

Research Experience for Teachers (RET)

**Develop a curriculum for a
simple, interactive,
climate model
to teach climate science
to high school students**

Colleen Cope

A photograph of three students in a science laboratory. They are wearing safety goggles and white lab coats. They are gathered around a clear plastic terrarium on a lab bench. One student is looking into the terrarium, while the others are looking on. The lab bench has various items on it, including a glass bottle, a spoon, and a sign that says "Person who made a mistake". In the background, there are lab cabinets and a microscope on a stand.

**Objective #1:
Plan effectively
by answering the following questions ...**

“What specifically do we want students to understand about climate?”

A young girl with blonde hair, wearing a white t-shirt with 'SEAL WORLD' on it, is sitting on a globe in a classroom. She is holding two green balls, one in each hand, and looking directly at the camera. In the background, there are other students, a desk with a globe, and a boombox on a chair. The scene is brightly lit, possibly from a window.

**“How will they demonstrate
their understanding?”**

**Workbook, tests, quizzes,
project, presentation**



“What activities will get them there?”

Always create a structure in which they are building their own knowledge based on curiosity

**iPad apps, labs, animations,
interpreting graphs and maps,
interactive computer simulations,
embedded video and materials (LSOP), game-based
learning, 3D-sim environments, etc., etc.**

A photograph of a science classroom where four students are sitting at a table. They are all wearing blue 3D glasses and looking towards the camera. The table in front of them is covered with papers, a calculator, and other supplies. In the background, there are blue cabinets, a water cooler, and a window with blinds. The text 'Objective #2:' is overlaid in the upper right quadrant of the image.

Objective #2:

**Make sure we're aligned with
the new State standards and
local or other standards**



Objective #3:

**Recruit teachers to use our
climate model ideas in their
classroom and provide feedback**

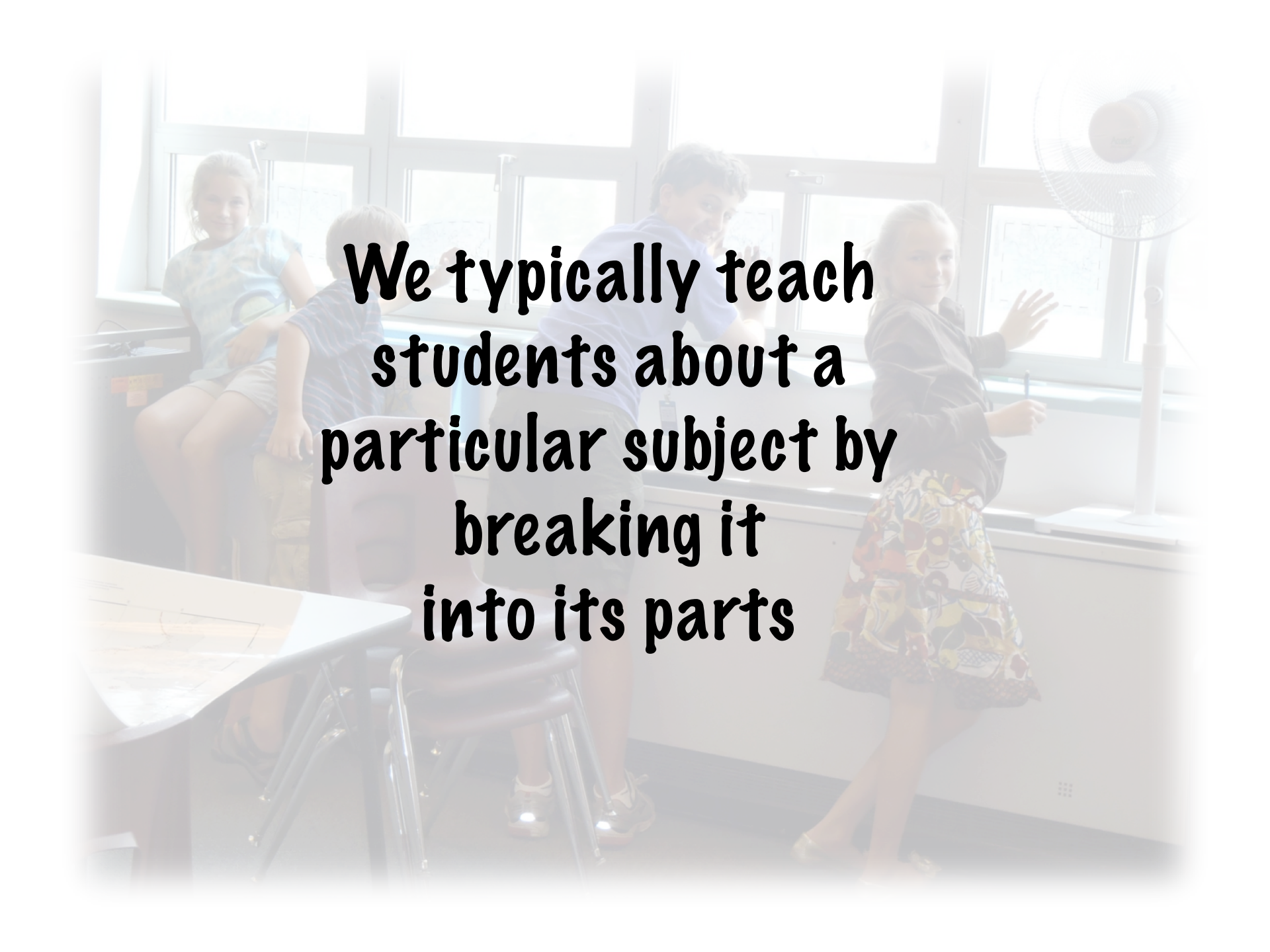
A photograph of four students in a science laboratory. They are gathered around a table, working on a project. A large blue plastic bag is on the table, connected to a blue corrugated tube. The tube is connected to a clear plastic tube filled with colorful beads. The students are looking at the setup with interest. The background shows blue lab cabinets and various scientific equipment.

Objective #4:

