



The Impact of the Systems Thinking in Schools Project: 20 years of Research, Development and Dissemination

Abstract

Teachers and school administrators are challenged with the complex task of providing engaging and relevant learning opportunities for students, while simultaneously managing federal and state-mandated standards of student achievement. High-stakes testing and 21st century workforce skills, and the challenge of preparing students for an unpredictable future lead educators to the investigation of new methods that address this complex instructional dilemma.

The mission of the Systems Thinking in School Project is to increase the capacity of educators to deliver academic and lifetime benefits to students through the effective application of systems thinking concepts, habits and tools in classroom instruction and school improvement. This paper will describe the impact of the Systems Thinking in Schools project on 21st century student learning and achievement.

Overview

Background

The Systems Thinking in Schools Project began in 1989 with a community-school collaboration that involved the Catalina Foothills School District in Tucson, AZ, Dr. Gordon Brown and Dr. Jay Forrester from M.I.T., and Mr. and Mrs. James Waters from Concord, MA. All had one vision in common, to develop generations of “systems thinkers” through the development of 21st century systems thinking classrooms and schools. Systems thinkers view themselves as members of a global community who strive to understand the complexities of today’s world systems and have the capability to face into problems with an informed capacity to achieve desired results. In these early years, little was known about bringing systems thinking to classroom instruction and school improvement, but the growing team of educators and leading systems thinking and organizational learning consultants developed proven methods that would deliver academic and lifetime benefits to students preK-12.

Dr. Gordon Brown, MIT professor emeritus and former Dean of the School of Engineering, was a resident of the Catalina Foothills School District. He fully recognized the challenges facing educators responsible for preparing students for a rapidly changing future. Referring to himself as a “citizen champion,” Dr. Brown provided support and mentorship in the initial stages of bringing systems thinking to a K-12 setting.

As they [children] grow up, if they're not exposed to these broader pictures, and their education is put out piecemeal, they don't get an opportunity to realize how things interconnect. It requires the shift of mind by our teachers to pass that kind of knowledge to students, so it [systems thinking] comes naturally to them. It's part of their intuitive processes of reasoning that they will become systems thinkers and not linear thinkers...To be a teacher is to be a prophet—you are not preparing children for today's world, but for the world of the next 50-75 years—a world we can barely imagine.

Dr. Jay Forrester of M.I.T., known as the father of system dynamics, a field related to systems thinking, describes the importance of a systems thinking education.

A systems education should give students confidence that they can shape their own futures. . . Inflation, wars, unfavorable balance of trade, and destruction of the environment have persisted for hundreds of years without public understanding of the causes. Such problems are too serious to be left to the self-appointed experts; the public must acquire the insights that permit participation in debates of such importance.

Mr. and Mrs. James Waters had the vision and saw the long-lasting value of systems thinking integrated into a K-12 education. Their financial support and guidance has enabled the Systems Thinking in Schools Project to develop and grow substantially as project staff has provided professional development services to interested educators in over 20 U.S. states and seven other countries.

21st Century Skills

In “Are They Really Ready to Work: Employers’ Perspectives on the Basic Knowledge and Skills of New Entrants to the 21st Century U.S. Workforce” (2006), leading business leaders were given a list of skills, both basic skills typically taught and measured in schools and applied skills (see Table 1).

Basic Skills	Applied Skills
English Language (spoken) Reading Comprehension Writing Mathematics Science Government/Economics Humanities/Arts Foreign Languages History/Geography	Critical Thinking/Problem Solving Oral & Written Communication Teamwork/Collaboration Diversity Info Tech Application Leadership Creativity/Innovation Lifelong Learning/Self-direction Professionalism/Work Ethic Ethics/Social Responsibility

Table 1: List of basic and applied skills used in polling leading U.S. Business CEOs and Directors, “Are They Really Ready to Work: Employers’ Perspectives on the Basic Knowledge and Skills of New Entrants to the 21st Century U.S. Workforce” (2006).

