Can Education Reform Get in the Way of Reforming Education?

A Simulator for Exploring Reform Strategies

The simulator, *School Reform Simulator*, can be found on the CLE website at *clexchange.org*

By Gary B. Hirsch, Creator of Learning Environments

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Introduction

Education reform poses great challenges for school systems. Reform is not a single, coherent strategy, but a large array of proposals for improving education. Each of these proposals has its own focus and advocates. Proposals for reform are often crafted independently of each other. School systems can easily be overwhelmed as they respond to this array of demands for reform and externally imposed measures to assure accountability. Different reforms interact with each other and with the system's ongoing operations. Poorly selected reforms can interfere with each other and do serious harm to school systems rather than improve their performance. Yet some change is essential.

This paper presents a simulator that school systems can use to understand the dynamics of education reform and, at an aggregate level, examine different strategies for implementing reform. It is based on a System Dynamics simulation model that represents key causal relationships among elements of reform and a system's ongoing operations. The simulator is not intended as a forecasting tool or "how to" guide, but a framework for helping school systems identify unanticipated and potentially damaging consequences of reform efforts. It can also help them determine combinations of reforms that work well together and can be mutually supportive. In addition, the simulator can help school systems and their constituencies understand the value of System Dynamics and Systems Thinking by applying them to issues of critical importance.

The paper begins by presenting elements of the model and using it to examine possible impacts of reform on a school system, especially one that is already struggling. The model deals with some basic determinants of student performance and ability to learn, problems that hinder learning, curriculum and processes of introducing and adopting new curricula, determinants of teacher motivation and productivity, and how various proposed reforms have an impact on a school system. The paper uses a series of simulations with the model to explain how elements of reform can interact in ways that create barriers to change and damaging vicious cycles. It then describes how school systems can use the simulator to examine strategies for implementing reform that avoid damaging consequences and have a chance for genuinely improving a system's performance.

The simulator and embedded model got their start as a model of innovation in schools. That model was developed by the author, working with a group assembled by Jay Forrester and Ted Sizer and funded by the Gordon Stanley Brown Fund. That model was further developed to include the interaction of curriculum innovation with education reform and school operations by the author and Dr. Linda Greyser of the Harvard Graduate School of Education under a grant from Mr. Allen Boorstein. The existing simulator should be regarded as a prototype that already has some interesting lessons to offer, but would benefit from further development

Modeling the Impacts of School Reform

Modeling the impacts of school reform requires us to first model how schools work and then reflect impacts of specific reform proposals. The causal model underlying the simulator represents school systems in an aggregate manner. While much more detail could be added in any area, the purpose of this model is to provide a high-level look at the impacts of school reform and how it will affect interactions among major components of school systems. Figure 1 provides an overview of the causal model underlying the simulator and how these major components relate to each other.

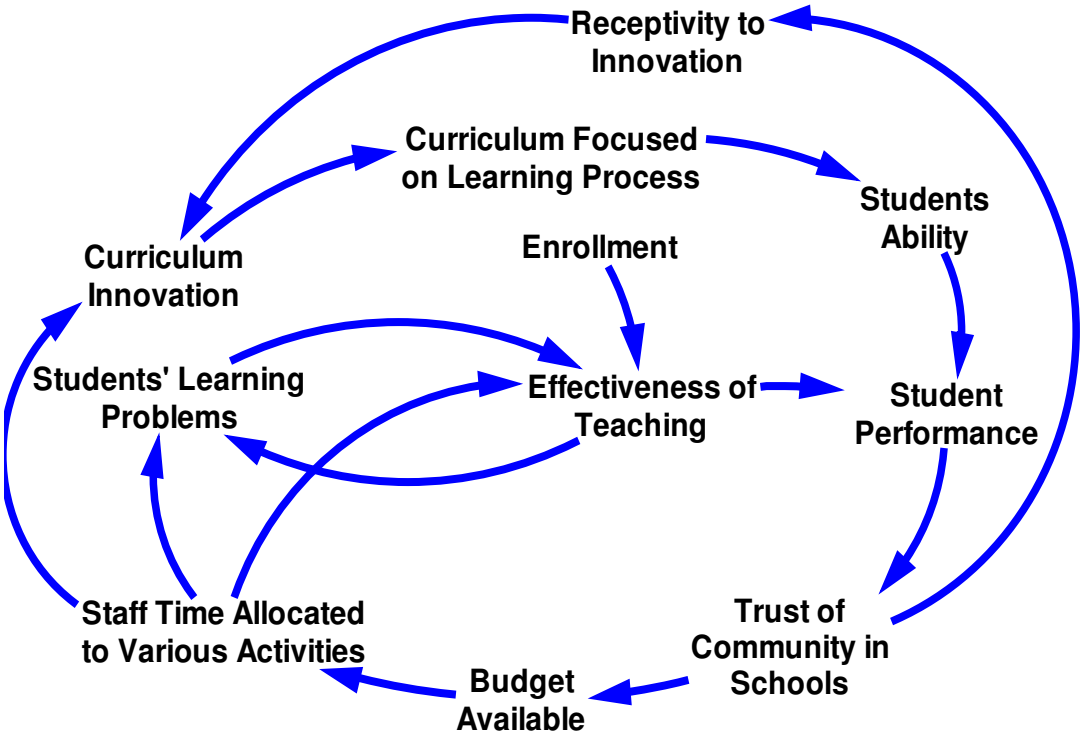

Figure 1: Overview: Model of Innovation and School Performance

As shown in Figure 1, Student Performance in a school system is a function of both students' Ability to Learn and the staff's Effectiveness of Teaching. Student Performance, in turn, affects the Trust of the Community in the Schools, and, in turn, its willingness to make Budget Available to the schools and Receptivity to Innovation. The Budget Available determines the Staff Time Allocated to Various Activities, which include regular instruction, remediating Students' Learning Problems, and implementing Curriculum Innovation. The ability to innovate depends on both having enough staff time available for curriculum innovation (and related activities such as Professional Development) and the community's Receptivity to Innovation. Curriculum Innovation focuses on fundamental changes in the learning process (i.e., self-directed) rather than simply delivering the Traditional Curriculum in new packaging. The new curriculum can then result in improvements in Students' Ability to Learn and Student Performance.

