

Transforming the Systems of Public Education

by Jennifer Groff

INTRODUCTION

The past five decades have produced a tremendous archive of initiatives, strategies, frameworks, and practices in systems change in public education. They have varied considerably in scope, strategy, and context, benefiting from having one central goal: *to increase student performance through improving teaching-learning practices*. Yet despite the vast set of knowledge generated by this work, few improvements have lasted and many system indicators exist today that demonstrate the unhealthy state of our current educational system. While the most effective reformers have positive strategies to offer us, even they have acknowledged the lack of systemic improvement, which is largely attributed to dysfunctional system structure.

While the education reform domain has mostly been populated by *traditionalists* (those working to repair the existing system), and subsequently *radicals* (those with alternative programs and schools), more recently a third group has emerged as *designers*—those seeking to purposefully redesign the system from the classroom outward.¹ These stakeholders employ methods in research and other disciplines such as System Dynamics to break through the wall encountered by traditional reformers—seeking to reinvent teaching and learning for the 21st century to engage all learners in an education that connects with our current world

I. A REVIEW SYSTEM CHANGE AND EDUCATION REFORM

Education system reform has come a long way since its appearance in the U.S. in the 1960s. During this progressive period, the system looked inward at the classroom, encouraging innovative and exemplary new forms of instruction and instructional settings (Elmore, Peterson et al. 1996). Extensive federally sponsored programs at this time were offered to encourage school change, yet according to the comprehensive study of their effectiveness and success in local implementation conducted by the Rand Corporation, most cases (large and small) came up short (Berman and McLaughlin 1978). Most of the programs were adopted to garner federal funds rather than the motivation for changing educational practice, with few being implemented properly, showing little transformative or sustained growth (Berman and McLaughlin 1978). By the end of the 1960s, isolated pockets of improved classroom instruction existed with little systemic dissemination. This lack of growth and disconnect, led to a stagnant period in the 1970s with little systemic growth, which was documented in the 1983 release of *A Nation at Risk*—spurring the accountability movement of the 1980s with the introduction of large-scale governmental regulation through mandated curricula and competency testing.

However, to many reformers, layers of bureaucracy were considered to be strangle-holding education systems, preventing the critical improvement desired. As a result, numerous reform efforts were launched in the mid-1980s with a decentralized strategy—where schools had increased ownership of their decision-making, allowing more flexibility to meet the needs of the specific context of each school. This decentralized strategy for school-based management with empowered roles for school leaders and educators came to be known as the "restructuring" movement. In reality, these efforts often played out with overemphasis on adherence to

¹ The research discussed here has been conducted at "large-scale" meaning entire national systems or their major subsystems, such as states or large districts.

implementation guidelines, leaving little flexibility for schools to adopt and fit a program to meet the dynamics of their needs. Additionally, it often resulted in a sporadic display of change across schools within a given district, where the central office was largely disconnected from the policies and practices of its schools (Fullan 1991). As a result of these dissonant movements – and their respective lack of progress – reform efforts in the 1990s found a renewed intensity in large-scale, comprehensive reform.

Michael Fullan, Professor Emeritus of the Ontario Institute for Studies in Education of the University of Toronto, arguably has the strongest track-record of effective strategies in large-scale reform, having led major initiatives in England, Ontario, Canada, New South Wales, and South Australia with dramatic results. From his analyses of education reform strategies, Fullan has concluded that "restructuring reforms that devolved decision making to schools may have altered governance procedures but did not affect the teaching-learning core of schools" (1991, p. 201). Countless case studies of districts attempting restructuring initiatives have demonstrated that the core goal of improving teaching-learning practices to increase student performance had not occurred.

Initiatives targeted directly at classroom instruction have not shown to be systemically effective either. Fullan argues that the largest hindrance to reform is the presence of too many ad hoc, uncoordinated innovations and policies (1999). Whole School Reform Models emerged in response to this, where the entire school seeks to adopt a new model (examples include Success for All, Expeditionary Learning Schools, CO-NECT Schools). These models have shown varied success depending on their implementation. On a review of 16 initiatives, (Datnow and Stringfield 2000) found that whole-school reform models can have successful outcomes when strong district and state support is present. Unfortunately, in hindsight, many schools adopted a certain model without the consideration of how it will fit the school's goals, culture, teachers, or students, resulting in minimal positive outcomes and sustained improvement (2000).

