Murdoch Middle School, Part II

A year after the teachers at the Chelmsford Public Charter School (CPCS—now called Murdoch Middle School) first met Steve Petersen in the hectic days leading up to the school’s opening, five of them once again sat before him in a Stella training class. They had signed up for a five-day version of the basic training of which they had seen parts the year before. This time, CPCS was paying for their training—Petersen had come to them, at the school, for free, the last time—in a lecture hall at the University of New Hampshire with a mix of teachers, professors, and managers from various industries among the students.

Again, Petersen poured water from cup to cup. Again, the students built tiny models and unleashed the dynamite on their mistakes. Again, there were varying levels of comprehension and frustration. But this time, there was no book ordering—the school and its office manager, who now handled such things, were miles away. No seventh-graders came through the lecture hall to meet the teachers. The teachers took notes, sketched stock-and-flow diagrams, and generally began to put together what they had learned, in bits and pieces, over the last year.

Ruthann Graham (Ruthann Corbett at the time), a seventh- and eighth-grade math teacher, worked with a math teacher from a different school to build some models students could use in class. A pair of humanities teachers worked with a UNH philosophy professor to build a model showing the dynamics of the social movements behind Martin Luther King, Jr. and Malcolm X. The group wrapped up the week agreeing that they had made progress, that it was professional development money well spent, and that their new understandings would certainly improve their classes. But none of the models developed by the teachers at UNH ever saw use in a classroom at the Charter School.

And Sue Jamback, who served as the school’s principal from its founding in 1996 until the end of the 2000-2001 school year, now thinks that perhaps that was as it should have been. “If I could do it over again,” she says, “I would hand teachers a guide accompanied by materials and lesson plans.” Though this statement might come as a surprise to those who witnessed the CPCS curriculum in action—the school used no pre-packaged materials, aside from a few math textbooks—Jamback says that she has seen a standardized curriculum work very well in the school she currently leads. “I have observed,” she says, “that good teachers become great ones and mediocre ones become good ones.”

Leah Zuckerman, one of the teachers who participated in the training, recalled, “I had a sense that I knew what the [stock and flow] diagrams represented and that I could understand the ideas behind the connections, but putting in the math myself seemed mystifying.” Others echoed her sentiments—though they understood the algebraic functions when Petersen explained them, the group was not yet able to determine what formulas and figures belonged where in the design of the model.
This gap was made quite apparent by an early unit during the 1997-1998 school year. Though students worked primarily on interdisciplinary projects at CPCS, they also participated in what the school called “skill classes” for a few hours each day. These classes were designed more traditionally than the project classes. Students might learn math computation techniques or grammar rules in their skill classes, then apply those skills in an upcoming project. After the training in New Hampshire, the seventh and eighth grade team decided it would be useful to have one of the first skill classes (During that school year, each project or skill class lasted four weeks.) focus on basic model-building.

Out came the cups of water. Out came the sand tray and the tennis balls and marbles and paper towel rolls. The teacher and students drew endless boxes and pipes and arrows and circles on the white board. Days rolled by, and many students seemed to be making sense of the new language and icons. It came time for a final assessment, and the students were assigned to create small models of their own. The school owned roughly twenty-five computers scattered about the eight classrooms, and the students spent a few minutes sketching stocks and flows and then scattered themselves to get to work. It took roughly ten minutes before the first student ventured into a situation that required math beyond that which was required to simulate deer being born and dying or bathtubs filling and draining and began, as everyone involved would have hoped, to ask for help.

Had the assignment been a piece of writing, of course, or a scale model of an historical site, there would have been several teachers available to push even the most advanced student to the next level of success. In the medium of modeling icons, however, there was no help available for students who were venturing beyond what their teachers knew. The sort of statement about learning implicit in such a situation—“Please just stick to what I already know, or we’ll both get frustrated.”—could not have been further from what the faculty at CPCS was hoping to say to their students. While some students enjoyed the freedom provided by such a situation, many others started to lose interest—after all, who wants to work hard on something new, only to find out no one can tell you if you’ve done any of it well?

Other kids, like some of their teachers before them, found the whole exercise utterly confusing and clicked along with little success. Still others constructed wildly complex tangles that produced colorful graphs. Those models looked as much like correctly done assignments as any others. There were, of course, no teachers available who could provide any sort of response beyond something along the lines of, “Well, I don’t quite think that graph makes sense.” In other words, if all learning depends on feedback, there was not going to be much learning here.

Or was there? While the teachers were convinced that few, if any, students had picked up even the little that made it into their curriculum about building models, they also saw that some students definitely understood something about what they were studying. Ruthann Graham says that she thinks all students left “with an understanding of
the big picture.” Sue Jamback is more specific, saying, “We were very successful at teaching the Five Disciplines.”