The model represents a system covering grades K-12 with 2500 students distributed about evenly over the grades. Student enrollment is assumed to remain constant unless students leave for alternative schools as they do in some of the later simulations that are described. Users of the simulator can also experiment with the effects of the growing enrollments that many districts are experiencing. There are 250 staff (200 experienced, 50 inexperienced) to start with and an annual budget of $12.5 million. Students have an average of 0.65 learning problems per student which reflects the fact that many students have no particular problems while others have multiple problems.

Figure 2 shows some of the relationships in a bit more detail. One focus of the model, Student Performance on Traditional Curriculum, is determined by Students Ability to Learn and Effective Staff Time per Student. Effective Staff Time per Student is a measure of the staff's capacity to work with students, adjusted for the prevalence of learning problems and other sources of demand on their time. Effective Staff Time reflects both the numbers of Staff Available and Staff Productivity which, in turn, is determined by the staff's average experience and its motivation. Average Experience will be drawn down in this system as in most school systems over the next few years as the large crop of teachers recruited in the 1960's and 70's retires and is replaced by new teachers. Teacher Motivation is affected both by the reasonableness of the workload teachers are given and other factors such as whether innovations the teachers help to implement are successful.

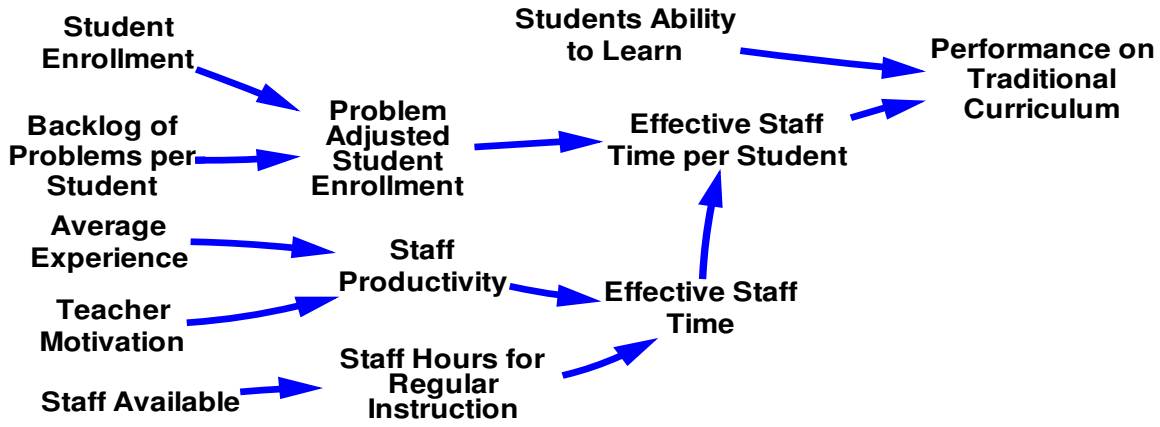

Figure 2: More Detailed Look at Determinants of Student Performance

Problem-Adjusted Enrollment is one measure of teachers' workload. It reflects total numbers of students and the average Backlog of Problems per Student. The problems include learning disabilities and difficulty with particular subjects and require staff time for remediation. They can also occur with greater frequency if staff are overworked and cannot spend enough time per student on regular instruction.

In the absence of external pressures or changes in enrollments, a school system with 2500 students might be expected to experience the stable, not very exciting behavior over a ten-year period shown in Figure 3. The staff is able to deal with student learning

problems that emerge and the Problem Adjusted Enrollment (red line (2)) and average number of Problems per Student remains roughly constant. The only deterioration over a ten year period is evident in a small decrease in Staff Time per Student (pink line (3)) and Performance on Traditional Curriculum (blue line (1)) as experienced staff retire and are replaced by new teachers who take a few years to get up to speed.