When asked to identify the top ten skills needed for the 21st century workforce, the overwhelming response centered on applied skills (see Table 2).

Rank	Skills most needed for a 21 st century workforce
1	Critical Thinking/Problem Solving*
2	Info Tech Application*
3	Teamwork/Collaboration*
4	Creativity/Innovation*
5	Diversity*
6	Leadership*
7	Oral Communication*
8	Professionalism/Work Ethic*
9	Ethics/Social Responsibility*
10	Written Communication*
	*Applied Skills

Table 2: Ranked order of 21st Century workforce skills identified by leading U.S. Business CEOs and Directors, “Are They Really Ready to Work: Employers’ Perspectives on the Basic Knowledge and Skills of New Entrants to the 21st Century U.S. Workforce” (2006).

Despite the high priority that 21st century business leaders place on applied skills, educators are held responsible primarily for student achievement that focuses on the measurement of basic skills. What is the relationship between these two skill sets, and what pedagogy best addresses classroom instruction that results in successful achievement of both?

A Systems Thinking Classroom

In order to engage students and hold them accountable in curriculum that addresses basic skills, instruction tends to focus primarily on federal and state standards and the newly developed Common Core Standards. The Common Core Standards for K-12 education represent an opportunity for significant shift in public education, creating an opening for innovation in curriculum and pedagogy toward skills that students need in the 21st century.

Assessments are needed to measure both basic and applied skills associated with Common Core standards and the complex demands of the 21st century. Little time is typically spent teaching applied skills, especially in classrooms where basic skill achievement gaps are broad, with some students’ basic skills being deficient.

A systems thinking classroom provides the advantage of effectively addressing the basic and applied skills as interdependent capabilities, both of which are needed to understand and work within complex systems currently embedded within curricular standards. (e.g. biological systems, economic systems, social systems, story structure as a system, mathematical modeling, etc.)

The benefits of a systems thinking approach are not limited to the achievement of prescribed, curricular learning standards. If the purpose of education is to develop the skills and knowledge necessary to manage the complexity of future problems, then educational institutions are

compelled to develop learners who think critically and act responsibly. Systems thinkers have the capabilities to face into problems with an informed capacity to achieve a desired result.

Many might argue that pressure to achieve academic standards associated with prescribed, standardized curricula takes educators away from the vision of developing students who have the skills needed for 21st century success. Statistical measures of student achievement are currently viewed as the most recognizable measures of success. Systems thinking classrooms and schools demonstrate that both standards-based education and systems thinking approaches can not only exist side by side, but can also complement one another. For most educators, short-term goals encompass the mastery of grade-level skills within a standards-based curriculum. These goals can best be accomplished and transformed into long-term achievement and success through a systems thinking learning environment. In this environment children are immersed in a practice field rich in relevant problem-solving, interdisciplinary connections, and opportunities for in-depth analysis accompanied by thought-provoking dialogue.

A systems thinking learning environment is motivating and engaging for even the most reluctant learner. Teachers report that the visual nature of the system thinking tools enables students to organize and express their thinking. The tools help motivate those children who tend to appear less involved, shy or reluctant to fully engage in learning activities. Teachers recognize that these children, just like their peers, are natural systems thinkers, as they readily make connections, embrace the big picture, and eagerly share new insights into the systems they're studying.

Research Methodologies and Settings

Over the past 20 years there have been a wide range of studies conducted to assess the benefits of systems thinking in classrooms and schools throughout the U.S. and abroad. Research efforts have involved multiple qualitative and quantitative methods, varied student populations from rural, urban and suburban settings and traditional public, charter, and private schools. The studies include strategically implemented collaborative action research, longitudinal video research, case studies, empirical studies, analyses of trends in standardized achievement test data, surveys and anecdotal methods. Thus, the data pool is extensive and delivers compelling evidence that calls to action a plan for scale up of the work of the Waters Foundation Systems Thinking in Schools Project.

