students understand how it works with money, they are able to recognize the same reinforcing structure in other settings. In other areas of the curriculum, they study population growth in humans and fish, bacterial growth, and the spread of epidemics using models. The bank balance structure ties into all of the other models of exponential growth. Exponential growth is the math lesson; system dynamics is the tool which helps students understand how it works and recognize it in the systems around them.

Understanding *dt*

The bank balance problem is used to explain how *dt* works. This is essentially a system dynamics lesson. Students know that fiddling with *dt* changes their model output, but they have no idea why. (For young students, we just give them the *dt* value and tell them not to change it. Often it is set at 1, because it is confusing and disconcerting for young students to think about half a person or half a mammoth.)

To experiment with solution intervals, students do pencil simulation (no computer) to compute and graph interest that is paid once a year over several years (say, 10%/yr. on an initial $100 deposit, for easy calculations.) Using the stock equation as their guide, they compute the value of the interest ($10 for the first year), add it to the bank balance and go on to compute next year's interest, and so on.

Balance(now) = Balance(last computed) + (Deposits) x dt
Deposits = Balance x Interest Rate

In this case, *dt,* the solution interval, represents the compounding time. When interest is compounded annually, its value is 1. Next students compute the value of the bank balance over several years when interest is compounded twice yearly. The deposits are multiplied by .5 because the bank pays only half of the interest over half a year. Students repeat the computations for quarterly interest, observing the difference in the accumulations and in the approaching smoothness of the graph lines as the intervals grow smaller.

Finally, students try the same simulations on their computer models of bank balances. They experiment with different values of *dt* representing annual, quarterly, and daily compounding. They compare annual percentage yields and discuss the diminishing returns of smaller and smaller compounding times.

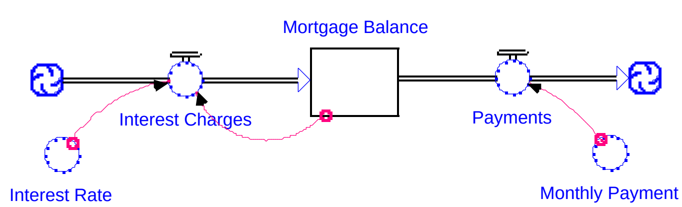
Technically, of course, *dt* is not linked to any real world value. It is an artifact, a simulation solution interval. However, it helps students understand how *dt* works if they can play with a more concrete example first. The familiar bank balance model makes the purpose of *dt* more accessible to them. Meanwhile, they are learning a useful lesson about banking their own money.

Constant and Compounding Inflows and Outflows

Once students understand the structure and behavior of the basic single positive loop model of a bank balance accumulating interest, they are ready to try other structures.

- They use their models to see what happens if they add constant deposits (allowances, for example) to their bank accounts as they also accumulate interest.
- They make withdrawals from their accounts, adding an outflow.
- They compare various savings plans. For example, is it better to save a small amount when you are young and just leave the money in the bank or can you wait until later to start saving? This is the basic bank balance model, but students use step functions and compare the accumulations.
- In all cases, students predict what the graph will do before they run the model, practicing mental simulation skills.

Students were working on these problems when their language arts teacher approached Rob Quaden with a question about refinancing his mortgage. He had been trying to weigh the various options using a spreadsheet but he could not figure out the formulas. Quaden turned the problem over to his eighth graders and asked them to build a model that could tell their language arts teacher what monthly payments he would have to make to pay off his $60,000 mortgage in 15 or 20 years at various interest rates.



In the students' models, the stock (the debt) had an inflow for the accumulating interest and an outflow for the monthly payments. They eagerly and easily answered the teacher's questions and learned about the concept of borrowing money to finance a large purchase. (Their language arts teacher was grateful and very impressed.)

Timber

Carlisle students do various activities using the classic system dynamics tree harvesting problem: predicting and graphing a stock of trees following different planting and harvesting policies. In the Timber Game, they use popsicle sticks to represent their trees, again using a concrete activity to help them grasp more abstract concepts. They count "trees," keep tables of values, and draw stock/flow diagrams and behavior over time graphs for different planting and cutting rates. Then they build their computer models.

