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THE IN AND OUT GAME

A Preliminary System Dynamics Modeling Lesson

Prepared with the support of The Gordon Stanley Brown Fund by Alan Ticotsky and Rob Quaden with Debra Lyneis

INTRODUCTION

The In and Out Game is a preliminary system dynamics modeling lesson for kindergarten and primary grade students which is also adapted for use with upper elementary and middle school students. Young students learn about stocks and flows by physically moving into and out of the group of players in the game. They count and graph the stock of players over several rounds and discuss how the resulting graph describes the behavior they have observed. Older students play an abbreviated version of the game. They are then introduced to the mechanics of STELLA system dynamics modeling software and build their own simple computer models of the game.

BACKGROUND: BUILDING A SYSTEM DYNAMICS CURRICULUM

Alan Ticotsky and Rob Quaden are systems mentors at the Carlisle Public School. Supported by the Waters Grant Foundation, their job is to help classroom teachers integrate system dynamics and systems thinking into their current curriculum using causal loops, stock/flow diagrams, and computer models. They have also begun working on a matrix of skills and lessons to teach students how to build and use their own models.

At this point, as the curriculum evolves, it appears that third graders are able to use and interpret simple models as a class. Fourth and fifth graders can build simple linear models and be introduced to the concept of feedback. Middle school students are ready to use and interpret more complex models. Middle schoolers can also build simple feedback models on their own.

The lessons include *The Mammoth Game*, by Stammell, Ticotsky, Quaden and Lyneis, for third graders; *Let It Roll!* by Quaden, Trierweiler, and Lyneis, and *Grow, Grow, Grow?* by Lombardo and Lyneis, for middle school science; and *Introduction to Linear Models: Using STELLA to Solve Word Problems* by Quaden, Ticotsky and Lyneis, for students in grades 5-8.

The In and Out Game comes at the very beginning of the sequence. For kindergarten and primary students, the game provides a concrete way to learn about stocks and flows. It also introduces them to graphing behavior over time. The game is used in an abbreviated form for older students who do not need to actually act out the game but who still need some link to the concrete process. Once students have played the game at any level, referring back to it quickly refreshes their understanding of stocks and flows in subsequent lessons.

OBJECTIVES FOR STUDENTS

- By physically moving into and out of a stock of players at set intervals, students will learn that a stock is an accumulation governed by flows in and out over time.
- Students will graph the behavior of the stock over time on a line graph.

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POLITICS AND THE "LAZY TEACHER"

Third in a series of "What It's Like to Be a Pioneer"

Prepared with the support of the Gordon Stanley Brown Fund by Debra Lyneis

Jay Forrester has suggested that we could speed the spread of learner-centered-learning and system dynamics in K-12 education by sharing tales of "what it's like to be a pioneer." It might help others who are starting out, or just curious, to know about other teachers' experiences, positive student outcomes, pitfalls, political issues, responses of administrators and fellow teachers, student and parent feedback, triumphs and tribulations. This paper presents just one little vignette. If you have other tales to share, please let Deb Lyneis know LyneisD@cle.tiac.net.

School board members get all kinds of calls. I remember one call that I received when I was serving on the board in Carlisle, Massachusetts. A parent phoned me to complain about our eighth grade science teacher, Jim Trierweiler. As she explained, her child

***Lazy Teacher** continued on page 8*

UPDATES…

International System Dynamics Conference

The International System Dynamics Conference was held this year in Bergen, Norway, August 6-10. All the initial keynotes—by Jorgen Randers (*Elements of the System Dynamics Method*), Peter Senge (*The Fifth Discipline, The Fifth Discipline Fieldbook, Schools That Learn*), and Barry Richmond (High Performance Systems, author of STELLA®)—were fascinating, each in a different way. The only problem was how little time they each were able to speak.

There was a sizeable group of K-12 educators at the conference, many of whom were presenters. System dynamics in K-12 education sessions included plenary presentations by Diana Fisher ("System Dynamics Models Created by High School Students"), from Wilson High School in Portland, OR, and Jeff Potash and John Heinbokel ("System Dynamics as a Foundation for a Course on Sustainable Development"), from the Waters Center, Trinity College, Burlington, VT.

Barry Richmond chaired an interactive panel discussion on "Toward Building a Shared Understanding of Understanding" with Mary Scheetz (Waters Grant Project, Portland), Frank Draper (Waters Grant Project, Tucson), and Tim Joy (LaSalle High School, Portland, CC-SUSTAIN, and Waters Grant mentor).

Nan Lux convened and moderated two of the parallel sessions, which included John, Jeff, and Diana again, as well as Frank Draper, Tim Joy, Will Costello, David Wheat, Paul Newton, Lees Stuntz, and Gordon Kubanek.

For a complete listing of the papers and their abstracts, look on the International System Dynamics Society Web site: http://www.albany.edu/cpr/sds/ .

Next year the ISDC will be held at Emory University in Atlanta, GA. It is a wonderul opportunity for K-12 to gain visibility. Anyone who is interested in participating should contact Nan Lux nlux@mit.edu. Papers are due to the program chairman (Jim Hines) by January 31st and abstracts for poster sessions are due at the same time. Hopefully, we will have a good turnout, and even have some students who would be willing to participate. All the academics, business people, and consultants need to know how well our kids can think!

If you are interested in receiving a brochure with a call for papers, e-mail Roberta Spencer, the Executive Director, at system.dynamics@albany.edu.

EDITORIAL

As the school year gets into full swing, there are a few tasks I hope that you practitioners in K-12 education will take on to help us all. First of all, to help keep communication open, would you take a moment to send in a paragraph or two about what is happening in your classroom, school, or district? It is inspiring for others to know what is going on across the country and even across the oceans. Please let me know via e-mail or phone!