Waters Foundation Research (2001-2006)

Over one hundred teachers and administrators from across the United States were involved in collaborative action research about the effects of systems thinking methodology on both student and teacher learning and school improvement. Waters Foundation coordinators developed a research model that is a synthesis of several collaborative action research designs (Caro-Bruce, 2004, Sagor, 2000). Seen as an essential aspect of the work of the Waters Foundation, collaborative action research was defined as “a process in which participants systematically examine their own educational practice using the techniques of research, for the purpose of increasing learning of students, their teachers and other interested parties” (Caro-Bruce, 2000). More specifically, the purposes of the Waters Foundation research were to:

1. provide a process teachers and administrators could use to investigate a question of personal significance related to the effects of systems thinking on student learning.
2. encourage collaborative reflection and inquiry so that teachers could continue to learn and refine their own skills.
3. provide a common language for sharing ideas, best practice methods, instructional plans, and assessment strategies.
4. develop and collect evidence that describes the effects of systems thinking and dynamic modeling on student learning.

The Waters Foundation research process included the following components:

1. formulation of a research question that is significant, measurable, and manageable;
2. design of an instructional plan utilizing systems thinking methodology appropriate to the question;
3. design of an assessment plan that includes triangulated data sources focused on both valid and reliable measures; and
4. a report of results and research insights that articulate both the influence of the study on practice and identify possible future studies.

Results and Scope of the Research

A meta-analysis of five years of data from the Waters Foundation research efforts surfaced findings that represented a culturally diverse cross section of students, classrooms and schools. Studies were conducted in a wide range of geographic and socio-economic settings representative of the diversity that exists in U.S. schools. Some studies considered whole school and grade level results while others focused on samples of students based on particular educational needs or conditions.

Collaborative meetings of Water Foundation action researchers focused on both research methodology and the reporting of results. Groups of researchers were organized in geographical areas (Northwest, Southwest, Midwest, Northeast, Southeast) throughout the process. In addition, there were four annual national sessions in which Waters Foundation researchers shared research questions, plans, results, and insights. The analysis of action research over a five-year span included data from both written reports and data collected during sharing sessions. It is important to note that no action research project stood alone in being identified as generating a particular finding or conclusion. The analysis focused on patterns of results that developed from a diverse group of researchers working in a variety of school settings.

Essential Questions

The first part of the meta-analysis categorized action research questions by a wide scope of inquiry topics including:

- How does systems thinking and dynamic modeling affect students' ability to learn existing curriculum, including basic skills?
- How does the use of systems thinking and dynamic modeling affect student engagement and motivation?

- How do students learn the concepts and tools of systems thinking and dynamic modeling?
- How does systems thinking and dynamic modeling help students use existing knowledge to build understanding of new problems or situations?
- How does systems thinking and dynamic modeling help students develop productive “school and life long habits”?
- How does systems thinking and dynamic modeling affect specific student populations’ learning?
- How does systems thinking and dynamic modeling affect whole school improvement efforts?

In addition, the action research questions were categorized into subject area, tool-specific, and student behavioral findings.

The second part of the analysis examined the data collected in each category and through a coding process, established trends of discovery in each. Data included student information, teacher information, qualitative and quantitative measures of research results, and conclusions and insights generated by the researchers.

Research Findings: The impact of systems thinking in classrooms and schools

Based on the five years of Waters Foundation action research that included 197 separate studies from schools and classrooms throughout the United States, there is evidence to support the following compelling trends:

Making Thinking Visible

Students use systems thinking tools to clarify and visually represent their understanding of complex systems. This visual approach allows the students to interact with and explore thoughts, perceptions, and mental models with precision and clarity.