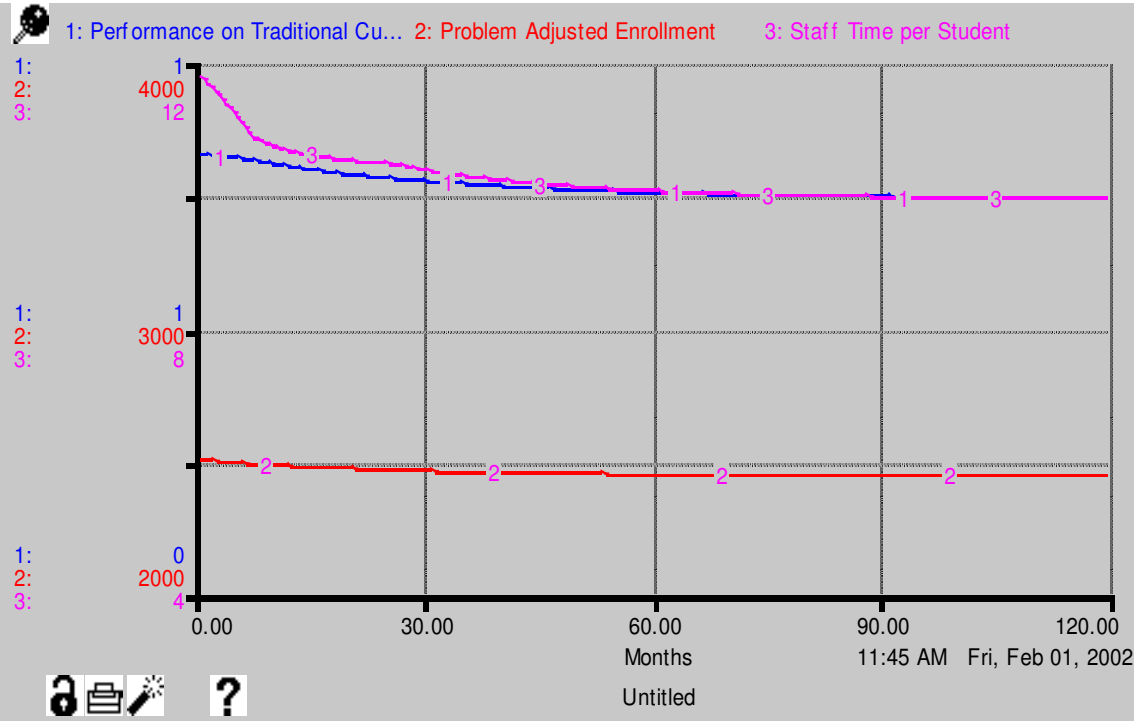

Figure 3: Stable Outcome Without School Reform

Introducing Reform: Greater Accountability with High-Stakes Testing

Now we'll start introducing some of the changes called for by popular school reform proposals into this quiet, stable system. Let's begin with increasingly stringent standards, enforced by high-stakes testing, about what students must know in order to graduate. This includes testing at lower grades to identify students who may ultimately have problems graduating under the tougher standards. As a result, student learning problems that may have "slipped by" are identified and must be dealt with. Students who are unable to graduate must stay on for additional remedial help. Enrollment grows a bit as some students remain instead of graduating. In the next simulation, with tougher standards and high-stakes testing imposed, the Traditional Curriculum is also assumed to expand to include more test preparation. As a result, staff must rush through the curriculum at a faster rate and Effective Staff Time per Student is lower.

Figure 4 shows the potential outcome for this implementation of school reform. Average Problems per Student grows over the course of the simulation and Problem Adjusted Enrollment (red line (2)) increases as a result. In the presence of a constant number of Staff Available, Effective Staff Time per Student (pink line (3)) declines. Performance

on the Traditional Curriculum (blue line (1)) declines as a result and the Performance Ratio declines even more steeply because it reflects poorer performance against growing expectations. What would have been a stable school system instead develops some serious problems. These would have been worse except that an increased dropout rate acts as a "safety valve" and relieves the system of some of its most troubled students. This is clearly not desirable for those students or the community.

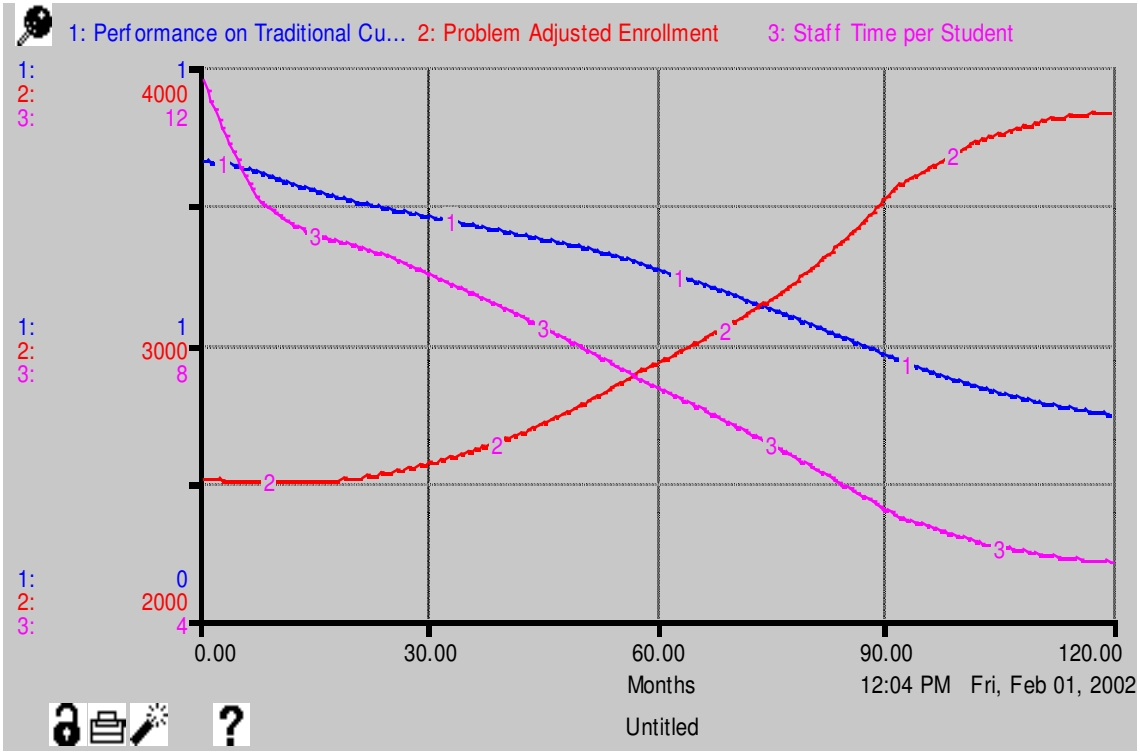

Figure 4: Results of Imposing Stringent External Standards and High-Stakes Testing

Why does imposing more stringent standards create these problems. Figure 5 shows the relationships that help to produce the growing problems. The circular sets of relationships traced by the causal arrows are called feedback loops. Some loops such as those shown in Figure 5 are called reinforcing loops and tend to drive the behavior of systems such as a school district in a particular direction. (Another type, balancing loops, tend to resist change in systems.)

As shown in Figure 5, more stringent standards and high-stakes testing may identify previously undetected problems and also cause some students (those with the most severe problems) to take longer to graduate. The higher enrollment (assuming new students are entering at the same rate) and greater average Problems per Student lead to a significantly increased Problem Adjusted Enrollment (a measure of the school system's workload) and lower Effective Staff Time per Student. This leads to a higher rate of new problems developing (staff don't have time to help students and they fall further behind until they have a serious problem in a course) and a lower rate of remediation of existing problems.

The higher prevalence of problems per student increases the system's workload even further, completing the loop. Additional Curriculum piled on to prepare students for the high-stakes tests only exacerbates these problems by reducing Effective Staff Time per Student. Thus a stable system is destabilized and driven in a direction that brings it severe problems.

