

Project I: Concept Learning Feedback Loops

Steve Wilhite
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Prof. Elizabeth Boling
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Design Report: Concept Learning

Individual or team name: Steve Wilhite

Introduction

The following is an instructional analysis document for a lesson on the concept of feedback loops. The lesson would be part of a unit on systems thinking intended for an entry-level economics class containing students with little or no previous exposure to systems thinking principles.

While the concept of feedback loops is far-reaching, with applications in numerous disciplines (as well as day-to-day living), this particular lesson will reference the current global financial crisis to provide real-world context, thus making the lesson ideal for an economics class.

Learner Analysis

General Learner Characteristics

Learners will typically fall in the age range of 18-20 years, and are assumed to have limited or no previous exposure to systems thinking principles.¹ Their presence in an economics class indicates a general interest in the subject as a field of study, and while real-world experience will be limited due to their age, general awareness of the financial crisis gripping the nation is likely to have colored their attitudes toward economics, resulting in feelings ranging from cynicism to confusion to outright despair.

Students who demonstrate apathy or a lack of awareness should be exceedingly rare given news media saturation, the upcoming presidential election, and the potential impact on their own lives as they enter the workforce and start families of their own. Some students may even have family members or friends who have been directly impacted by the crisis, perhaps losing a job or their home.

Complacency, on the other hand, will be more common, and can be attributed to the confusion and hopelessness that are the only alternatives for many people in our society. Few if any students will have any understanding of the causes of the current crisis, and mental models will be sketchy. A conceptual or analytical framework for making sense of the situation will be noticeably lacking.

Entry Competencies

Learners are assumed to have grade-level reading abilities and approximately tenth grade math abilities, and should be able to read and interpret a simple line graph (though actual math equations will not be performed as part of the lesson, the corresponding thinking and analytical skills will be of benefit to learners). Some prior knowledge of the current fiscal crisis is not necessary, but will help provide immediacy and context for the lesson.

¹ On the off-chance that an enlightened high school teacher provided some previous exposure, students can be asked a few basic questions before instruction begins to confirm that this is a new concept for them. Students who indicate some awareness of systems thinking principles can be enlisted as helpers while the lesson is conducted to keep them engaged.

Learners should have the physical capacity to draw basic shapes (i.e., squares, circles, arrows), to see text and diagrams on a whiteboard, and to engage in discussion with classmates and the instructor.

Special Needs

Accommodations for hearing or sight-impaired students can be made if they do not disrupt the class or slow it down to the point of not being able to achieve the lesson objectives in the allotted time. Students lacking small motor control should be able to complete the lesson by observing other students engaging in the drawing activities.

Process Used to Complete Learner Analysis

One of the key assumptions of this lesson design is that the target audience is reflective of society in general in its lack of awareness or understanding of systems thinking principles. Systems thinking and system dynamics are still, unfortunately, considered esoteric fields of study, and have yet to make serious inroads into public school curricula. In addition, the assumptions made about the target audience are informed by several years of direct observation of and interaction with students in this age range while teaching college-level freshman composition courses.

To validate the assumptions about attitudes toward and knowledge of the current economic crisis, an informal survey of five (5) subjects in the target age group was conducted using a pencil and paper survey (subjects were drawn from the members and advisors of the youth group at my church). The survey included the following questions:

1. Please rate your confidence level in corporate leaders to find solutions to the economic crisis this country is currently experiencing. (Scale from 1-5, where 1 is "Very low" and 5 is "Very high.")
2. Please rate your confidence level in the federal government to find solutions to the current crisis. (Scale from 1-5, where 1 is "Very low" and 5 is "Very high.")
3. Please indicate the level to which the current crisis has directly or indirectly affected you and/or your family. (Scale from 1-5, where 1 is "Not at all" and 5 is "Deeply.")
4. Please rate your understanding of the root causes of the current economic crisis this country is experiencing. (Question will use a scale from 1-5, where 1 is "I'm clueless" and 5 is "I saw this coming three years ago.")
5. If you were able to develop a better understanding of the nature and causes of the current economic crisis, what impact would this have on your feelings about the crisis? (Select from three choices: I'd feel better, My feelings wouldn't change, I'd feel worse.)

Questions 1 and 2 were designed to gauge participants' perceptions of the role corporate and government leadership has played in precipitating current economic conditions. Responses to this question have some bearing both on attitudes and on general awareness that leadership decisions and strategy can have a far-reaching influence on systems as complex as the national economy.

Question 3 was also designed with two goals in mind: to gauge how much participants feel that economic conditions affect their own lives, and to determine the likelihood of strong emotions being evoked in learners by the context chosen for the lesson. Seeing themselves as part of the larger system is critical to an understanding of the concepts taught in this lesson, while some emotional distancing will be necessary to analyze the system effectively, and in turn develop a working knowledge of systems thinking tools and principles.