- Students use behavior-over-time graphs (BOTGs) to depict their understanding of patterns and trends. BOTGs are visual tools that help students describe orally and in writing what and how they are thinking.
- Connection circles and causal loop diagrams help students describe their understanding of the connections and interdependencies of complex systems including historical systems, scientific systems, economic systems, cultural systems, political systems, and literary systems, both fiction and nonfiction.
- Students for whom English is a second language have demonstrated marked improvements communicating their thinking both orally and in writing as a result of using behavior-over-time graphs, causal loop diagrams, and the other systems tools.
- When students make their thinking visible through the use of systems tools, teachers can immediately identify misconceptions that students may have about curricular content.

Making Connections

Systems thinking tools help students make connections between curricular areas and relevant life experiences.

- When students use systems thinking concepts and tools, teachers have noted an increased number of incidences of transfer from classroom lessons to students' real-life experiences.
- An understanding of systems' structures enables students to see the similarities between seemingly different systems. For example, the understanding of how a contagious disease infects a population helps students understand how a rumor spreads or a fashion trend grows.

Solving Problems

Students of all ages learn and independently use systems thinking problem-solving strategies.

- Students experienced in recognizing and using systems thinking concepts and tools seek out new and varied perspectives when solving problems.
- Students use systems thinking vocabulary and concepts to question and challenge seemingly obvious solutions to complex problems. For instance, students use systems thinking archetypes like Fixes that Fail and Shifting the Burden to identify and analyze both short- and long-term effects of actions.
- Systems thinking concepts and tools help students understand their own beliefs/mental models and behaviors. Students use BOTGs for self-assessing how behaviors and emotions change over time; ladder of inference for understanding the development of inferences; and causal loop archetypes for retelling the dynamics of particular situations.

Developing Readers and Writers

Systems thinking concepts and tools help students develop as readers and writers.

- When students use the concepts and tools of systems thinking, they are better able to
 - retell and summarize a piece of writing;
 - analyze character, plot, setting and theme and the relationships among these literary components;
 - identify point of view and the author's/characters' mental models;
 - describe cause and effect relationships; and
 - express themselves descriptively.

Increasing Engagement

When using systems thinking concepts and tools, many students show increased motivation, engagement, and self-esteem.

- When using systems thinking tools as a prewriting strategy, students who had been producing below-average writing wrote more (quantity) and developed more thoughtful, insightful content (quality) than they had previously.
- When asked to "tell the story of a line" (BOTGs), "tell the story of a loop" (causal loop diagrams), or "describe a stock-flow map," many usually reluctant students were more willing to participate in front of others, using visual diagrams as they described ideas or theories.
- Students in special education classes voiced satisfaction at being able to understand challenging concepts typically presented to their non-special education peers but not to them.

Independent Studies

In a case study conducted in an inner-city school in Portland, Oregon, *Systems Thinking: Teacher conceptions and implementation* (2001), Tracy Benson found that teachers viewed systems thinking as an important life-long orientation and incorporated this view in their teaching. The impact of professional development structures in support of systems thinking such as training, access to resources, coaching, planning time, outside assistance, and a collegial atmosphere was significant. Teachers involved with systems thinking developed and articulated theories about the effects of systems thinking on their students. These theories greatly influenced both attitudes and practice, thus generating results that supported teacher hypotheses.

In *Assessing the effectiveness of systems-oriented instruction for preparing students to understand complexity* (2006), Richard Plate found systems-oriented instruction to be a promising pedagogical tool for preparing students to understand complex social and ecological systems. Plate investigated the impact of using cognitive maps with undergraduate students from the University of Florida (UF) and with middle school students from Portland, Oregon. In each study, participants read an article about a hypothetical fishing controversy involving the interaction of social, economic, and ecological processes and worked through a cognitive mapping exercise during which they were able to express their interpretation of the situation described in the article. The cognitive maps produced by the students were then subjected to a battery of quantitative and qualitative evaluations.