Fullan's work in understanding, designing, and implementing strategies for large school systems has led him to the conclusion that neither top-down nor bottom-up approaches are effective and sustainable. As a result of this work, Fullan and others have put forth a Tri-Level Model built on the idea there are three critical levels of school systems – *school & community*, *district*, and the *state* – and that sustainable improvement is achievable when initiatives are targeted at the levels' interrelationships (Fullan 1994; Fullan 2001; Fullan, Rolheiser et al. 2001; Barber and Fullan 2005). At the school/community level, building *capacity* in five areas is critical: (1) teacher's knowledge, skills, and dispositions, (2) professional community, (3) program coherence, (4) technical resources and (5) principal leadership that improve the previous four (Fullan 2001 p. 5). Therefore, the main objective of the District is to generate and support capacity growth in its schools—which means creating policies and structures that enable the aforementioned factors of school capacity. Likewise, the State must support districts in their efforts through a blend of pressure, support, and problem-solving.

In this work, Fullan and colleagues have identified six key elements and six fundamentals to the design of a large-scale reform initiative (see Figure 1). Although these variables have been shown to be critical in reform initiatives, it is the design and implementation as a whole to a specific context that is most critical. However, even with positive results, few are sustained over time (Fullan 2009). In reflecting on the journey of education reform, Fullan concludes: "as long as you have external models coming and going there will never be more than a small proportion of schools and districts involved, and any pockets of success will be short-lived (2001, p. 4);" therefore, "the primary goal is to alter the *capacity* of the school to engage in improvement" [and] second, "*sustainable reform* can only be achieved when working with *whole systems*" (2001, p. 5). Aligning the whole system is critical, because no matter what capacity and gains a school makes, if the outer policies undermine those initiatives, the school improvement can not and will be sustained.

6 Key Elements to Large-Scale Reform	6 Fundamentals to Large-Scale Reform
<ol style="list-style-type: none"> 1. Develop the entire teaching profession, so that all teachers are working towards the goal 2. Small number of ambitious priorities 3. Two-way street between instruction and assessment 4. Distributed, coordinated leadership at all levels of the system 5. Focused, mostly non-punitive, comprehensive, relentless intervention strategy 6. Use money to drive reform only in the service of the previous five fundamentals 	<ol style="list-style-type: none"> 1. Ambitious standards 2. Good data and clear targets 3. Devolved responsibility 4. Access to best practice and quality professional development 5. Accountability, <i>and</i> 6. Intervention in inverse proportion to success (low-improving schools receive extra attention)
From Fullan & Levin, 2009	From Fullan, 2009

Figure 1. Key characteristics to large-scale reform initiatives in education.

II. SYSTEM DYNAMICS AND EDUCATION POLICY

Fullan's work has had the most notable impact in education reform largely as a result of an understanding of *systems*. Systems are complex, interconnected structures that are filled with feedback loops where behaviors and actions in one part of the system impact (or are constrained) by other parts of the system. They are characterized by nonlinear, counterintuitive behavior, where not only is effect rarely proportional to cause, but often they are far apart in the system. In other words, effects or changes to one part of the system often play out much differently than intended because the change causes dynamic effects in the system as a whole. This complexity makes all systems inherently difficult to understand intuitively and therefore *policy resistant*—because our decisions often elicit unintended responses (Sterman 2001). The education system is no different from other complex systems. There are many examples in current education policy where the outcomes are very different than what had been intended (Groff ; Wheat 2004). An example of this is provided in Box 2.