Question 4 was designed to assess participants’ understanding of the nature of the current economic crisis. Despite the phrasing of the question, the intention is not to determine if participants truly understand the root causes; rather, the question should provide a fairly good indication of whether the participants have a basic understanding of the main factors involved in the crisis, such as bad mortgages, failing financial institutions, and government bailouts. If present before instruction begins, this basic understanding will decrease the amount of time that needs to be spent setting up the background context for the lesson.

The purpose of question 5 was to twofold: 1) responses should be a good indicator of current attitudes towards the economic crisis, and 2) responses will feed into the needs analysis, hopefully confirming an expressed need for instruction in a systematic method for developing an understanding of current economic conditions.

Survey results

	1	2	3	4	5
Question 1:	4		1		
Question 2:	4	1			
Question 3:	1	1	2		1
Question 4:	1	1	2	1	
Question 5:	3 said they’d feel better, 2 said their feelings wouldn’t change.				

Interpretation of results

Questions 1 and 2 show a clear lack of confidence in both corporate and government leaders to solve the current crisis. The responses to question 3 are not surprising given the young age of the respondents (all were in the 16-18 year age range), but they do indicate at least a nascent awareness of the economic difficulties the country is currently undergoing and its potential impact on their lives. Question 4 indicates that the majority of the respondents have spent some time observing and possibly thinking about the crisis. Question 5 has a majority of the respondents indicating a desire to develop a better understanding of the crisis.

Task Analysis

Upon completion of this lesson, learners should be able to represent graphically and in narrative form the feedback loop or loops that underlie the systemic failures that resulted in the current financial meltdown in this country. They should be able to accomplish this

using common systems thinking terminology and concepts. In doing so, they will demonstrate the following skills and abilities:

1. Discuss the definition of “mental model” and identify ways in which their mental models may be skewed somewhat from reality.
2. Distinguish between linear and non-linear (closed-loop) causal relationships.
3. While the subprime mortgage crisis is described by the instructor in narrative form, draw and label a basic stock and flow diagram containing the following elements:
 - a. An inflow of high-risk loans into the system via loan originators
 - b. A stock of high-risk loans held by lending companies
 - c. An outflow of high-risk loans being bought up by investment firms, packaged as mortgage-backed securities and sold on the secondary market
 - d. Home prices shown as a stock with the change in price as both the inflow and outflow, and a connector showing its influence on loan originations
 - e. A connector between the outflow and the inflow of high-risk loans indicating the influence of the outflow rate on originations
 - f. A connector between the high-risk loan inflow and the change in price flow indicating the influence of the inflow rate on home prices
 - g. A stock of written-off loans accumulating from the outflow of loans in default from the high risk loans stock
 - h. A connector showing the influence of written-off loans on the outflow of mortgage-backed securities

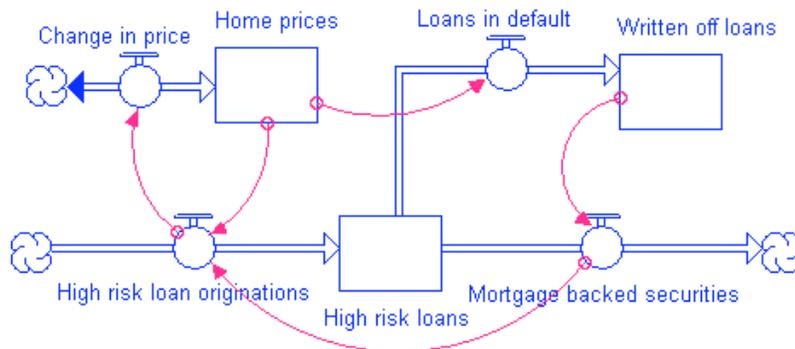


Figure 1: Stock and flow diagram representing the conditions leading to the current financial crisis.

4. Describe/trace the reinforcing feedback loop that goes something like this:
 - a. As long as the demand for high-risk loans on the secondary market remains high, originations of these loans is high, which in turn drives up home prices, increasing the demand for nontraditional (high-risk) loans.
 - b. When the demand for high-risk loans on the secondary market decreases (possibly due to exogenous factors such as increased regulatory scrutiny or endogenous factors such as increasing awareness of high-risk exposure), originations of high-risk loans will also decrease, which in turn brings home prices down to less inflated levels.
 - c. The decrease in demand for high-risk loans, combined with the high-risk exposure caused by the accumulation of high risk loans in their portfolios, causes lenders to tighten their credit standards, decreasing the number of potential home buyers and driving home prices even lower.

- d. Decreasing property values increases the number of high-risk loans going into default due to the rate resets and negative amortization associated with these loans, eventually causing the secondary market to completely dry up.
- e. Lather, rinse and repeat until the financial market collapses under its own dead weight.