For one Timber problem, students are asked to harvest twice as many trees each year (an exogenous input.) This is the first time that they are asked to model a changing outflow, a new challenge. The question always arises about why a forester would want to cut more trees each year. In discussion, students conclude that people must want to buy more wood, maybe because the population is growing or because people are building more new houses. They decide that "demand for trees" should really be another stock in their model. This demand determines the cutting flow. For now, this is as far as students go with the idea, but their questions indicate a good opportunity to explore the principle of supply and demand further with a system dynamics model.

Fish Banks, Ltd.

Eighth graders play the game, *Fish Banks, Ltd.* by Dennis Meadows (UNH, Laboratory for Interactive Learning, www.unh.edu/ipssr.) Playing their roles as owners of fishing companies, students chase profits by buying boats and deciding where to deploy them to fish. As their fleets grow, they face rising overhead costs and diminishing catches. Eventually, the fish stock is depleted and many of the students' companies go under. To students, this game is "for real." They are immersed in an economic system, although they do not study it expressly in those terms. Later, students build a model of the game and use it to test various policies to see if they can run a sustainable fishery. What happens if there is a tax on new boats, or a requirement to retire boats, or a limit on the allowable catch? Students implement these policies and in the process face the challenges of managing a scarce resource. They learn about carrying capacities, they make profits and decisions about reinvesting them, and they experience competition driven by the profit motive. Stepping back, they understand the tragedy of the commons and the very real risk of fish depletion in our oceans. Fish Banks raises many good economic questions.

EcoFair

Every year, eighth graders prepare individual science research projects on topics related to ecology. Although these are science projects, each student also works with another teacher on the eighth grade team to write a paper and prepare a final presentation for EcoFair, an exhibition to which local scientists, parents and the public are invited. Every project must include behavior over time graphs, as well as stock/flow and causal loop diagrams of the problem. (In recent years, students have begun using these tools to organize their writing, with improved focus and clarity in their work as a result. They are not yet ready to build independent computer models of their projects, however, beyond using the simple structures or models they have used in classes.)

The EcoFair presentations are always wonderful. Each year, the students do a better job of using the system dynamics tools to articulate their ecology problems and possible solutions. Now that they focus on a question or problem rather than just describing a topic, however, they find that they often raise many more questions. As they begin thinking about causes, it becomes clear that their issue and its solution are more complex than they first thought.

Examples of EcoFair projects:

- What is wind power's effect on reducing oil imports?
- Is genetically engineered food a problem or a solution?
- What effect would fusion power have on global warming?
- Should CAFE standards for automobile efficiency be strengthened?
- Should fishermen be allowed to increase fishing on George's Bank (off the Massachusetts coast)?
- Are hydrogen fuel cells a good alternative to fossil fuels?

These are science projects, so the students typically focus their research on the science aspects of the problem. For example, the student reporting on hybrid cars expounded on how the car operated and how fuel efficient it was, concluding that hybrid cars were far superior to internal combustion cars and should be used by everyone. Only when teachers asked him to take a look at the cars actually on the highway did he begin to consider that there may be more to the issue than just the science. Why aren't more people buying hybrid cars? What are the trade-offs? Are there hidden costs in fuel consumption? How do we weigh the environmental concerns against the economic concerns? And so on. Similar questions arise from all of the ecology projects.

Until now, the trade-offs between environmental and economic concerns have loomed unaddressed as students delved into their science research, but it is apparent that students need to consider the many factors that come into play. It is not enough to focus only on the science because the real world causes and solutions to the problems involve economic decisions as well. The issue for teachers in Carlisle is how to help students accomplish this. One possible approach is to formally introduce some economics instruction into the social studies curriculum. Since the social studies teacher already coaches individual students on their EcoFair papers and presentations, he is aware of the need for fuller explanations. Students themselves are raising the economic questions, driving the need to expand the curriculum.

