Scholarship Recipients at the 2010 ST/DM Conference Reflect upon their Experiences

Last June, we gathered at the Babson Conference Center for the 2010 ST/DM conference. For many, it was the first experience at one of our conferences. Two scholarships supported attendance for many of these first-timers. One was the Tracing Connections Scholarship, from isee systems, honoring Barry Richmond and the book *Tracing Connections*, created in his memory. The other was a scholarship from the System Dynamics Society. Scholarship recipients were asked to reflect on their experiences with system dynamics in K-12 education, following the 2010-2011 school year and send us a written report on how they used ST/SD during the year, describing what they did, how it worked, what they want to do next, and how they would improve what they have done. The reports are inspiring and fun to read. We offer a few herein, to stimulate discussion and learning. More reports will be shared in subsequent issues.

Tracing Connections and System Dynamics Scholarship Reflections

Barbara Casanova

I was truly honored to be selected as a recipient of a Tracing Connections and System Dynamics Scholarship for the Systems Thinking and Dynamic Modeling Conference at the Babson Executive Conference Center in Wellesley, Massachusetts last summer. The conference was incredible and helped me make another shift in my thinking and understanding about Systems Thinking and Dynamic Modeling in K– 2 Education.

Andrew Jones' Keynote, entitled *How Your Students Can Use System Dynamics to Save the World* (Jones, 2010), confirmed what my colleagues and I have been observing with primary age children in terms of developing understanding of System Dynamics through physical interaction. When you "live the system, you experience the system as part of it." (Jones, 2010) Jones spoke of his "Carry Your Garbage" experiment in college. Participants put the things they would normally throw away in the garbage, in a bag and carried the garbage around with them. By the fifth day, participants had a bag full of garbage. The physical interaction with their bags of garbage forced them to look at the way they used things. It forced them to look at the long-term consequences. It created a feedback loop which brought about the need for action to change. Jones said that the "first objective for a curriculum of Systems Thinking for children should include experiences that help children see the world as an interdependent whole." As educators, we can provide these experiences and give the children "the tools to change the world." (Jones, 2010)

The session *How Does a System Dynamicist Think?* with Dennis Meadows (Meadows, 2010), added to my understanding of dynamic modeling. Dennis outlined the process of creating a model that makes problems visible. He talked about having a shared experience as a reference point for the group. The shared experience provides common background information when discussing mental models. It also helps with the development of shared vocabulary when identifying specific behaviors, goal setting and problem solving. The examples Meadows presented helped me understand how to use the tools to "design changes to meet a goal and to bring changes to real life." (Meadows, 2010)

These two sessions inspired me to want to develop a lesson that would actively involve the children in taking control of their own actions to create a positive change in some aspect of their lives. I wanted something that would incorporate a shared experience, as well as have a positive impact on the world. I wanted to incorporate the Habits of a Systems Thinker to see if knowledge could be the leverage needed to create a positive change. That's when the idea came to me. In my

classroom, we had been investigating the Desert Environment and discussing ways to help take care of the earth. I could incorporate the children's desire to help care for the earth with a simple act they do every day. The lesson is called "The Drinking Fountain." (Casanova, 2010)

The Drinking Fountain lesson grew out of a daily observation I made as my Kindergarten children got drinks of water after lunch recess. I noticed a lot of water being wasted as they stood in line day after day and took their turns to get drinks. Water is such a precious resource, especially here in the Tucson desert. We needed to do something to solve this problem. I could have just told them that they were wasting water, but I believe it would have had little impact on addressing the problem. I thought about my latest experiences with Systems Thinking and Dynamic Modeling at the CLE Conference 2010, and decided that this would be a perfect opportunity to develop a model for reducing the amount of water children waste when getting drinks.

I decided to solicit the help of a second/third grade class. Many of the students were my former students and are very familiar with Systems Thinking (ST), ST tools, ST Habits and data collection. I spoke to the second/third grade students and their teacher and explained what was happening at the drinking fountain. I asked them to help collect data for one week. Each volunteer counter would count one – one thousand, two – one thousand, etc. for every second of water being wasted and not drunk. The data would be recorded on a Behavior-Over-Time Graph (BOTG). The BOTG would be used to show the Kindergarten children the amount of water they were wasting each day.

The results were astounding. Data collected for the whole class, for a time period of six days, ranged from a low of 15 seconds of water wasted to a high of 91 seconds of water wasted in one day. The average for the trial period was 47.66 seconds per day. The majority of the Kindergarten children did not even realize that they were wasting water. I decided to do a role play of getting a drink of water to help the children identify some of the common behaviors that were affecting the waste of water. I recorded their observations on a Stock/Flow Diagram. Some of their observations included: looking at the other kids instead of drinking right away, someone else pushes the water button, talking instead of drinking, splashing the water, pushing the water button too many times, pushing the water button too long, and playing with the water.

