Systems Thinking and Climate Change

Building Systems from SCRATCH

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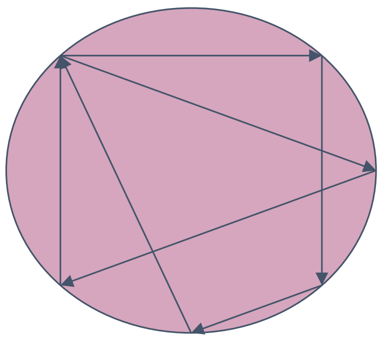
Creating a Connection Circle



Choose components of the system that:

- Are important to changes in the system
- Are nouns or noun phrases
- Increase or decrease in the story.

- Write the components around the circle, including no more than 5 to 10.
- Identify components that cause other components to increase or decrease.
- Draw an arrow from the cause to the effect.
- Look for feedback loops.

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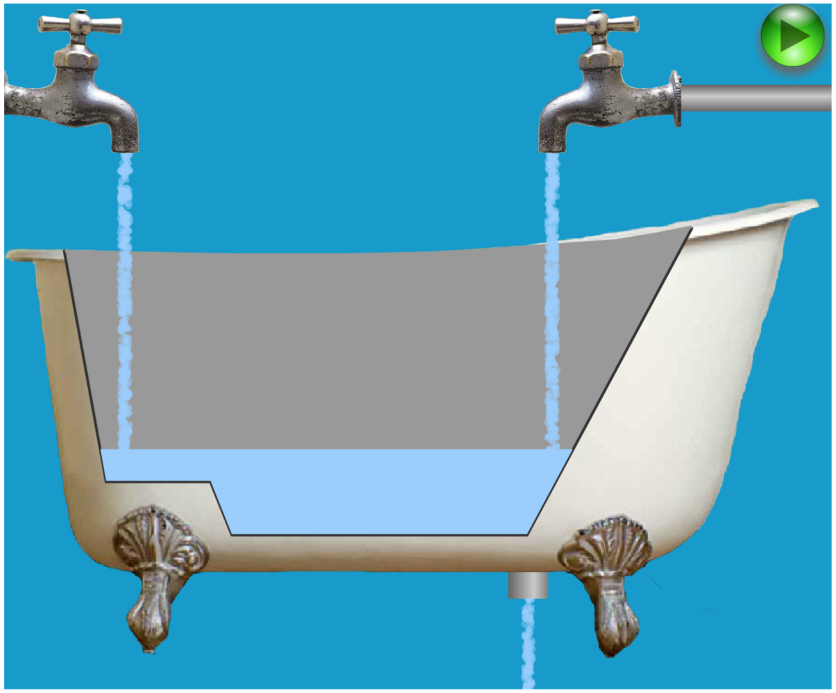
Systems and climate change

- Bathtub model

http://www.scied.ucar.edu



Systems Components in Climate Change: Carbon Cycle

- Components, “stocks” or reservoirs of carbon
- Flows of forms of carbon among components
- Interactions with other systems (e.g., water cycle)
- Feedbacks (e.g., temperature rising; more energy use; support/suppress plant growth)
- Humans have unbalanced the amount of carbon in one reservoir (atmosphere) by taking it from another (fossil fuels in pedosphere)

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Computational Thinking

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Computational thinking (CT)

Jeannette Wing: CT is a way to formulate problems so that we can solve them, using a computer (a human) to solve them

CT for all teachers

* CT = concepts, skills, and dispositions that get more sophisticated as students get older
* CT is cross-curricular, so all teachers can introduce CT skills
* CT has a shared vocabulary that can be highlighted in lessons from every discipline
* Most teachers are already incorporate CT basics, but may not know it
* CT doesn’t necessarily require computers.