In order to cope with this, the field of System Dynamics (SD) offers tools to map the feedback structure of a system in order to understand why a system is behaving the way it is; to test and plan for policies before implementing them, and to increase the likelihood they produce the outcomes desired. Since its inception nearly 50 years ago, system dynamics has been applied to numerous fields, including businesses, medicine, economic behavior and even environmental change (Forrester 1998). Unfortunately, these tools have rarely been used in education policy. Although several notable researchers have begun introducing these tools to the education reform discourse over the past two decades, one can speculate that this lack of presence in education reform work is largely due to people's lack of familiarity with complex systems and systems thinking—as evidenced by the design of most of the reform work of the past 50 years. Yet sprinkled throughout the literature are endeavors to apply SD to education policy and reform. For example, Garet used SD to demonstrate the dynamics of numerous aspects of the education system (see 1974). Moreover, Wheat has illustrated unforeseen dynamics of student achievement when Standards of Learning were introduced to an education system by generating an unintended side-effect that undermined rather than supported the standards (2000). In Wheat's model, a "70-percent achievement rate" on the assessments introduced to accompany the standards, which to many seemed quite reasonable; however, as this goal is achieved over time, it will induce an expected increase in expectations that is

unsustainable, impacting student/teacher motivation and “thereby reducing learning productivity and causing learning rates to be lower than they otherwise would be” (2000, p. 7).

What is System Dynamics?

The field of System Dynamics (SD) launched from the work of MIT engineering professor Jay Forrester, who was creating new tools and methodologies for business management. SD was first applied to social systems in 1968, when Forrester worked closely with former Boston mayor John Collins to look at the challenges of urban design. One area in which they examined was low-cost housing—meaning housing constructed for the underemployed and not available to any other segment of the population (Forrester 1968). Working closely with city officials, they found that:

“Economic distress in declining American cities in the 1960s generated symptoms of high unemployment and deteriorating housing. It appeared natural enough to combat such symptoms by government intervention to build low-cost housing. But the modeling study showed, as events have since confirmed, that such urban areas already have more low-cost housing than the economy of the city can sustain. Public policy to build more such housing merely occupies land that could instead have been used for job-creating businesses, while at the same time the housing attracts people who needed jobs. A low-cost housing program introduces a powerful double force for increasing unemployment, both by reducing employment while at the same time attracting people seeking work. Low-cost housing programs in inner cities become a social trap. The policy of building low-cost housing actually creates poor and unemployed people, rather than alleviating personal hardship.”

(Forrester 1991 p. 19)

Ultimately, constructing low-cost housing was a powerful process for creating poverty, not alleviating it. This example demonstrates how the natural human tendency to attack symptoms of a problem; however, in the end this may be counterproductive and actually harmful to the system seeking corrections in the future. Rather, identifying the system cause of the problem and generating a high-leverage is the long-term solution to the problem (Forrester 1991).

Box 1. Explanation of System Dynamics.

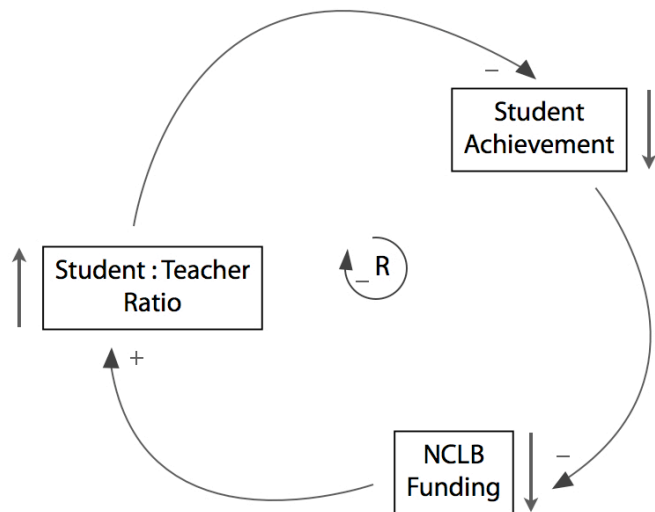
How can this happen? Unfortunately, most legislation is designed with linear, cause-effect thinking, and it is passed with little or no analysis of its system effects by either policymakers or advocates. Jay Forrester, the father of SD, explains that “governments pass laws after superficial experiments using a country as a laboratory...including no dynamic modeling of the long-term effects” (1998 p. 6). Herein lies the greatest potential in SD tools—testing new policies and system changes, rather than using the current education system as a test bed for policies generated with human cause-effect thinking. Once a model is built using SD tools, one can better plan for policies and changes to the system by forecasting their dynamics. Although the method can be time-consuming and challenging, it offers the best way to “gain experience with a system, because activity in the real system is infeasible, costly, or impossible” (Banathy 1973; Gareth 1974). Forrester advocates for this type of ‘designing the future’—“people try to cope with the failures of systems, but seldom attempt to redesign systems to reduce failure” (1998, p.1).

