Making Friends:
The Shape of Change

The text of
Lesson 2: Making Friends
From the books

The Shape of Change
and
The Shape of Change: Stocks and Flows

By Rob Quaden and Alan Ticotsky
With Debra Lyneis
Illustrated by Nathan Walker
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The Shape of Change

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http://www.clexchange.org

milleras@clexchange.org.

Introduction

After reviewing why making friends is important, students play a non-competitive tagging game. They track the rate of growth of friendships in the class when students employ their friendship skills and behave in friendly ways. By changing the rules of the game each time it is played, students can discover the effect of rates of growth. Math skills such as graphing, comparing, and computation reinforce affective concepts including cooperation, inclusion, and friendship in this adaptation of "The Friendship Game" by Peg Clemans.[1]

Materials

Large display area (easel pad, display board, or chalkboard)
Large easel graph pad
Markers, chalk
Set of name cards of class members in a paper bag or container

How It Works

Creating a sense of community within a classroom does not happen automatically. Teachers devote significant amounts of time and energy to ensuring that learning flourishes in a supportive, caring environment. Many schools include some type of social competency program in their curriculum. In Making Friends students follow up work on cooperation and civility. They investigate the rates of growth possible in building friendships when students behave in friendly ways and everyone is included.

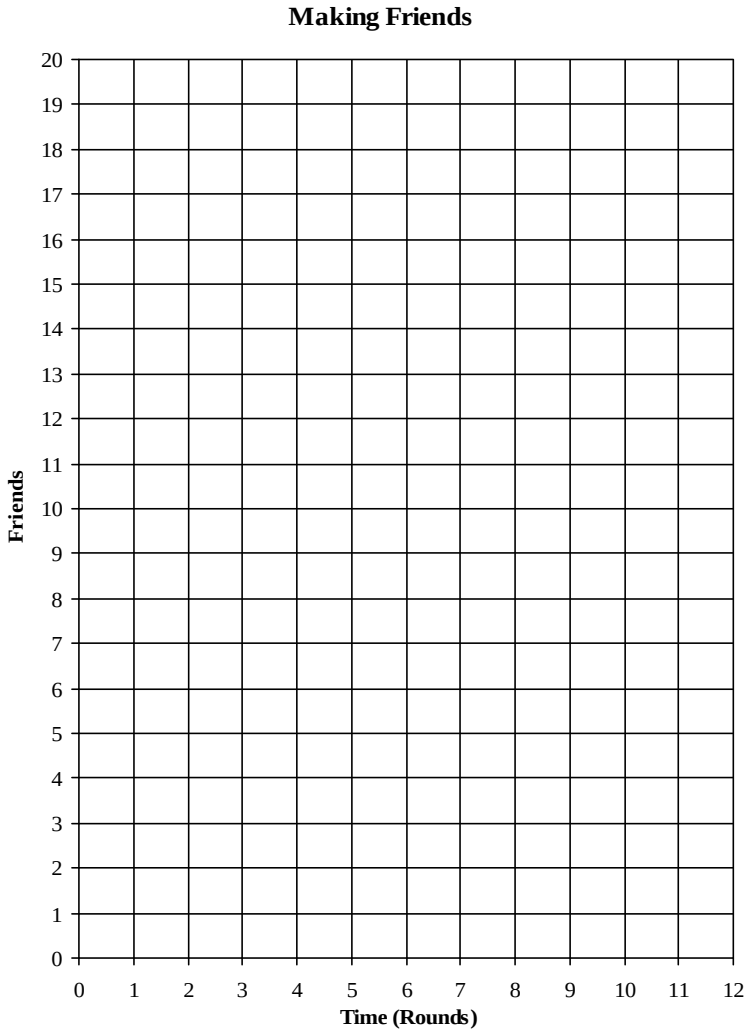
Making Friends allows students to try different scenarios non-competitively and compare the results. Choosing members of the class to build a "Friendship Team" reinforces the goal of including everyone. Students benefit greatly when they approach cooperative learning and other collaborative educational techniques with a positive attitude.

Students play and graph two different versions of the Making Friends game.

- In the first game, two students are added to the friendship team each round. Adding a constant number each time produces a straight line on the graph, or linear growth. It takes a long time to get everyone on the team.
- In the second game, each student already on the friendship team recruits a new member each round. As the team grows larger, the number of new members also grows larger each round. It takes only a few rounds to include everyone. This accelerating growth produces a curved line because the size of the team determines the number of new players. This pattern is called exponential growth.
- In both games, the shape of the line on the graph represents the nature of the growth – an important and non-trivial concept for students.

Procedure

1. Prepare a large graph before playing. The horizontal axis represents time in rounds of the game. The vertical axis records the number of Friends and is labeled with the number of students in the class. Also prepare a table. You will graph two or three games on the same graph for comparison, but you will use a new table for each game.