With this new knowledge, we set off to collect data to see if we could decrease our water wasting when getting drinks. The children's awareness levels increased dramatically. They were very focused at the drinking fountain. They did not let their neighbor push the button. They looked at the water more closely and were ready to catch the water in their mouths when it came out. Data collected for the whole class reflected their ability to take control of their actions and make a decrease in the amount of water being wasted. The range went from a low of 8 seconds of water wasted to a high of 25 seconds of water wasted in one day. The average for the trial period was 19.8 seconds of water wasted per day. That was a decrease of almost 28 seconds of water per day, an improvement of over 50%. The children truly felt empowered. They created a positive change that would help the world! Isn't it wonderful how a simple observation can grow into something so great?

After sharing the Drinking Fountain (Casanova, 2010) success story with my Systems Thinking study group, we decided to design a Recycling Project for Earth Day. The Recycling Project focuses on reducing the amount of garbage going to the landfill by recycling milk cartons and drink containers in our school cafeteria. The results will be presented at Camp Snowball in Tucson, Arizona July 21 – 25, 2011. Hope to see you there!

REFERENCES

Casanova, B. (2010). The Drinking Fountain. Tucson, Arizona.

Jones, A. (2010). How Your Students Can Use System Dynamics to Save the World. Systems Thinking and Dynamic Modeling for K-12 Education. Wellesley, Massachusetts.

Meadows, D. (2010). How Does a System Dynamicist Think? Systems Thinking and Dynamic Modeling For K-12 Education. Wellesley, Massachusetts.

Zerrin Doğanca

Last year, I attended "Systems Thinking and Dynamic Modeling Conference" as a presenter. It was the first time that I had attended a conference in USA and I was one of the few participants who are out of USA. I presented my study on comparison of two classes on the same subject in the presence and absence of causal loop diagrams. The instructional activity was taken from Waters Foundation Website; "Be Nice to Spiders" (http://www.watersfoundation.org/images/media/Be%20Nice%20to%20Spiders%20PDF.pdf). The activity was modified for the purpose of the research and translated into Turkish.

Firstly, I want to mention about the atmosphere when I presented my paper. Although, there were two great presentations at the same time of my presentation, I had a very concerned audience. I had attended several conferences in Turkey and in Europe. And, generally 10 or 15 minutes are devoted for each presentation and speakers are always in a rush to express themselves in such a short time. I had about half an hour to explain my study in detail, to show my instructional activities designed for the experimental and control groups. After my presentation, there were some questions about the instruction in the research. And, the most important part is that we examined the causal loop diagrams all together and tried to make them as simple as possible for the 5th grade students. It was a funny and instructive practice. In the conferences, I generally get very nervous, but this was the first time I felt so comfortable, and I really enjoyed the moments, even in the questioning part!

Another important gain of this conference for me is that I met several teachers and listened to their works on using System Dynamic tools in their classes. These studies motivated me to go further on integrating system dynamics tools in science classes and made me believe that these applications are possible in real school environment.

I was able to collect several exemplary lesson plans and ideas for classroom applications and bought some very good books to study for my PhD dissertation. (The book T*he Shape of Change, Including the Shape of Change Stocks and Flows* is my favourite.) Throughout this year, I modified the seventh grade science unit "Human and the Environment" by using system elements: feedback loops, stock and flow diagrams, and dynamic modeling. The unit includes several dynamic issues: population dynamics, food chains and webs in an ecosystem, environmental problems and effects of these problems to our planet. Moreover, I worked on designing two instruments for assessing system thinking skills and views of students about some dynamic ecological problems. In Spring 2011, these instruments and the instructions based on systems approach were applied to two seventh grade classes in a public school in Istanbul. The preliminary results and experiences from this pilot study will be presented in PhD Colloquium in the 29th International Conference in Washington D.C. in July 2011. Based on the feedback that I will get in the PhD Colloquium, the experimental study, including a control group that will be taught as the standard science curriculum suggests, will take place in Spring 2012.

Michael Hanson

The experience at the 2010 Babson Systems Conference has influenced my approach to using systems thinking in the classroom. I came to the conference with a team from the Tahoma School District. We have been working for 2 years to incorporate more systems thinking into our district. We have attended multiple conferences and trainings. The Babson conference, by far, was the single most useful professional development to help us incorporate ST/SD into our classrooms.

I enjoyed learning from the professionals at the conference. The most useful presenters, for me, were the classroom teachers and those who have experience at using systems thinking with young learners.

