

A Model of Educational Innovation

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The Challenge of Innovation in Schools

It is difficult to implement innovations in schools. Everyone favors innovation, but focuses on different things depending on what they believe is the “magic bullet” for improving schools. Discussions of innovation are often confused because people lump together many different types of innovations including new curricula and methods of teaching, ways of evaluating students, and methods of managing schools. Even though a number of innovations are being considered or implemented at the same time, they are often treated in isolation from each other as well as from what is already going on in the school. Different kinds of innovations compete with each other for resources with the frequent result that none really gets the resources and attention it needs to be successfully implemented. Rather than replacing the existing curricula and systems, innovations are often added to what is already in place. As a result, innovations in schools often create “pushback” in the form of resistance from overworked teachers and students. Teachers may feel that innovations are attempts to “fix something that is not broken” and represent change for change’s sake. Their fears are often confirmed when widely-touted innovations are replaced by the next fad a few years later.

Background of This Effort

How can innovations be planned and implemented to avoid these problems and produce an effective impact? This paper describes a model of innovation in schools developed to provide a framework for discussing and understanding these problems. The model has also been used to answer some “What if?” questions about different approaches to implementing innovations and produce some simple rules of thumb.

The model grew out of conversations between Jay Forrester and Ted Sizer who leads a group called the Coalition of Essential Schools and has written extensively on change in schools. Gary Hirsch got involved and, under a grant from the Gordon Stanley Brown Fund, set out to model innovation in schools. A group that included Forrester and Sizer and a number of other educators guided the work and identified critical factors affecting innovation in schools. Additional insights were provided by a small group of educators actively involved in applying System Dynamics in their schools.

The work is in an early stage. The model is presented to elicit reactions from the System Dynamics community and from educators and especially from people who are in both camps. This paper presents some of the model’s structure, results of simulations with the model, and implications for implementing innovation in schools drawn from those simulation results. (A more complete description of the model and simulation results entitled “Innovation in Schools: A Model to Help Structure the Discussion and Guide the Search for Strategies” (D-4765) is available from the Creative Learning Exchange at <http://sysdyn.mit.edu/cle>.)

Modeling Innovation in Schools

1. Curriculum Innovation Process

One part of the model focuses on the process of innovation itself. As shown in Figure 1, the model depicts innovation in schools as a multi-stage process with several factors at each stage that affect the extent to which a curriculum innovation is adopted and has impact. (In this discussion, model variables appear in Title Case.) Users of the model can specify the magnitude of an innovation as a function of its Breadth of Applicability (whether it applies to a small group, an entire grade, or an entire school system), Rote Memorization vs Deeper Understanding, and Generality of Applicability (to a specific subject area or a set of skills applicable to a broad range of subjects). Resources required for implementing an innovation will depend on its magnitude as well as the Distance from Current Practice that the innovation represents.