Identification of Experts

It was necessary to consult experts in two different fields during the preparation of this lesson: finance and systems thinking. Financial expertise was not hard to come by on the Web, with respected sites such as Forbes.com, BusinessWeek, the London Financial Times and others providing exhaustive news and editorial coverage of current financial conditions. My own experience as an instructional designer and manager within the Home Loans division at Washington Mutual provided me with additional insights.

Systems thinking expertise was provided by the late Dr. Barry Richmond, who personally provided me with my first instruction in systems thinking eight years ago, and whose book, *An Introduction to Systems Thinking* (2000), was an invaluable resource. Before his death, Dr. Richmond was considered one of the preeminent authorities on systems thinking, especially in its business applications.

How Accuracy of Content Was Confirmed

Two methods were used to confirm the accuracy of the instructional content:

1. Authoritative books and articles were consulted.
2. System dynamics modeling software applications (*iThink* and Vensim) were used to create the stock and flow and causal loop diagrams included in this design document. While this does not guarantee the accuracy of the content, some error-checking of model structures is an automatic feature that came into play several times during the design of the lesson.

Before production begins, the designer intends to submit the causal loop portions of the lesson to at least one expert in the systems thinking field for feedback. While it is not unlikely that some of the diagrams and models will be modified as a result of this feedback, the structure and context of the lesson should remain unchanged.

Process Used to Complete Task Analysis

To complete the task analysis I personally went through the exercise of modeling the system in a software application called *iThink* which was specifically designed for this type of activity. In doing so, I continually challenged my own assumptions about the system, mentally overlaying the model on the real-world system. Through several iterations, and making numerous modifications, I brought it as close to reality as possible without making it overly complex. Since the learners will not be using the software for this lesson, I deliberately avoided using the math features of *iThink* and stuck to the visualization features, which can be emulated with paper and pencil or whiteboard and marker.

I also reread much of the Barry Richmond book to reacquaint myself with some of the more technical aspects of the field, to refresh my vocabulary and to compare the examples in the book with the one I was creating for this lesson.

Context Analysis

Needs Analysis

The concept of feedback loops is difficult to master, and the subordinate concepts and intrinsic skills it encompasses are equally difficult. The common emphasis in K-12 education on the rote learning of facts and figures complicates matters, as does our societal inclination to focus on the individual and on the here and now as opposed to long-term effects and the behaviors of systems. This lack of training and enculturation in closed-loop (*vis-à-vis* linear) thinking results in individuals who lack the ability to analyze and interpret the behavior of systems in the world around them (Plate, 2008).

More importantly, students lack the empowerment of being able to apply systems thinking concepts to problems they encounter in their own lives. The disillusionment or hopelessness that is frequently felt by individuals faced with problems they have no way of understanding is a felt need that will be addressed in this lesson. Whether the problems are large in scale (e.g., economic crises, global warming, social issues) or small in scale (e.g., weight management, time management, relationship issues), being able to visualize the dynamic, systemic relationships inherent to each problem is an important first step in taking action to solve them (Lyneis, Stuntz, & Richardson, 2003).

College students in particular, whose fields of study will most likely deal with systems on some level, will benefit greatly from an understanding of the concept of feedback loops. In this context, closed-loop thinking can be thought of as an additional weapon in students' critical and analytical thinking arsenal.

Instructional Context

This lesson will be taught as the fifth and penultimate lesson during a systems thinking unit in an entry-level course in economics. As designed, it should be conducted in a small classroom setting (rather than a lecture hall), though with some modifications it could possibly be adapted to a distance education format. Since the lesson is fairly self-contained, it could probably also be adapted to entry-level classes in other disciplines, such as business administration, ethics/philosophy, sociology, psychology or history. While systems thinking is highly relevant to the physical sciences, the topic of this lesson would limit its effectiveness in these settings.

It is not assumed that the instructor will have a background in systems thinking; therefore, part of his or her preparation for teaching this lesson might be some background reading to become acquainted with the field. The [System Dynamics Society website](#) and [Pegasus Communications](#) (also see [this page](#)) offer excellent free resources that provide a good introduction to the field and are easy to understand.

The lesson will take approximately two hours to teach; however, the two hours can be broken up into smaller segments without hindering the lesson objectives. Ample thought, however, should be given to the unit's placement within the larger course. Ideally, the

concepts taught during the unit will be reinforced throughout the remainder of the course by applying them to new topics as they are covered. Activities similar to those described in this design document can be conducted using other topics, or informal discussions can be stimulated that apply questions and techniques introduced in this lesson.

The diagram in Figure 2 illustrates how the lesson on feedback loops will be situated within the larger systems thinking unit. The concept map in Figure 3 shows the conceptual relationships of feedback loops within the systems thinking field.