Round	Friends
Start	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

2. Ask students how they make friends. What qualities define a good friend? Can you have more than one friend at a time? What are the behaviors and skills that they can practice to be good friends? This conversation can be very rich and earnest, especially if the class has already been engaged in team building activities.

Generating and posting a list of Friendship Skills before playing is very important. Tagging a player in the Friendship Game represents practicing the behaviors designed to create a caring, cooperative classroom. Here is one example of a list of friendship skills:

FRIENDSHIP SKILLS
Be a good listener
Respect differences
Include everyone
Share
Be helpful
Smile

3. Explain that students are going to play a simulation game in which players pretend to make friends. They will play until all the members of the class are on the Friends Team.

4. Choose two or three students to begin the game on the Friends Team and remove their names from the container of name cards. (Choosing three works well if the total number of players is a multiple of three; otherwise choose two.) Move the chosen players to a designated area of the classroom where the Friends Team will meet. Record the data on the table as shown.

Game 1

Round	Friends
Start	2
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

5. On a signal from the teacher, the rest of the students close their eyes. The first Friends Team players each randomly draw one student name card from the container. They silently walk over and tag those people gently. Tagging them will assume they have employed their friendship skills. The tagged people open their eyes and walk back with their taggers to the Friends Team area. When the turn is completed, everybody opens their eyes and helps record the data for that round.

6. The original Friends Team players *stay* in the Friends Team area and the newly chosen players prepare for their turn. Students close their eyes, while the new players

draw name cards and bring one more person each back to the Friends Team area. Again, count and record the number of friends on the team.

? **Before playing each round, ask students to predict what will happen to the number of friends in the next round.**

? **Is a pattern emerging?**

Game 1

Round	Friends
Start	2
1	4
2	6
3	8
4	10
5	12
6	14
7	16
8	18
9	20
10	22

After a round or two, students will be able to predict the pattern of growth. As the game progresses, continue to keep track of the size of the Friends Team using the table. Play the game until everyone is a member of the Friends Team. If numbers are uneven and the last turn does not end with everyone getting to choose, include the teacher or imagine there is an extra player or two.

7. When the game is over, use the data to make a line graph as a class, tracking the number of players on the Friends Team. Help students locate points on the graph and connect them with a line. Ask the students to analyze what happened.

A line graph helps students see the pattern of change over time. We call this a *behavior over time graph*.

? **What do you notice? What happened to the number of friends?**

? **Why is the line straight?**

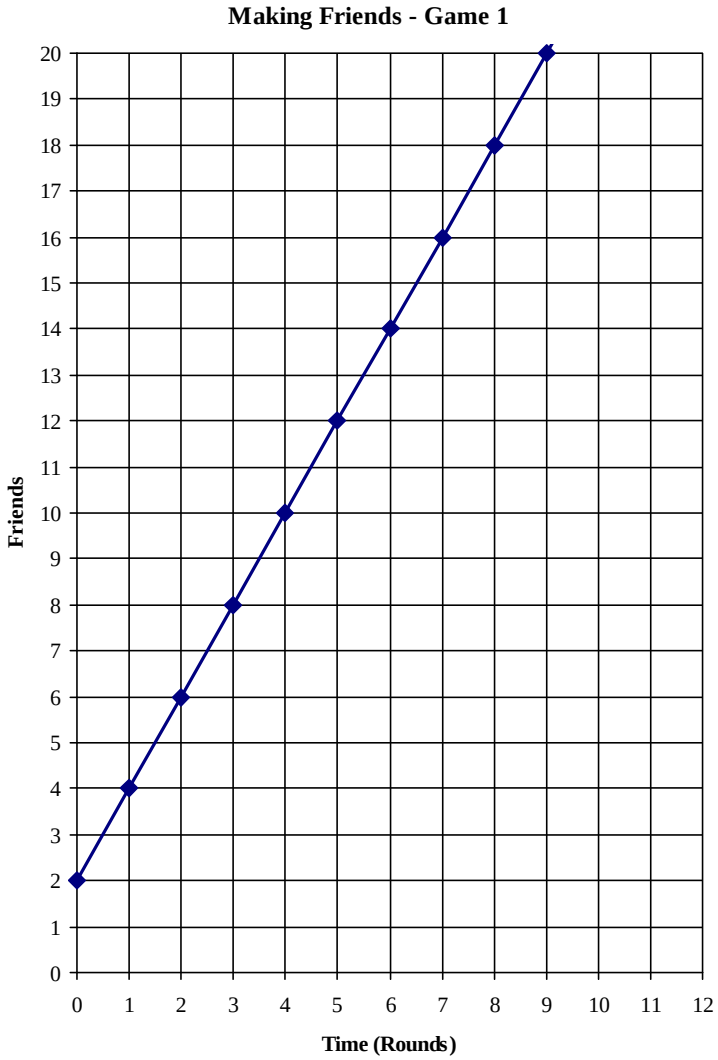
The team grew by the same number of players each round.