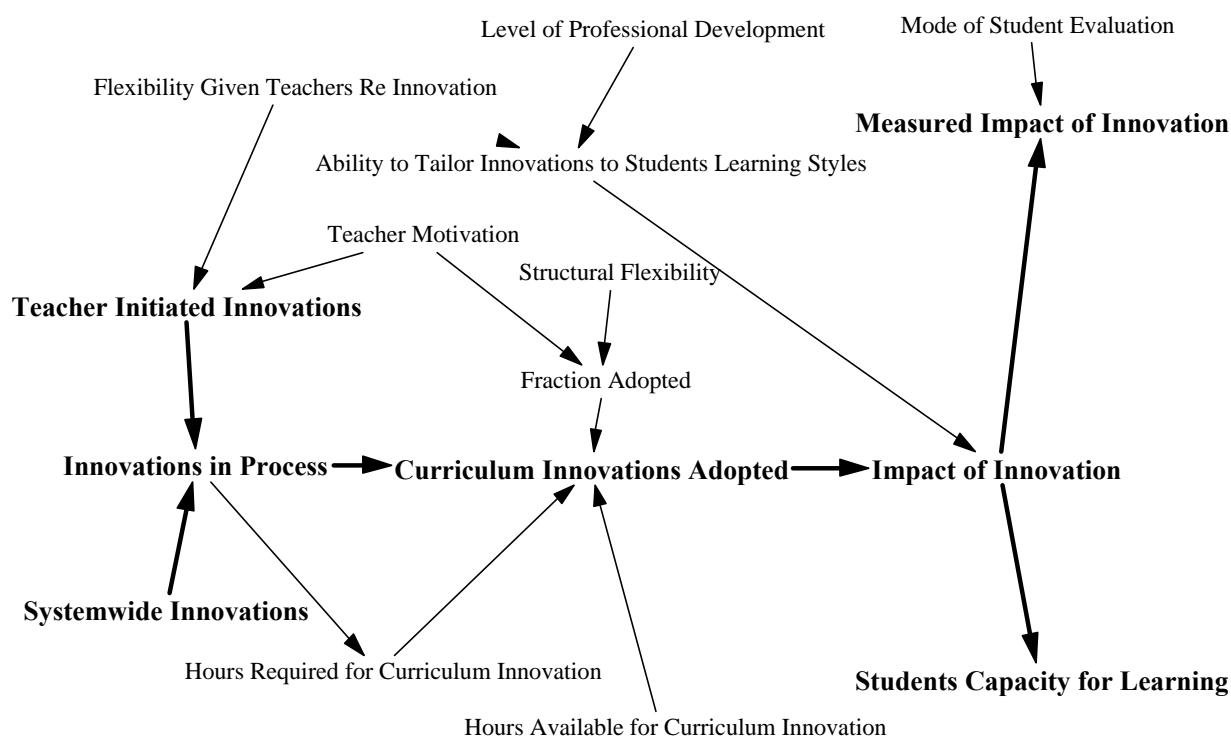


Figure 1: Curriculum Innovation Process

As shown in Figure 1, new curricula may be introduced as Systemwide Innovations and/or Teacher Initiated Innovations. The rate of Teacher Initiated Innovations depends on a climate affected by both Teacher Motivation and the Flexibility Given Teachers Re: Innovations. New curricula introduced by either route become Innovations in Process and can eventually, if conditions are right, become Curriculum Innovations Adopted. The Fraction Adopted (of Innovations in Process) is also a function of Teacher Motivation as well as the Structural Flexibility in a school. Structural Flexibility might, for example, be reflected by a scheduling system that includes different-sized blocks of time rather than a rigid, single-sized block that is inadequate for more elaborate student-directed, learning experiences. Low Teacher Motivation

and/or low Structural Flexibility can cause most of an innovative curriculum to be discarded rather than being adopted. The Rate of Adoption is also affected by the ratio of Hours Available for Curriculum Innovation to the Hours Required for Curriculum Innovation. Having more hours available will permit a faster Rate of Adoption.

Adoption of curriculum innovations does not guarantee that they will have an impact. The Impact of Innovation will depend on both the level of Curriculum Innovations Adopted and the Ability to Tailor innovations to Students Learning Styles. The Ability to Tailor Innovations to Students Learning Styles depends, in turn, on Flexibility given Teachers Re: Innovation and teachers' Level of Professional Development. These factors suggest that innovations cannot simply be implemented in lockstep fashion and be expected to have an impact on students. Teachers need the flexibility to tailor innovations and the skill to adjust curricula to meet student needs.

The Impact of Innovation has its effect in two places. One is directly on Students Capacity for Learning and the other is on the perception of teachers and the community of the impact, expressed as the Measured Impact of Innovation. Why differentiate between the Impact of Innovation and Measured Impact of Innovation? Many curriculum innovations will produce impacts that are largely invisible because the Mode of Student Evaluation in use does not reveal the impact. For example, an innovation may produce an increase in higher-level skills. If the Mode of Student Evaluation in effect is merely traditional testing of rote memorization, these higher-level skills will be invisible and, in this case, the Measured Impact of Innovation will be negligible even though the Impact of Innovation is significant.