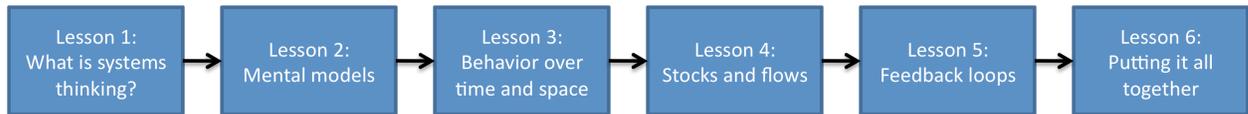


Figure 2: Systems thinking unit flow

Transfer Context

As described above, the concepts learned in this lesson have the potential to be applied in many areas of students' lives and have a significant long-term impact on their world view. Near-term transference can be realized by continually revisiting the concepts and applying the skills as new topics are introduced in the course. As students start to take more advanced courses in their fields of study, and if they have sufficiently internalized the concepts and skills, they will begin to recognize patterns of archetypal systemic behaviors in virtually any system they encounter.

Though logistical problems prevent its inclusion in the evaluation plan for this lesson, it would be interesting to interview students 3-4 years after completing instruction to determine how much of a long-term impact the lesson has had on their world view, and how much it has influenced their further studies.

Process Used to Complete Context Analysis

The needs analysis is largely based on observations and anecdotal evidence acquired during several years of teaching college courses in English composition. Especially in advanced composition classes, where critical analysis and persuasive writing are emphasized, I encountered with high frequency students who displayed an inability or unwillingness to perform even a rudimentary analysis of research topics, readings or discussion topics. More recently, question #5 in the survey described above elicited responses that (hopefully) confirmed an expressed need for instruction in a systematic method of analyzing economic conditions to understand them better.

The instructional and transfer context is the result of a deliberate attempt to build as much flexibility as possible into the lesson. I wanted to avoid technical and logistical limitations, as well as potential conflicts with existing curricula and/or surrounding instruction, while still providing some options for integrating the unit into the larger course of instruction through informal transference activities.