Secondly, this coming summer at the International System Dynamics Conference in Atlanta we have the opportunity to inform interested people in the field of system dynamics about the K-12 effort. In the past there have been teachers (and some students) at both the annual Systems Thinking in Action Conference, sponsored by Pegasus Communications, and at the International System Dynamics Conference. In 2001, the ISDC is back in the US and accessible to us. I encourage anyone who is interested to contact Nan Lux nlux@mit.edu.

Thank you!

Lees Stuntz stuntzln@clexchange.org

RESOURCES…

Schools That Learn

Peter Senge has joined with five other authors (Nelda Cambron-McCabe, Tim Lucas, Bryan Smith, Janis Dutton and Art Kleiner) to create a new book, *Schools That Learn*, a Fifth Discipline Fieldbook for Educators, Parents and Everyone Who Cares about Education. Similarly to the previous Fieldbook, *Schools That Learn* starts with an introduction including a primer for the five disciplines. It is then divided into three major portions, the Classroom, the School and the Community.

One of the strengths of the book, like its predecessor, is the number of voices present. There are a myriad of approaches, different thinking styles and thoughtful insights from experienced educators and people who have spent

Resources *continued on page 12*

THE IN AND OUT GAME continued from page 1

- Students will observe how the graph changes if the flows are changed. They will make predictions and test them. They will learn that a steeper line means faster growth.
- Students will be introduced to a system dynamics stock and flow diagram of the game.
- Students will recognize that the concrete game, the graph, and the stock and flow diagram are all different ways to describe the same behavior.
- Older students will be introduced to STELLA modeling on the computer.

PREPARING FOR THE GAME

Time Requirements

- Allow about 45 minutes for kindergarten/primary students to physically play the game and graph it as a class.
- By fifth grade, allow 30 minutes for an abbreviated version of the game and an introduction to the mechanics of STELLA as a class; allow an additional 30 minutes with students at the computer building models.
- Allow one class period for middle school students for explanations and modeling.

Materials

- For young students, you will need a large easel pad and markers or blackboard and chalk.
- For older elementary and middle school students, you will need an easel pad or blackboard plus computers loaded with the STELLA software.
  - STELLA is available from High Performance Systems, Inc., 45 Lyme Rd., Suite 300, Hanover, NH 03766. Tel. 603-643-9502. http://www.hps-inc.com
  - The model accompanying this paper is in STELLA 5.0, but it can be built on any earlier version as well.
  - One computer for every two students is ideal, but use what you have.
  - It helps to have a projection device or large monitor for class demonstrations.

Additional Hands

- When the upper elementary and middle school students are working at the computers building models, it is very helpful to have additional adult support for the students. Recruit a "STELLA literate" teacher, parent, or more experienced student to help students fix glitches in their models. Since students will progress at varying speeds, some will need basic help while others will need to be challenged further. It is difficult for one teacher to keep up with all the students in a large class in this beginning modeling lesson.

PLAYING THE IN AND OUT GAME

Playing the Game: Kindergarten and Primary Grades

1. Explain to the students that they will be playing a game and keeping track of the number of players in the game. They will be making the rules of the game, counting the players, and recording their data on a table and on a graph. Designate a place in the room for the players to stand and delineate it with rope or masking tape on the floor. Also delineate the flow "pipes" into and out of the stock of players.

2. Set the rules for the first game as "2 In and 1 Out." This means that for every round of the game two students will go into the group of players and one student will go out. The designated place on the floor is empty to start.

3. Play several rounds of the game with the teacher selecting volunteers. Ask all of the students to count how many players are in the box *at the end of each round* and record that data on a table on the blackboard or easel pad. Record the initial number of players (0) on the first line. See Figure 1.

4. Analyze the data a bit by asking students to look for patterns. Discuss how the number of children going in or out each round remains constant while the total number of players increases. Why is this? Solicit predictions for the next rounds.

5. Next, graph the total number of players over time. On a large graph, explain that the vertical axis tells how many players are in the game and goes from 0 to the number of students in the class. Time, in this case the number of rounds, is on the horizontal axis.

   - Explain to students that this will be a *line graph* which will show us patterns of behavior over time. Since most young students are familiar with only bar graphs, line graphs may need their own introduction either as part of this lesson or beforehand. Use Unifix cubes and large grid graph paper to explain the line graph in a concrete way. As you count the total number of players each round, stack that number of cubes and hold it against the graph just as students would build a bar graph. This time, however, instead of coloring in the column on the graph, just put a dot on the graph representing the *top* of the stack of

In & Out Game *continued on page 4*

Round	Players Going In	Players Going Out	Total Players
(Start)			0
1	2	1	1
2	2	1	2
3	2	1	3
4	2	1	4
5			

Figure 1

THE IN AND OUT GAME continued from page 3

cubes, "to save time." Do this for a few rounds until students are able to understand the dots and connect the line without the cumbersome blocks. In system dynamics, it is very important that students use line graphs because they show patterns of behavior over time.

- The vertical scale on the classroom graph goes from 0 to the number of students in the class just to give that scale a concrete meaning for students in this introduction. Later, this scale will change.

6. Draw the line graph. Start with 0 students at time 0, and graph the number of players as a class, one round at a time, continuing on as the students play out a few more rounds. Play long enough for students to see a pattern. See Figure 2.

7. Discuss the graph with the students. What does it say? What predictions can they make?

8. Let the children change the rules (3 In and 2 Out, for example) and play the game again. Depending on the class, you may be able to omit the table or just briefly set it up and focus on drawing the graph. Graph the behavior on the same graph as the first game to compare them. What is different, and why? Let students observe that a steeper line means that the number of players is growing at a faster rate; a flatter line shows slower growth.

