Seeing Below the Surface: Systems Thinking

Joan Yates
Catalina Foothills School District
Systems Thinking in Schools Partnership
6085 North Kolb Road
Tucson, Arizona
(ph) 520-575-1243
(fax) 520-575-1370
jyates@cfsd.k12.az.us

Andrea Davidson
Catalina Foothills School District
6085 North Kolb Road
Tucson, Arizona
(ph) 520-577-5075
adavidson@cfsd.k12.az.us

Seeing Below the Surface: Systems Thinking

When should the Forest Service let fires burn rather than extinguish them? What's the window of time in which it should be a tax dollar priority to remove graffiti from walls in neighborhoods? When a friend asks you a question and you think the honest answer will hurt him or her, how do you decide what to say? What strategy, or combination of strategies, would you support to keep a lily pad from completely covering the surface of a pond in the local park? Is it best to treat a child's ear infection with antibiotics? If you had been an advisor to President Truman during World War II, what would your recommendation have been about use of the atomic bomb? Should manmade roads and picnic areas that have been destroyed by floodwaters in national parks be rebuilt, or should the areas be left to return to their reclaimed natural states? As an individual, how do I weigh the short-term versus long-term advantages of investing with fellow tax payers in the local infrastructure, versus keeping more of my money and investing personally in a privately-funded, visionary transportation plan?

These questions call for the types of decisions adults typically make in their work, civic, or social lives. Rather than having our students wait until they are adults to grapple with such decisions, we need to offer learning environments in which they can develop thinking habits and techniques that will serve them throughout their adult lives as they experience the unforeseen problem-solving opportunities they'll face professionally and personally, the likes of which we can barely imagine in 2008. In our work with students, we've found that the habits and techniques of systems thinking offer concepts and tools that bolster the decision-making and critical thinking skills of students from kindergarten through twelfth grade.

Systems Thinking Enhances Critical Thinking

Systems thinking has become an increasingly popular reference in business and educational literature in the past 10 years. In our work with students and adults, we have drawn from many experts in the fields of system dynamics and systems thinking. One source written specifically for people interested in education defines systems thinking as "… the ability to understand (and sometimes to predict) interactions and relationships in complex, dynamic systems: the kinds of systems we are surrounded by and embedded in. … ST enables you to see the big picture, the minute details that make it up, and the way parts interact over time" (Senge et al., 2000, p. 239).

Because seeing relationships and the big picture will be essential for success in the future (Pink, 2005), it's imperative that we provide our students the means to approach any system they are studying, or in which they're interacting, as systems thinkers.   An additional advantage to providing students with techniques that help them reflect on, establish their beliefs about or decide what actions to take in systems is that it will improve their critical thinking abilities, as critical thinking encompasses "reasonable and reflective thinking focused on deciding what to believe or do" (Ennis, 2001, p. 44).

The Iceberg-Seeing Below the Surface

The field of systems thinking includes many techniques and tools teachers scaffold instruction in, up through computer modeling. One versatile tool that is used across academic areas from grades three through twelve derives its name from a physical analogy to an iceberg (Senge et al., 2000).

The systems thinking "iceberg" (student examples and photographs available upon request) represents the concept that what is seen about a system, as with an iceberg, is just the tip of it. In the case of a system, that "tip" would be the most recent event or events that have taken place. To truly understand

a system, one must go below the surface of the water line to examine the bulk of the system—the patterns and trends that have developed over time within the system; the underlying structures in the form of policies, rules, or physical structures that have generated the patterns and trends; and the mental models, that is beliefs, values and assumptions that led to the structures being created.

For example, when using the iceberg, students look an at Tucson's current population figures. Then, students look for patterns and trends using another systems thinking tool, behavior- over-time graphs, to capture data relevant to the variances in population over time. At the next level of the iceberg, students identify the underlying structures that contribute to the population increase over time including governmental, cultural, and natural structures. Finally, students analyze the assumptions, beliefs and thoughts of the different groups of people related to the population increase of Tucson. In Tucson's case, what have people thought and believed that have led them to take actions that has increased the population through the years?

Student-centered dialogue among peers flows from the use of the iceberg, as students work from top to bottom or bottom to top answering questions inherent to each level of the iceberg. Whether students are studying population fluctuation in an area over time, the change in a literary character's level of self-confidence, or the causes of a revolution, investigation and interpretation of trends, structures and mental models shared among students helps open them to the fact that not everyone in a situation has the same interpretation of information, just as everyone in a situation does not hold the same beliefs or values.