An Example of SD in Education Policy: Classroom Size and NCLB

Class size and student-teacher ratio has long been considered a critical factor on student achievement, and therefore is a stock that should be monitored. For example, in the mid-1990s, California's average elementary classroom size was 29 students (Bohrnstedt & Stecher, 2002). By the aforementioned findings, this number is far beyond the scope of an acceptable ratio. The status of this stock could alert us to consider designing and implementing policies that help lower this ratio. In system dynamics language, we might try to understand the current dynamics of the system, in order to create new feedback loops that bring this stock down.

We can begin to understand causes of change in a stock such as this by identifying the influences or system elements effecting this change using causal loop diagrams. Often these diagrams are based on the stores of mental models and knowledge we hold. One causal loop we could identify is related to current policy structures of the No Child Left Behind Act (NCLB). This law, enacted in 2001, sought to improve student performance of primary and secondary schools through increasing achievement standards tied to federal funding. Under the law, schools that consistently underperformed were subject to loss of funding and potential takeover by the government. While the policymakers undoubtedly crafted this law with the intent to "push" educators to improve their teaching to provide all students with an adequate education, we can see an unintended reinforcing loop that can ultimately have the directly opposite effect; the Causal Loop Diagram demonstrates these dynamics. If schools were already struggling with student performance, and these schools had suboptimal student-teacher ratios before NCLB was implemented, they were not positioned well to meet the requirements of NCLB. After continual student underperformance, a school would be subject to diminished federal funding, thereby leaving them with less resources to operate the school.

One way this lack of resources is often handled is by consolidating classrooms and increasing the number of students a teacher is given, thereby increasing student-teacher ratio, which we have seen leads to diminished student achievement, and so on, as the loop reinforces itself. Consider also, that minority and low-income students – those most targeted by the creation of NCLB – are the ones most-impacted by student-teacher ratio. Therefore, schools largely consisting of minority and low-income students are the ones most likely to fall into this reinforcing loop.



Box 2. Example of unintended effects in education policy, using System Dynamics tools.

III. REFORM VS. DESIGN

When one begins to see the world through a system dynamics lens, it is clear why add-on programs and reform initiatives targeted at one part of the system have had such a poor track record. It also becomes evident why Fullan has called for all those involved in a reform initiative – from teachers to state officials – to be "system thinkers" (Fullan 2005). Although the work of system reformers like Fullan and others have shown short-term positive results, we are still left with many highly problematic schools, and many of the positive results have dissipated over time. Reflecting on this, Fullan explains it as, "the infrastructure is dysfunctional,

yet infrastructure is essential to large-scale sustainable reform" (2001, p. 15). Forrester's work in system dynamics further explains this: "As in a bad airplane design, which no pilot can fly successfully, such badly designed [systems] lie beyond the ability of real-life managers" (1998, p. 7).

Thus far, the work in education system change has been about *improvement*—programs and initiatives directed at ameliorating and bettering the current practices. They have largely been targeted at the mid-level of the system, *system management*, with the hope of deeply impacting the *teaching-learning core* (see Figure 2). Yet if the overall *system governance* is dysfunctional and does not have the dynamics to support the desired outcomes, all reform/improvement initiatives will move the system minimally, resulting in some unintended/undesirable effects, and never be sustained. Thus, true educational change can only come about by designing a new infrastructure that supports effective classroom environments *from a system's perspective*.