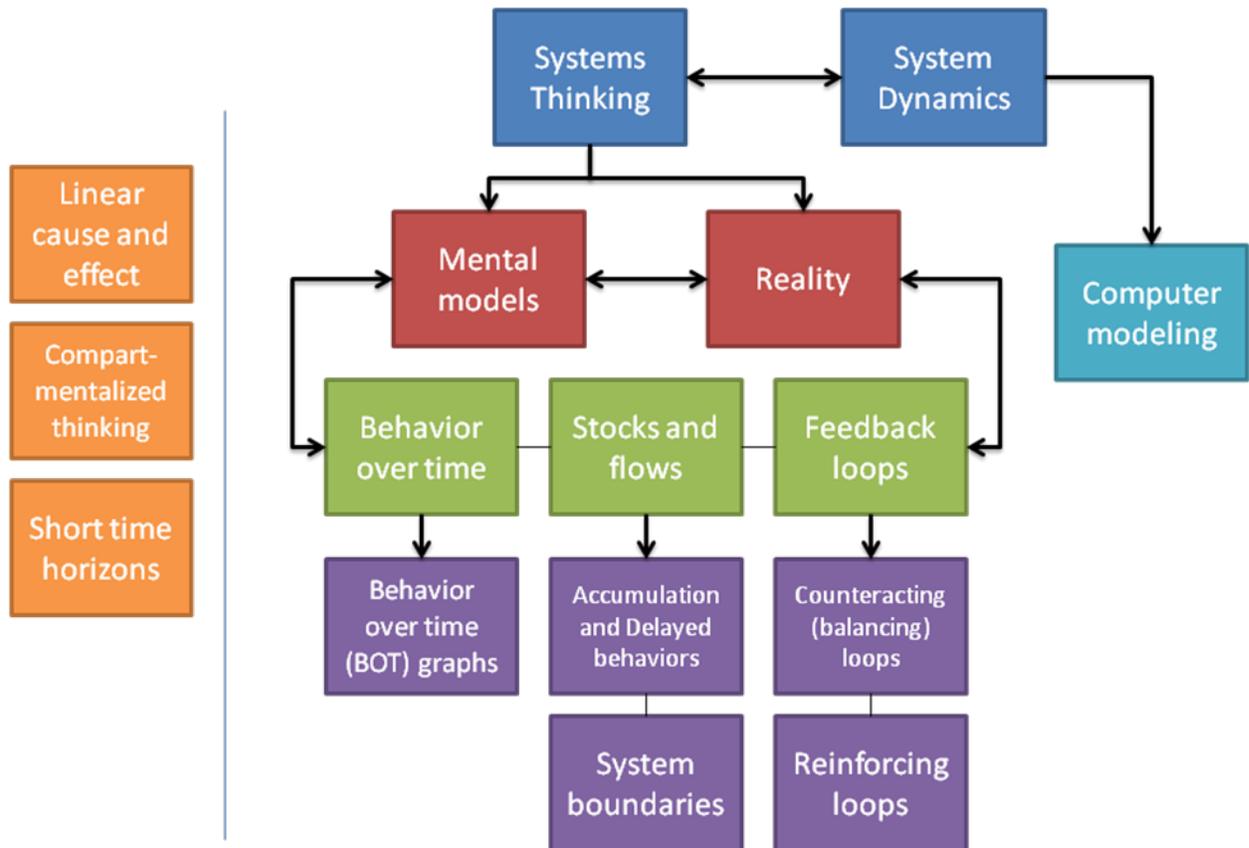


Figure 3: Systems thinking concept map

Objectives of Instruction

Overall Goal of Instruction

Upon completion of this lesson, learners will be able to recognize a feedback loop in a system, discriminate whether it is a counteracting or reinforcing loop, and portray the feedback loop both visually and verbally. This tool will help them correct their own mental models, and make predictions about the behavior of a system over time. Though an admittedly lofty goal, this lesson has the potential to alter their world view, opening up solutions to problems that before seemed insurmountable.

Specific objectives

- Given a causal relationship such as that of fluctuating home prices and the demand for high-risk loans, the learner will illustrate in a simple causal loop diagram the closed-loop dynamics of this relationship, thus showing the inadequacy of linear cause and effect in explaining the relationship.
- Given a series of stock and flow diagrams each containing a feedback loop, the learner will identify which ones represent a reinforcing feedback loop, and which ones represent a counteracting feedback loop, with 80% accuracy.
- Given a narrative description of the feedback dynamics present in a system, the learner will draw a stock and flow diagram that accurately represents that system.
- Given a dynamic system such as the subprime mortgage business, the learner will apply the concept of feedback loops to explore and expose flaws in his or her mental model, making explicit the role that assumptions about reality play in all mental models.

Testing/evaluation plans

What is to be evaluated

Learners will primarily be evaluated on the level to which they have grasped the concept of feedback loops in a dynamic system. Learners should be able to discriminate between reinforcing and counteracting (balancing) feedback loops (classificatory attainment), and apply the concept of feedback loops in order to correct and/or validate their own mental models of (or misconceptions about) a system's dynamics (formal attainment) (Klausmeier, 1990, p. 103). The instructor will assess their ability to demonstrate this both graphically and verbally in such a way that it clearly communicates their understanding to another person.

Evaluation Strategy

Since verbal articulation is one of the primary objects of evaluation, I have selected participation in class discussions as one of two evaluation methods to be used for this lesson. Discussion is an essential component in the instruction, and learners' participation in both small group and class discussions is an easily observed, highly transparent indicator of how much they "get it." Learners should be evaluated less on the quantity of their participation, and more on quality.

The second, more formal method of evaluation will be an in-class activity in which students will be read a somewhat simplified narrative account of the events leading up to the nation's current financial crisis. As the narrative is read, students will individually draw and label a stock and flow diagram that depicts the systemic behaviors described in the narrative, especially any feedback loops. Neatness should not be a factor in evaluating students' performance. Rather, students should be evaluated on their grasp of the feedback loop sub-classes (reinforcing and counteracting loops) and how feedback loops relate to the superordinate concept of a dynamic system.

How feedback is to be provided to the learner

During instruction, verbal feedback (both corrective and reinforcing) will be provided by the instructor directly to learners who speak up during class discussions, and also during the drawing and small group activities. Sensitivity should be used in providing verbal feedback to avoid feelings of inequity in the classroom that might demotivate some students and hypermotivate others. Feedback on the stock and flow diagram can be provided either in writing or orally (or both), depending on the preferences of the instructor and the needs of the learner. This feedback should refer back to the rubric to provide the learner with a tangible point of reference for interpreting the instructor's comments.

Practice activities

What is to be practiced

1. Recognizing and articulating the feedback dynamics present in a system
2. Distinguishing between reinforcing and counteracting feedback loops
3. Relating specific types of feedback loops to the typical behavior-over-time (BOT) graph patterns they generate
4. Representing feedback loops in simple stock and flow diagrams

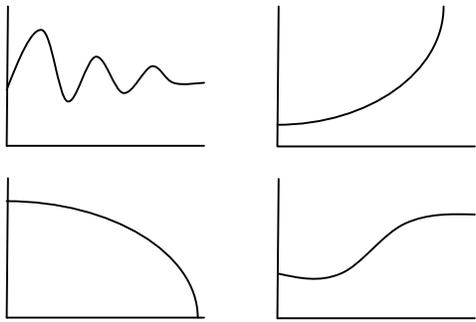
Strategies for how practice will occur

	Type of Activity	Ind./Group/Class	Approx. Time
1	Socratic discussion	Class	20 minutes
2	Worksheet completed in class, followed by class debrief	Individual/Class	15 minutes
3	Small group discussion, followed by class debrief	Group/Class	15 minutes
4	Small group discussion, followed by class debrief	Group/class	20 minutes