When third and fourth graders, who are generally developmentally egocentric, worked regularly with the iceberg as an analysis and synthesis tool, they exhibited a marked increase in level of respect and

consideration shown for each other.   They realized their own way of thinking wasn't the only way of thinking and understood that other mental models exist in the world. In the classroom, a mutual understanding that "we can disagree and still be agreeable" developed, allowing students to accept that one's thinking isn't the "right answer," and that there are multiple perspectives. This broader perspective prepares these young people to see "a bigger picture" as they increasingly engage in their global citizenship.

The bigger picture doesn't apply just to a global stage in the future for the students, though. As with any valuable learning strategy, we want our students to take the iceberg "tool" and use it in any applicable situation, be it another subject area or a non-academic, life situation. And they do. Third graders who have regularly used the iceberg academically have come in from recess, come up to the poster of the iceberg graphic organizer hanging in the classroom and stood there in a small group analyzing and working through a conflict that had just occurred on the playground. Clearly, these students had become adept at questioning what they'd experienced and analyzing their social system through the levels of the iceberg. "Iceberg thinking" or systems thinking had become a habit to them.

Habits of a Systems Thinker

We have found that helping students develop the habits of systems thinking offers them some strengths and maneuverability as decision makers, as evidenced in the previous example of the post-recess third graders. Explicitly teaching decision-making using systems thinking as habits of mind empowers students to think critically at high levels of cognition. In our work, we identify 13 habits of a systems thinker (www.watersfoundation.org), some of which correspond to habits of mind delineated separately in Costa's and Marzano's work (Costa & Kallick, 2000; Marzano et al., 1997). A number of the habits correspond to the thinking evoked by the iceberg.

Changes perspectives to increase understanding is a habit of mind of a system thinker that necessitates the students go below the surface or event level to analyze what is not obviously visible. This habit allows students to see multiple patterns and the mental models of various individuals or groups of people in relationship to a bigger picture. *Seeking to understand the big picture* constitutes an additional systems thinking habit that students acquire.

Observes how elements within systems change over time, generating patterns and trends, another habit of mind of systems thinkers, prompts students to examine what's been happening through time, and perhaps repeatedly, that could be producing a pattern or trend, as per the second level of the iceberg. Students employing this habit *consider both short and long-term consequences of actions*, which is another of the habits a systems thinker develops. These critical thinkers see how the pattern level of the iceberg affects the event level and mental model level, because the consequences of actions can influence events and also affect people's attitudes and beliefs.

Students who become adept at systems thinking through use of the iceberg tool *consider how mental models affect current reality and the future*, which facilitates *surfacing and testing assumptions* that the students themselves, or figures in history or literature, hold.

Habits Lead to Systemic Decisions and Actions

Students practicing the habits of a system thinker ultimately *use understanding of system structures to identify possible leverage actions*. Once they've analyzed a system in which they're operating, as the third graders did after recess, or used the iceberg to synthesize information they were studying on World War II as juniors in the district high school did, students are better able to decide which action

or actions when put into place are most likely to bring about a favorable, long-term result. In addition, these young systems thinkers employ the habit of *checking results and changing actions if needed*.

As we strive to help our students become young people who are systems thinkers who metaphorically go below the below the water level on the iceberg to see relationships and the big picture, it serves us and them to structure our lessons so that the students have the opportunity to work through the thinking embedded in the levels of the iceberg. If we give students the techniques for critically analyzing any system they're studying, up through and including a process by which to come to a decision about a probable leverage action, with the internal caution to check the results, they will have the habits of systems thinking required to make decisions not only in 2008 but in 2018 and beyond.

References

Ennis, R. H. (2001). Goals for a critical thinking curriculum and its assessment. In A. Costa (Ed.), *Developing minds a resource book for teaching thinking* (3rd ed., pp. 44-46). Alexandria, VA: Association for Supervision and Curriculum Development.

Costa, A. L., & Kallick, B. (2000). *Discovering and exploring habits of mind*. Alexandria, VA: Association for Supervision and Curriculum Development.

Marzano, R. J., & Pickering, D. J., et. al. (1997). *Dimensions of learning teacher's manual*. Alexandria, VA: Association for Supervision and Curriculum Development.

Pink, D. H., (2005). *A whole new mind why right-brainers will rule the future*. New York: Riverhead Books.

Senge, P., & Cambron-McCabe, N., et. al. (2000). *Schools that learn a fifth discipline fieldbook for educators, parents, and everyone who cares about education*. New York: Doubleday.

Waters Foundation (2003). *Systems Thinking in Schools A Waters Foundation Project*. Retrieved August 31, 2007 from http://watersfoundation.org/