From the conference we developed a set of learning targets (largely stolen from the Tucson folks) that gave us direction. We then began developing a series of steps for how to incorporate systems thinking into the classroom. This has been refined over the year and now closely resembles the steps found both in a document created by Linda Booth Sweeney, and one presented by Nalani Linder and Colleen Ponto:

1. Tell the story
2. Name the variables
3. Determine the system boundaries
4. Sketch the trends
   - behavior-over-time graphs
5. Make the system visible
   - connection circles
   - causal loop diagrams
   - stock / flow diagrams
6. Look for leverage for sustainability
   - iceberg model

We have also created documents using connections circles to begin a story.

Much of my work with students this year has centered around our creation of ecocolumns. The students created websites to follow the changes in several factors over the course of the year. At one point I had them create a model on STELLA for the nitrogen cycle within their ecocolumn. This was not very successful for me. I believe that the potential is there to use this in the future but I lacked a clear vision for what I wanted them to get out of the model. I plan on continuing with the STELLA model again next year and refining my thinking about how this will help them understand their ecocolumn.

I also plan to increase the use of the systems thinking steps above throughout the year on various environmental issues.

We used the above steps over the course of about three hours to analyze issues that are caused by America's addiction to oil. Students were given the freedom to identify a particular problem stemming from oil addiction. The level of ownership and the depth of understanding were evident. Student conversations are at a level that is not normal in a nonsystems-based lesson.

We intend to expand our use of systems thinking into several areas of our science curriculum. Currently it is used in our AP Environmental Science program and a little bit in our chemistry program. We have plans to incorporate lessons into our 10th grade biology program. We feel that we have developed enough basic knowledge that we can begin to expand the use of systems thinking. We are very interested in continuing our relationship with the folks from CLE and hope to attend the next conference.

Torrey McMillan

When I attended the 2010 ST/DM conference last summer, I was in a period of transition professionally and personally. After seven years of leading the Sustainability Studies Department at The White Mountain School, I was stepping out of schools and teaching for a year to recalibrate and consider what would come next. I was

fairly certain that my next steps would involve sustainability education and systems thinking and dynamics in some way, but I was not sure what form that would take.

As I write this report, that next step is just ahead of me. Starting in the fall, I will be directing the Center for Sustainability at Hathaway Brown School, an independent school in Shaker Heights, OH. As part of my work there, I will be developing an educational program that introduces students to the principles and practices of sustainability and provides opportunities for them to dive headlong into this field if they are interested. Systems thinking and dynamics will be integral to my work there. The resources I collected and the connections I made at the 2010 conference will serve me well as I embark on this new position.

That said, my experience at the 2010 conference also influenced my thinking and professional growth over the past year. I had the opportunity at the conference to speak with systems thinkers and modelers working at all levels within the educational system and people working outside of education. This was incredibly helpful as I considered what my next professional step would be. At that time, I was considering returning to school for additional training in systems modeling, working as a consultant to K-12 schools, but outside the classroom, and returning to the classroom. In the weeks and months that followed the conference, as I explored different possibilities, I drew on the conversations I had while at the conference. Ultimately, I decided to dive back into hands-on K-12 education, and do so with a commitment and passion for ST/DM.

Shortly after the conference, I also attended a Sustainability Institute for high school educators in the Boston area. I was there as a support resource for a cohort of Boston area school teachers who are developing a pilot sustainability education curriculum for integration into the Boston Public Schools. At the workshop, I often found myself helping teachers think about how to integrate systems thinking into their lessons. In particular, I drew on Diana Fisher's work as I helped math teachers find their role in sustainability education. Learning from Diana about her approach to math education has had a tremendous influence on my own thinking about math education, and I have this conference and the previous SD conference in Albuquerque to thank for helping me to make that connection.

Finally, I have embarked on additional professional development in the past year, enrolling in an 8-month certificate course in biomimicry. As I have pursued my biomimicry studies, I have focused my inquiry on the intersection of biomimicry and system dynamics, both with an eye to educating and to changing the way we design systems. In my studies I have asked questions such as:

How does nature construct resilient systems? What are the elements that make them resilient?

What does it mean to optimize rather than maximize in system design? How might this be important as we design systems?

What does a biomimetic economic system look like? Could we model this?

Where are the points of overlap between biomimicry, systems thinking and dynamic modeling, and sustainability?