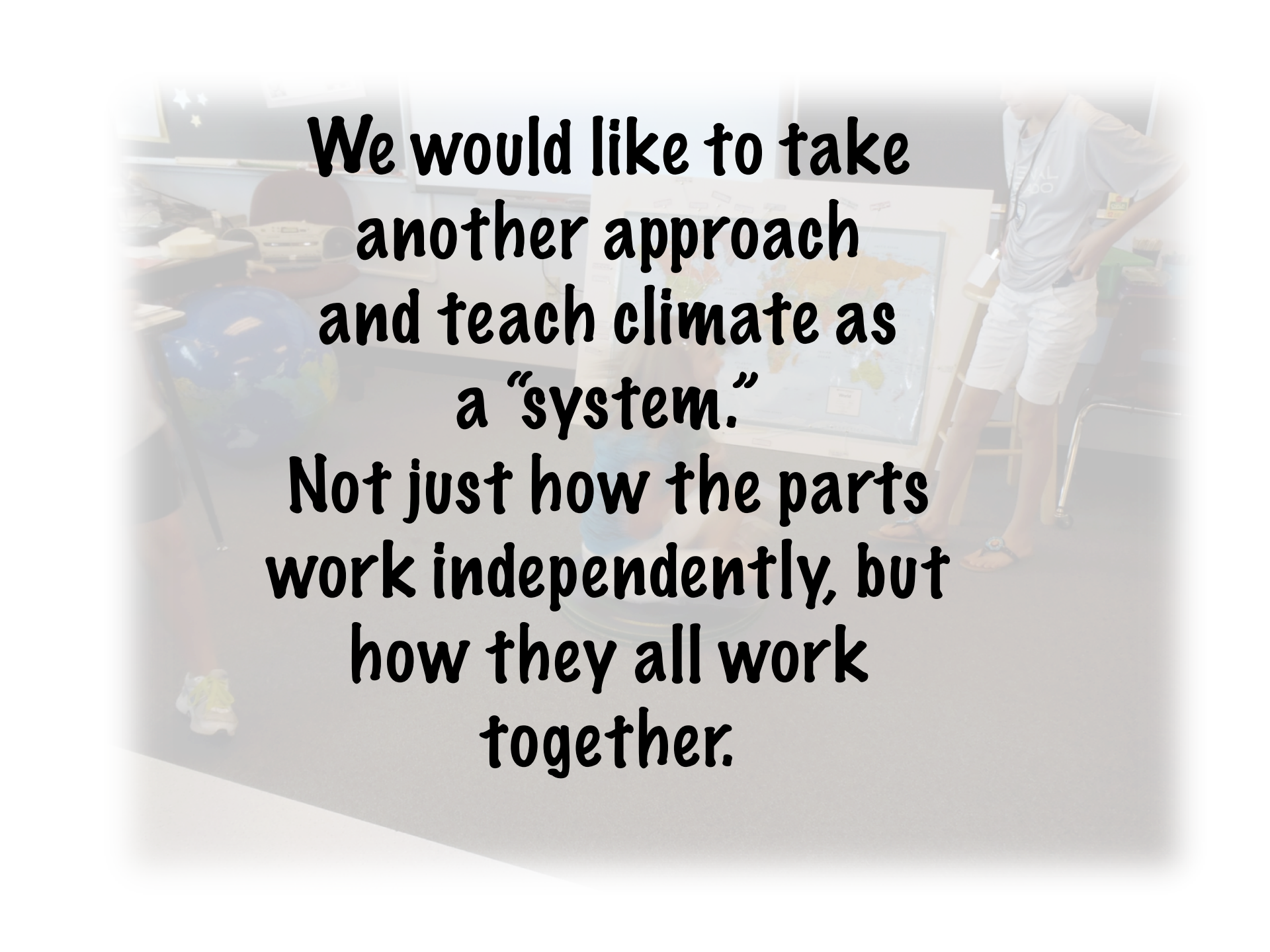
**Take this innovative method
and publish it in a educational
journal**

A woman with blonde hair, wearing a blue and white plaid shirt and a lanyard, is looking down at several colorful educational cards laid out on a table. In the background, a man in a blue t-shirt with a list on the back is standing near a bulletin board decorated with stars. A world map is visible on an easel to the right. The scene is set in a classroom or meeting room.

So where do we start?

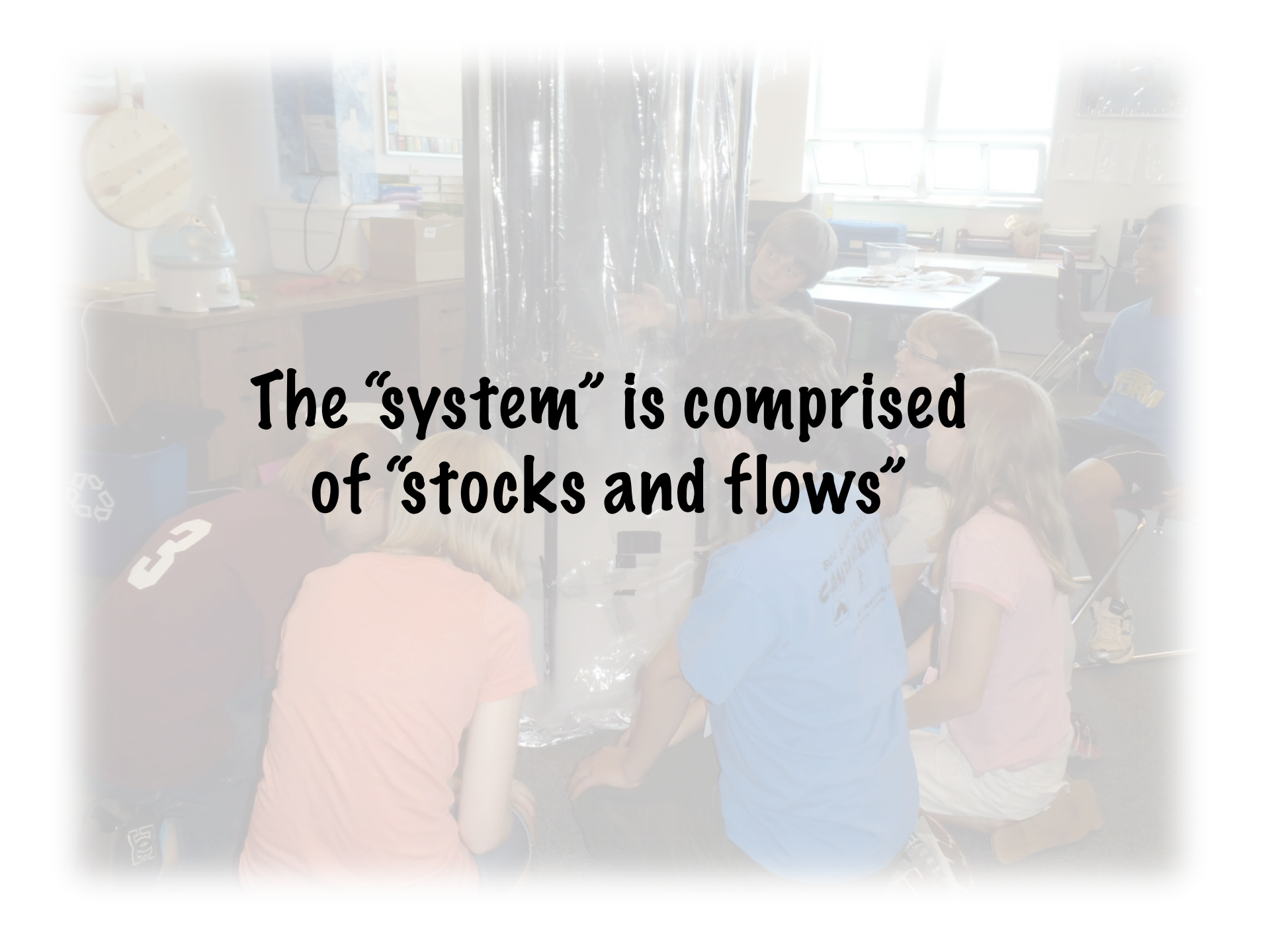
A photograph of a classroom scene. A teacher, a woman in a blue shirt and dark pants, is standing and interacting with four young students. One student is sitting on a desk, another is sitting on a chair, and two others are standing near a window. The room has large windows, a desk with a fan, and a whiteboard. A large, bold, black text overlay is centered in the image.