CT is a problem-solving process that includes (but is not limited to) the following characteristics:

-Formulating problems in a way that enables us to use a computer and other tools (like a human brain!) to help solve them

-Logically organizing and analyzing data

-Representing data through abstractions such as models and simulations

-Automating solutions through “algorithmic thinking” (a series of ordered steps)

-Generalize (transfer) this process to a variety of problems

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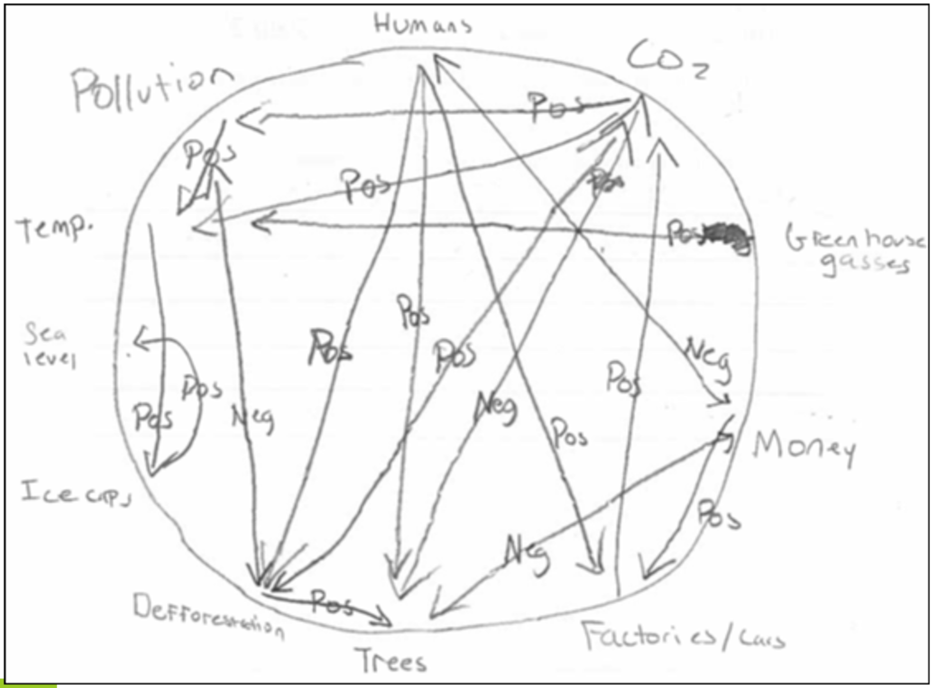
CT category: Computational Problem Solving

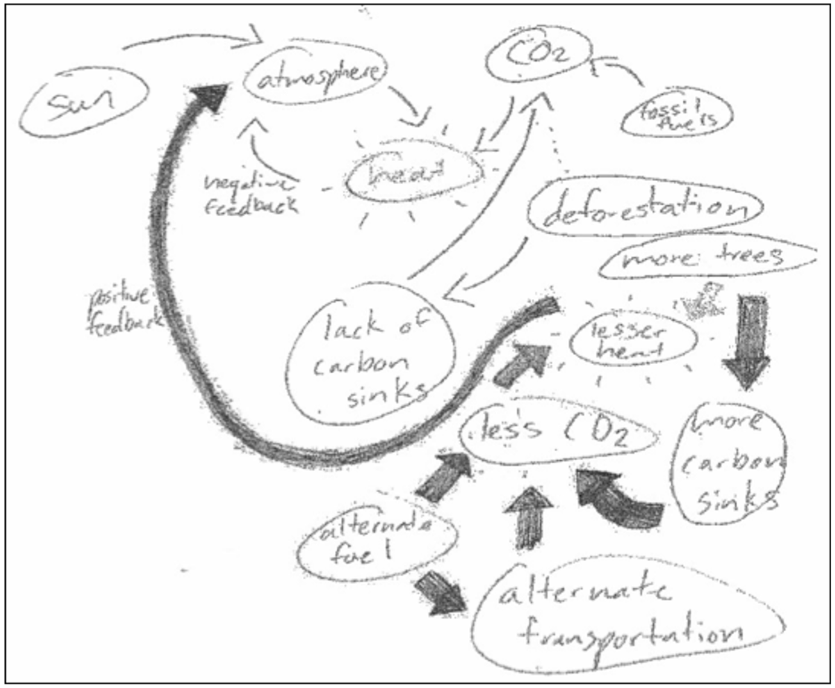
Solution preparation	-decompose or reframe systems/phenomena to be able to use Scratch to represent them -simplify complex systems/phenomena
Programming	-program iteratively, use algorithmic thinking
Abstraction	-create abstractions of climate phenomena (e.g., systems diagram, game design template) -understand Scratch code as abstraction -remixing
Debugging	-debug their own and others' Scratch projects