There are two central reasons to consider *design* (transformation) over traditional *reform* (improvement):

The first is a lack of systemic, sustained achievement of the outcomes desired in our current education systems described previously. This has resulted in stakeholders across (and outside) the educational system calling for dramatic transformation (noteworthy reports are listed at the bottom of the references page), including the development of coalitions such as the Partnership for 21st Century Skills—a convergence of government, private and public organizations, and scholars seeking a reorientation of the education system to meet the needs of our current society, which is working to dramatically restructure curricula and policy in numerous states (although the impact of this work on student achievement is yet to be determined).

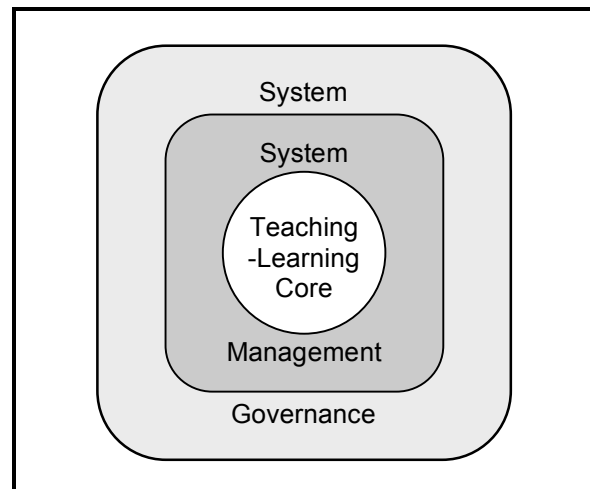


Figure 2. Levels of analysis of the education system.

The second reason is more critical and even goes beyond the scope of education system change work thus far. The world around us has shifted dramatically in last 10 years as a result of information technologies. Not only does this have implications for what we teach students, more critically it has implications for *how* we teach them. Students are engaged in practices and behaviors in a world that is farther and farther from what the classroom looks like every day, making it harder and harder for them to connect with and be motivated to engage in current instruction. Cognitive science has shown us that motivation is one of the most foundational components in order for true learning to occur. How have new technologies changed how our students? How do they think and engage in the world? What new skills are needed? How can these technologies be leveraged to engage learners in the types of learning experiences we know to be effective? Even if we are able to get better at school reform and make the systemic changes we seek, unless it ultimately gets at these questions those changes will be irrelevant anyway. Young people will continue to leave the system and seek education (or just stimulation) somewhere else, at a greater rate than we are already seeing. And even those who remain in the system, seeking the educational goals we currently have set for them, they will receive only a "partial" education—one in the "basics" and content knowledge, but not in new skills and capacities that are sought after in today's world (Partnership for 21st Century Skills 2002). Innovative instructional practices that achieve these goals will require different management, organization, physical, and instructional arrangements than our schools currently present (Salisbury 1993). Both of these reasons are substantial on their own; combined, they give unassailable fodder to the consideration of alternative, systemic approaches to education. Various education scholars and practitioners across the field offer their picture of what a new system might

look like—often characterized as individualized and time-variable, where instruction is student-centered, leveraging diverse pedagogies and models for students to achieve learning outcomes based on their learning style and interests (Fullan and Levin 2009). While considerable convergence and overlap in theoretical designs is encouraging, making a new system a reality is a different matter.

The Design movement is built on the premise that an improved education system can only be achieved through a redesign of the whole system. By understanding how systems work, systems designers' perspective on previous reform efforts shortcomings have resulted because they have “stayed within the boundaries of the existing system, probing what is wrong and what we should change to make it more effective” (Banathy 1992 p. 32). Although the Design movement is young and ever so slowly making its way into the educational change discourse, scholars in this arena have generated initial efforts that prove promising—including frameworks, principles, processes and models addressing this goal (Banathy 1991; Banathy 1992; Banathy and Jenks 1993; Reigeluth 1993; Salisbury 1993; Hargreaves 2003). Bela Banathy, one of the strongest leaders of this movement, was a systems scientist and founder of the International Systems Institute before turning his attention to the education system. During his career, he created numerous Ph.D. programs that incorporated systems thinking and tools into their curriculum; and his work later in his career was oriented directly at the transformation of the public education system using these tools, as introduced in influential works such as *Systems Design of Education: A Journey to Create the Future* (1991), and *A Systems View of Education: Concepts and Principles for Effective Practice* (1992). His works provide important explanations, frameworks, and tools that are even more important relevant today than when they were first introduced nearly two decades ago. Banathy's and others' works on system transformation through design have been lost because they are largely inaccessible if you have no understanding of system dynamics or systems thinking first. Forrester also understood this to be the central barrier to applying these techniques to all disciplines, which is why he spent the remaining decade-plus of his career advocating for introducing systems thinking concepts to K-12 curricula—so that young adults emerging from the education system would be equipped with the thinking styles and tools to address the complex, real problems of the world today.