**We typically teach
students about a
particular subject by
breaking it
into its parts**

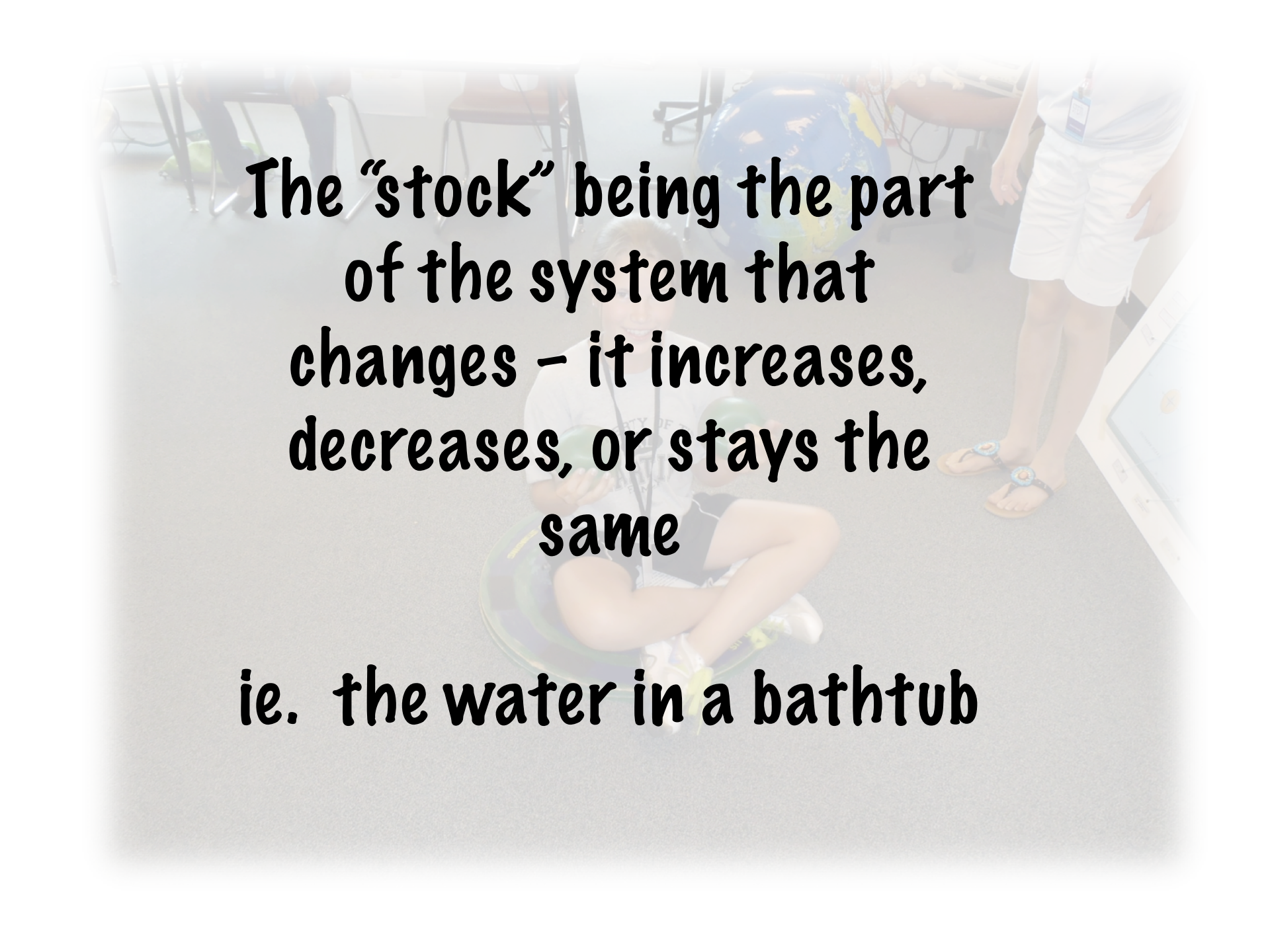


**We would like to take
another approach
and teach climate as
a “system.”**

**Not just how the parts
work independently, but
how they all work
together.**



**The “system” is comprised
of “stocks and flows”**

A person is sitting on a large globe in a classroom. They are holding a green balloon. In the background, there is another globe on a stand and a person standing. The scene is brightly lit, possibly with a projector screen in the background.

**The “stock” being the part
of the system that
changes – it increases,
decreases, or stays the
same**

ie. the water in a bathtub



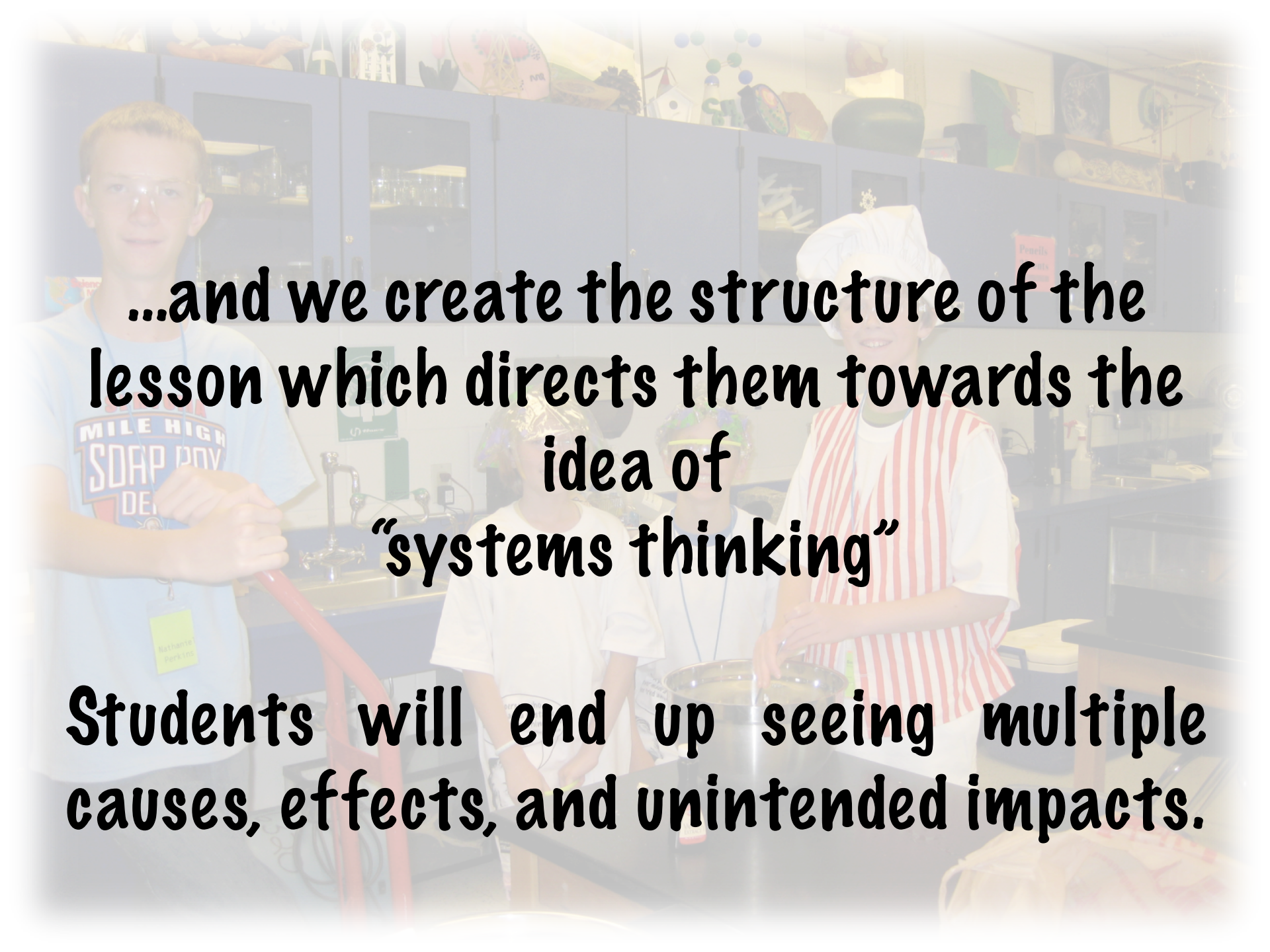
**The “flows” are rates of
stuff that go into or out of
the stock...**