The UF study involved a pre-test/post-test format, in which the students were evaluated at the beginning and end of a semester class using systems-oriented instruction. In the Portland study the cognitive maps of students who have been receiving systems-oriented instruction were compared to those of students who have been receiving conventional instruction. In the UF study, results showed that students' ability to apprehend key aspects of the situation described in the article had improved significantly over the semester. In the Portland study the systems groups displayed a greater understanding of the situation described in the article than the control groups. While the differences observed are not definitive enough to make strong claims about systems-oriented instruction based only on these studies, they are strong enough to warrant further studies assessing systems-oriented instruction's worth as a pedagogical tool.

Student Surveys

Over the course of their 13 years in school, high school students have experienced hundreds, perhaps thousands, of different instructional methodologies. In some ways, students may be perceived as experts in the field of learning because of the breadth of their experience with various teaching styles, instructional strategies and pedagogies.

Each year over the course of an eight-year period from 1998-2005, graduating seniors at one Tucson high school that has served as a systems thinking demonstration site were asked to self-assess the impact of using systems thinking and dynamic modeling tools on learning subject-area content. In addition, survey data were collected from feeder middle schools from 2003-05. Students were asked to identify the tools they had used at some point during their school experience from kindergarten through 12th grade. They also identified contexts in which they recalled using the tools, including specific computer simulations (see Table 3).

Survey Questions	Average responding “Yes”
Was using systems concepts/tools an effective way to learn class material?	Middle School – 64% High School – 80%
Do you think you learned more by using these systems concepts/tools/ simulations than you would have otherwise?	Middle School – 56% High School – 59%
Have you used or could you imagine using systems concepts/tools at times when not required, either in schoolwork or in social situations with friends/family?	Middle School – 22% High School – 31%

Table 3: Average affirmative responses to questions posed in end-of-the-year surveys of middle and high school students (2003 – 2005)

It is known that students have very different learning modalities, so to say that any one instructional strategy is effective for 80% of high school seniors, creates a compelling rationale for using that methodology as one way to reach a large percentage of students. Perceptual data, although not always aligned with factual data, can have a powerful impact on action. Although implied in the questions, students who see a strategy as effective will be more apt to be engaged in the learning process while using that strategy.

To further reinforce this premise, a recent high school graduate from Nanjing, China who presented his work at the 2009 International System Dynamics Conference gave some advice to a group of attending K-12 teachers and system dynamicists. His challenge to them was to use systems thinking to engage students, to actively interest them in being involved in their own learning. For him, because his teachers integrated ST/DM through engaging interdisciplinary projects, he became excited about his own learning, and felt he had the tools needed to explore, process, and connect the subject-area learning to something meaningful. Listening to student perspectives such as these add yet another facet to determining overall effectiveness.

Systems Thinking in Schools Project Demonstration Sites

Catalina Foothills School District

As the home district of the first school supported by the Waters Foundation Systems Thinking in Schools Project in 1989, Catalina Foothills School District in Tucson, AZ has developed a long history of systems thinking integration in classroom instruction and organizational learning. Sustained systems thinking integration is evident as over the past 20 years, the district has had 3 superintendents and principal turn-over in each of its seven schools. Considered a national model for 21st century learning, Catalina Foothills has held its place as a leader in systems thinking integration in classrooms and schools. Evidence to support their successes include:

- *Structuring Schools for Success : A practitioner's view* (1994), provides a documented account of the learning journey of Catalina Foothills' first school to integrate systems thinking in classroom instruction and school culture.
- *...that school in Tucson* is a longitudinal research study sponsored by the Kellogg Foundation. This study follows up with eight former middle school students from the district who had experienced systems-based learning while in sixth through eighth grades. The study provides video footage of these individuals as young adolescents and 14 years later as young professionals. Strong visual evidence demonstrates the long-lasting impact of a systems thinking educational experience at the middle level on higher education academic pursuits, career preparation and community involvement.
- Districtwide adoption and integration of systems thinking as an essential component of the 21st century skills framework resulted in the development of [rubrics](#). As a Waters Foundation demonstration district, Catalina Foothills classrooms have hosted visitors from throughout the U.S. and abroad.