Description of practice activities

	Description of Practice Activity (See Appendix B for samples)	Relationship to Objective(s)
1	This activity will rely on the instructor using the Socratic method to draw students into a discussion exposing the feedback dynamics present in many common, everyday relationships. Students will be asked a series of open questions to get them thinking and talking about the importance of feedback in a	This activity is designed to stimulate thought about the nature of feedback dynamics in systems. This should start the process of helping students recognize the inadequacies of linear

	Description of Practice Activity (See Appendix B for samples)	Relationship to Objective(s)
	<p>dynamic system. These questions can be written on the board before class to “get students’ wheels turning” before the discussion begins. For example:</p> <ul style="list-style-type: none"> a. Why do arguments tend to flare up and get out of control? b. What keeps our core body temperature constant despite fluctuations in the weather? c. What are some reasons that a child who is scolded often for misbehaving might act out even more often and in worse ways? d. What are some reasons that addictive behavior – drug use, overeating, gambling, spending money, etc. – is so difficult to cease? e. What prevents people who are not prone to addictive behavior from overindulging? f. Why does traffic take so long to recover after an accident has been cleared from the highway? 	<p>causality in explaining the behavior of systems.</p>
2	<p>Students will be given a list of several feedback loops and instructed to label each one with an “R” for reinforcing, or a “C” for counteracting. After several minutes of performing this activity individually at their desks, the instructor will lead students toward a consensus on the correct answers during a class discussion.</p>	<p>This activity will help students distinguish between the two sub-classes of feedback loops, which will bring them closer to a classificatory attainment of the concept.</p>

	Description of Practice Activity (See Appendix B for samples)	Relationship to Objective(s)
3	<p>Students will be broken up into small groups (3-4 in each). Each group will be given one of the BOT graphs shown below. The groups will decide whether the graph depicts a reinforcing or a counteracting feedback loop, and then report back to the class with an explanation of their findings.</p> 	<p>An intrinsic attribute of feedback loops is that they represent behaviors that occur dynamically over time and space. This activity will promote the attainment of this attribute, and further reinforce the distinction between the two sub-classes of feedback loops. Clockwise from the upper right, the graphs shown here represent a reinforcing loop with an increasing stock, a counteracting loop with a delay, a reinforcing loop with a decreasing stock, and a counteracting (balancing) loop.</p>
4	<p>A series of 3-4 brief narrative descriptions of feedback loops will be read to the class in sequence (see Appendix B for samples). Students will work in their groups to draw a stock and flow diagram representing each of the narratives on large post-it sheets. When they are finished, they will post their sheets on the walls of the classroom. When all of the groups' diagrams have been posted, the class will critique each one.</p>	<p>The goal of this activity is not to create perfectly accurate representations of the systems in question. Rather, students should be able to demonstrate that they have grasped the relationship between stocks and flows and feedback loops within the systems thinking concept model.</p>

How feedback is to be provided to learners

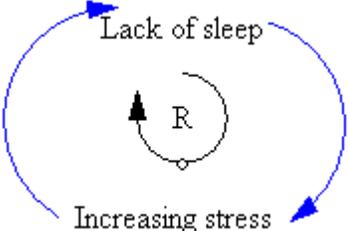
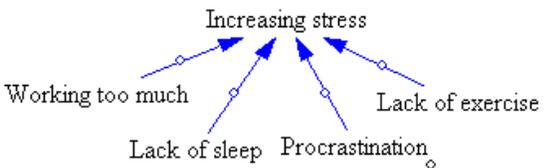
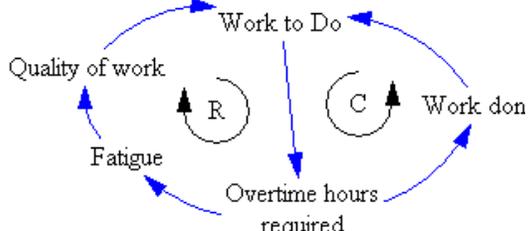
1. As students collectively provide a simple list of answers to each question, the instructor should lead the class towards a narrative description of the feedback loop(s) involved in each system. For example, an answer given to the traffic question might be "lingering brake lights and congestion." This can be rephrased in narrative form to go something like this: "The sight of brake lights in front of them causes people to apply their own brakes, creating a continuous chain reaction that wanes only when the length of time drivers apply their brakes gradually decreases as they more quickly realize that traffic is not stopping in front of them."
2. When the class reconvenes, the instructor will go through each example one at a time, asking for a show of hands to find out how students labeled each example. In each case, students who were in the minority will be asked to justify their response.