Perhaps, then, as the staff became more and more literate in the language of feedback, causality, and stocks and flows, that language began to appear in more classroom conversations. In the months that followed the UNH training, the staff had begun to make greater use of causal loop diagrams and the language of the Five Disciplines in their weekly meetings. Few of their drawings would have translated easily into working simulations, but they served to help the staff better explain the thinking behind various ideas. For example, that school year the teachers spent a great deal of time monitoring a portfolio system that was the primary determinant of whether students were promoted from one grade to the next. Drawing ideas with stocks and flows helped the staff ask questions like, “Are you saying that simply spending more time on work helps students learn more, or is there something else we need to have them do?”

These questions led to systems with better, or at least more deliberate, designs. Ruthann Graham remembers using similar language with her students: “I think the most effective teaching tool [that used systems thinking and system dynamics] may have been a processing form that steered students back to the causes and effects and consequences of their behaviors.”

Sue Jamback, though, isn’t convinced that the staff didn’t bring on those same behaviors themselves. “We taught many raging adolescents to question authority,” she says, referring to an early attempt to teach students the definitions of each of the Five Disciplines. The students seemed to know they were important, but the phrases were truly just vocabulary words until the teachers reduced the terms to a few simple examples and, within days, all 154 students had an idea of what “mental models” were. The working definition among students, remembers Leah Zuckerman, became something like, “Any idea you used to have that you just realized you would be better off without.”

Suddenly, annoying customs ranging from showing up on time to not being allowed to play football at lunch just because you were a girl were exposed as the social constructs they were. “Teaching them about mental models before we were completely ready to do it,” says Sue Jamback, “was like giving them a match and dynamite. I think they were distracted by it all.”

After a few months during which nearly all of the systems thinking and system dynamics exposure came through such discussions—why it’s important to clean up graffiti, why hitting people doesn’t tend to stop them from teasing you, why the fact that homework is part of the prevailing mental model about school doesn’t mean that we ought simply to abolish it—the seventh and eighth grade team attempted to integrate dynamic modeling into the curriculum yet again. “We had to,” says Graham. “It was in the charter and...we owed it to the creators of the school and the students who were attending.”
Enter Gary Hirsch. Hirsch had first visited CPCS one year earlier. He was one of a few system dynamics professionals who had volunteered time to help the new charter school get its ST/SD curriculum up and running. The first steps, however, had been halting, as teachers figured out how to best integrate the contributions of experts with the daily realities of middle school: varied levels of comprehension and self-control, limited technological resources, and so forth. Like Steve Petersen before him, Hirsch says, “It was a bit chaotic.” The plan this time, however, was different. Rather than simply having Hirsch plan a lesson and teach it to the students, he would spend several weeks planning with two teachers before he would ever appear in class.

With this new approach, the three seemed to be moving along a promising path. Having guest lecturers had proven ineffective and everyone—the principal, the teachers, the trainers, the system dynamicists—had agreed that the best lever for improving system dynamics instruction for students was increased system dynamics instruction for the teachers, coming in the form of exactly this sort of collaboration. The intention was for the team to create a simulation for student use and fully integrate it into a curriculum unit.

And so, one winter afternoon before the upcoming Journalism Project, a pair of teachers—Leah Zuckerman and Dan Barcan—sat talking with Hirsch. He stood at a whiteboard smudged gray with the group’s revisions and translated everyone’s thinking—in this case, about the dynamics of running a small newspaper—into a rough causal loop diagram. Though the initial ideas came from the teachers, and though the topic came from one that the school would have covered with or without system dynamics, the work of turning ideas into loops and, eventually, models, was led by Hirsch. Those materials, in turn, would become part of lessons planned by the teachers, in which Hirsch would participate right through the assessment phase. All involved could lead in their own areas of expertise, help students in class, observe their progress, and help decide what to teach next.

A few weeks later, after another meeting and some e-mail contact, Hirsch returned with a working model of a small newspaper business. Players using the flight simulator could adjust staffing levels to hire more writers, editors, and ad salespeople. They could also set the price of a copy of the paper. In the first meeting at which they had the finished model, the three simply played with it. The teachers saw firsthand how dynamic models provide little in the way of insight if the user doesn’t predict the results first and then reflect upon what has actually happened after the simulation is run. They watched what happened when they entered extreme values—for example, having a staff of one hundred percent ad salespeople. They poked around in the stock and flow assembly itself to try to follow the causal and feedback links.