? **Why does it slant upwards diagonally?**

The number of players increased each turn.

? **What would happen if you had another class join and you kept playing for 5 more rounds? 10 more?**

The straight line would be extended, slanting diagonally at the same angle and rate.



Game 2

8. Tell students that they will play another game. The rules will change. This time, instead of simply sitting in the Friends Team area after choosing a new friend once, *every* friend will now be able to choose a new friend *every round*. After all, people are not restricted to one friend! People can use their friendship skills over and over.

What do the students predict will happen? Ask for opinions and record the predictions on the board. Predictions are just best guesses for now, a way to help students think about the results as they unfold. Play the game and record the results on a data table similar to the table used for Game 1.

? **Before each round, ask students to predict what will happen to the number of friends in that round and in future rounds.**

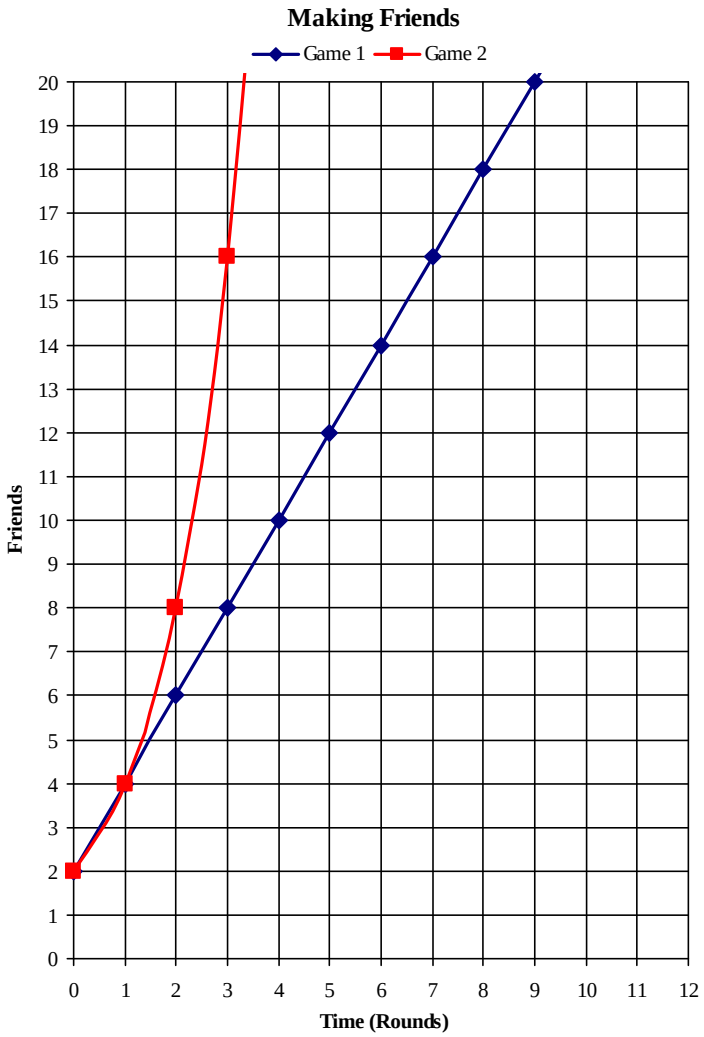
? **Is a pattern emerging?**

Game 2

Round	Friends
Start	2
1	4
2	8
3	16
4	32
5	64
6	

9. Graph Game 2 on the *same graph* as Game 1, but use a *different color* marker.

Allowing players on the Friends team to choose new friends every time in Game 2 will cause doubling. The line will curve and grow faster than the line in Game 1.



Bringing the Lesson Home

Use the graph and questions like these to focus the discussion on what happened to the number of friends in the game. Then, relate the lesson to the students' own life experience**.**

Be sure to save enough time for this important lesson wrap-up. Help students use the game to build critical thinking skills and an understanding of their own friendship behavior.

? **What does the graph tell us about what happened to the number of friends in Game 1 and Game 2?**

In both games the number of friends increased, but the Friends Team grew much faster in Game 2.

? **How are the lines different? How are they similar?**

Both lines go up, indicating an increase in the size of teams, but the line in Game 2 curves, getting steeper with each round. Older students can explore the concept of slope when comparing the lines. Younger students can use terms like "steeper" and "flatter."

? **Did the rate of making new friends change in Game 2 compared to Game 1? Why?**

Yes. In Game 2, players on the Friends Team were allowed to choose a friend every round rather than choosing only once.

? **Why does Game 1 produce a straight line and Game 2 produce a curved line?**

In Game 1, the same number of friends joined the team each turn. Therefore, the graph showed a steady increase represented by a straight line. In Game 2, the number of players joining increased each turn, so the slope of the graph became steeper as the game progressed. The more members there were on the team, the more new players got chosen each round, making the team even bigger for the next round of choices, and so on. This pattern is called compounding or exponential growth.