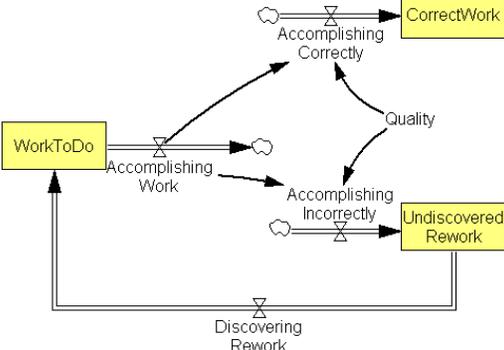
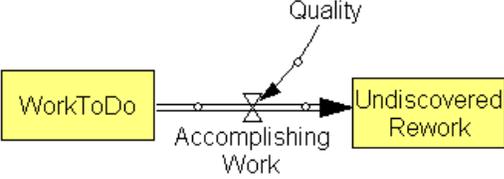
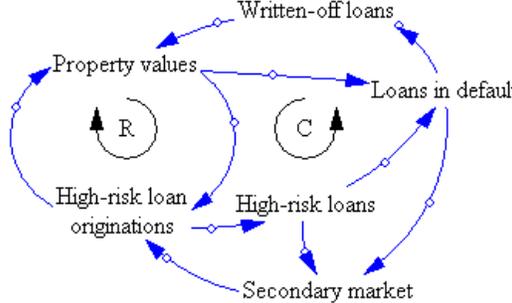
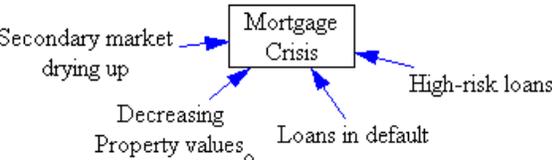
Whether the minority or the majority labeled the example incorrectly, the instructor will gently point out the misconception(s) that led to the mislabeling, and through further discussion will ensure that students can articulate the true nature of the feedback loop before moving on to the next example.

3. Feedback will be provided by the instructor to each group verbally during the class debrief. This public feedback can be supplemented by semi-private feedback provided to each group during the activity as the instructor observes their discussions.
4. Again, verbal feedback will be provided to each group during the class debrief. Care should be taken while providing feedback during this activity to avoid critiquing the drawing skills or neatness of each group's diagrams. The proper labeling of each element and the direction of the flows are the key components to be evaluated, and even these may contain minor mistakes without drawing corrective feedback. As long as each group appears to grasp the key concepts, and is able to explain the rationale behind their diagrams, their work should be considered more than adequate.

Examples and Non-examples of the Concept

Examples and non-examples to illustrate differences between linear causality and closed-loop causality:

Examples	Non-examples
 <p>Simple reinforcing feedback loop that shows lack of sleep increasing stress level, which in turn causes the person to lose sleep in a never-ending cycle.</p>	 <p>Laundry list of items that might increase stress levels in a person. Does not show interrelationships or feedback loops.</p>
 <p>Causal loop diagram shows the counteracting and reinforcing feedback loops influencing the volume of work to be done. Overtime increases the amount</p>	<p>Laundry list of items contributing to workload doesn't show interrelationships between the parts of the system.</p>

Examples	Non-examples
<p>of work accomplished, but also increases fatigue, which in turn decreases quality of work and increases rework.</p>	
 <p>Stock and flow diagram shows the reinforcing feedback loop present in the discovering of rework adding to the work to be done, which in turn increases the likelihood of work being done incorrectly.</p>	 <p>Stock and flow diagram is a gross over-simplification of the system illustrated in the correct example. It implies that all work flowing out of WorkToDo ends up in the Undiscovered Rework stock, which obviously isn't true.</p>
 <p>Diagram shows reinforcing and counteracting feedback loops at work in the mortgage crisis, as well as the inherent delays.</p>	 <p>Diagram does not show the feedback dynamics present in the system.</p>

Introductory presentation of instruction

How context for instruction will be set

Setting the context for instruction will simply be a matter of recalling the changing financial conditions in our country over the last two years or so, at a high level. A series of questions such as the following might be asked:

- Why do conditions seem to be getting worse and worse?
- Why didn't the company executives and the government see this coming?
- Why did changes in lending practices at financial institutions not reverse the predicament they had created for themselves, at least not in time to avert disaster for some of them?

- Why is the mortgage crisis having such a far-reaching effect on so many areas of the economy?

The idea behind the questions is not to elicit correct answers, but to get learners thinking about their current mental models related to the economy.