They also realized that, while Hirsch hadn’t taught middle school students, he did have plenty of experience debriefing simulations with all sorts of other groups. And in direct contrast to Hirsch’s experience the year before, the teachers were able to provide some guidance on what exactly he ought to do in the class while the students were using the model. Together, the three created some questions that would help students reflect on
the simulation, and they talked about what sorts of insights students ought to be able to gain from different scenarios.¹

After the students had written articles and created their own newspapers (the first three weeks of the unit), the teachers presented the model as the final part of the Journalism Project. The team adjusted its schedule so groups of twenty-three students could have two uninterrupted hours to play with the flight simulator. The eight temperamental computers on which the model was running all decided, for whatever reason, to work at the same time. Students looked at an overhead projection of the control panel for the simulator, made some predictions about what would increase their newspaper’s bank balance, and hit the computers to test their assumptions. For the first time, students at the Chelmsford Public Charter School were learning their “content” — the stuff that normally comes from textbooks—as the founders had intended: with a working dynamic model.

Hirsch and the teachers worked the room, asking questions as groups ran their simulations. If groups were simply changing variables and clicking “run” as fast as they could, they asked them to talk about the reasons why they were making particular choices. If a group seemed to be able to turn a huge profit, they steered them to the diagram of the stocks and flows itself and asked questions about what dynamics the students thought had led to their great wealth. (On one occasion, the answer to this one was, “Well, I saw a stock that was called ‘bank balance,’ so I clicked on it and just typed in a bigger number.” Beware the simulation that looks as if it has a “scoreboard.”)

After the students had “run the newspaper” for about an hour, the teachers began a group conversation about the dynamics of the model itself. Since they had drawn countless loops in the planning process, they were able to create simple causal loop diagrams as students explained their theories about what had gone on. Normally, teachers at CPCS would have students write for five or ten minutes to prepare to talk about the answer to a particular question. Here, they had the students sketch behavior-over-time graphs as they talked. The students quickly began to show their literacy in the language of modeling tools.

It was clear that all involved had seen a great deal of progress beyond what their efforts had produced the year before. Hirsch no longer felt like he had been hired as a substitute and “dropped in” to a classroom. He sensed that the kids were “learning the key lessons while having a good time. Exactly what education should be.” And the teachers no longer felt as if they had been left in charge of some strange animal—Hirsch had vetted the model (indeed, he had built it) just as they had the actual lesson plan, though all three had seen both the model and the lessons develop from ideas to finished products. And his presence plugged the gap that had appeared earlier in the year, since there was a very slim chance of students encountering a situation he wasn’t able to understand.

¹ See related article, model and curriculum unit, by Debra Lyneis et al., on the CLE website, catalogued as CC2000-10Newspaper
While it is easy to say that teachers, especially those centering their classes on a dynamic model, ought to get out of the business of worrying about whether they can answer all questions that come up and focus instead on simply asking more questions, in practice asking good questions probably requires a deeper understanding of the subject matter at hand than just providing answers. And while it wasn’t Hirsch’s purpose, *per se*, to be the “advanced teacher,” the three adults in the room did wind up spending lots of time with specific groups of students. Hirsch wound up with a group that quickly understood the basic dynamics of the model, and he was able to push them much further than the teachers would have been able to on their own.

Soon after the kids had gone home for the day, one of the teachers went to a computer to investigate a question a student had asked about the inner workings of the newspaper model. The computer responded that the file had a deadly virus and wouldn’t be bothered just then. But it had hung on long enough for the school to see significant progress in its ST/SD teaching. Teachers had collaborated with an experienced model-builder to create a piece of curriculum that did not exist before. What materials are out there for teachers to help seventh- and eighth-graders understand the dynamics of the newspaper business? It seems safe, despite the size of the textbook industry, to say that there are none. They had also been equipped with a deep enough understanding of the dynamics involved in the lesson to answer new questions as they arose. The teachers had, at the very least, become literate enough to teach this small part of a project using system dynamics tools.

This literacy, taken for granted in math and English and science and music classes, enabled them to explain things to students in a variety of ways, to assess student comprehension, to provide targeted feedback, and to offer modifications—such as a less complicated graph for a struggling student or a more nuanced question about feedback loops for a more advanced one. By working with someone who understood system dynamics in the same way the teachers themselves understood algebra or portfolios or other common middle school topics, they became much better equipped to not simply “have system dynamics” in the classroom, but to *teach* it as a real part of the curriculum.

The lesson from all this seems to be so simple that it wouldn’t be worth writing if the stakes weren’t so high. “If Jay [Forrester’s] dreams are to be lived in more than just isolated pockets, there has to be considerable effort spent to standardize a program that can be mass produced and replicated,” says Sue Jamback. (In fact, meetings have begun to do just that over a course of many years.) When the teachers at CPCS tried to teach subjects before they were ready—indeed, before they even really understood what “ready” meant in the context of teaching ST/SD, the results were disappointing. But when they took months to plan two days of instruction, with an expert working alongside to help create materials and provide help understanding the dynamics illustrated in those materials, the results were quite encouraging. The question was whether they would be able to repeat that experience and create more than just a newspaper unit quickly enough to teach their students more about systems, maintain enrollment, and have their charter renewed.

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