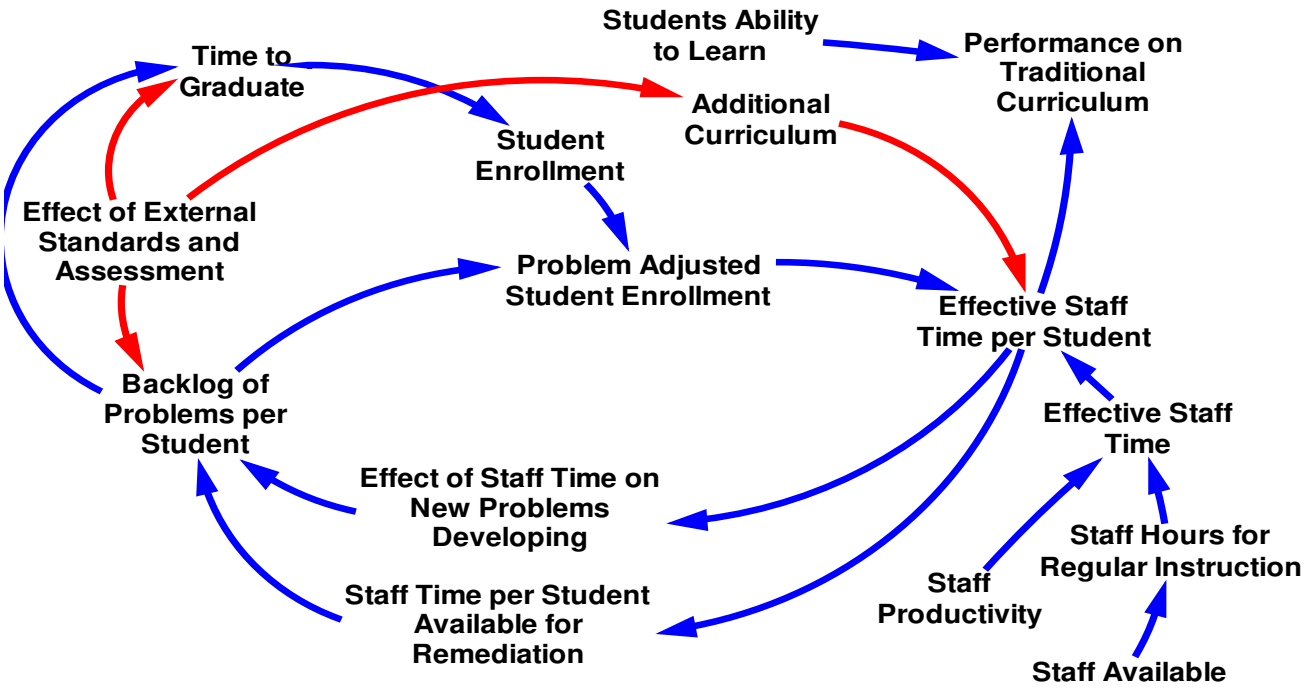

Figure 5: Reinforcing Loops That Exacerbate Problems Caused by Imposing Stringent External Standards

Further Reform: Providing Competition for the Public Schools

Now what happens if an additional measure advocated by reformers is added to the mix? What if students and their parents are able to choose alternative schools if they become dissatisfied with the performance of the public school system? Under such arrangements, they are able to take portions of the school budget with them in the form of vouchers for private school tuition or budgets to support charter schools. Let's add this to the effects of greater accountability via high-stakes testing.

The results are shown in Figure 6 on the next page. These reveal a potential disaster for school systems that are already struggling and whose students can simply opt out as performance declines and take precious resources with them. The first graph shows that enrollment (blue line (1)) holds on for several years, but suddenly begins to fall as a set of vicious circles drives students into alternative schools. Enrollment in those schools (red line (2)) increases as rapidly as the public schools decline. The shift in enrollment into alternative schools occurs in response to a falling Performance Ratio (pink line (3)), the result of both rising expectations and falling performance.