9. Introduce the students to a stock and flow diagram on the blackboard as another way to describe how the number of players in the game is changing. The "Number of Players in the Game" is the "Stock." The stock can increase by the flow of "Players Going In Each Round;" it decreases by the flow of "Players Going Out Each Round." Let the students help in defining these terms. The clouds mean that we have as many players as we need to use and that once they are out of the game we don't have to think about them. Use the bathtub analogy as another example of a stock and flows. The level of water in the tub depends on the amount of water flowing in the faucet and out the drain over time. See Figure 3.

Playing the Game: Fourth and Fifth Grade

Upper elementary grade students do not need to physically move into and out of the group of players to grasp the concept of stocks and flows, but describing the concrete game to them and playing an abbreviated version of it does help them with this abstract idea.

1. Explain to students that the In and Out Game is used to introduce system dynamics to "little kids." Since they did not play it when they were younger, and since they are so much smarter now, you will only have to tell them about the game for them to get the idea. They will play a quick version which takes about 15 minutes. After they play the game, they will build computer models of it. (For students who have played the full game in earlier years, this quick review is also very helpful.)

2. On the board, set up the table as described for younger students, and explain the rules of the game: "2 In and 1 Out, each round." To give them a concrete grounding, tell the older students how the "little kids" would actually move to a circle on the floor

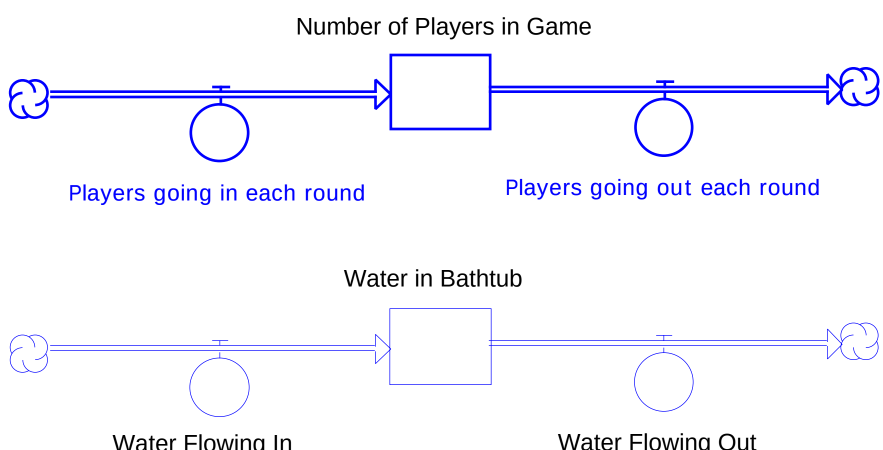

Figure 3

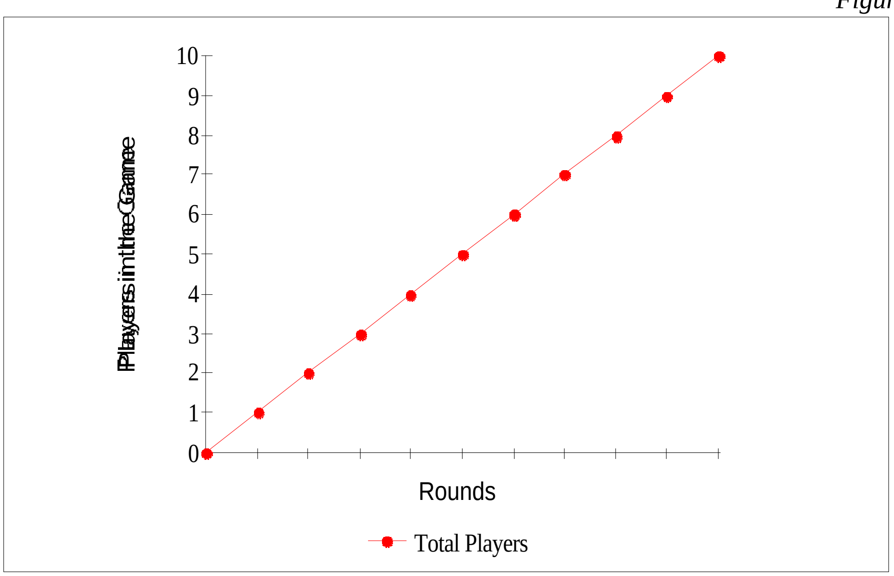

Figure 2

and count the players in and out. To save time, they will just stand up at their places and sit down to represent players going in and out. Designating students to stand (in) and sit (out), play a few rounds and record the data on the table. Students will not need to physically stand, sit and be counted for more than a few rounds before they are ready to continue on a more abstract level.

3. Analyze the data briefly, looking for patterns. For students, this will be similar to function games or "What's My Rule?" in math. Let them discover that the flows in and out are constant, while the total number of players keeps growing because more go in than out each round. Ask them to predict what the total might be for 20 or 30 rounds and explain why.

4. As a class, graph the data for the total number of players on a behavior over time graph, as described for younger students. The vertical scale represents the total number of players, while the horizontal scale represents time, in rounds. The graphing goes quickly with these students. Discuss the steepness of the line and make predictions for other in and out values. Some classes may want to graph the flows also and discuss why those produce horizontal lines.

5. Play the game with other rules and graph them on the same graph to compare the lines. If students need the concrete reminder, let them stand and sit for a couple of rounds. Otherwise, compute the increments on the table or solve them verbally as a class.