2. Community and Teacher Responses to Innovation

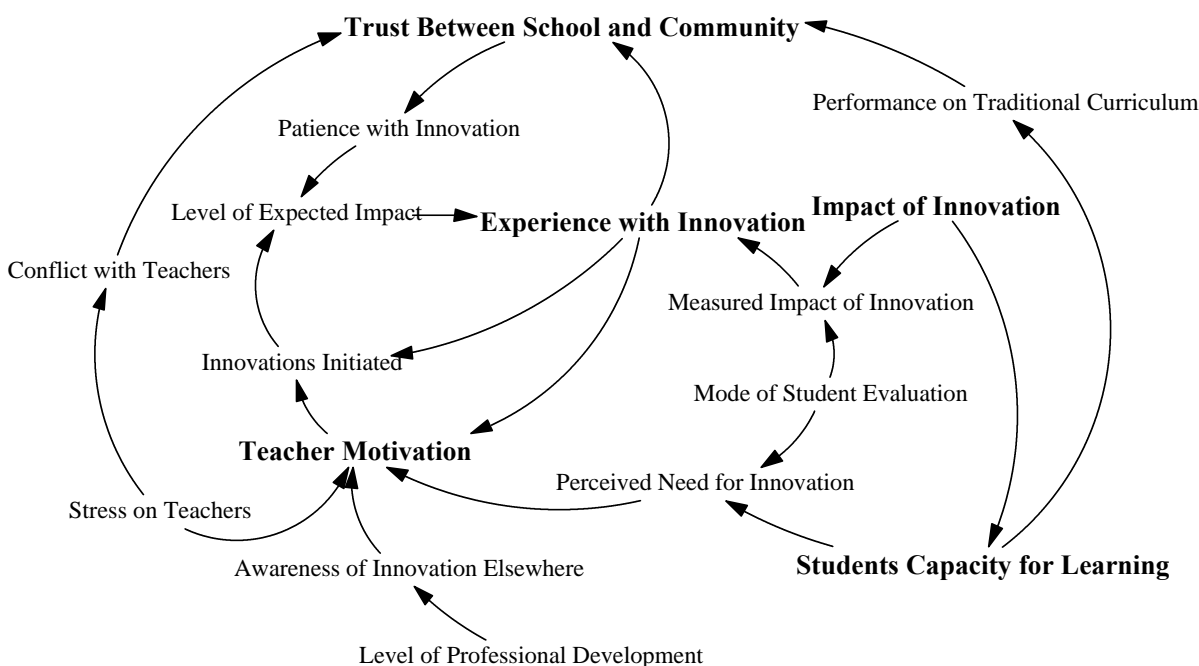


Figure 2: Community and Teacher Response to Innovation

The other part of the model deals with how teachers and other members of the community respond to innovation and how this, in turn, affects the future climate for and acceptance of innovation. Teacher Motivation is critical for assuring that any innovation will be adopted. Low motivation will mean that teachers will only “go through the motions” in working with an innovative curriculum and an innovation will have minimal impact on how students learn. The group identified several factors that can affect Teacher Motivation. Experience with Innovation is especially important. As shown in Figure 2, Experience with Innovation changes depending on how the Measured Impact of Innovation compares with the Level of Expected Impact.

Perceived Need for Innovation is another factor affecting motivation. Teacher Motivation will be low unless teachers see an innovation as meeting a real need. Perceived Need for Innovation also depends on the Mode of Student Evaluation since a need may exist, but be invisible if the measurement system in place does not reveal the need. Again, a Mode of Student Evaluation focused on rote memorization will not reveal inadequacies in higher level skills. Teacher Motivation may also be greater if teachers have an Awareness of Innovation Elsewhere that can come from a higher Level of Professional Development. Teacher Motivation can also be undermined by Stress on Teachers if they are forced to spend extensive numbers of hours adopting innovative curricula in addition to their ongoing duties.

The community’s response is as important as that of teachers. The group identified Trust Between School and Community as a key variable affecting innovation. Experience with Innovation has as an important effect on this variable as it does on Teacher Motivation. Conflict with Teachers arising from Stress on Teachers will also undermine Trust Between School and Community. Performance on Traditional Curriculum will also affect Trust Between School and Community. Diverting too much time from the traditional curriculum to work on innovative curricula will provoke a negative reaction from the community if Performance on Traditional Curriculum falls before the benefits of innovation can be realized. A higher level of Trust Between School and Community will increase the community’s Patience with Innovation which will enable the Level of Expected Impact to develop more slowly and allow more time for the Measured Impact of Innovation to grow and favorably affect Experience with Innovation.

3. Overview: Putting Innovation and Teacher and Community Response Together

Figure 3 puts key aspects of the innovation process and responses to innovation together to provide an overview of the complete model. It shows how Trust Between School and Community can have an important effect on changing the conditions that affect innovation. A high level of Trust Between School and Community is assumed to be necessary for making any changes in the Mode of Student Evaluation and in Structural Flexibility. In the absence of sufficient trust, communities are likely to react conservatively to proposed changes and want to stick with a “tried and true” approach to running a school. A high level of Trust Between School and Community may also make it possible to cut back on Tasks in Traditional Curriculum and Hours Required for Traditional Curriculum and leave more Hours Available for Curriculum Innovation.