Although the Design movement in education reform may be considerably different from traditional approaches, these experts in systems change have powerful strategies to guide education systems change in the 21st century. (Banathy 1992) offers four basic conditions to accessing revolutionary change to our education system:

- Bringing about “systemic change” requires the development of a systems view of and systems thinking in education;
- “Break-the-mold systems” coming out of the creation of revolutionary new designs call for an approach *very different* from those we have used heretofore. It calls for the understanding and use of *Comprehensive Systems Design*;
- Creating a new image and design through *Transcendence* (leaving the old system behind which is most difficult but unavoidable) and *Transformation* (creating a new design, represented by such concepts and practices as “learning systems,” “learning territories,” “learning experience trails,” “learning guides,” and “learning communities”); *and*
- Achieving a new design through exploring the essence of what education is about: its relationship with – and relevance to – the society, the designation of its societal functions, the kind of learning to be offered in an information/knowledge age, the way it should be offered, and the design of its organizational forms and arrangements that can support learning and human development.

IV. DESIGNING THE FUTURE

What will future educational systems look like? The idea of a drastically different education system—or alternative means altogether for achieving the goal of *learning* in our society—is beginning to have an increasing presence in the field of education. “Alternative futures” are offered by two notable projects, the *Think Scenarios* by the OECD and the UK-based Beyond Current Horizons program—both offer six very different visions of what our educational systems may evolve into. The scenarios do not offer complete pictures of future systems that solve our systemic problems, rather potential scenarios of what our current systems may evolve into based on current societal trends. Nonetheless, these tools are useful for increasing the flexibility for the concepts held by education and opening them up to other, innovative possibilities.

Very recently, researchers have made significant advances in applying system dynamics and modeling tools to guide future policy development based on analysis of past and current dynamics in education, particularly as it relates to the development of science and math students. Developed by the Raytheon company over the past three years, the model process data on variables such as class size, teacher turnover, gender differences, teacher salaries, and data from scholarly research. What is most commendable about this initiative is the support website for the tool, designed to allow anyone who registers to freely download the model and contribute to the analysis and discourse of it—this is where modeling is most powerful, when the tacit knowledge carried by stakeholders within in the system is allowed to rub up against and help form the model, which dramatically increases its validity. Brian Wells, Raytheon’s chief systems engineer who helped develop the system, recently explained in an Education Week article that “the model is not meant to provide definitive solutions, but rather help policymakers ‘think through the problem, [and] can help you discover unintended consequences’ ” (Cavanagh 2009). This is a dramatic and noteworthy step in the field of educational policy.

Moving forward in efforts to change our schools to be effective, sustainable institutions that meet the needs of all learners for the 21st century may feel like a nebulous, daunting task. However, using the lessons we have gained from education reform, education research, and systems work we can build a plan for effectively designing these systems, rather than seeking to make partial changes that have little opportunity to be sustained by the system (Hargreaves 2003). Transformation means strategically working within the three systems levels (see Figure 2) to redefine the teaching-learning core through disciplined innovation and strategically designing and building an infrastructure to systemically support it.

Getting lasting change that produces the effects we desire means fundamental redesign at all of these levels. It is worth re-emphasizing the essence of the aforementioned four conditions for systems change in education offered by Banathy:

“Achieving a new design through exploring the essence of what education is about: its relationship with – and relevance to – the society, the designation of its societal functions, the kind of learning to be offered in an information/knowledge age, the way it should be offered, and the design of its organizational forms and arrangements that can support learning and human development” through the consideration of new models of “education” and new pathways to advanced learning (such as “learning systems,” “learning territories,” “learning experience trails,” “learning guides,” and “learning communities.”