6. Introduce the stock and flow diagram as described for the younger students, or review its application to this activity for students who are already familiar with the concept. Again, point out that the table, the graph, and the stock and flow diagram are all different ways to describe the same behavior. Time is stated *explicitly* in the table and graph as "rounds"; it is *implicit* in the stock and flow diagram. Be sure to make this clear. The stock of players accumulates as players flow in and out over many time intervals, or rounds.

Playing the Game: Middle School

Since middle school students are becoming more abstract thinkers and their graphing skills are more advanced, the In and Out Game can be just a quick lesson at the blackboard for them. Although these students do not need to physically act out the game, a description of the concrete activity does help to anchor their understanding. Explain the game as "little kids' would play it. Then work on the table, the graph, and the stock and flow diagram on the board together as a class, as described above for upper elementary students. Older students are ready to try the game with a variety of different rules yielding different graphs. They are also ready to graph the stock and its flows on the same graph to begin to grasp that the flows determine the *slope* of the stock.

BUILDING THE MODEL

After graphing the In and Out Game, upper elementary grade students and middle schoolers are ready to be introduced to the mechanics of STELLA and to build their own models of the game.

What Is a Model?

Discuss with students the concept of a "model" as a smaller version or picture of something we want to study. In this case, they will use STELLA software to build a system dynamics computer model of the In and Out Game. The computer will play the game just as they did, but because the computer can make calculations more quickly, students will be able to try many different rules on the computer game in a shorter time. The In and Out Game is so simple that they really do not need a model to figure it out, but building a model of a simple system will make it easier for them to understand more difficult models later.

Building the Model

Using a large monitor or a computer projection device, demonstrate how to set up a STELLA model. Caution students to pay close attention to the instructions and take notes if necessary because they will be building their own models in a few minutes.

1. Open a new model. The model-building tool bar is all students will need at first. Demonstrate how to highlight, drag and plant a stock, reviewing that a stock counts up what accumulates. Label the stock "Total Players in Game." Similarly highlight, drag, and connect the flows into and out of the stock. The flows are "pipes" that fill up and drain the stock. Label the flows "Players Going In Each Round" and "Players Going Out Each Round." (See below for complete model.)

2. Once the model is drawn, click on the globe icon in the upper left corner of the screen to go to the math mode, x^2. The question marks mean that students need to enter their values for this game. Click on the stock and enter "0" for the Initial Value; this is the number of players at the beginning of this game. For the flows, review the rules, "2 In and 1 Out each round," and enter those values; the computer will add 2 players and subtract 1 player *every round*, just as students did when they played.

3. Next set up the graph. Drag a graph icon onto the screen and click to open it. Double click on the graph to open its dialog, highlight "Total Players in Game," and choose the arrow to select it. Click "OK."

4. From the menu bar, click on "Run" and "Time Specs." Tell students to change the DT to "1," "*just for this time* because it will make the numbers easier for this game." Setting DT tells the computer how frequently to do the calculations. Set at DT = 1, it will compute once every round, just as

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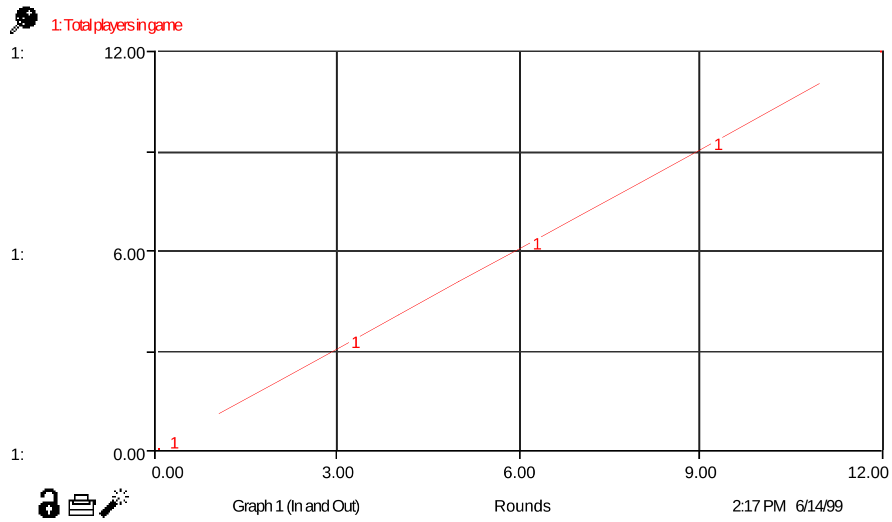
students counted players at the end of every round, and the computer will replicate the table just as the class computed it without decimal fractions of people. This is a fine point, and understanding DT is an important lesson in itself, reserved for another time. It is also not the purpose of a system dynamics model to simply replicate what we can do by hand. However, for this first introduction, an exact replication helps students bridge the gap from the concrete game to the abstract computer model. (Students are ready to use the default DT = .25 and deal with decimals after this introductory lesson.)



5.Next, run the model. Be sure that the graph is open. From the menu bar, select “Run” and “Run.” Watch the computer draw the line on the graph. Examine the scales and read the graph to see that it is the same as the graph the students drew as a class during the game.

6.Check the table too. Click and drag the table icon from the toolbar. Click to open it and double-click on the table itself to set it up. Highlight and select the stocks and the flows for display. Click “OK.” Run the model again to see the calculations. The computer table should look just like the class table, which always impresses students. (Once they are set up, both the graph and the table will run together in subsequent runs.)

7.That is all there is to it. Tell students that it is their turn to build their own models just like this one at their computers. Then, get out of their way!

Troubleshooting

Students are very facile with computers and take to this quickly and fearlessly (much more easily than adults!) Although students are quite good at remembering the instructions, they make a few common mistakes which you will see as you circulate among the teams at the computers.