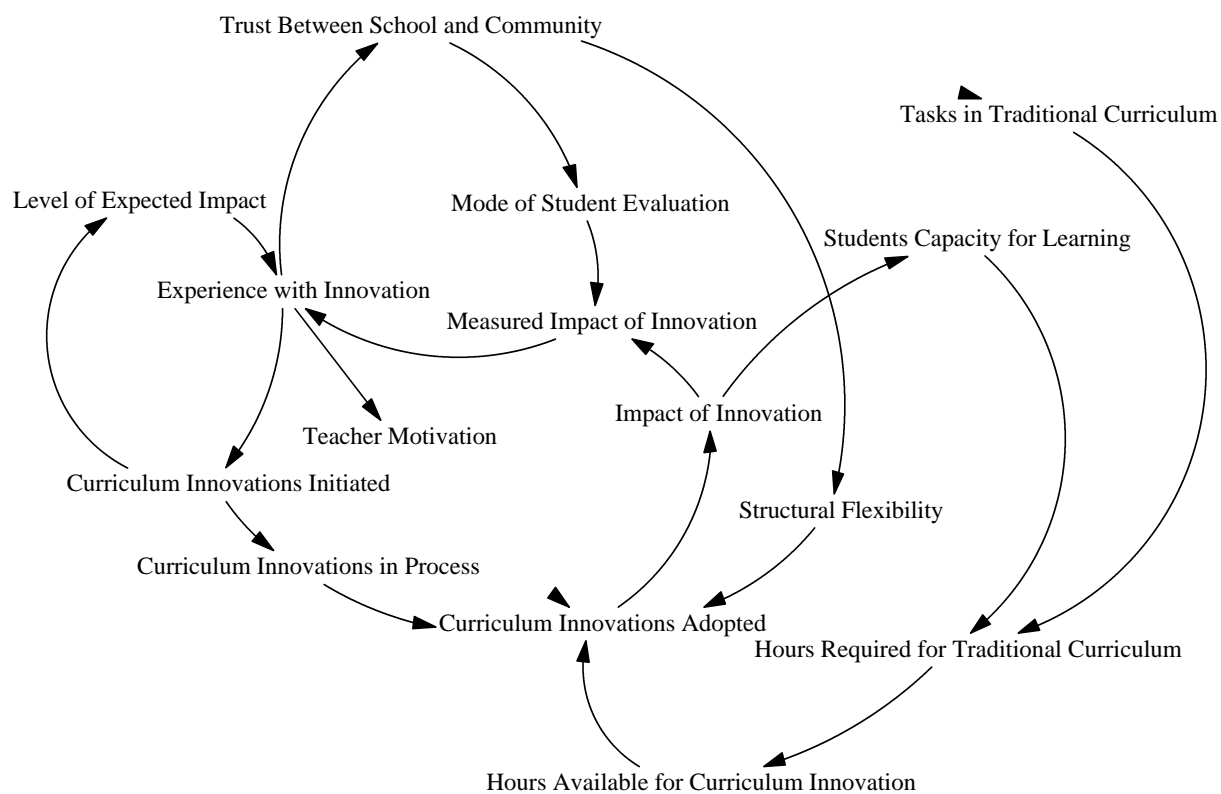


Figure 3: Overview: Putting Community and Teacher Response Together

The relationships shown in Figure 3 contain several reinforcing loops that, if harnessed appropriately, can help schools overcome the inertia that usually serves as an impediment to innovation. In one set of loops, positive Experience with Innovation will lead to higher levels of Trust Between School and Community that make it possible to change the Mode of Evaluation and increase Structural Flexibility. These changes can then lead to a higher Fraction Adopted and Measured Impact of Innovation which produce further improvements in Experience with Innovation. Being able to cut back on Tasks in Traditional Curriculum as a result of higher Trust Between School and Community will reduce Hours Required for Traditional Curriculum and make more Hours Available for Curriculum Innovation. This will, in turn, lead to more Curriculum Innovations Adopted, greater Impact of Innovation and Measured Impact of Innovation, and further improvement in Experience with Innovation and Trust Between School and Community.