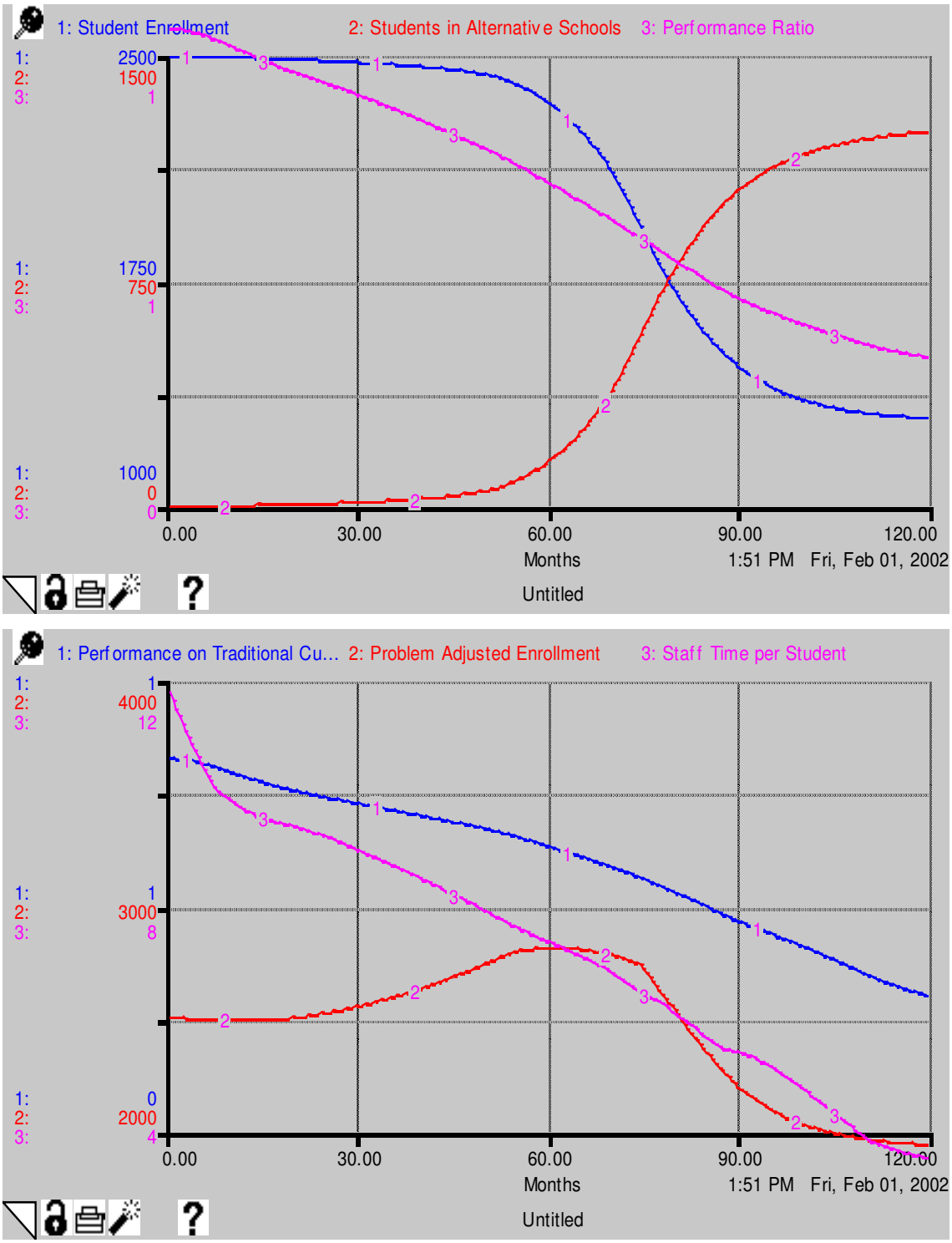

Figure 7: Results of Implementing Access to Alternative Schools

As shown in the second graph in Figure7, Performance on the Traditional Curriculum (blue line (1)) falls sharply as total Staff Available declines. This happens because

students leaving for alternative schools take chunks of the school budget (the $5,000 average per student) with them and new staff cannot be hired to replace those who leave. Problem Adjusted Enrollment (red line (2)) increases for a while, reflecting growing Problems per Student, but ultimately falls as students flee the public schools. Effective Staff Time per Student (pink line (3)) drops as a result, even though the number of students is also declining. This is because the public school system has much of the same overhead, even with fewer students, and budget reductions must come disproportionately from staff salaries. As Effective Staff Time per Student goes down, Performance on the Traditional Curriculum suffers further and the vicious circle continues.

Figure 7 shows the additional reinforcing loop that drives the decline seen in this simulation that also interacts with the loops that were described earlier. These loops suggest that a schools system that starts to fall behind in responding to the pressures of school reform may fall further behind as time goes on, especially if it lacks additional resources for catching up. Losing resources as students and their families "vote with their feet" only makes things worse.

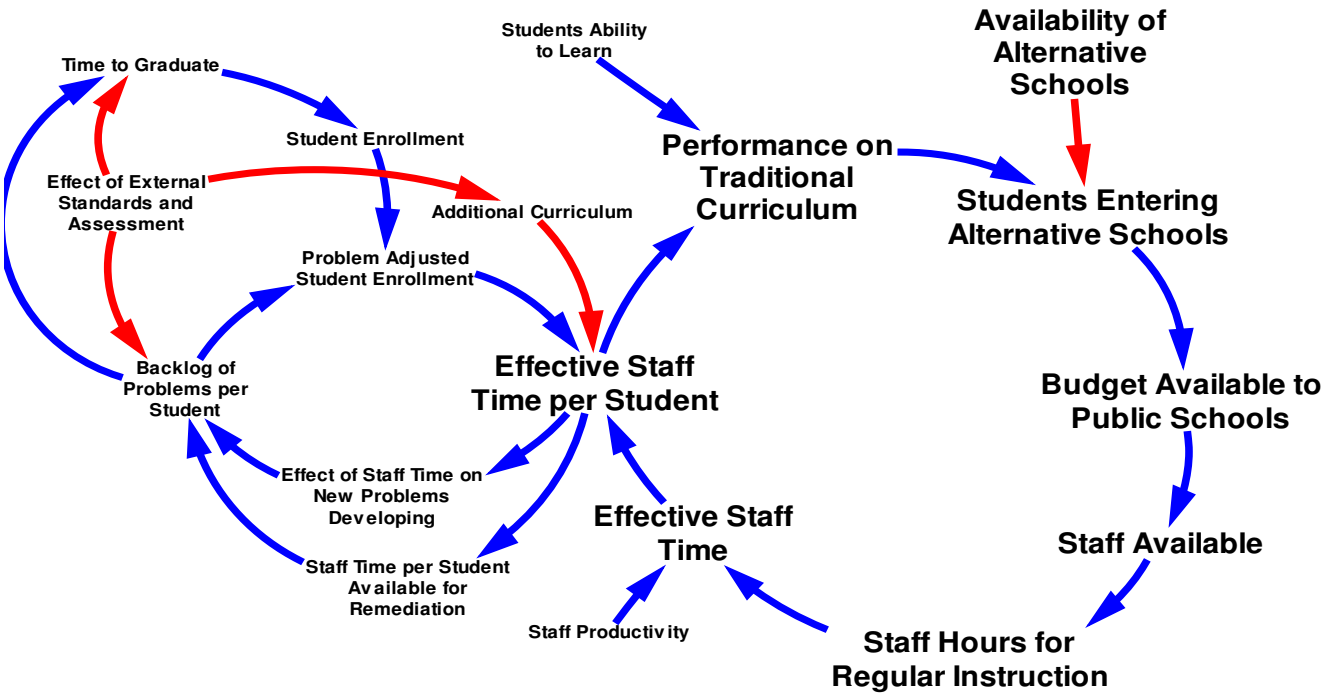

Figure 8: Reinforcing Loops Through Student Access to Alternative Schools

A Different Approach: Curriculum Innovation and Students' Ability to Learn

The simulations so far have assumed that the school system would deal with the pressures on it by simply working harder to deliver the traditional curriculum. What about adopting a new curriculum that will increase Students Ability to Learn as well as teaching them differently and teaching them new things? This sort of curriculum would emphasize self-directed learning together with compatible assessment methods such as the use of portfolios. This new curriculum and its effects on Students Ability to Learn

would hopefully let the school system get ahead of the demands on it created by school reform and stabilize at a higher level of performance. Figure 9 shows the relationships affecting the Adoption of New Curriculum and Students Ability to Learn in greater detail. It also shows the reinforcing loops that would ideally help a school system benefit from curriculum innovation.