CT category: Modeling, systems thinking

System investigation	-systems related to climate change -decompose systems into components -identify relationships among components -understand a game as a system -recode others' games to include a system/system interactions
Understand-ing relationships	
Model design	-create games as 'models' of aspects of climate change -understand operations (in Scratch) to model systems components
Model construction	
Communicat-ion	-conduct peer critique, present game and poster describing their work to an audience

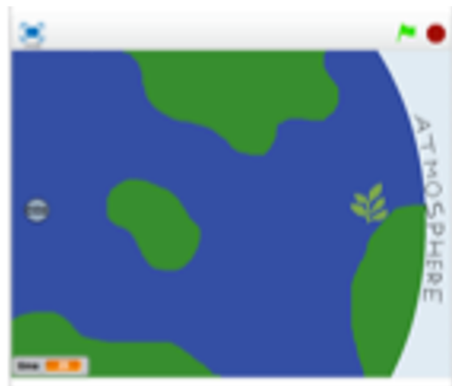
CT manifest in student **work**: Systems diagrams

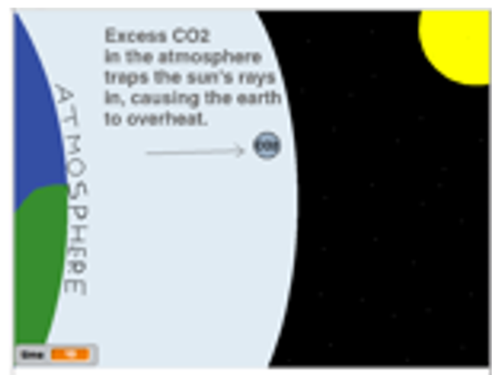




CT manifest in student work: Games

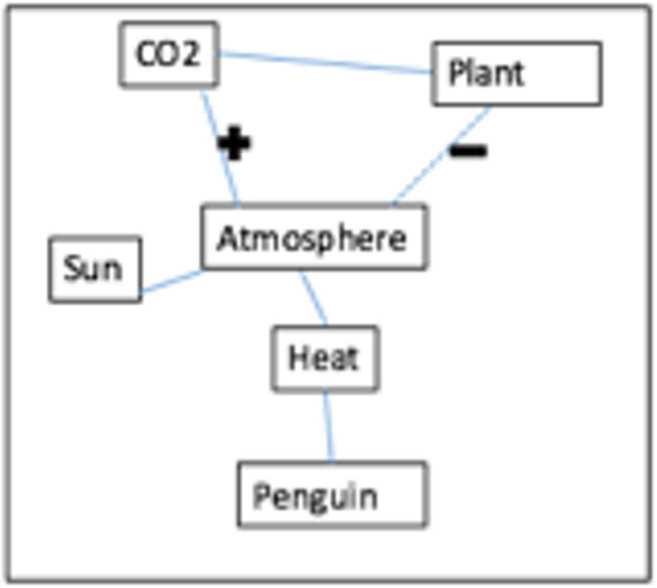
- two-player game
- “race/battle” genre
- one player acts as a CO_2 molecule, the other as a leaf
- CO_2 dodges leaf to reach the atmosphere, while the
- leaf catches CO_2





How does CT manifest in student work?