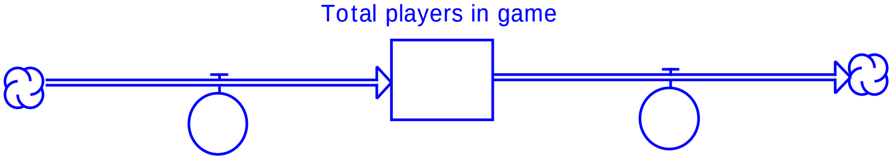
- Insist that students label all stocks and flows clearly. Some students are inclined to skip this step to “get to the action.” However, it is very important that they understand that a stock is an accumulation of something that is changed over time by flows of units of the same thing. In this case, the stock of *total players* is changed by numbers of *players flowing in or out per round*. It is also important to label a model so that students can clearly communicate their ideas to others.

- When building the flows, students need to drag the arrow *completely into the stock* so that it is connected. (If there is a cloud where the flow should join the stock, ask students to erase that flow using the red dynamite icon and draw it again.)

- Be sure that flows go in the right direction. The in-flow must start in a cloud and flow *into* the stock; the out-flow must start *in* the stock and flow *out* to a cloud. The model computes the flows in the direction in which the arrows are drawn.

- Remind students to *double click* on the graphs or tables to open their dialog boxes.

- Insist that students read the *graphs* and use the tables only to check for values at specific points to confirm their estimates. Some students will be inclined to look only at the table for output. You want them to focus on the *pattern of behavior* rather than just on



Equations:	Units:
Total_players_in_game(t) =Total_players_in_game(t - dt) +	
(Players_going_in_each_round - Players_going_out_each_round) * dt	Players
INIT Total_players_in_game = 0	Players
Players_going_in_each_round = 2	Players/round
Players_going_out_each_round = 1	Players/round

the details. When you check their work, accept *no* tables unless you see and discuss the graphs *first.* This is a very important system dynamics skill to develop.

More Challenges

Some students, especially in the older grades, will build their models quickly and be ready for more challenges. Try these:

- Can you get the line on the graph to be less steep? (Less slope, smaller net in-flow .)
- Can you make it steeper? (Greater slope, larger net in-flow.)
- Can you start the line at a different level. (More initial players.)
- Can you make the line slant the opposite way? (Out-flow >in-flow.)
- Can you make it horizontal? (Out-flow = in-flow.)
- Can you make it horizontal starting at a different level?
- What does it mean when the line crosses zero? (If they have studied negative numbers.)
- For any graph, can you predict and solve the value for 20, or 30 rounds? (Change the length of simulation.)
- What happens if the flow changes during the game? (Step functions.)

NOT QUITE SYSTEM DYNAMICS

The In and Out Game is a preliminary lesson for introducing students to system dynamics. It teaches them about graphing, stock and flow diagrams, and the basic mechanics of STELLA. Although it lays the groundwork, the In and Out Game is not quite system dynamics yet for two subtle but very important reasons.

Feedback

System dynamics explores the feedback nature of systems. Feedback occurs when an action causes a response which in turn influences the action again. The cause of the behavior lies within the system. In the In and Out Game, a constant number of players flow into and out of the stock of players every round, no matter what, and the change in the stock is linear. There is no feedback because the size of the stock does not influence the flows. The cause of the change comes from outside the system: We add and subtract a constant number of players each round.

The In and Out model could include feedback if, for example, the flows were a percentage or fraction of the stock. You might add 1/3 of the total number of players to the game each round. The number of total players would grow exponentially because you would be adding 1/3 of a larger and larger number of players each round. Compounding interest works this way. Students will learn to do this soon, but it is left out of the first introduction just to make it simpler.

Continuous vs. Discrete

System dynamics looks at patterns of change over time and the underlying feedback structures which cause those patterns. It is more focussed on the big picture than on counting every single event. In examining population growth, for example, a system dynamics model would look at varying birth rates and death rates and how interrelationships within the system cause the population to change over time. A system dynamics model would not count and plot every single birth and death, because it would be too cumbersome and it would yield a jagged graph where broad patterns would be obscured. (At some level, all events are discrete, but if you look at them that way, you get so bogged down in the details that you cannot see the big picture.)

The In and Out Game does count every single player because it is intended as a preliminary activity for children who are very concrete thinkers. It seems to help them understand the abstract concept of stocks and flows if they can physically act it out and count bodies. The simulation uses a solution interval (DT) of 1 so that the model's table replicates the students' own table. A smaller DT would give a more continuous output, but it would also yield "partial people" which is both confusing and disconcerting to young children at first.

Once they are grounded with the concrete understanding, children seem better able to see the more abstract continuous nature of a system dynamics model. In later lessons, they are willing to see that something could be flowing into the stock more quickly than they could count it and that a computer can easily make lots of quick calculations. Later, when building more complex models, they will learn to use smaller values for DT which more closely approximate continuous behavior. The In and Out Game is just a first step.

YOUR FEEDBACK

We welcome your feedback on the In and Out Game. Please send your comments, concerns, and suggestions for improvements to us through the Creative Learning Exchange. Thank you.

This article and its adjunctive model are available by mail from the Creative Learning Exchange or on-line from the website <http://sysdyn.mit.edu/cle/> catalogued as SE1999-09In&OutGame. Examples of the other lessons mentioned are also available:

CC1997-01LetItRollRampModel
CC1999-04Mammoth Extinction
MA1999-09LinearModelsIntro
SC1997-01GrowGrowYeastModel

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POLITICS AND THE "LAZY TEACHER" continued from page 1

was having difficulty with a lab assignment in Jim's class. Students had been working on the lab in teams. (Jim's entire introductory physical science course is structured around lab work in cooperative teams, which she did not like, but that is another story.) Stumped, her child's team asked Mr. Trierweiler why their experiment was not working as expected. "And do you know what Mr. Trierweiler told them?" the parent demanded indignantly. I held my breath, and she continued, "He said, 'Well, what do *you* think? How about trying this?'" As I breathed a quiet sigh of relief, she continued to insist that Mr. Trierweiler should have just *given* the students the answer. His failure to do so confirmed her opinion that Mr. Trierweiler was "just a lazy teacher who probably didn't even know the answers himself!"