Improvements in Students Capacity for Learning will also reduce Hours Required for Traditional Curriculum (i.e., students will be able to learn more efficiently), increase the Hours Available for Curriculum Innovation, Curriculum Innovations Adopted, and Impact of Innovation and further increase Students Capacity for Learning. Increases in Students Capacity for Learning can also increase the Impact of Innovation which can then produce further increases in Students Capacity for Learning. Finally, positive Experience with Innovation will increase Teacher Motivation which will, in turn, lead to greater Curriculum Innovations Adopted, Impact of Innovation, and Measured Impact of Innovation and additional improvement in Experience with Innovation.

Simulating Different Strategies for Implementing Innovations in Schools

A number of simulations were done with the model to get an understanding of what is necessary to successfully implement innovations. Initial conditions were established that made the model simulate a “middle of the road” school system with Experience with Innovation that was essentially neutral (a value of zero on a scale of -40 to +40). A reasonably benign history up to that point had produced values of Teacher Motivation and Trust Between School and Community of 0.5 on scales of zero to one. Because it is a fairly traditional school system, the Mode of Student Evaluation and Structural Flexibility have values of zero and 0.1 respectively on scales of zero to one.

The natural first step was to simply simulate the introduction of a large curriculum change by itself. A large project was chosen that maximized all of the attributes (Breadth of Impact, Rote Memorization vs Deeper Understanding, and Generality of Applicability) and was implemented at the beginning of the simulation. Not surprisingly, it produced only a minimal Impact of Innovation and almost no Measured Impact of Innovation at all. Experience with Innovation, Teacher Motivation, and Trust Between School and Community all dropped precipitously. Without attention to increasing Structural Flexibility, the Fraction Adopted was low and Curriculum Innovations Adopted and Impact of Innovation were also low as a result. The small Impact of Innovation that was produced also did not translate into a Measured Impact of Innovation because nothing had been done to change the Mode of Student Evaluation. Clearly, introducing a major curriculum innovation alone would not be successful.

The next step was to combine the major curriculum project with additional investments of time in increasing Structural Flexibility and changing the Mode of Student Evaluation. (Both are assumed to require significant numbers of teacher hours in addition to the curriculum innovation.) All of these interventions were initiated together at the beginning of the simulation. Rather than producing an improvement over the first simulation, the results were even worse if that is possible. What happened? Trying to accomplish all of these changes at once left too little time for doing any of them well or in a timely fashion. Curriculum Innovations Adopted increased very slowly as a result. As the Level of Expected Impact increased, Curriculum Innovations Adopted could not keep up. Experience with Innovation fell and caused Teacher Motivation and Trust Between School and Community to fall as a result. With all of the changes starting at once, the increases in Structural Flexibility and change in Mode of Student Evaluation were too little and too late to really help. Once Trust Between School and Community began to fall, it was also impossible to accomplish anything in these areas.

Delaying the curriculum project until after Structural Flexibility had increased and the Mode of Student Evaluation had changed was a logical next step. The next simulation delayed the start of the curriculum project by two years. The results were somewhat better, although not an unqualified success. The Impact of Innovation and Measured Impact of Innovation exceeded the Level of Expected Impact for a while, but leveled off while the Level of Expected Impact kept rising. As a result, Experience with Innovation, shown in Figure 4, grew for a while and reached a peak of 6 before declining. This modest, but temporary improvement helped to produce a

The benefits of spending more time on professional development were not realized since the increased time on that activity took time away from curriculum development and kept the new curriculum from being adopted in time to meet the Level of Expected Impact that developed. Does this mean that professional development is a bad idea or a poor use of time? Of course not! This result merely suggests that increased time on professional development must be combined with other elements in order to contribute to a better strategy for implementing innovation.

What will work better? Increasing Flexibility Given Teachers Re: Innovation does appear to make a big difference in producing a sustained effect. By increasing the Impact of Innovation and Measured Impact of Innovation, this intervention sets several reinforcing loops in motion that create a sustained effect rather than the temporary success seen in the earlier simulation as displayed in Figure 4. Figure 5 displays the results of increasing Flexibility Given Teachers Re: Innovation in addition to the interventions that were part of the earlier simulation. Rather than reaching a peak and then declining, Experience with Innovation reaches a level of 15 and appears to remain at that level. As a result, Trust Between School and Community achieves a level close to one and stays at that level. Teacher Motivation achieves a higher level as well. (Note the change in scale for Teacher Motivation and Experience with Innovation between Figures 4 and 5.)