? **What would happen in Game 2 if another class joined the game?**

Even though the number of players would be much greater, only one more round would be required to complete the game because the Friends Team doubles each round.

? **Which set of rules creates a fully inclusive Friends Team faster?**

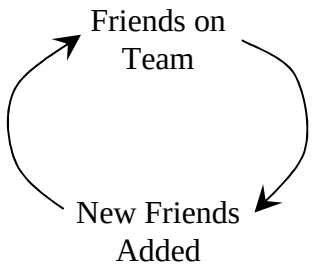
Allowing players to choose a friend each turn is much faster than allowing them only one choice per game.

? **How can this relate to our class?**

If students use their friendship skills often with all their classmates, friendships spread quickly. The atmosphere in the class is much friendlier when everyone is included.

Feedback

Feedback occurs when the size of the existing team affects the number of new arrivals, which in turn affects the size of the team, and so on. This process reinforces growth and produces a curved line on the graph. For example, if the team doubles each time, it can grow from 1 to 2, to 4, to 8, etc.



Variations and Extensions

New Rules

The next time students play Making Friends, they can try out rules of their choice. Encourage them to change variables, such as the original number of friends at turn zero or the number of friends one person may choose. Remember to reinforce the connection to what the simulation represents: using friendship skills to grow a cooperative, supportive classroom environment.

Unfriendly Behaviors

In Making Friends, friendships spread through positive behaviors and interactions. Unfortunately, negative behaviors can also spread by the same growth mechanism. Teasing can spiral out of control on the playground, for example, if students begin to join in. Peer pressure can lead to other negative behaviors. If students are confronting issues like these, use the Friendship Game to point out objectively each person's responsibility in determining the pattern of spread. They can use their friendship skills to turn things around.

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[1] For an earlier version of this lesson see "Graphing the Friendship Game: A Preliminary System Dynamics Lesson" by Ticotsky and Lyneis, 2000 available from the Creative Learning Exchange at www.clexchange.org.

Both lessons are adaptations of the original "Friendship Game" by Peg Clemans, Catalina Foothills School District, Tucson, 1996, available at www.clexchange.org.

Making Friends

*This lesson builds on the classroom activities described in **The Shape of Change,** by Rob Quaden, Alan Ticotsky and Debra Lyneis, 2004, The Creative Learning Exchange. You can download the text of the original single lesson or get the graphics and layout in the complete book from the CLE at www.clexchange.org.*

The Shape of Change

In Lesson 2 of ***The Shape of Change***, students played a game to observe and compare how the number of friends grew as new friends were added each round, first by a constant number and then by doubling. See Pages 17-25 in ***The Shape of Change*** for the complete lesson.

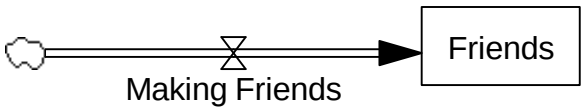
Overview

Of the two games played in Making Friends, Game 1 is based on the same stock/flow structure as the In and Out Game. During each round of the game, the number of new friends is constant. This causes the total number of friends to increase at a steady rate.

However, the structure of Game 2 is completely different. In that game, the number of existing friends *caused* an increase in the number of new friends, because *each* existing friend chose a new friend each round. As a result, the number of friends increased at an increasing rate. This represents the fundamental concept of **feedback**.

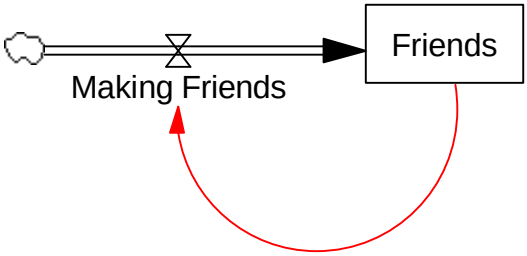
Seeing the Structure

1. Ask students to draw a stock/flow map of Game 1. Point out that the map looks similar to the In and Out Game.



2. Ask why this map would not explain Game 2. Students should realize that the flow "Making Friends" changed throughout the game. It was not constant.

3. Ask students to explain why the number of friends in Game 2 increased so much faster. The number of friends in the stock determined the number of new friends flowing in because each friend recruited a new friend each round. In other words, the stock influenced the flow. To show this on the map, draw a connector arrow from the stock to the flow.



*Note: The curved arrow is not a flow – no friends are moving from the stock. Rather, the red arrow indicates that **information** about the size of the stock affects the size of the flow.*

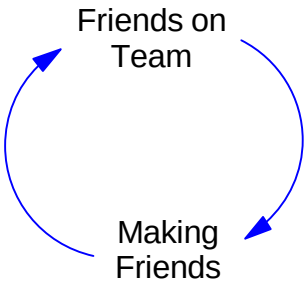
This is an example of **positive feedback,** also called **reinforcing feedback.** The stock increases the flow, which increases the stock, which in turn increases the flow, etc. This process goes on and on, increasing the value of the stock faster and faster.