Borton Primary Magnet School, Tucson Unified School District

In a culture of team learning where skilled teachers use inquiry to learn with and from their students, the habits and tools of systems thinking find fertile soil for helping to improve student achievement. Such is the case at Borton Primary Magnet School, a preschool through fifth grade school created as a desegregation magnet school in 1979 with a focus on early childhood practices and fine arts, adding systems thinking as a formal part of its focus and becoming a Waters Foundation demonstration site in 2005.

Borton's discovery of systems thinking began in 2003 when a teacher-librarian incorporated systems thinking tools to improve students' reading comprehension. As her students showed improved retelling scores, produced stronger pieces of writing and generally expressed their thinking with greater clarity, other teachers began to learn more about the systems thinking tools that she used. One at a time, through systematic collaboration, teachers became curious and eventually committed to learning about this approach that was making a difference for children. Few people thought that young children were capable of the abstract thought required for in-depth systems analysis of various academic topics. Taking their cues from the students, Borton teachers realized that with proper scaffolding, their young students were capable of far more than they had previously believed. Every staff member proceeded to request and receive training in systems thinking.

In 2010, Borton Primary Magnet School, labeled an excelling school by Arizona Learns, routinely incorporated systems thinking to provide children an integrated, meaningful curriculum in all subject areas. The tools and the habits of systems thinking help students make connections, make their thinking visual, solve problems and communicate ideas in every subject area. Students use the tools to self-assess their own learning. Recently a second grade student described that when using behavior-over-time graphs to assess the level of difficulty of each step in solving a word problem, she realized that while solving subtraction problems was still more difficult, reading them was easier. This type of self-assessment was not commonplace prior to the inclusion of systems thinking as a part of the instructional methodology.

At the 2006 Microsoft U.S. Innovative Teachers Forum, the Borton Learning Team of Ginger Snider, Sheri Marlin and Reneé Olson were honored for exemplary collaborative work that impacts student achievement through their use of systems thinking. This team was also one of four selected to represent the U.S. at the Microsoft Worldwide Innovative Teachers Forum. At this international event that showcased 65 teams from 35 countries, Borton was selected as one of ten teams, and the only U.S. team, to receive recognition; in Borton's case, it was for its integration of technology and systems thinking tools to support the teaching of content.

Borton Primary Magnet School seeks to create a community of learners. It is common for teacher dialogue to reflect what they have learned through careful observation of their students. It is also common for teachers to challenge each other's thinking by asking questions that prompt teachers to push students into deeper, more precise thinking. Action research done by two teachers at the school as part of their evaluation concluded that students for whom English is a second language have demonstrated marked improvements communicating their thinking both orally and in writing as a result of using behavior-over-time graphs, stock-flow maps and other systems tools, as measured by the AZELLA, Arizona's standardized test for assessing language learning.

In spring of 2010, Borton needed a new principal. Knowledge of systems thinking was deemed a requirement for the new hire. Holding a belief that these methods of instruction have become an integral component of the Borton instructional framework, staff and parents were clear in expressing their belief that this qualification must be a priority of the new administrator. The current principal expresses solid support of systems thinking.

Gridley Middle School, Tucson Unified School District

The teachers of Gridley Middle School have been following a similar path as those at Borton Primary Magnet. At Gridley, systems thinking began with several teachers eager to find new ways to engage students and increase the level of rigor and thinking in their classrooms. Without any pressure from school administration, those interested in learning more about systems thinking as a valuable instructional methodology slowly increased when teachers saw examples of student work, and heard stories that illustrated the benefits of this method of instruction. In addition, the principal of the school, having experience with systems thinking when she previously worked in Catalina Foothills, modeled its application to organizational learning and the formation of positive school culture.

Ritenour School District

An inner-city school district in St. Louis, MO, Ritenour is a stellar example of how systems thinking benefits students of all socio-economic and ethnic backgrounds. Over 80 percent of the students attending Ritenour schools receive free or reduced lunches. Systems thinking habits and tools have contributed to student efficacy and achievement at all levels. The methods, championed in the district by Assistant Superintendent Mary Scheetz, have, over time, impacted graduation rates, measures of student achievement and the development of student opportunities to participate in a wide variety of projects with Washington University.