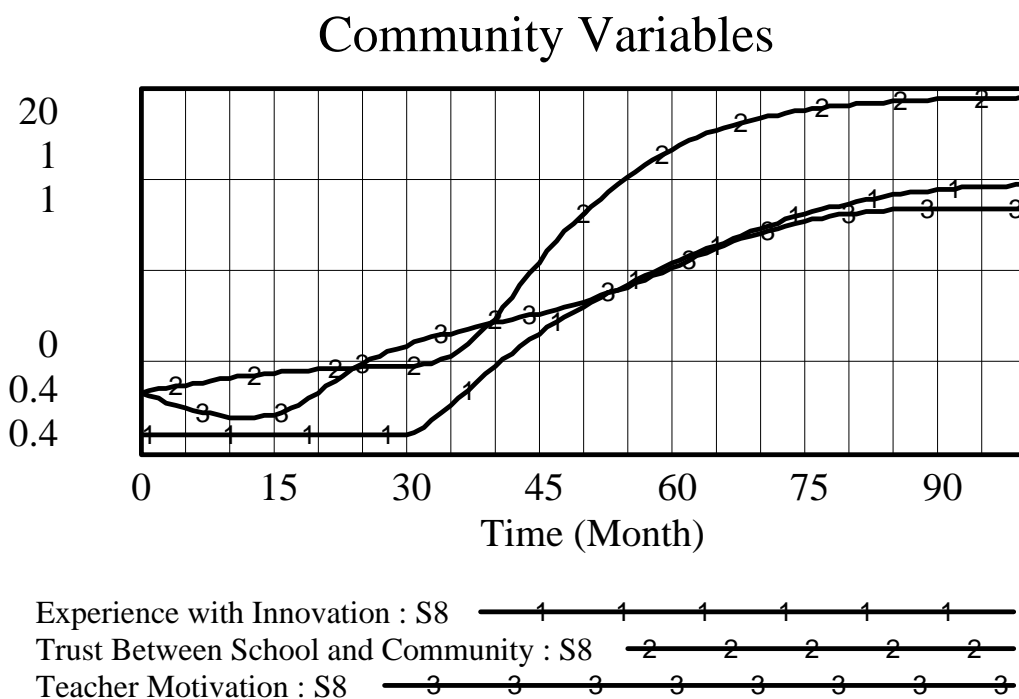


Figure 5: Effects of Increasing Flexibility Given Teachers Re: Innovation

This result is encouraging, but can be improved upon. Two more simulations were done that combined several of the interventions. One combined the increase in Flexibility Given Teachers Re: Innovation with the 20% reduction in Tasks in Traditional Curriculum (in addition to the other interventions contained in the earlier simulations). The second added to this already

comprehensive combination an increase in time spent on professional development (from the baseline value of 12 hours per month to 18 hours per month).

Each of these enhancements produced somewhat better results. The first combination benefited from the additional Hours Available for Curriculum Innovation made possible by the reduction in Tasks in Traditional Curriculum. The Rate of Adoption was somewhat faster as a result and Curriculum Innovations Adopted and Impact of Innovation grew more quickly. Experience with Innovation reached and maintained a higher level. In the second combination, increased time on professional development further improved the results instead of producing a disaster as it had done in an earlier simulation. The reduction in Tasks in Traditional Curriculum had made the necessary time available to do more professional development and still have enough time for implementing the new curriculum. The higher Level of Professional Development that was achieved helped to increase the Impact of Innovation by enhancing teachers' Ability to Tailor Innovations to Students Learning Styles

Another thing that was examined is the potential impact on innovation of other trends in education such as "high stakes" testing being introduced in many states. A simulation that assumed such testing might cause a 20% increase in Tasks in Traditional Curriculum as a result of "teaching to the test" produced disastrous results. The additional time required for test preparation left too little time available for curriculum innovation and the other changes required to prepare the way for the new curriculum. The result suggests the need for a cautious approach to planning innovation in the context of broader changes going on and for carefully replacing traditional curriculum with new curriculum rather than simply trying to pile on more work.

Simulations were used to explore other issues as well. One focus of the work was the fit between characteristics of schools and nature of innovations they can successfully implement. The same set of interventions used in the simulation (S8) shown in Figure 5 were used with a school system that was assumed to have lower initial levels of Teacher Motivation and Trust Between School and Community (values of 0.25 rather than 0.5 on a zero to one scale). These lower levels might be the result of some unfortunate events in a community's past. As shown in Figure 6, the result of this simulation (INIT25) is significantly worse in terms of the Experience with Innovation that is realized. The lower levels prevent the curriculum innovation and other changes from getting off the ground and achieving the reinforcing effects produced in the community with the better initial conditions. Rather than growing and achieving a stable level as in the earlier simulation (S8), Experience with Innovation in this simulation (INIT25) reaches a low peak and then drops off.