- Six components
- 4-link causal chain
- 6 total links



Triadic game design

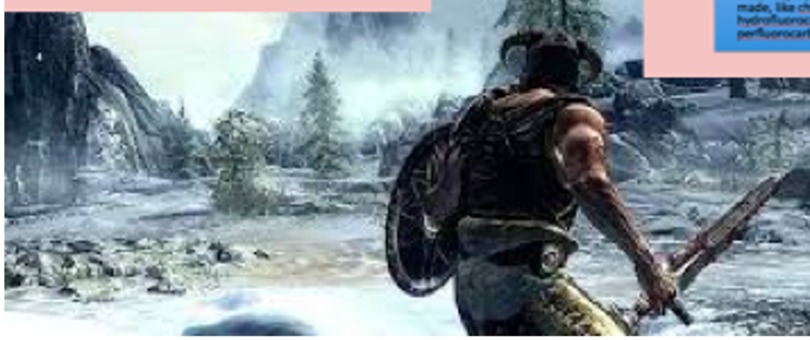
Triadic Game Design Principles

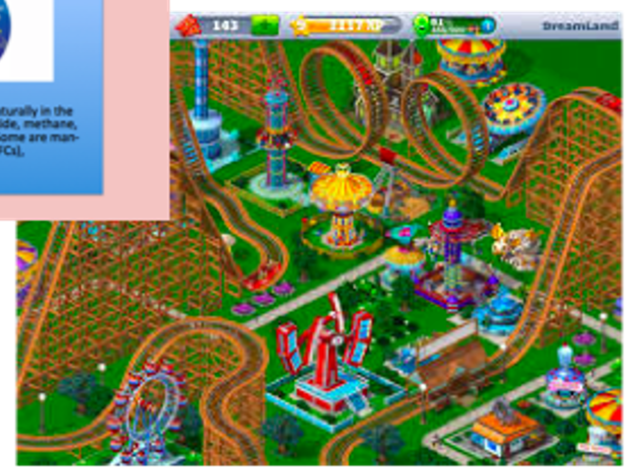
- Reality: Real world content of a game
- Meaning: Learning goal or outcome of a game
- Play: Game genre, player experience of a game

Harteveld, C. (2011). Triadic Game Design. Balancing Reality, Meaning and Play. New York: Springer.

Triadic Game Design

Reality: the topic or real world content





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Triadic Game Design

Meaning: the player experience or purpose of the game; what will the player come away with?

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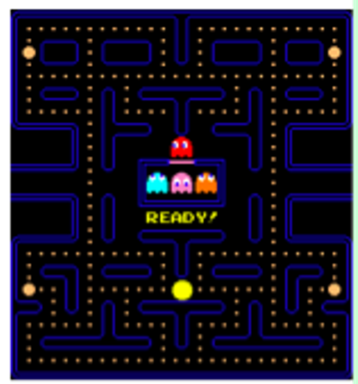
Triadic Game Design

Play: the look and feel of the game; the game genre



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Participatory Pedagogy

What characterizes participatory cultures

- People create something
- They contribute to a shared purpose
- They take ownership over the quality of their contributions
- They openly share skills, knowledge, and artifacts
- Expertise is distributed
- Informal mentorship is pivotal
- Diversity of ways of participating
- Focus is on skills rather than abilities (novices contribute)

Participatory Pedagogy

Participatory pedagogy	**Feature of curriculum**
Students create, and their creation is a contribution to a shared purpose	-Game creation to teach others about climate change
Students choose	-Choice of CC topic, game genre
Expertise is distributed among group members, and skills, knowledge, and artifacts are shared openly	-Pair programming -Student experts -Constructing concept maps (“systems diagrams”)
Diversity of ways of participating	-Programming -”Look-and-feel” design features -Conceptualizing game -Student presentations
Focus on skills rather than abilities	-Novice to expert Scratch users contribute equally to knowledge-building

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Resources for Distributed Expertise

- Peers
- Game Design Cards
- Creative Computing Curriculum Guide
- Google
- Teachers
- Project website