Refer back to the game. At first, one friend chose one friend, making two friends in the stock. In the next round, the two friends each chose a new friend, making four friends in the stock. Then those four friends each added a friend to make a total of eight friends in the stock, and so on, doubling each round.

Positive feedback is another name for a vicious (or virtuous) cycle. Growth that is gathering speed can also be called snowballing, escalation or compounding growth. It is a feedback loop that reinforces itself.

A Causal Loop

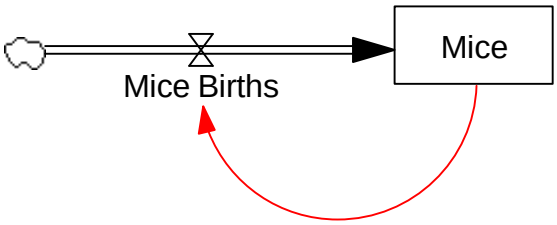
This drawing is another way to show feedback. The causal arrows mean that an increase in friends on the team causes an increase in making new friends, which in turn causes an increase in the friends on the team, and so on. (More details later.)



A causal loop diagram is a quick sketch of the feedback loops, while a stock/flow diagram shows us more precisely how the changes work. We use them together to think about change over time.

4. Ask students to think about real-life examples of positive feedback. There are countless examples of positive feedback in the world around us.

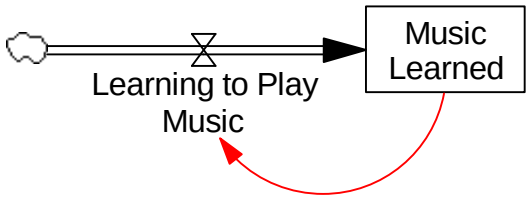
   Example 1:



   If you start with just a few mice, they give birth to baby mice, which grow into adult mice, which give birth to more baby mice, etc. Given that most people consider mice pests, this is an example of a vicious cycle.

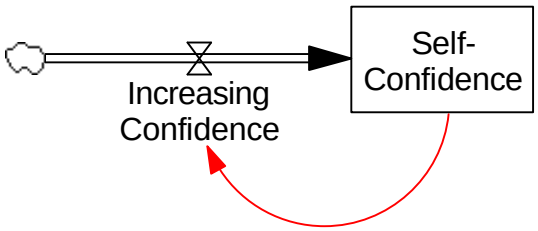
   Note that this map is incomplete and does not show the complete dynamics of mice populations. For example, the map does not show mice deaths and it does not specify a birth rate. More on these later.

Example 2:



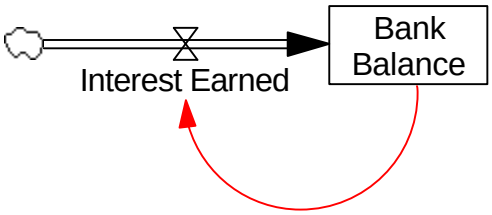
Once you learn to play a simple piece of music, you are able learn a more complicated piece, and so on. Here the reinforcing loop would be a virtuous cycle.

Example 3:



The more self-confidence you have, the more willing you are to take on new situations, which then increases your self-confidence.

Example 4:

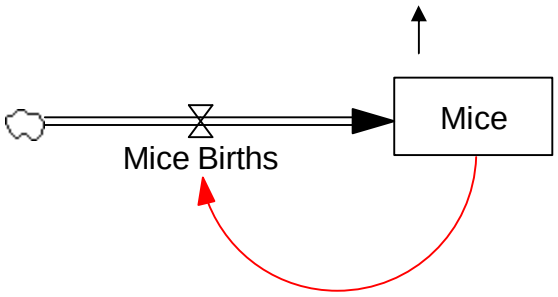


The more money you have in a bank account, the more interest you earn, giving you even more money in the account, and so on.

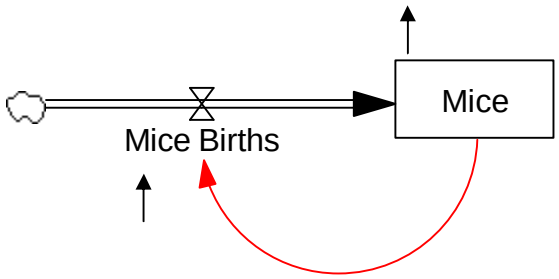
Note: Time is implicit in every stock/flow diagram. For example, money is deposited to the bank balance per month, adding to the total accumulation of dollars in the stock over time.

5. After drawing each map, trace the feedback loop by following the direction of the flow and the connector arrow. To understand how the stocks and flows change, it is helpful to draw up or down arrows to show increases or decreases around the loop.