Now, what do you do with a call like that? I knew from experience with my own children that this parent's description of the class was accurate. I also knew from observing Jim that it is entirely by his design. Jim is a master at learner-centered learning; he firmly believes that students learn best when they take charge of their own learning. Led by their own questions, students seek answers and grow in the process, building on their own natural curiosity and eagerness to learn. Jim loves to see students of all levels scratching their heads together in labs. Students long remember Mr. Trierweiler as a favorite teacher because he teaches them to *think* and work together. The administration not only supports Jim's approach, but also asks him to mentor new teachers, believing that learner-centered-learning brings fundamental improvement to education by providing students with skills they will need in a rapidly changing world.

Still, if one parent calls a school board member with a concern about this teaching approach, there are sure to be others out there who feel the same way. And, their concerns should not be lightly dismissed. These principles guide our response in Carlisle:

1. Recognize that these parents genuinely care about providing the best education for their children. They would agree with us that education must improve, but their solution would be to do *more* of what has been done in the past, with the teacher as the central dispenser of knowledge and facts, and the students as passive receptacles. It is natural for parents to find comfort in this approach because that is how education was structured for them. In their view, intensifying the same effort would lead to much-needed improvement in education.

Teachers must also relinquish their role as dispenser of all knowledge and become guides and learners, allowing students to raise questions which may not always be easy to answer. It would be much simpler for teachers to just stand there and spoon-feed "the facts," but the students' enthusiastic response and deeper learning are the rewards for the effort.

Many parents who were skeptical at first come to appreciate this different approach to teaching and learning when they witness their kids' progress. The students are definitely challenged. They learn a great deal on their own. They thrive.

> There are those that we can convert, and there are those that we will just have to outlive!
>
> *- Jay Forrester*

However, one basic lesson of system dynamics states, "If you do more of what you've always done, you'll get more of what you've always 'got'." If education must improve to meet the needs of a changing world, then it has to change fundamentally. This is a very difficult idea for some parents to accept for their kids.

2. Make sure that you set very high standards for children and for yourselves. Learner-centered-learning does *not* mean that students can do whatever they want or that teachers are not teaching. On the contrary, learner-centered-learning must set very high and clear expectations for children. It is actually much more work for teachers because they must structure the class for problem-solving, they must continuously monitor each student's progress, and they must be available to offer guiding questions to help students figure things out for themselves, keeping them challenged but not frustrated.

3. Keep the community informed and involved. A school belongs to its community, and open lines of communication between the two benefit everybody, especially when innovation is considered. In Carlisle, we explain our curriculum through newspaper articles, newsletters, parent meetings, and school board meetings. We also invite the community to our annual Carlisle Education Forum where townspeople, teachers, and parents get together on a Saturday morning to listen to a guest speaker and discuss their vision of education for the future. According to Jim Waters, education investor and long-time school board member in his hometown: "Don't get too far ahead of your taxpayers." Look to your community for feedback and support.

4. Remember the long run. Although many parents will be convinced by improved student performance, and many

***Lazy Teacher** continued on page 12*

Drama—Public Speaking: Factors of Success

Documentation written by and based on a lesson created by Pat Burrows and Anne LaVigne

Grade Level: 6th Grade

CFSD Curriculum: Drama - Speech Writing

Lesson Objectives: Students will understand how various factors relating to a performance affect one another.

Students will be able to give each other specific information about various patterns observed as they practice their speeches in order to improve their final performances.

Systems Concept(s): feedback relationships, patterns over time, interdependencies

Systems Tool(s) CLD, BOTG

Activities at a Glance:
Day 1: Students explore interdependencies between success, performance, and practice.
Day 2: Students learn how they will use BOTGs to give their peers feedback during practice.
Additional days: Students practice and use BOTGs to give their peers feedback.

Time Allotment: Two periods for lessons; additional periods as desired for students to conference/practice with peers.

Integration Area(s): This method could be used in any area that involved a presentation or performance.

Materials Needed For Lesson:
Materials: Handout for peer review (see attached), overhead transparency pens, blank overhead transparencies

Equipment: Overhead projector or chalkboard

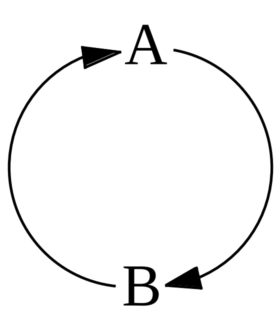
Preparation: Copy peer review handouts (at least two copies per student to start).

Background Information:
Students need to understand the following concepts prior to these lessons:

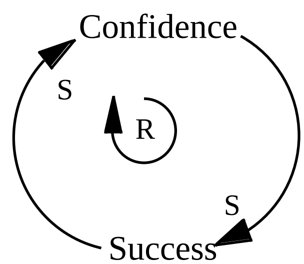
- aspects of a good speech, including interesting topics, details, examples
- clarity of voice, eye contact, rate of delivery, and volume
- internal interference, e.g., not listening, talking to neighbor, walking around, etc.
- aspects of positive feedback during a speech, including listening, being attentive, clapping at the end, etc.