**ie. flow into or out of the
bathtub**

The background image shows a school campus. In the foreground, a paved path leads from the bottom center towards the right. A person in a red shirt is standing on the path to the right. In the middle ground, two people are sitting on the grass. In the background, there is a large white building with a prominent staircase on the left side, surrounded by green trees under a clear sky.

We can get creative with the metaphors by modeling anything measureable.

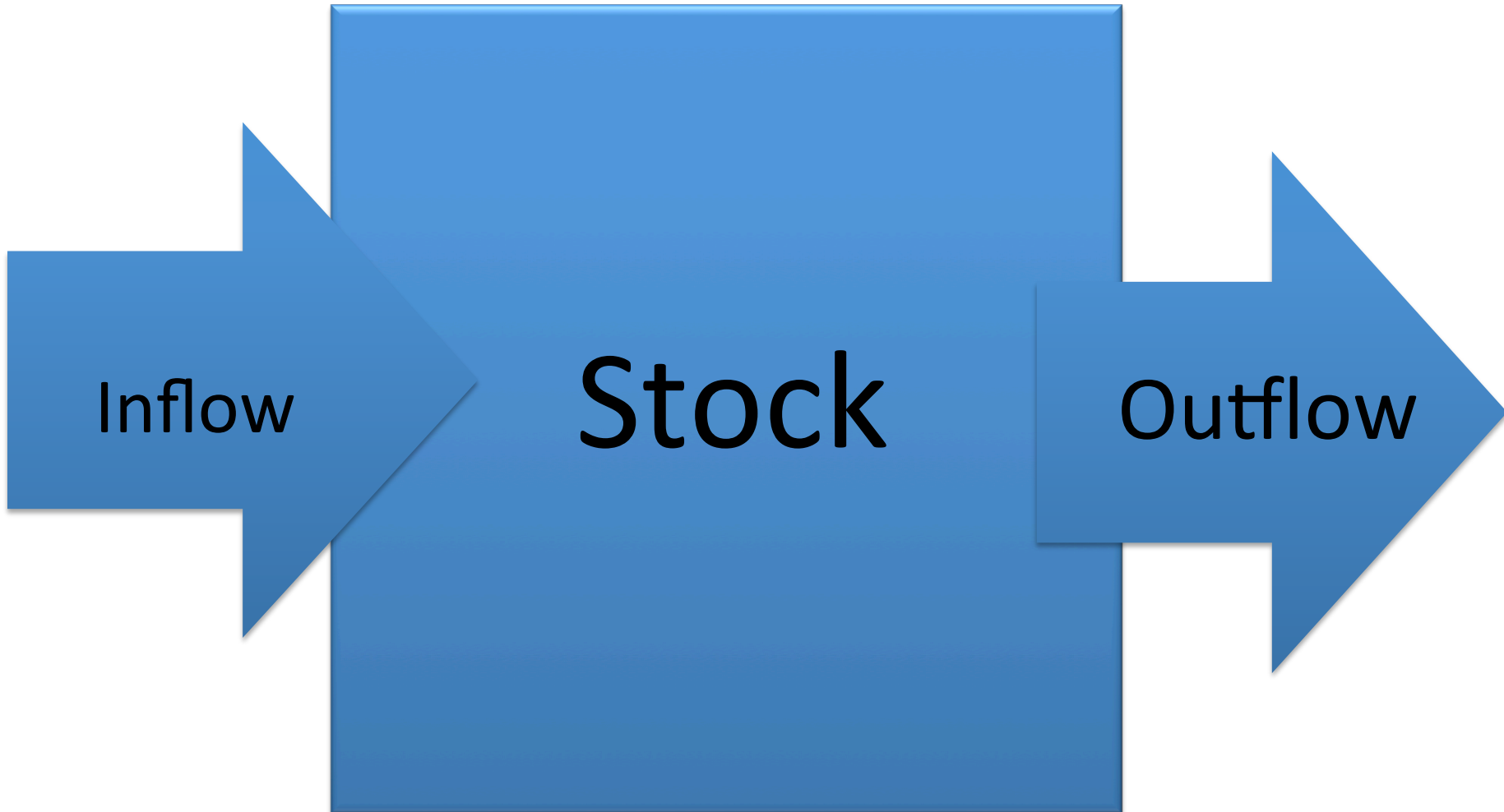
So we start by having the students create their own stocks...out of anything.

A science classroom with blue cabinets and various scientific equipment. A male student in a blue t-shirt with 'MILE HIGH SDAP BOY' and safety goggles is on the left. A female student in a white t-shirt is in the center. A female teacher in a white chef's hat and a red and white striped vest is on the right, working with a large metal pot. The background is filled with scientific models and supplies.

...and we create the structure of the lesson which directs them towards the idea of “systems thinking”

Students will end up seeing multiple causes, effects, and unintended impacts.