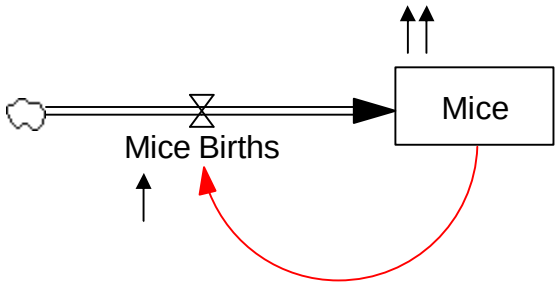
   Using the mice example, show an initial **increase** in the number of mice by placing an up arrow in or near the stock:



   Tracing the red connector, the increase in the number of mice will **increase** the number of mice births because more mice will have more babies. Show this by drawing an up arrow near the flow:

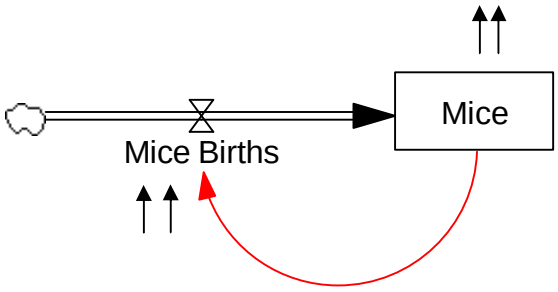


   Following the flow "pipe," this increase in mice births further **increases** the number of mice above what it would have been. Add another up arrow near the stock:



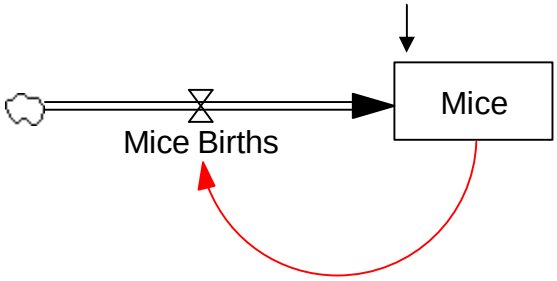
   Note: Mice births always increase the population, but increasing the births produces even more mice than there would have been otherwise.

An increase in mice further **increases** the mice births:

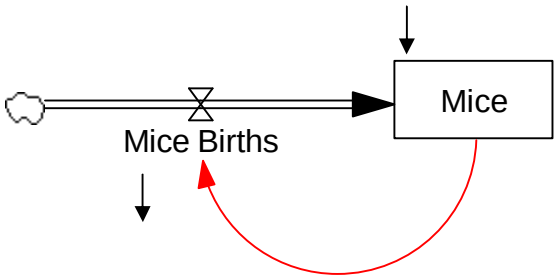


No matter how long we follow this process, more and more arrows will line up, all pointing in the same direction. This indicates that the number of mice will increase at a faster and faster rate.

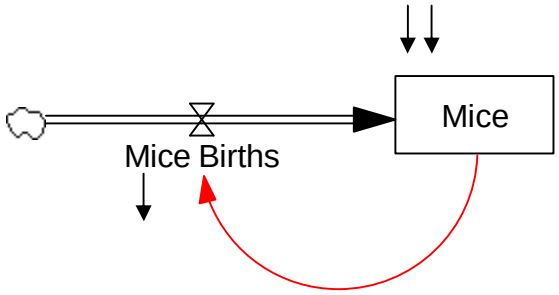
6. Note that we started this process by **increasing** the number of mice. We could also have **decreased** the number of mice at the start, in which case the initial arrow would point down:



The result of this decrease would be that, all other things being equal, the number of mice births would also **decrease**. Show this by placing a downward arrow near the flow:



If the number of births decreases, the number of mice **decreases** relative to what it would have been if there had been no decrease in the number of births. (With any new births, the number of mice is still growing, but because fewer mice produce fewer births, the stock is growing at a slower rate.) Show this by adding another downward arrow near the stock:

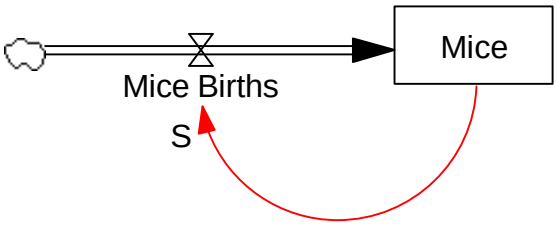


The situation with the downward arrows is analogous to the one with the upward arrows. No matter how long we continue the process, more and more arrows will line up, all pointing in the same direction.

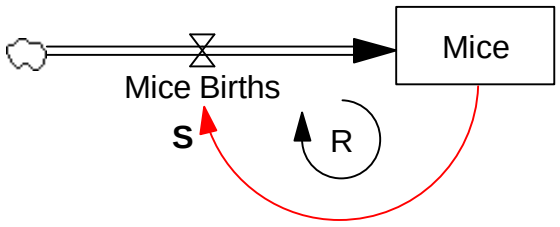
In a reinforcing feedback loop, any change is amplified each time around the loop.