Activities:
Day 1: Practice, Success and Confidence

- Ask a series of questions to help students brainstorm factors that affect their success when they give a speech.
  - When you stand up in front of the class to give a speech, what do you really want?" List ideas on the board, e.g., getting a good grade, experiencing success, having everyone listen and be attentive.
  - What do you think affects your grade or your success? List ideas on the board, e.g., interesting topic, details, enthusiasm, good examples, practice.
  - How do you feel when you've done really well?
- Explain the concept of systems feedback. Focus on the idea that if (A) something happens in a system, then it can affect something else in the system (B). Feedback occurs when (B) comes back around and affects (A). The relationship continues around in a circle.



- Explain that some of the factors on the board can affect each other in this way.
- Ask students a series of questions to look at how the factors are related (See attached CLDs for examples of some of the relationships that could be explored).
  - What is your grade based on? e.g., how well you do or success of the speech
  - What affects your success? How do you need to feel in order to be successful? e.g., confidence
  - Draw a loop showing how confidence and success affect one another.



  - What increases your confidence? Practice, positive feedback.
  - If you do not have a very successful speech, how will the audience react? e.g., not listening, talking. What is this called? Internal interference. (Note: Internal interference comes from within the system and can be changed by members of the system, in this case, the students and teacher. For example, a student tapping his pencil has the choice to stop this behavior. External interference may come from the outside and usually cannot be changed from within the system. For example, the phone ringing, someone banging on the door, or the principal making an announcement over the intercom.)
  - Draw internal interference into the loop and explain. How might that affect your confidence? decreases it?

Factors of Success *continued on next page*

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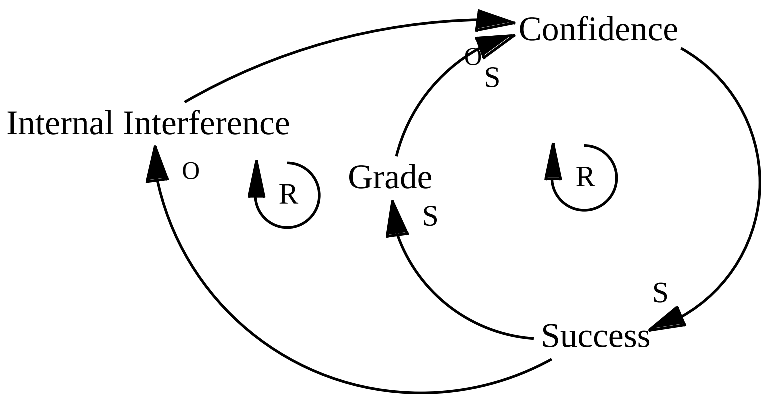
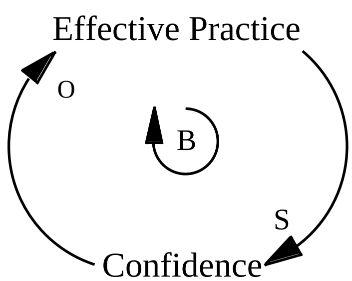
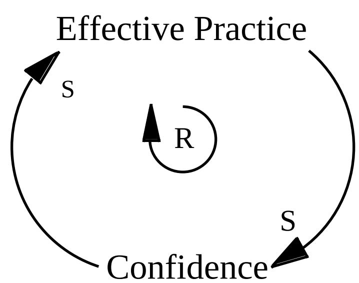
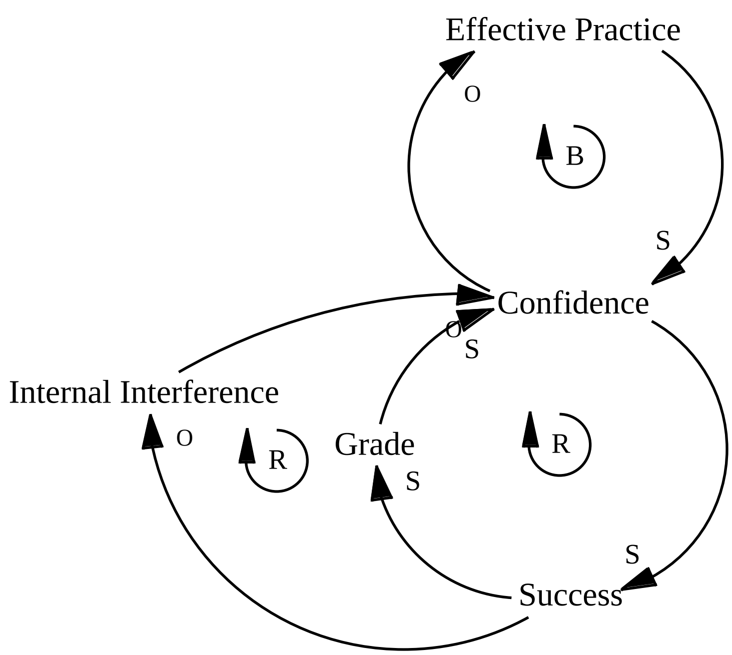


- Add in the loop how practice affects confidence. Note: This loop could be reinforcing or balancing depending on the students' mental models about how confidence affects practice.





- Add grade into the loop.



- Add any other ideas into the loop as desired.
- Explain that students will monitor how much practice they are doing over time and then, after their speech, be able to reflect on their success based on the amount of practice.
- Have students create BOTGs of the amount of practice they are doing per day from the time that they start writing their speech until it is performed. Y-axis could be labeled with minutes of practice and the X-axis could be labeled from the beginning of the writing process up until the speech.