**Students will realize when they start moving
stuff into and out of stocks
and keeping track in tables and graphs, that...**



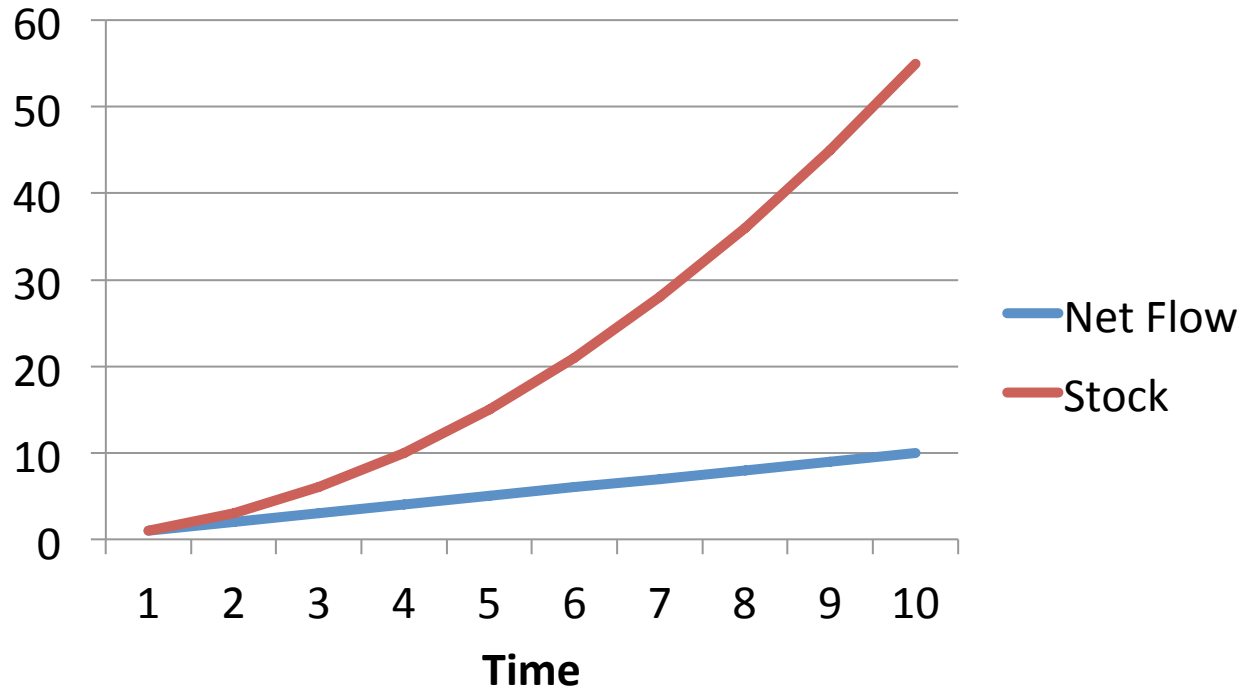
1. Stocks are impartial



Time	Net Flow	Stock
1	1	1
2	2	3
3	3	6
4	4	10
5	5	15
6	6	21
7	7	28
8	8	36
9	9	45
10	10	55

“But my flow only increased by a “little” each year??”

Stock-Flow Graph



A person is sitting on a grassy area, holding a clear plastic bottle. The bottle is inverted and placed over another clear plastic bottle that is upright on the grass. The water in the inverted bottle is dripping into the upright bottle. The person is wearing a white t-shirt with a colorful graphic and blue pants. The background is a plain wall and a potted plant is visible on the left.