Other emerging demonstration sites include schools in Winston-Salem Forsyth County School District in North Carolina and Tahoma School District in Maple Valley, Washington.

Demonstration charter schools include City High School in Tucson, AZ and Innovation Academy Charter School in Tyngsboro, MA.

Testimonials from Notable Waters Foundation Demonstration School Visitations

Sam Rawlings Walton, the grandson of the founder of Wal-Mart, visited Waters Foundation demonstration schools in Tucson, Arizona in May of 2011. Though Mr. Walton has followed career interests beyond Walmart, he is an ardent supporter of the company's sustainability and supply chain strategies. As a trained hydrologist, Sam maintains multiple philanthropic efforts around water management, marine ecosystem- and fishery restoration, and closing the education opportunity gap in American schools. After visiting the demonstration schools, Mr. Walton reflected:

I am excited to see this skill set being sought after in professions, and even more excited to see this fostered in schools. What I have seen in these schools is that the students get a very strong set of tools and that, clearly, these tools enable them to think independently and to work with peers on wonderfully complex subjects. The students are really able to come up with understanding of complex scenarios and have a strong sense of what the drivers of those scenarios are... Additionally, the integration of systems teaching in schools brings a much needed resiliency and a dynamic learning culture to teachers and administrators who have the courage to reach outside of traditional boundaries. This resiliency is proving to be critically important as schools today face real pressures to evolve into the learning institutions we hope to have moving forward.

Michael Fullan, internationally recognized author and expert on whole system change in education, described his impressions from a 2011 visit to Waters Foundation demonstration schools:

We have shown that it is possible to work together to move schools from underperforming to proficient and to strong proficiency. But we have not yet accomplished much in terms of higher order skills. What I saw in Tucson showed me otherwise. I saw teachers and most importantly students who saw the systems worldview as exceedingly practical in their day-to-day work and studies. It was impressive.

Summary

Our future depends on preparation efforts made today. That is why it is a growing priority to encourage educators to develop and apply their own systems thinking capacity to teaching and learning. Children will need to have the skills and knowledge necessary to manage the complex problems they will ultimately inherit. It is imperative that K-12 schools and classrooms strive to develop and nurture the 21st century learning in order to prepare the next generation for the needs of tomorrow. Educators should not underestimate the systems thinking capabilities of children and should re-examine instructional practices that fragment educational objectives into unrelated, non-systemic parts. I don't recall this highlighted part having been addressed previously in the paper. It's not generally advisable to introduce new points in a summary.

Schools across the United States and around the world, are currently applying and integrating systems thinking into instruction and school improvement efforts. The demands of the 21st

century necessitate the development of skills and knowledge necessary to manage the complexity of current and future problems. Thus, educational institutions are compelled to develop learners who think and behave as systems thinkers. Systems thinkers understand the complexities of today's systems and have the capability to face into problems with knowledge and skill.

The goals of standards-based curricula (e.g. Common Core) along with the skills that ensure students are prepared for college and the 21st century workplace can best be accomplished through a systems thinking classroom learning environment. In this environment children are immersed in a practice field rich in relevant problem-solving, interdisciplinary connections, and opportunities for in-depth analysis, and thought-provoking dialogue. It is imperative that schools and classrooms strive to develop and nurture the 21st century learning associated with systems thinking in order to prepare the next generation for the challenges of tomorrow.

Current world issues demand immediate and thoughtful attention, and world, national and local leaders are seldom patient for the time it takes to invest in and build a capacity for action. Recognizing the inherent 12-16 year time span it takes to educate a young person through traditional schooling, the time is now to begin to build a systems thinking capacity in today's youth, thus developing and educating learners of all ages who are prepared to address today's and tomorrow's challenges, making a positive difference in their communities and their world.