Day 2: Peer Review

- Ask, what are some of the factors that are important to consider when giving a speech, regardless of what the topic is? e.g., eye contact, rate of delivery, volume, clarity of voice.
- Explain that if we can focus practice on these areas, then the practice time will be more effective. One way to do this is to get assistance from peers.
- Explain that they will start to use BOTGs in order to give their peers very specific information about how they are doing in these specific areas.
- Pass out the peer review handout and explain that students will meet with a partner (use the same partner over time for consistency in identifying improvement) who will listen to their speeches and give them information on one or two of the areas at a time.
- In terms of the graphs, talk about what each one of the areas means and what would be most desirable for each one in order to have a successful speech, e.g., making a lot of eye contact with various individuals throughout the room, varying the rate of delivery as appropriate to the topic so the speech is not monotonous, etc.
- Review steps for peer review.
  - Decide together on which factors (graphs) you will focus on during peer review.
  - Listen to your partner's speech.
  - Graph the areas you chose.

Materials Now Available from the CLE

The following documents are now available from us or the Web site www.clexchange.org

SYSTEMS EDUCATION

SE2000-06SustainablInterest **Building Sustainable Interest in Modeling in the Classroom: The Implications of the S-Curve for Hooking New Practitioners in Schools.** Gordon Kubanek

This paper presents experiences of the past two years experimenting in classrooms using the principles of systems thinking. Five strategies that have been practiced in three countries are presented in detail, with examples of experiences in Canada, Australia and Singapore. The author believes that system dynamics needs to focus on more than computer modeling. As a community, we need to push for changes in the overall teaching process and in the learning strategies that it, by its very nature, implies. [Systems Education, Cross Curricular, K-Adult] ($1.00)

SE2000-06SystemStories **System Stories for Children.** Linda Booth Sweeney

How many children's stories embody systems principles? Over the past several years, on a journey in an attempt answer to that question, the author found a growing number of stories that embody systems principles and archetypes. This excerpt is taken from a longer piece that includes an introduction to targeted systems concepts, an analysis of 15 stories and tips on how to use the collection. [Systems Education, Cross Curricular, Elementary School, Middle School] ($1.00)

SE2000-06BeforeAssessment **What Behaviors Are Desirable in Students Creating System Models? A Step before Assessment.** Diana Fisher and Tim Joy

This presentation attempts to take one step back from the assessment issue and determine what the authors feel are desirable traits in a student or student group who has chosen to study problems from a systems perspective. [Systems Education, Cross Curricular, High School] ($1.00)

VIDEOS

VIDEO00100 **Insightful Little Models.** Dr. George P. Richardson

(Cost: $15.00) From the 2000 ST&DM Conference in Stevenson, WA. Dr. Richardson emphasizes little models which contribute to our insights about the world around us. He classifies insights into three categories with their appropriate tools, utilizing several models: deficit and debt, oscillating spring, welfare archetype, and an urban model to illustrate insights which could be gained from them. Kinds of Systems Insights: • Dynamic insights—Tool: graphs over time. • Structural insights—Tool(s): stock-and-flow/causal-loop diagrams. • Systems insights: "Dynamic behavior is a consequence of system structure"—Tool: computer simulation.

VIDEO00200 **Insights from Forty Years in System Dynamics.** Dr. Jay W. Forrester

(Cost: $15.00) From the 2000 ST & DM Conference in Stevenson, WA. Dr. Forrester reminds us that the information around us in our mental database is many times what we have in our written database, and that our written database is many times larger than our numerical database. Models based on all three are the most powerful. He also reiterates the Characteristics of Complex Systems—Transfer of problems between sectors, Tradeoffs between present and future, Resistance to most policy changes, Very few high-leverage policies, Transfer burden to the intervener, Cause and effect not close in time or space—and challenges us to expand on this list. (Please note that the video has intermittent audio problems which cannot be remedied.)

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- Meet with your partner to discuss the graphs.
- Write the suggestions from the conference below the graph(s).

Additional Days: Practice

- Students use the peer review process described above to practice and improve their speeches.
- Students update their BOTGs to keep track of the amount of practice they are doing on a daily basis.

Debrief/Closure/Assessment:

- Students give final speeches and receive a grade based on the quality of the speech, and are assessed for participation and effort in the peer review process.
- Debrief the experience with a class discussion.
- How do you believe using this process of peer review affected the success of your speech?
- If the grade received was not desirable, what could you focus on next time in order to get closer to your goal?

Extension(s)

- Continue using similar methods of peer review throughout the year as the students prepare for upcoming performances.

The complete document, catalogued as EN2000-02PublicSpeaking, includes Peer Review worksheets for the students, and is available from the CLE or the Web site.

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Politics and the "Lazy Teacher"

continued from page 8

townspeople will offer support for change, others who are wary of educational innovation will continue to resist. They are entitled to their opinions; respectful disagreement is a healthy thing. However, our school will continue to encourage the spread of learner-centered-learning and system dynamics in our curriculum because we believe that in the long run it is the best way to prepare children for their future, not our past. Advice from Jay Forrester puts it into perspective: "There are those that we can convert, and there are those that we will just have to outlive!"

Resistance to educational innovation is inevitable; the deeper the change, the deeper the resistance. If you are introducing system dynamics and learner-centered-learning in your school, you will hear it. Recognize that resistance, though frustrating, lends stability to the system, insuring that lasting change is gradual. Maintain very high curriculum standards so that students will win converts slowly over time, and slowly build community support. Then, armed with a vision of better education for children, find the patience to "outlive."

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Resources

continued from page 2

much of their adult life focused on the education of our children. The book delves into a worthwhile discussion of three of the interrelated aspects of schooling in our time and place.

The articles have authors as divergent as Jay Forrester and Howard Gardner. *Schools That Learn* contains an impressive array of practical tips and thought provoking ideas, all in the easy to access "Fieldbook Format" pioneered in the previous Fieldbook. The book is available from Pegasus Communications, http://www.pegasuscom.com.

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