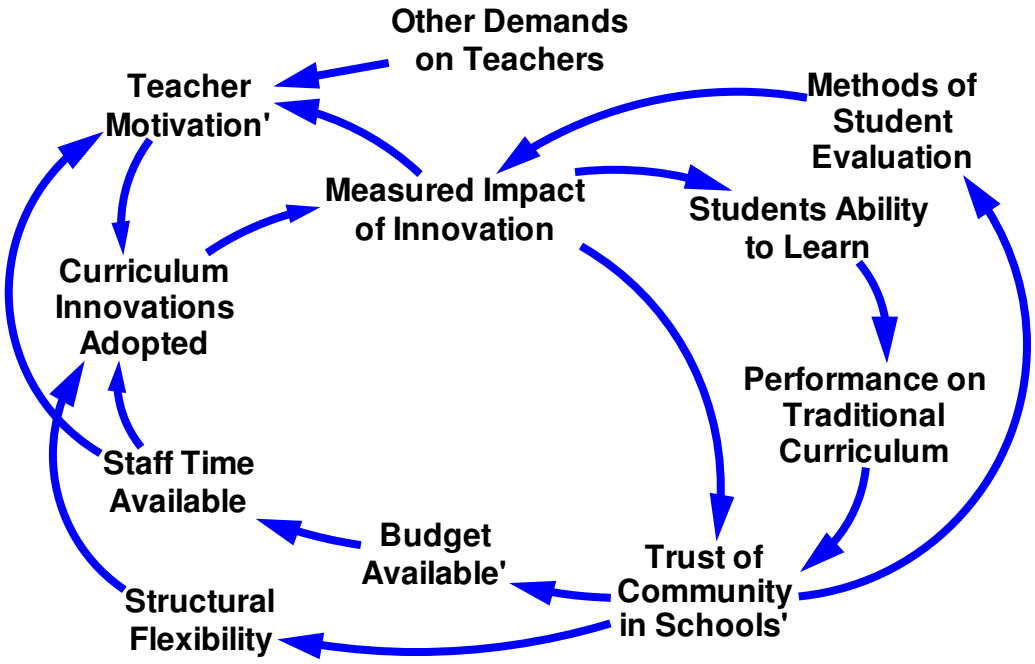

Figure 9: Relationships Affecting Curriculum Innovation

As shown in Figure 9, Curriculum Innovations Adopted are assumed to have their impact on Students Ability to Learn. However, there are several essential co-requisites for curriculum innovations to be adopted and have a measurable impact. One, for example, is the Structural Flexibility needed to have a scheduling system that supports longer class periods and blocks of time needed for self-directed learning activities. Another is having Methods of Student Evaluation such as portfolios and exhibitions that are appropriate for demonstrating the results of these new curricula. Having sufficient budget and staff time available is certainly a necessity. Placing major time requirements for curriculum innovation on teachers who are already stressed by demands on their time (including preparing students for high-stakes tests) will reduce Teacher Motivation that is essential for implementing new curricula.

If everything goes well, the set of reinforcing loops shown in Figure 9 can produce some wonderful improvements in a school system's performance. Improvements in Students' Ability to Learn and Performance on Traditional Curriculum will lead to an increase in Community Trust in the Schools which helps to sustain the conditions required for continued innovation and further improvements in Students Ability to Learn. This means more budget and staff time and greater receptivity to changes such as new Methods of Student Evaluation and increased Structural Flexibility.

The next simulation examines the results of adopting this sort of major curriculum program together with a new assessment scheme and a scheduling system with larger blocks of time to permit inquiry learning. These changes are superimposed on all of the other changes already reflected in the previous simulation. The results, unfortunately, are indistinguishable from and actually a bit worse than those displayed in the previous simulation. Figure 10 compares Staff Effort per Student, the key measure of the staff's capacity to educate students and deal with their learning problems, in two simulations. The blue line marked (1) is from the previous simulation whose results were shown in Figure 7, the one without curriculum innovation. The red line marked (2) reflects the result of introducing a major new curriculum program in addition to everything else going on. Staff Time per Student declines more steeply in the latter.

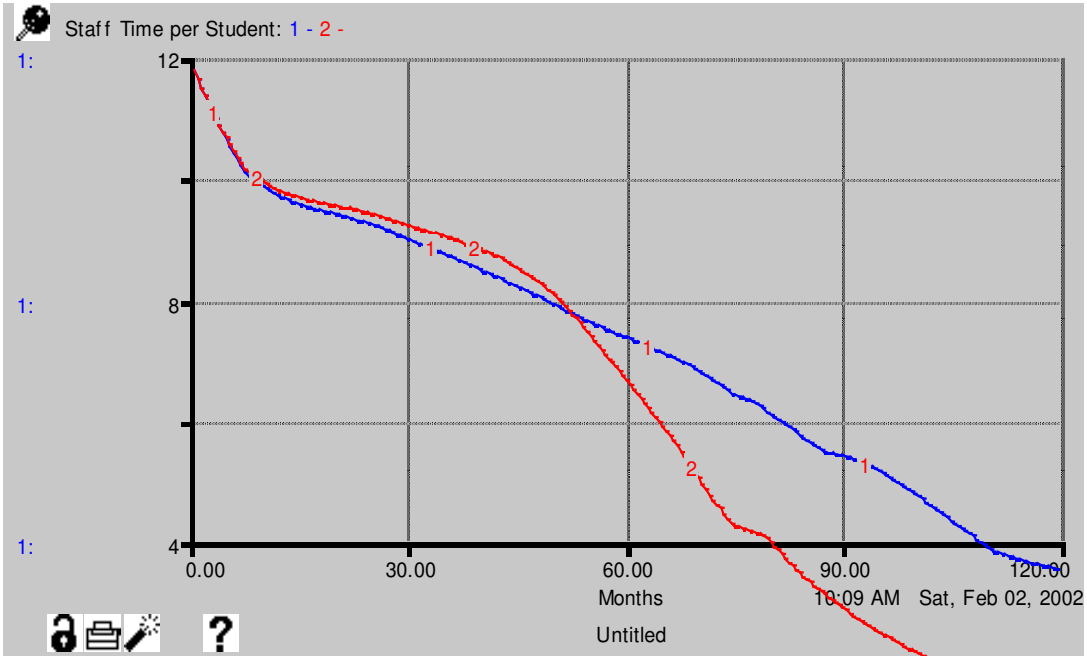

Figure 10: Comparison of Staff Time per Student Between Simulations Without (1) and With (2) Curriculum Innovation--Effect of Staff Overload