Does this mean that a community with such an unfortunate history cannot successfully undertake curriculum innovation? Not necessarily. Such a community might instead have to approach innovation in a different manner. Figure 6 also displays the result of another simulation (INIT25TI) in which, instead of a major Systemwide Innovation initiated from the top down, the emphasis is on Teacher Initiated Innovations. Experience with Innovation grows much more slowly in this simulation, but achieves a moderately positive, apparently sustainable level rather than dropping off as it did with the Systemwide Innovation.

Graph for Experience with Innovation

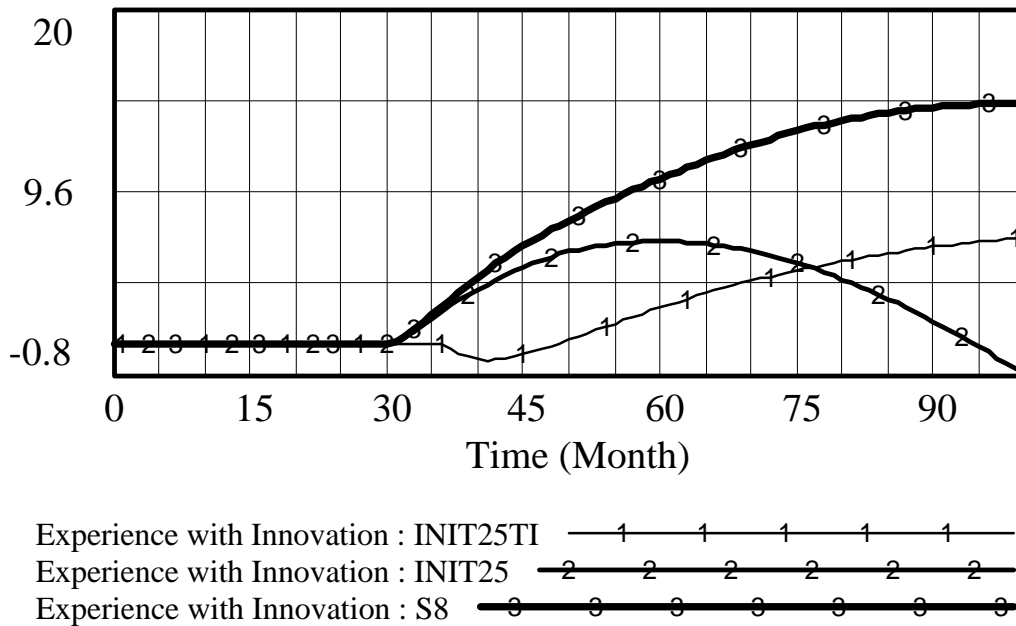


Figure 6: Simulations with Lower Teacher Motivation and Trust Between School and Community

Conclusions, Next Steps

The work done so far, while tentative, suggests at least some rough “rules of thumb” for implementing innovations in schools. The key insight is the interdependency of curriculum innovations with other types of changes in areas such as student assessment and scheduling systems. Curriculum innovation must also be planned in the context of changes going on in response to external pressures such as “high stakes” testing. The simulation results also suggest the importance of thinking carefully about replacing traditional curriculum with new material and methods rather than simply adding on extra work. The last set of simulations reported on also suggest the need for school systems to understand their strengths and weaknesses and implement curriculum innovations accordingly. A final insight was the potential value of using System Dynamics for examining the problems of innovation in schools and for other complex problems schools are facing.

The next steps are to have the work described in this paper reviewed by a larger audience within the System Dynamics community and among educators, especially those using System Dynamics as part of their curriculum and/or to improve the management of their schools. Let us know what you think. Does the model adequately represent the factors that affect the success of innovations in schools? Is the response of various groups to innovations faithfully represented? How do curriculum innovations interact with other things going on in schools? Does the model need to be elaborated on in the area of student response to innovation? As indicated earlier, more complete materials are available through the Creative Learning Exchange. Comments can be

communicated to the author via e-mail at GBHirsch@aol.com or at 7 Highgate Road Wayland, Ma. 01778.