How people are educated needs to be fundamentally reconceptualized—it no longer just occurs between the four walls of the classroom.

A new educational system – like any complex system – is a network of interdependent components that work together to try to accomplish the aim of the system; *a system must have an aim* (Deming, 1993). It would *seem* that the aim of the education system is ‘rigorous learning for advanced cognitive development for all students’—yet how many of the system’s structures and policies are created and employed at directly achieving this goal? System designers offer a strong lesson here: they start their work with a “system level of

focus.” The structure and dynamics of a system are designed based on that level of focus. For far too long that level of focus in education has been some other level such as governance, administration, or even instruction. But education is primarily about *learning*—it is the central service and goal of the public education system. It is the focus of inquiry in all the research on cognition and human development, and the reason we have substantial bodies of knowledge in those domains. When the *learner*, and *the act and the process of learning* are the level of focus for the system design, then new designs and new paradigms of what constitutes education can be conceived—and the system will be structurally designed from the inside-out to support learning arrangements and opportunities that meet the diverse needs of our current generation and beyond.

A new design means entertaining and creating new models, arrangements, situations, and opportunities for learning to occur. This may – and likely should – look vastly different from what schools embody today. As innovative models of learning continue to emerge, they must be considered and studied for effectiveness. And the community as a whole must embrace and continue to encourage this type of innovation across the board. To move the Design efforts from research and literature to action and the real world means employing stakeholders across the system in the process.

How can existing agents within the system participate in this process? As Fullan and Banathy have advocated, they should start by becoming *systems thinkers*—learn about system dynamics and systems thinking to be able to more actively participate in the system design and change. Then embody *Transcendence* and *Transformation* by participating in alternative models and practices of teaching and learning. Classroom teachers are the most central agents in this work, and should be encouraged to participate in the “innovation upswing.” Innovative models both inside—and largely outside—traditional schools must be encouraged. Existing school systems should be supportive while still holding schools accountable. The UK has begun such efforts for “disciplined innovation” in schools with a policy that affords schools the opportunity to apply to the Secretary of State for ‘power to innovate’—granting them permission to explore alternative models, practices, and approaches to learning (Hargreaves, 2003). In this model, some classrooms and schools will be radical innovators while others will be modest. As innovation grows – especially outside the traditional education system – the knowledge needs to be shared throughout the system. In the system of education, this will likely require the creation of networks and channels to more effectively share this new knowledge. As new models and approaches to learning show to be effective, System designers can begin designing systems structures and policies to support them, being sure to check for unintended effects and dynamics within the system. As new systems and models begin settling in place, the work of Fullan and others (which fundamentally is about *change*) will be invaluable as we work to get stakeholders and groups at all levels to evolve with the capacity to support a transformed model of teaching and learning.



Of course, none of this will come easily, and none of it will come overnight. It will take a combined capacity of strategic planning and disciplined innovation at all levels of the system to achieve a transformed system, which is a tremendous undertaking. But the alternative is another decade of minimal effects in system reform, as we lose more and more learners each day to a system that is not designed with them in mind. The day has come where a tremendous amount of stakeholders in the system, and out, have called for a transformed system, radically different from what we have today—with the evidence to support their demands. If we truly are educationists, and seek the best educational experiences for all learners, then we have no excuse not to leverage all that we know about cognitive science, educational technology and systems change to provide the very best educational experiences to all of our students.