Why should something so promising as a new curriculum yield such poor results and actually make things worse. The problem is not in the new curriculum, but in the way it is implemented. The term Other Demands on Teachers in Figure 9 suggests a reason for this disappointing result. Trying to implement a new curriculum (and new assessment and scheduling systems) while teaching the entire traditional curriculum and preparing students for the high-stakes tests is simply too much to do any of this well. This result is a good reminder that school systems are "going concerns" that must keep educating students even as they respond to reform. The teaching staff is stretched thin and can't do anything well. Performance suffers and a negative experience with innovation prevents any further changes from being implemented.

Figure 11 shows the behavior of several variables related to innovation in the simulation where curriculum innovation is attempted on top of everything else being done. Poor Experience with Innovation (blue line (1)) because too little staff time is available to implement the new curriculum effectively leads to a fall in both Teacher Motivation (red line (2)) and Trust Between School and Community (pink line (3)). The reinforcing loops shown in Figure 9 exacerbate early problems and lead to further declines that eventually prevent any curriculum innovations from being adopted.

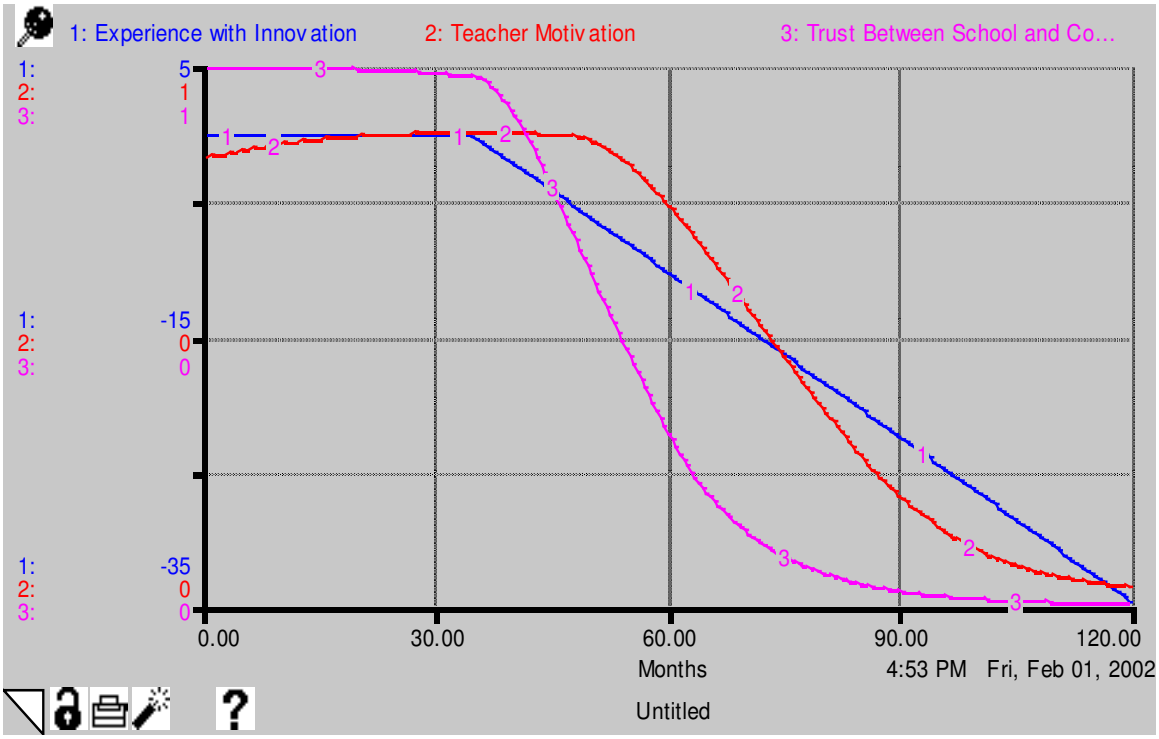

Figure 11: Variables Associated with Unsuccessful Innovation

Cutting Back on the Traditional Curriculum

How can we avoid this problem and benefit from new curricula that help to improve Students Ability to Learn? One strategy would be to review the traditional curriculum, be selective, and make significant cuts in what is being taught as well as avoiding expansion of the traditional curriculum to reflect test preparation. This requires some courage since every part of the curriculum has its advocates and school systems typically don't cut back on what is taught. They often just add new things and leave it up to teachers how to get everything done. Figure 12 shows the results of simply avoiding the expansion of Traditional Curriculum (for test preparation) assumed in previous simulations plus making an additional modest cut in that curriculum. All other conditions assumed in the previous simulation are the same. The scales have been expanded upward to accommodate the growth in the measures that are displayed.

The additional time made available by the cutbacks in the traditional curriculum lets teachers spend enough time on implementing new curricula. Early success leads to further success as the reinforcing loops in shown in Figure 9 produce steady improvement. As shown in Figure 12, Performance on the Traditional Curriculum rises substantially over its starting level as increases in Students Ability to Learn arising from the new curriculum augment improved staff effectiveness. Effective Staff Time per Student increases as staff members are leveraged by students who are able to be self-directed learners. The Problem Adjusted Enrollment goes down not due to a decline in the actual numbers of students, but because the average Problems per Student drops as staff members are able to be more effective in dealing with those problems.