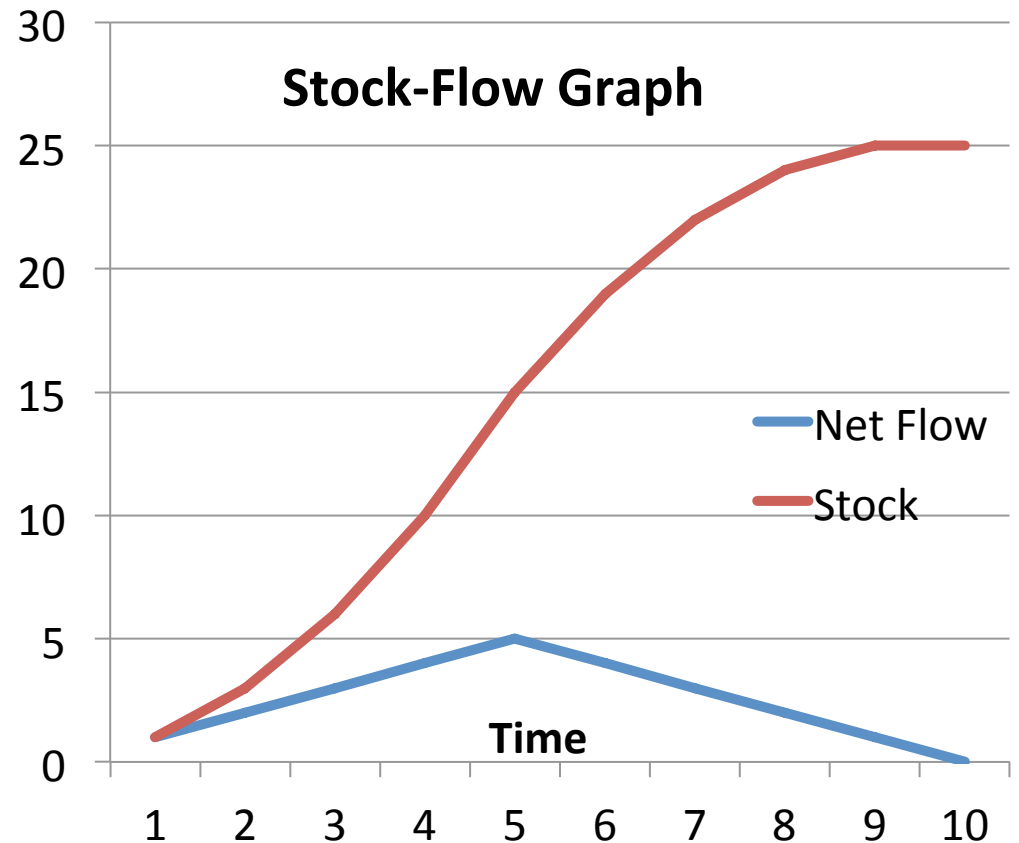
1. Stocks are impartial

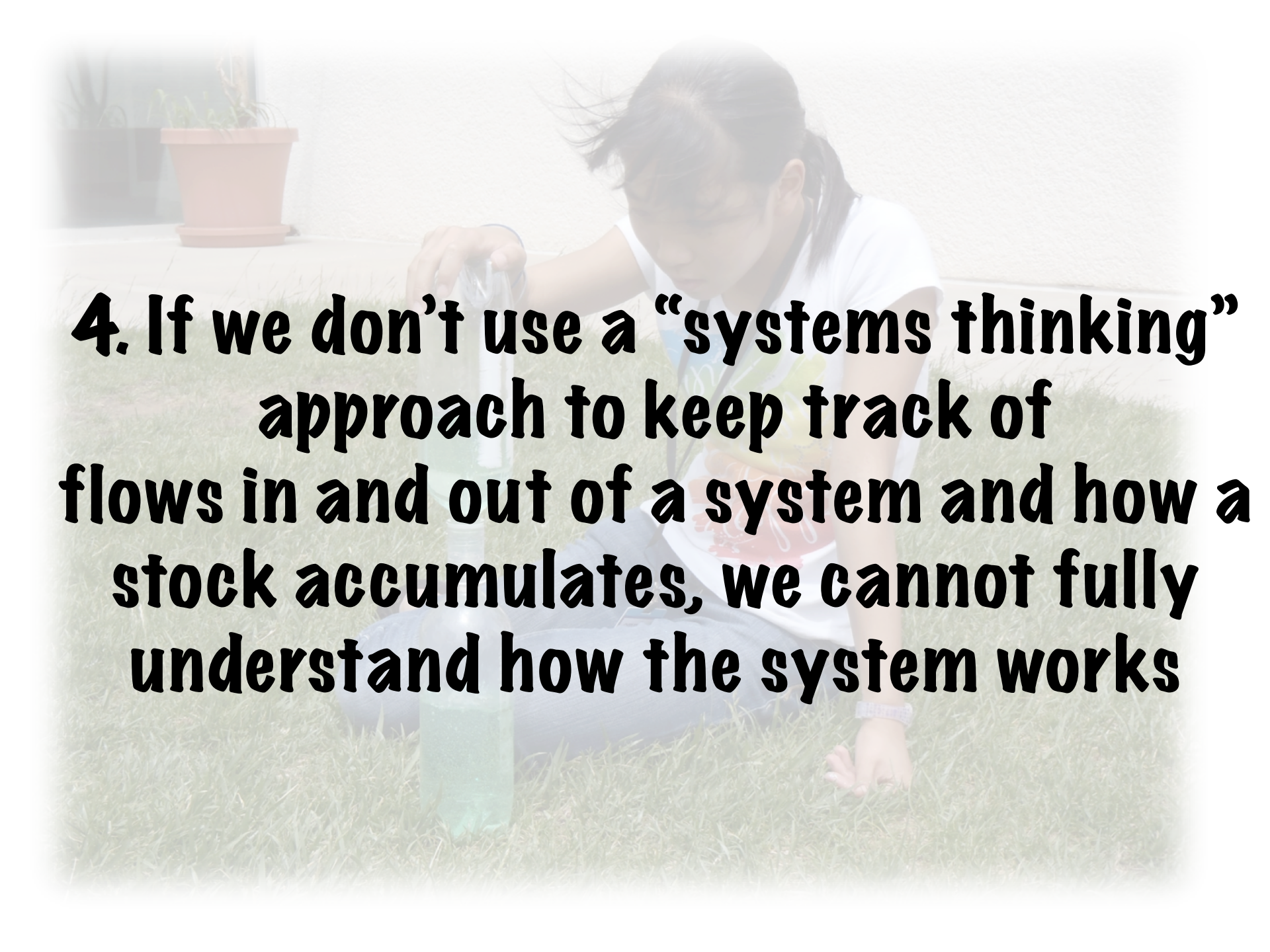
2. Inflows and outflows can be on extremely different time scales

3. The stocks always lag behind flows

Time	Net Flow	Stock
1	1	1
2	2	3
3	3	6
4	4	10
5	5	15
6	4	19
7	3	22
8	2	24
9	1	25
10	0	25

**“My flow rate
decreased to ZERO
but my stock remains?”**

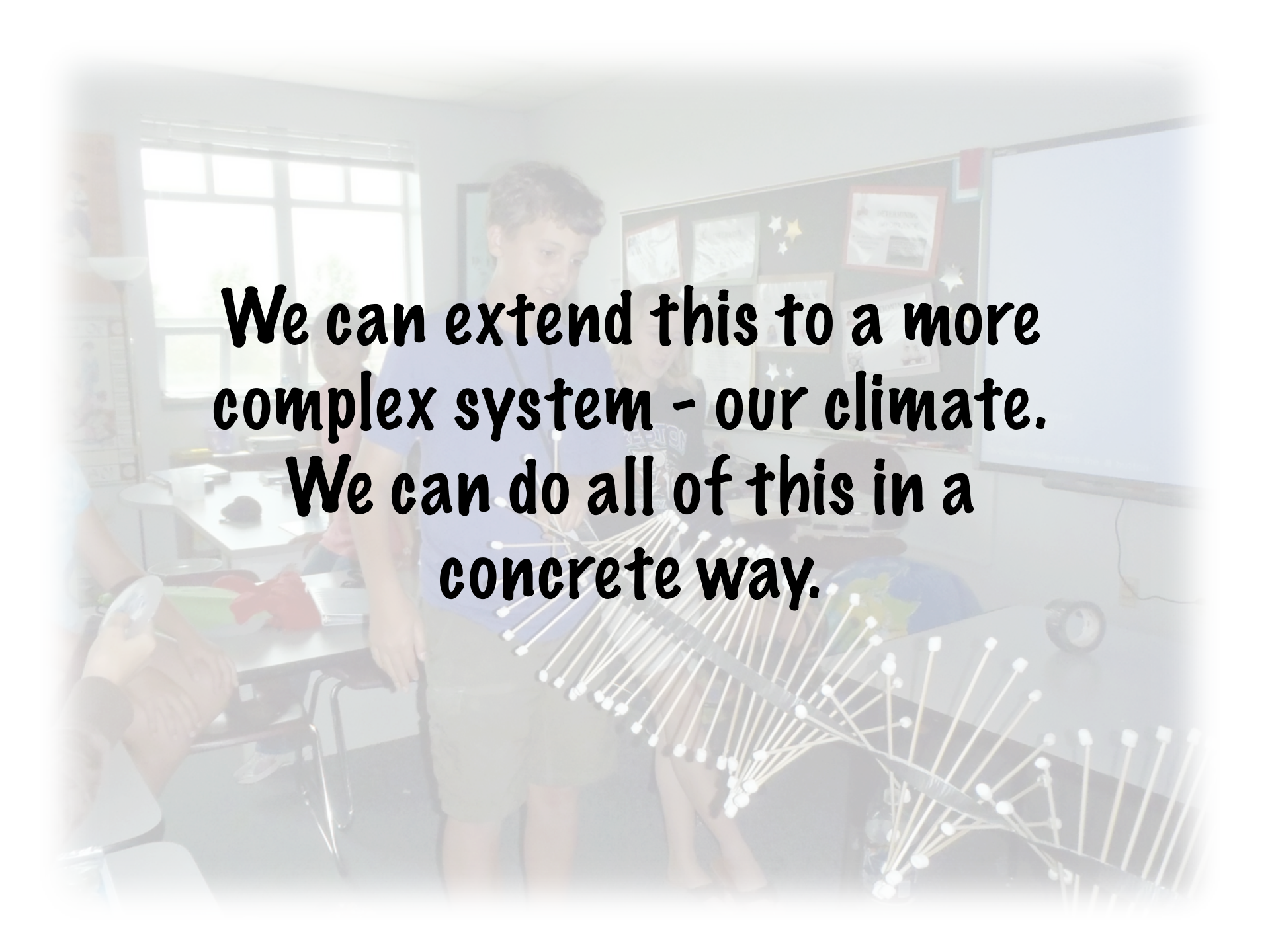




4. If we don't use a "systems thinking" approach to keep track of flows in and out of a system and how a stock accumulates, we cannot fully understand how the system works



**It's a simple idea
but has profound implications.**



We can extend this to a more complex system - our climate. We can do all of this in a concrete way.