REFERENCES

- Banathy, B. (1992). Designing educational systems: Creating our future in a changing world. *Educational Technology*, 32(10), 32-34.
- Banathy, B. (1991). *Systems design of education: A journey to create the future*. Englewood Cliffs, NJ: Educational Technology Publication, Inc.
- Banathy, B. (1973). *Developing a Systems View: The Systems Models Approach*. Lear Siegler Fearon Publishers.
- Banathy, B., & Jenks, L. (1993). The transformation of education: By design. *International Journal of Educational Research*, 19(2), 105-144.
- Barber, M., & Fullan, M. (2005, March 2). 'Tri-level development': Putting systems thinking into action. *Education Week*, 24(25), 32-35.
- Berman, P., & McLaughlin, M. (1978). *Rethinking the Federal Role in Education*. Santa Monica, Calif: Rand Corporation.
- Berman, P., & McLaughlin, M. (1973). *Implementing Innovations: Revisions for an Agenda for a Study of Change Agent Programs in education. Study of Change Agent Programs: A Working Note*. Santa Monica, Calif: Rand Corporation.
- Cavanagh, S. (2009). Computer tool sizes up math, science policies. *Education Week*, 29(36). Retrieved from www.edweek.org/ew/articles/2009/07/08/36simulate.h28.html on August 3, 2009.
- Darling-Hammond, L. (2000). Futures of teaching in American education. *Journal of Educational Change*, 1, 353-373.
- Datnow, A. & Stringfield, S. (2000). Working together for reliable school reform. *Journal of Education for Students Placed at Risk*, 5(1), 183-204.
- Deming, W. E. (1993). *The New Economics for Industry, Government, Education*; Second Edition. Cambridge, MA: The MIT Press.
- Forrester, J. (1998). *Designing the future*. Address at Universidad de Sevilla, Sevilla, Spain. December 15, 1998.
- Forrester, J. (1991). System Dynamics and the Lessons of 35 Years. A chapter written for De Greene, K. (eds.) *The Systemic Basis of Policy Making in the 1990s*. D-4224-4 Accessed on March 28, 2009 at <http://sysdyn.clexchange.org/sdep/papers/D-4224-4.pdf>
- Forrester, J. (1971, January). Counterintuitive behavior of social systems. *Technology Review*, 52-68.
- Forrester, J. (1968). *Principles of systems*. Waltham, MA: Pegasus Communications.
- Fullan, M. (2009). Large-scale reform comes of age. *Journal of Educational Change*, 10, 101-113.
- Fullan, M. (2005). *Leadership and sustainability: System thinkers in action*. Thousand Oaks, CA: Corwin Press.

Fullan, M. (2001). *Whole school reform: Problems and promises*. Paper commissioned by the Chicago Community Trust. Retrieved from <http://www.extranet.ou.nl/inter-studie-alg-o31411/Symposium4/materiaal/Whole%20school%20reform%20-%20Fullan.pdf> on July 7, 2009.

Fullan, M., Rolheiser, C., Mascall, B., & Edge, K. (2001). Accomplishing large scale reform: A tri-level proposition. Prepared for the *Journal of Educational Change*. Retrieved from http://www.michaelfullan.ca/Articles_01/11_01.pdf on July 7, 2009.

Fullan, M. (1994). Coordinating top-down and bottom-up strategies for educational reform. In Anson, R. (Ed.) *Systemic Reform: Perspectives on Personalizing Education*, 7-24.

Fullan, M., & Levin, B. (2009). The fundamentals of whole-school reform: A case study from Canada. *Education Week*, 28(35), 30-31.

Garet, M. (1974). Educational policy and system dynamics. *Journal of Research and Development in Education*, 7(2), 119-144.

Groff, J. (unpublished manuscript). *System Dynamic Models in Education System Design*.

Levine, A. (2009). Waiting for the transformation. *Education Week*, 28(2).

Partnership for 21st Century Skills. (2002). *Learning for the 21st century: A report and mile guide for 21st century skills*.

Reigeluth, C. (1993). Principles of educational systems design. *International Journal of Educational Research*, 19(2), 117-131.

Salisbury, D. (1993). Designing and implementing new models of schooling. *International Journal of Educational Research*, 19(2), 133-144.

Sterman, J. (2001). System dynamics modeling: Tools for learning in a complex world. *California Management Review*, 43(4), 8-25.

Wheat, D. (2000). A systems approach to education policy and administration. Presented at the Systems Thinking and Dynamic Modeling Conference in Portland, Oregon, June 25, 2000. Retrieved from www.clexchange.org/ftp/conference/cle_2000/session%2044.pdf on March 3, 2009.