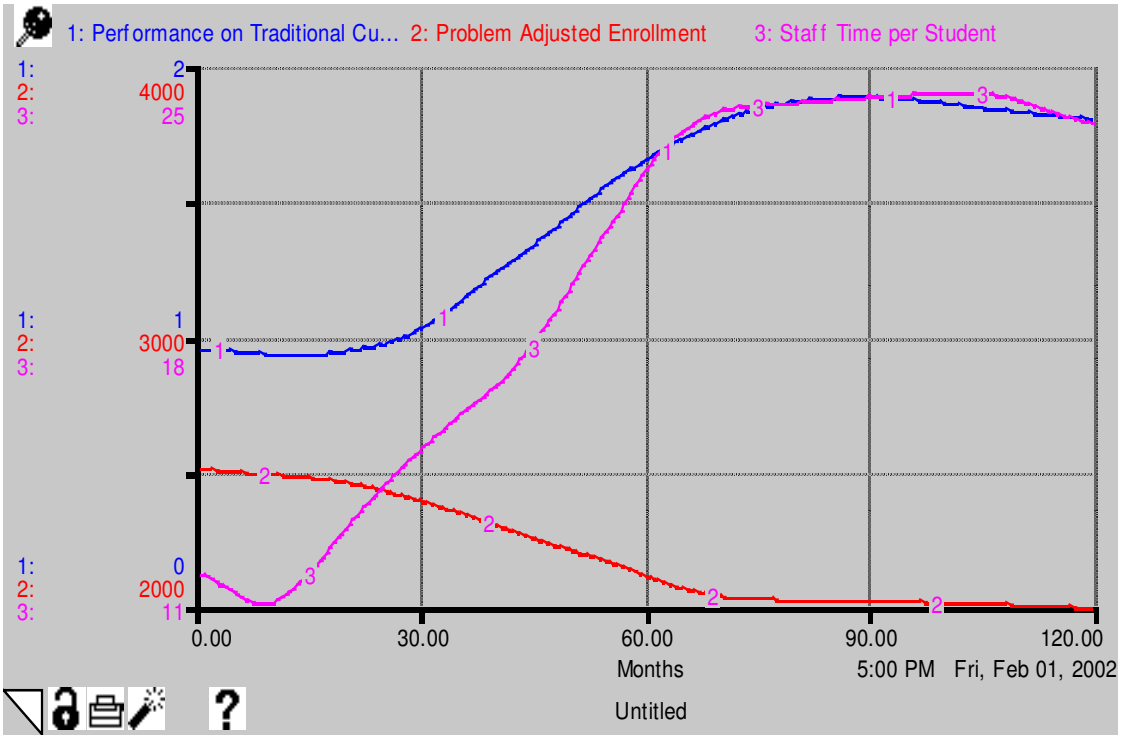

Figure 12: Results of Simulation with Curriculum Innovation and Modest Cutback in Traditional Curriculum

The tremendous difference between the results of this simulation and the previous one is a good example of the importance of finding leverage points in systems. The need to cut back on the traditional curriculum would not have been at all obvious if one was looking at a "laundry list" of possible changes. It is only in the context of a system of interacting factors that such a leverage point becomes apparent.

Using the Simulator

The simulations presented in this paper illustrate a nice range of the kinds of scenarios and strategies that can be examined, but are only a small fraction of the much larger array that users of the simulator might explore. Those using the simulator can examine strategies that include different combinations of:

1. Increases or decreases in the Traditional Curriculum.

2. Staff hours devoted to Professional Development.

3. Fraction of staff time spent on remediation of student problems (vs. regular instruction).

4. Introducing a new curriculum initiative and the timing with which that program is initiated.

5. Introducing a new Mode of Student Evaluation and its timing.

6. Introducing new Structural Flexibility (e.g., a scheduling system) and its timing.

The timing of these last three initiatives is important since it makes it possible to phase programs in gradually rather than "piling on" an overwhelming amount of work for teachers. In the last simulation shown, for example, the new curriculum was not initiated until 24 months into the simulation, after the new Mode of Student Evaluation and scheduling systems had already begun to be implemented. Starting the curriculum initiative at the same time would have produced disastrous results similar to those seen in the previous simulation.

Users of the simulator can examine these strategies against the backdrop of many different scenarios reflecting combinations of assumptions about:

1. Growth or decline in student enrollment.

2. Rates of imposition of external standards on schools.

3. The initial budget available to the schools.

4. Whether or not students have access to alternative schools.

5. Initial levels of Teacher Motivation and Trust Between School and Community.

There are also limited opportunities to do something called sensitivity analysis. This is a process of changing assumptions, doing simulations, and observing the impact on the results. This is useful since many of the relationships in the model are based on assumptions and it is natural to ask if the results would change if the assumptions were

different. For example, users can run the same simulations using a more pessimistic assumption about the relationships between Staff Time per Student and Performance on the Traditional Curriculum (i.e., it takes more staff time to produce the same improvement in performance) and see the effects of this change.

Future Development

There are a number of possible directions for the simulator's future development. One is an expansion of the model to make it somewhat less aggregated. For example, it could be expanded to reflect separate modules for the Elementary, Middle School, and High School grade levels since each has somewhat different missions and resource requirements. Students would flow from one level to another, taking their backlogs of problems with them. With this breakdown in grade levels, it would be possible to examine different resource allocations among the levels and strategies for intervening more aggressively in dealing with student problems at different grade levels.

Another kind of disaggregation would enable people using the simulator to take different roles in the process. They might, for example, play as advocates for particular kinds of reforms or as representatives of key constituencies such as teachers, students, school board members, administrators, and parents. Playing these kinds of roles would give them a good sense of the difficulty of creating coherent reforms in the face of such disparate points of view.

Other potential enhancements might include giving school systems the ability to plug some of their own numbers into the simulator. Again, the purpose is not to create a forecasting tool, but to tailor the output of the simulator to a scale that is familiar and thereby help make its lessons more relevant. At a later point in time, this ability to customize the simulator could lead to its development as a more elaborate planning and budgeting tool.

Comments, requests for additional copies, etc. to

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The author would like to hear from organizations interested in collaborating on or funding the further development of the simulator and school systems that would like to participate in field-testing and further development.