Prerequisites needed for instruction

Based on the placement of this lesson within the systems thinking unit described above, learners should have a basic understanding of the following systems thinking concepts:

- Dynamic systems
- Behavior-over-time graphs
- Stocks and flows

To help set the context for the lesson, learners will also be expected to have some cursory knowledge of the current mortgage crisis. This can be facilitated by having students read an article about the mortgage crisis as homework the night before the lesson. [Wikipedia](#) has a detailed article on the crisis; a [radio show](#) aired on NPR that explains the crisis; [Accordion Guy](#) has an interesting treatment complete with comic strips; and the [New York Times](#) has a good, brief article.

Key terms, acronyms, other information needed to facilitate instructional experience

Stocks and flows, mental model, BOT (behavior-over-time) graph, causal loop diagram, reinforcing feedback loop, counteracting (or balancing) feedback loop, high-risk (subprime) loans, mortgage-backed securities, secondary market, loan default, written-off loans.

First look at objectives to be achieved and skills, knowledge to be learned

The objectives for this lesson will be presented immediately after the context is set during the opening discussion. Essentially, the objectives will be phrased in such a way that it will be made clear that if only the corporate CEO's had known how to perform these tasks, they may not have gotten us into the fix we're in now.

Motivational strategies to be used in instruction

Two primary strategies will be used to motivate learners:

1. Learners will be shown the inefficacies in using linear causality and compartmentalized thinking to explain the events in our lives and solve problems. They will also be shown how an inability to use causal loop thinking could very well be at the root of our current financial crisis. In both cases, the relevance to learners' own lives will be emphasized, and satisfaction will be derived from knowing that they are learning how to do something that has the potential to avert catastrophe, create solutions to problems, and have a positive impact on their lives at both a personal and social level.

2. An attempt will be made to show how systems thinking, and feedback loops in particular, tie into some of our most pressing global issues, including politics and diplomacy, global warming, health issues, animal extinctions, etc. Indeed, the final lesson of this unit will have students engage in an online global warming simulation that was built using systems thinking concepts and principles. This strategy will be instrumental in building confidence in this approach to systems analysis and problem-solving.

Both of these strategies will be interwoven throughout the lesson rather than making them an explicit part of instruction.

Basic plans for instructor materials

This lesson was deliberately designed to be low-tech. A typical classroom with whiteboard or blackboard and walls for posting group work are all that are required for the conduct of the lesson. The instructor should have no difficulty drawing the simple diagrams that will be presented as examples; however, since sequential slides will not be provided, care should be taken by the instructor to avoid clutter on the white or blackboard. A disorganized appearance of the diagrams on the board could easily lead to confusion among students. In fact, it would be better to erase the board after students have been given an opportunity to copy the diagrams into their notebooks, rather than having numerous diagrams visible on the board simultaneously.

Student materials will be limited to the handouts required for practice activity #2 and #3. The instructor's lesson plan will contain an instructor version of each of these handouts. To provide additional support for instructors who are not conversant in systems thinking concepts, detailed pacing information and plenty of examples will also be provided in the lesson plan. While the instructor is encouraged to incorporate personal experiences and her own examples into the lesson, at no point will the lesson plan require the instructor to do so.

Since the lesson is targeted at young adults, leaving them completely in the dark as to the instructional strategies and tactics that will be used would be counter-productive. After the initial context-building discussion, the instructor should inform students that some group work will be involved in the lesson, as well as some light drawing. To avert the anxiety that often accompanies both of these activities, students should be reassured that neither the drawing nor the goals of the group activities will be overly complex.

References

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Appendix: Sample Feedback Loops for Use in Practice Activities

The following examples can be used by the instructor during practice activities.

Example	Type (R or C)	Narrative description	Diagram
Core body temp	C	Nerve endings pick up changes in core body temperature, sending a signal to the hypothalamus in the brain, which in turn speeds up or slows down cell metabolism, the process that generates heat in our bodies. At the same time, air temperature affects the rate at which heat dissipates from the body.	
Arguments	R	A person stating an opinion is met with hostility by the other person, causing defensive posturing and heightened emotions on both sides that get worse as the argument continues.	
Child misbehaving	R	A neglected child gets attention from adults only when she misbehaves. Craving any attention she can get, she acts out more often and more severely, which increases the scolding and decreases self-esteem, thus reinforcing the behavior.	
Addictive behavior	R	Person engages in addictive behavior to escape feelings of self-loathing. Feelings are intensified as behavior worsens, reinforcing addiction.	
Non-addictive behavior	C	Person engages in potentially addictive behavior (e.g., drinking too much alcohol) resulting in negative consequences (e.g., hangover, DUI) that prevent person from engaging in same behavior in the near future. However, with the passage of time, regret dissipates, increasing the likelihood of repeating a mistake.	

<p>Traffic accident</p>	<p>R</p>	<p>The sight of brake lights in front of them causes people to apply their own brakes, creating a continuous chain reaction that wanes only when the length of time drivers apply their brakes gradually decreases as they more quickly realize that traffic is not stopping in front of them.</p>	
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