TOWARD A K-8 ECONOMICS CURRICULUM WITH SYSTEM DYNAMICS

We have come to appreciate Forrester's suggestion that students need to understand economics and that system dynamics is the way to do it. But, there are hurdles. The big impediment to introducing economics goes back to the earlier issue: there is no established economics curriculum for K-8 students, and teachers do not have a deep background in the subject. We will be starting from scratch, seeking help where we can find it. The goal will be to use system dynamics models to give students an awareness of economics as it ties into other areas of their curriculum. So far, for example, the bank balance problems have been lessons in math or system dynamics that have also illuminated money management issues. We need to give more attention to economics itself in the curriculum context.

One resource will be the *Voluntary National Content Standards in Economics*, developed by the National Council on Economic Education in partnership with the National Association of Economic Educators Foundation for Teaching Economics (also available on-line). The standards outline twenty basic economic principles that students need to understand in order to effectively conduct the ordinary business of living and participate fully in our complex global economy. There are benchmarks for grades 4, 8 and 12, along with assessment criteria and available teaching materials. The standards focus on developing an understanding of basic economic concepts as they apply to the students' daily lives, in non-technical language. (They do not intend to deliver the material of a high school Economics course, for example.) Students learn about scarcity of resources, the need to make choices, weighing costs and benefits of alternative decisions, opportunity costs and trade-offs, spending and saving their money, and more, all in a context relevant to them. Our goal will be to find good ways to use system dynamics with these standards and lessons in ways that tie into the current math, science and social studies curricula. We will try to pair system dynamics with economic education from the beginning.

Another challenge to introducing K-8 economics in Carlisle is finding ways to infuse it into classes throughout the school. Rob Quaden is a systems mentor helping other teachers in their classes, but he is also an eighth grade algebra teacher for three days each week. He can easily experiment and implement system dynamics lessons with his own students. He and Alan Ticotsky (a full time-mentor) have greater difficulty establishing system dynamics lessons throughout the curriculum in other teachers' classes, however. Quaden and Ticotsky are always welcomed to co-teach with regular class teachers throughout the school, and many teachers seek them out for help with system dynamics lessons of their own. Furthermore, all teachers are now required to do at least one system dynamics lesson each year. This is very encouraging progress. System dynamics is seeping into the curriculum in Carlisle.

The issue is sustainability, however. While there are already many teachers committed to the systems approach, how can we get more teachers comfortable enough to make it part of their everyday teaching repertoire without the support of the mentors? How do we embed system dynamics so deeply into the culture and practice of the school that it continues on without us in Carlisle, and into other schools? This is the current challenge for the mentors in all areas of the curriculum. It will take steady work building on the firm foundation already laid.

Adding economic education into the mix adds to the challenge. (Somehow, the systems approach fosters such risk-taking as Bill Gale did with his fourth graders.) K-8 teachers are already very busy, pressed to meet standardized test goals, and not always familiar with economics. There is no established curriculum for K-8 economics or system dynamics. Yet, economic issues tie into many areas of the curriculum, and students will certainly need an understanding of economics to navigate the complex global economy. As Forrester urges, system dynamics can give students a practical understanding of economic concepts. Carlisle is making a start.

References

Forrester, Jay W., "Learning through System Dynamics as Preparation for the 21st Century," Keynote Address for the Systems Thinking and Dynamic Modeling Conference for K-12 Education, 1994, Creative Learning Exchange, www.clexchange.org

Meadows, Dennis, *FishBanks, Ltd.*, Institute for Social Policy Research, UNH, Durham, NH.

National Council on Economic Education, 1997, *Voluntary National Content Standards in Economics*, National Council on Economic Education, New York.

(Many examples of K-12 system dynamics curriculum materials prepared by teachers across a broad range of grade levels and subject areas are posted at the Creative Learning Exchange website at www.clexchange.org)