While I do not have much to report about what I have actually implemented and tried in the past year and how I think I could improve it, I will enter my new position in the fall with an incredible toolkit and set of connections and resources to draw on that my time away from the classroom has given the chance to develop. I look forward to sharing my work with you in the future as I work with teachers at Hathaway Brown to integrate systems thinking into their classes and bring new programs to the school. Some of the work I hope to do at HB in the coming 1-3 years includes:

Working with teachers at all grade levels to integrate systems thinking into their classrooms (HB is a preK-12 school). This will be new for me, as I have up to this point worked primarily on high school curriculum. I will certainly draw on the good work of the folks at the Waters Foundation for this.

Introducing math teachers at HB to systems thinking and modeling, and perhaps teaching a systems modeling class as an advanced math/sustainability elective.

Running a multi-school climate policy simulation using the Climate Interactive carbon simulator.

Bringing together biomimicry and systems thinking/dynamics in diverse ways for students and for others in the Cleveland area.

Many thanks to all those who helped make it possible for me to attend the 2010 conference. It was an incredibly valuable experience for me. I hope to be there again in 2012, with new ideas and experiences to share.

Donna Rishor

I have decided to analyze the artifact of a modified Systems Thinking problem-solving activity called Warped Juggle (Booth Sweeney, Meadows, 2008), through the lense of constructivism that I used in my classroom this year. In this team activity, students stood in a large circle. They were given instructions that they were to pass the ball so that everyone in the circle touched the ball in sequence and that they would be timed to see how quickly they could do it. To facilitate efficiency, students were asked to keep one hand up until they had received the ball, at which point they were to put their hand down. They were told that they could pass the ball to anyone who had not yet received it.

At that point, a ball was tossed to one of the participants in the circle and the activity began, amid much confusion and chaos. Once everyone had gotten the ball, I asked them if they wanted to practice it again, now that they had an idea of what to do, before being timed. Of course they agreed and the game began again, much the same way as the first time, but with a little more focus and direction. For the third trial, the group was timed as they performed the task. The timing factor promoted more focus but students remained standing in the same configuration, usually tossing the ball across the circle to a team mate. Time was 27 seconds. Next I asked them if they thought they could perform the task with two balls being passed around the group. At that point the activity became interesting because the balls were intersecting each other's paths and it got a little more difficult for the students to keep up. The time increased by a few seconds and that proved to be the catalyst that students needed to assimilate new learning, (Posner, et al., 1982). Student leaders emerged and ideas began flying. Students who normally do not talk to one another engaged in lively discussion about the best way to solve the problem. More timid students approached me in an attempt to use the teacher as the means to deliver their ideas to their classmates but were redirected to the group when I reminded them that I was just the timer of the activity. Slowly the group became united in their pursuit of a common goal.

Finally students decided that they were ready to be timed again. This time, though, it appeared that they had completely thrown out their prior ideas as they lined themselves up sequentially into the ball toss pattern they had created and tightened up the circle significantly. Everyone worked together as they passed the ball to the person next to them around the circle and the completion time decreased. They suggested doing it again because they thought they could do it faster. Student leaders again emerged and encouraged the group to tighten up and bring the circle closer together. Of course the time decreased but students were still not satisfied and began their animated discourse once again. For the next timing they were, once again, standing close together in a circle but decided that the two most physically agile among them were going to run around the inside of the circle while everyone held their hands out and touched the ball to their hands. The time was three seconds for a class of 30 to touch each of two balls. The class was satisfied and triumphant. High-fives occurred between the group members and, if only for a while, students put aside their differences and came together to solve a problem.

The theory of constructivist learning assumes that learning occurs as individuals interact with one another and their environment. Children seek to make sense of their world and this sense-making becomes more sophisticated as it builds upon prior successes and failures, (Bransford 2000). As they mature, children have more knowledge, and that knowledge

becomes progressively more sophisticated to aid them in future problem solving endeavors. Many of the systems thinking activities in the Playbook lend themselves nicely to problem solvers of all ages.

I had facilitated this activity with adults at a Professional Development meeting in the past and they were more adept at seeing what needed to be done in order to meet the objectives of the task. Children, however, approach problems in a different way because their age classifies them as more novice problem solvers and, therefore, less likely to recognize meaningful patterns of information that could help them (Bransford, 2000). The children needed to go through the entire problem-solving process in order to complete the task. The adults, on the other hand, began at a higher level, by passing the balls around the circle to the person next to them on the first attempt. From there, however, the actions of the adults and the children were nearly identical in nature and sequence.