A young child with glasses is blowing a red horn in a classroom. The background features a chalkboard with handwritten notes, a world map, and a water bottle on a stool. The text "Still have fun learning about it" is overlaid in the center.

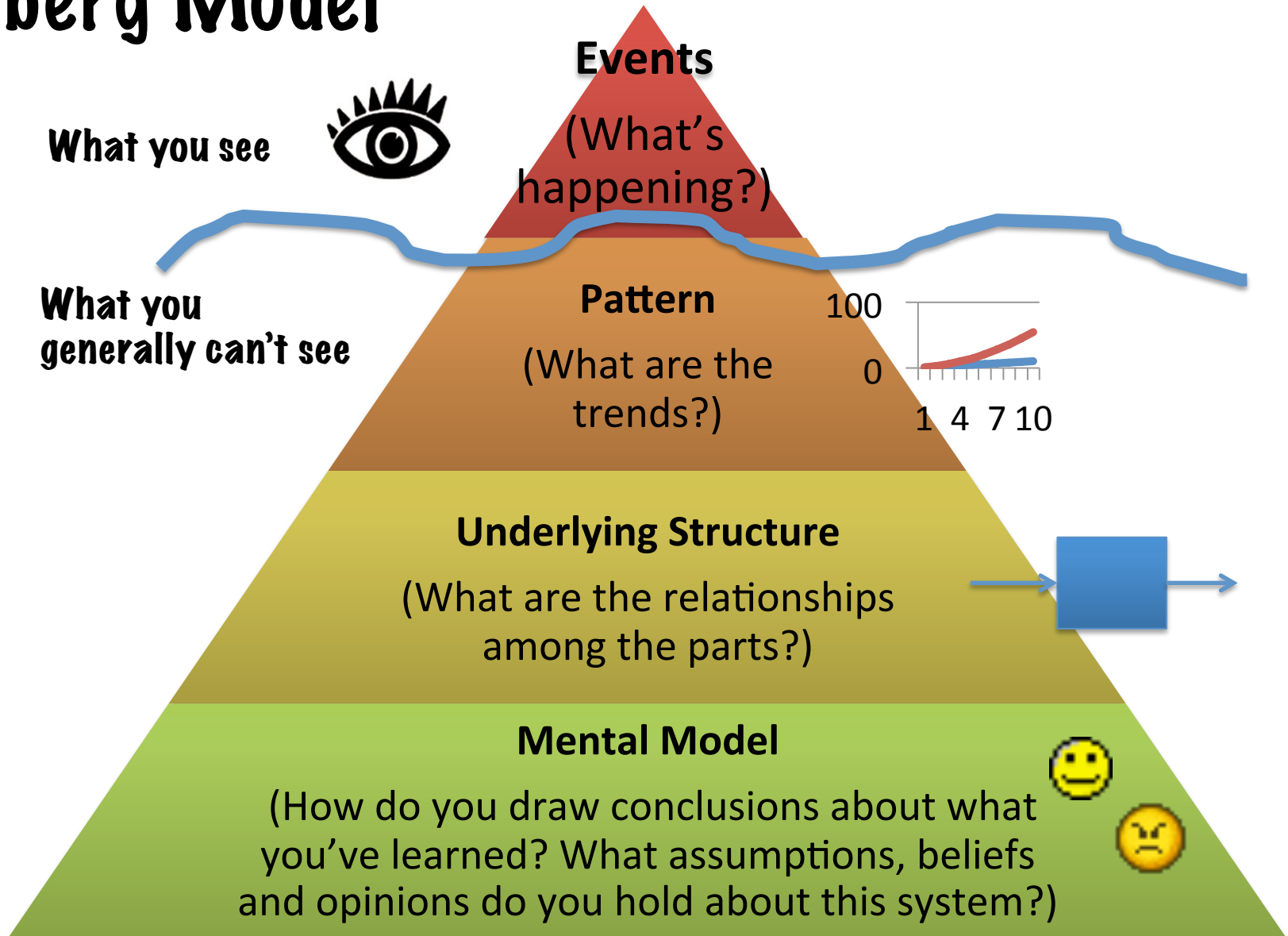
**Still have fun learning
about it**



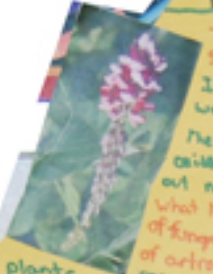
Because after all...

They are kids!

Iceberg Model



Pueraria KUDZU



The place it's origin of Invasive Species is Japan and China, Asia
Introduced in 1800's, there was a problem Australia-

The forest was supreme nitric oxide and nitrogen and crowds out native species.
What kills it is twelve species of fungus and forty species of arthropods or birds.



Pea family, climbs, can reach 35 to 100' long, Purple flower 1/2 long, Roots as big as tree has milk, home, source of starch, and richer than soy beans.

plants and oxide overgrow and kill other because of the nitrogen

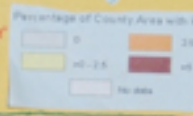
Alex P. Herl
Marius Mayer!



Made Starch and was for Soda.



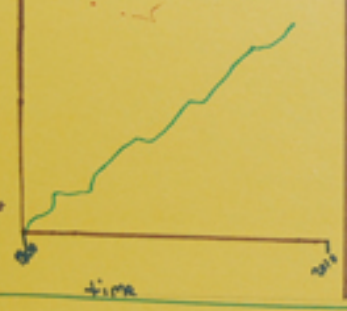
This is where kudzu is grown



people are using chemicals and need killer to kill kudzu, but it is killing other plants too so they have to stop

Events

Kudzu population over time



The Kudzu has grown population over time and the vine's can grow to 100'



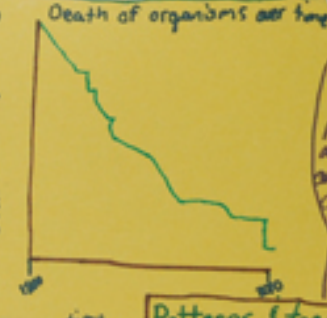
Kudzu can grow fast over everything including houses. As an example in this image.

Decline in other plants



I didn't know that any plants could grow to 100' high.

Deaths of organisms



The plants are dying and so are organisms. The organisms die because they can't eat Kudzu.

Patterns & Trends

Kudzu is growing over trees and bushes often makes shapes which look like familiar animals and objects

The Harvard Medical School is studying kudzu as a possible way to treat alcoholic cravings.

Kudzu is also known as becoming a problem in southeastern Australia, and has been seen in isolated spots in Northern Italy Liguria Maggiora.
Kudzu was introduced by Japan into the United States in 1876 and is now common throughout most of the southeastern United States. Kudzu has been spreading at the rate of 150,000 acres (61,000 ha) annually.

Scientists at the University of Virginia and Columbia University have discovered that the kudzu vine activates dopamine, nerve waste, and nitrogen in a chemical reaction which produces ground-level ozone.

For successful long-term control of kudzu, it is not necessary to destroy the entire root system, which can be quite large and deep. It is only necessary to see some kudzu to destroy the kudzu root system.