7. There are two distinct, but related concepts that need clarification.

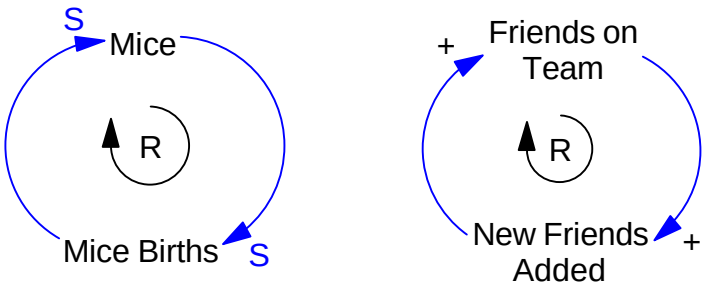
   - First, note that, all else being equal, an **increase** in the stock leads to an **increase** of the flow and that a **decrease** in the stock leads to a **decrease** in the flow. In other words, the change from the stock to the flow is in the ***same*** direction. This is shown by either adding the letter S (for "same") or the + sign near the arrowhead. Doing so eliminates the need for the up/down arrows, although they are helpful at first.



- The second concept is that positive feedback produces a **reinforcing loop**. Each time around the loop, an initial increase (or decrease) is reinforced again and again. To show that the number of mice will increase faster and faster (with more arrows always pointing in the same direction) write an R in the loop for "Reinforcing."



Causal Loop Diagrams

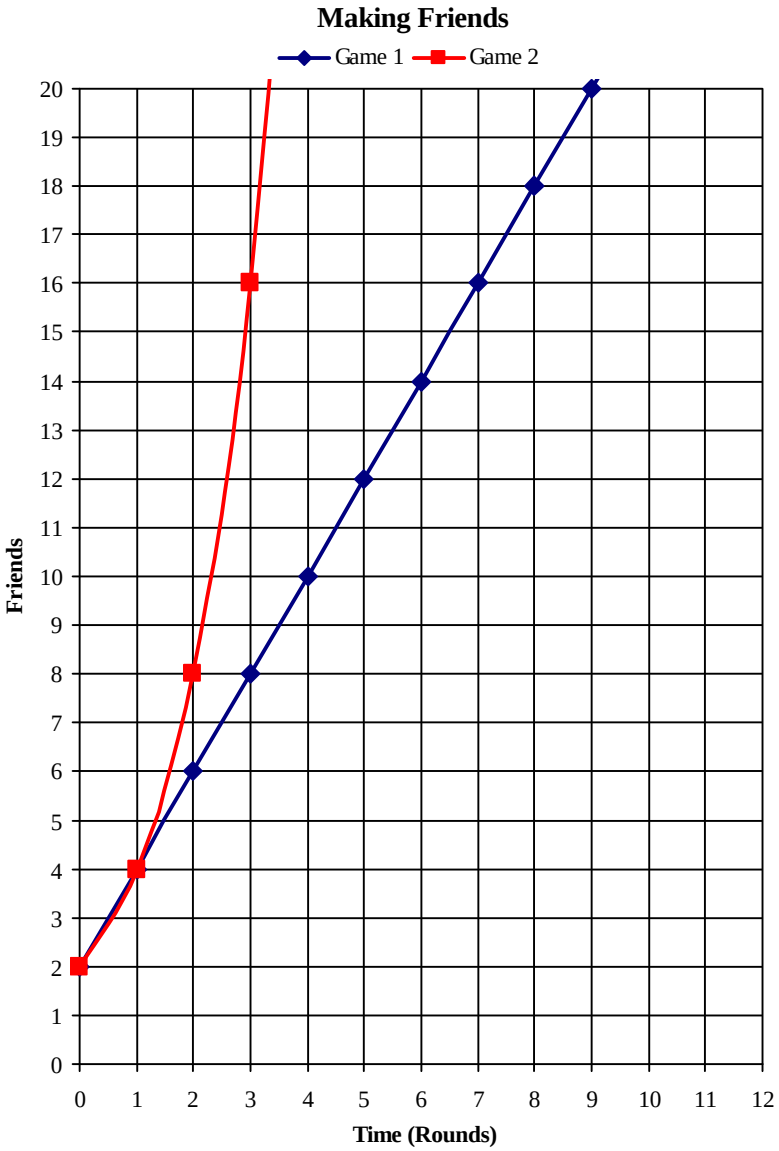


An increase in mice causes an increase in baby mice which causes an increase in the number of mice, and so on around the loop. Likewise, a decrease in mice would trigger a decrease in births, producing fewer mice than there would have been otherwise, and so on. The label "R" tells us that this is a reinforcing feedback loop.

Now we can also complete our Making Friends causal loop drawing. The "+" sign is another way to show that an increase (decrease) in one variable causes an increase (decrease) in the next variable, beyond what it would have been.