Students were not provided explicit instruction on how to complete the activity. Instead they had to construct their own meaning from the situation and develop an effective strategy for meeting the goal. The activity would not have been possible if I had given the students the exact instructions for performing the task. They would have simply stood in a circle and held their hand out while someone ran around them with the balls. By being placed into a situation where a clear goal was set but no other direction provided, students were able to learn from the other students and their own errors in incremental steps leading toward an effective solution to the problem. They were actively engaged with the challenge and worked happily and excitedly to come up with a solution. Far from finding the lesson boring or dry, students completed the lesson feeling successful and smart, knowing that they had worked together as a team to construct knowledge. This systems thinking activity helped students to form a bond and to truly see that the class exists as a system in which working together is crucial for success.

By using the learning theory of constructivism, teachers can help students develop their novice skills and processes into the level used by experts, thereby helping them achieve that status. Students need practice in constructing their own knowledge and making sense of the systems around them if they are to be successful when solving problems in their academic coursework or situations in life.

REFERENCES:

Booth Sweeney, Linda and Meadows, Dennis. (2008). Warped Juggle. Systems Thinking Playbook (pp 38-42). Sustainability Institute.

Bransford, John D., Brown, Ann L., Cocking, Rodney, R. (2000). How Experts Differ From Novices, How Children Learn. How People Learn, (pp. 49 and 112). National Academy Press, Washington, DC.

Posner, George J., Strike, Kenneth A., Hewson, Peter W., Gertzog, William, A. (1982). Accomodation of a Scientific Conception: Toward a Theory of Conceptual Change. Science Education, (pp. 212-227).

Dan Goldner

I wish I could write to you with a dramatic story of how System Dynamics is flourishing at my school. The truth is I gave little attention to it this year. I would like to explain a little about why, and then to outline my thoughts for next year.

This year I am in my first year teaching high school mathematics in Dorchester. I planned to teach Algebra 2 and AP Calculus this year; when I arrived in the fall I learned I would also be teaching Geometry. Thus, each night I was responsible for preparing three different lessons, all for the first time.

Last summer, after the CLE conference, I was fortunate to discover a curriculum resource that provided time-tested

day-by-day curricula for all three courses based on a learner-centered model, and these materials became my lifeline. I had just enough time each night to review the lesson for the next day, decide how to introduce and frame it for the students, and do my grading. I found I was hesitant to drop a chapter of my curriculum to make time for an isolated project (of any kind, including SD) because I was not yet familiar with what progress students would make through the required curriculum, nor what kinds of dependencies would show up among chapters. The bottom line is I had little of my own time to devise an SD offering and felt I could risk little course time to try it.

However, I did learn enough to begin to see how and where SD could fit in next year. My AP Calculus students finished the year still not having a good intuitive grasp of the relationship between derivatives and integrals, and I am thinking about starting the year introducing stocks and flows and doing some simple SD modeling to make those concepts into the central vocabulary for the course. In Algebra 2, I now understand the curriculum enough to see how and where I might use some of Diana Fisher's material to add to what I'm already doing.

Neither of these ideas get at the central aims of SD education which, to me, are (1) helping students perceive and think about feedback and (2) use iterative modeling as a way to develop understanding of, well, anything. Instead, both these ideas are in the category of using SD tools and vocabulary to do an incrementally better job of what I am already doing.

Another possibility I've considered is inspired by Diana's work and by the student-run work being done in Toronto. I am considering devoting a significant amount of time in the Algebra 2 course to helping students develop models of anything they are interested in, perhaps emphasizing the possibility of students using modeling to understand materials from other classes (for my students, primarily chemistry, literature, or history). I'm frankly not sure I can pull this off—I have enough freedom at school to try it, but it could turn out to be a very ambitious instructional task. I do not see doing this with AP Calculus until the last four weeks of school, as the College Board syllabus is demanding and leaves little time for applications and explorations of the basic material. Even in Algebra 2, where I have more flexibility, it will be a challenge. Diana has certain exercises she does in Algebra, but her modeling courses are separate electives.

I should know more by the end of summer what I plan to attempt next year, and then, of course, the actual school year will reveal what I actually am able to implement. I have four main considerations for next year:

1. I want a learner-centered classroom with high student interest and engagement.

2. I believe iterated modeling is how humans understand the world.

3. I believe recognizing and considering feedback is extremely important.

4. I have a responsibility to help students understand some mandated content.

The first three are consistent with a focus on SD, and the fourth can be if I can develop the pedagogy to help students connect the required mathematical skills and concepts to the modeling work. This is certainly possible but not easy to get right. Also this summer, I am exploring learner-centered approaches that come out of the traditions of pure mathematics rather than modeling, and which, when done well, have achieved levels of student engagement and personal and academic growth similar to those described in the SD success stories. I will sort all this out and determine what the best tack to take will be for my second year of teaching.

I am really grateful to the SDS and the CLE for your support and encouragement. Integrating all this is harder than I thought it would be, but I'm just getting started.