Because of the rapid growth of kudzu, signs along the highways in the south sometime become covered in late summer.

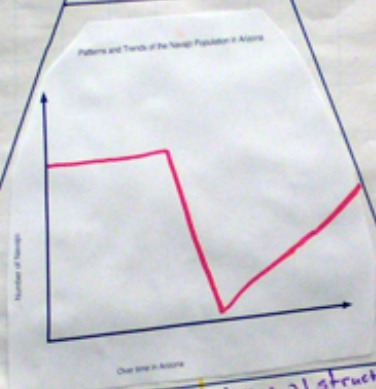
Kudzu has made a big change in life because it has stuff (plants)

Mental Models & underlying Structures

Events

The Navajo population in the late 1800s was thousands
ALIZONA

Patterns of Behavior



Government structure

Gadsden Purchase - U.S. government purchased land from Mexico.

U.S. soldiers posted notice for Navajo to leave the Arizona territory.

U.S. soldiers enter area known as Arizona today, reservations!

Physical structure

Sheep graze on the sweet grass of the mesa.

Navajo tend peach orchard.

U.S. soldiers enter area known as Arizona today.

river, stream

Fort Sumner is in New Mexico, reservations

Underlying Structures

Social structure

Navajo women own sheep.

Navajo men are warriors.

Navajo men are hunters.

The spring provides fresh water.

Pioneers are moving west.

Resources

river, stream

horses

Navajo tend peach orchard.

Sheep graze on the sweet grass of the mesa.

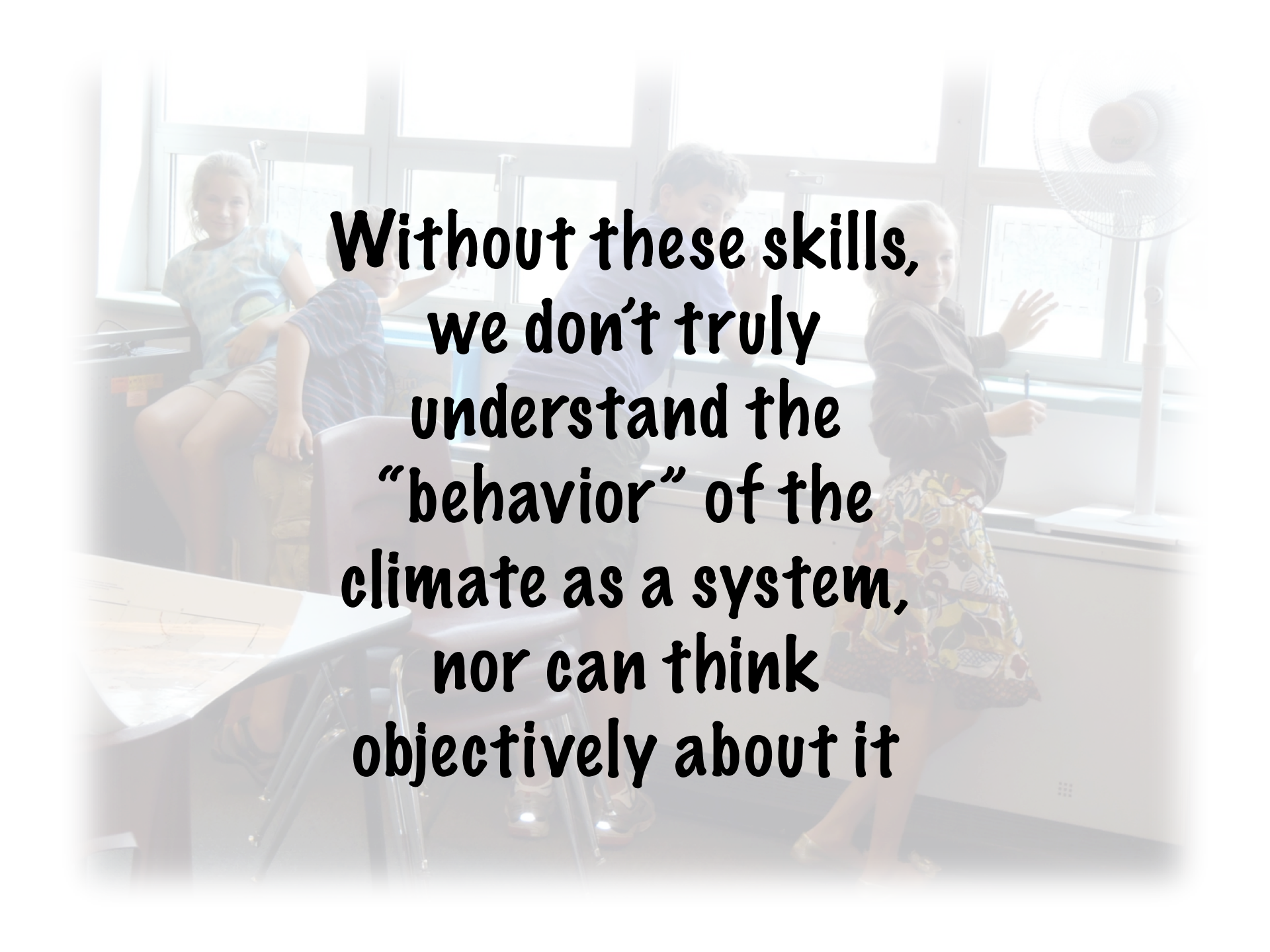
The spring provides fresh water.

Navajo grow corn, squash and beans in the field.

Models

What assumptions, beliefs, and values do people hold about the system.

- U.S. Government thought if they got all the Indians out of the area they could make A.Z. a shift faster.
- Navajo people believed that if they got to happy the gods will punish them.
- Pioneers valued the gold in Arizona.
- Navajo people valued the rivers and streams for water.
- Pioneers wanted A.Z. because they wanted more land.

A faded background image of a classroom. A teacher is leaning over a desk, interacting with three young students. One girl is sitting on a chair, another is standing and pointing at a window, and a third is standing nearby. A large fan is visible on the right side of the room. The overall scene is brightly lit, likely from large windows in the background.

**Without these skills,
we don't truly
understand the
"behavior" of the
climate as a system,
nor can think
objectively about it**

A photograph of three students in a classroom setting, likely a science or art room. They are seated at a dark table, focused on a project. The student in the foreground is a girl with blonde hair in a ponytail, wearing a blue hoodie, and is working on a sheet of paper with colorful dots. The student in the middle is a boy in a black t-shirt, also working on a similar sheet. The student in the background is a boy with glasses in a blue shirt, looking towards the other students. The table is cluttered with various materials, including a pencil, a small box, and several sheets of paper. In the background, there are shelves with various items, including a box labeled 'Rainbow Glasses' and a 'FRAGILE' sign. The overall atmosphere is one of collaborative learning and hands-on activity.

**We can extend this awareness
into a
service learning project**



For example:

- **researching policy**
- **interviewing scientists**
- **speaking to elected officials**
- **creating short PSA videos**
- **maybe even sponsor a school project**

Time to get started