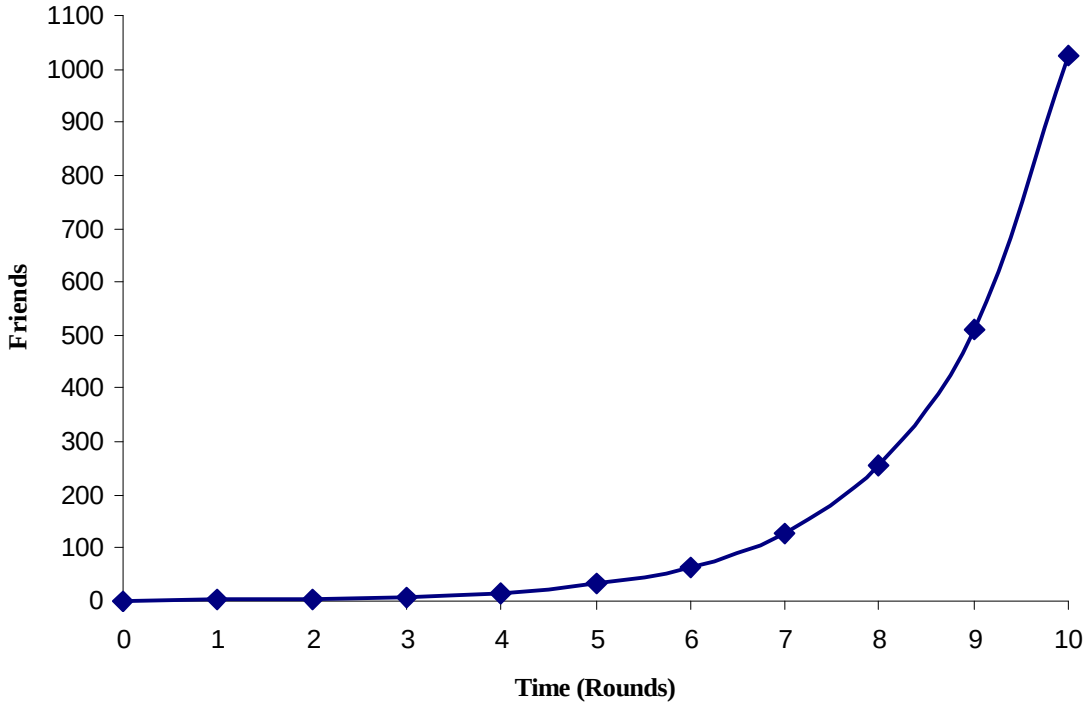
? **How do these stock/flow maps relate to the graphs we drew of the friends game in *The Shape of Change*?**

*In the first game, the number of new friends was constant each round, so the line on the graph showed linear growth, a straight line. In the second game, however, the number of new friends depended on the number of friends already on the team because **each** friend chose a new member for the team each round. More friends led to even more friends. This escalating growth appeared as a curved line on the graph.*



? **In Game 2, we could play only three rounds before running out of players. What would the graph look like if we had enough students to play ten rounds?**

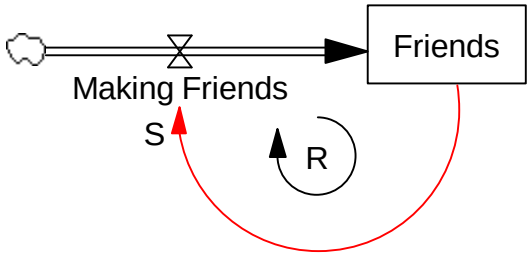
Growth would escalate rapidly. Starting with one student on the friends team and doubling the number of members each round, there would be more than a thousand members after ten rounds! A reinforcing feedback loop produces this pattern called ***exponential growth****.*



? **Think about our mice. Does our stock/flow map produce this same behavior for them? What about money in the bank and the other examples we discussed?**

Yes, they are all examples reinforcing feedback loops that can cause the stocks to grow exponentially until something limits their growth..

? **Think again about the Making Friends game and graph. Tell the story of this completed stock/flow diagram.**



The total number of friends on the team, the stock of Friends, is increased by the inflow of new friends each round. As players make new friends, the team grows.

This map describes the second game when the number of friends on the team affected the flow of new friends because each friend chose a new friend each round. The more friends there were on the team, the more new friends were added (a change in the same direction labeled "S"). The number of friends kept growing at an increasing rate, producing a steepening curve on the graph. We call this pattern exponential growth, a hallmark of a reinforcing feedback loop (labeled "R").

If, partway through the game, we decreased the stock by taking some players out of the game, that would cause a decrease in the number of new friends below what it would have been otherwise (a change in the same direction). With fewer new friends, the team would grow more slowly than it would have otherwise. Like the mice population, the team would still grow but at a slower rate.

The stock/flow maps lay out the structure for us. The causal loop diagrams and the behavior over time graphs give us another view of the same thing. Used together, they help us understand how and why things change over time.