Using Scratch to Teach 21st Century Scientific Thinking Skills

Y. Debbie Liu

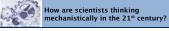
21st Century Scientific Thinking

Systems Thinking: Thinking with an awareness of complex causal system

Mechanistic Thinking: Thinking with a mechanical or engineering undertone

Interdisciplinary Thinking: Thinking flexibly across different disciplines

Quantitative Thinking: Thinking with mathematics Distributed Thinking: Thinking beyond the individual mind to involve other persons or technology



Understanding Goals

- The ranid advancement of technology and the accuracy ulation of informat te patterns of scientific thinking and research in the 21st centur

- the patterns of scientific thinking and research in the 21⁻ century. Designing and contain a novel cognition by combining variability and the scheduled components of the science of the

Background Information

Beyond the Scientific Method The scientific method has been comm ly correct way to conduct scientifi that all of science proceeds in much th accurate. Perhaps some scientists migh it in the stereotyped, step-by-step way scientists report their work in this way In fact, scientists throughout history co approach a scientist uses depends on th

particular question or problem being stu patterns that are specific to its particular 21st Century Scientific Thinking Skills With the explosion of advancements in s century, scientists at the cutting edge of 1 their work. Five prominent scientific thir mechanistic thinking, interdisciplinary th In this lesson, students will explore what

Mechanistic Thinking It is a way of thinking that has a mechanic scientists' modular synthetic and purpos

iu, Y-T. D., & Grotzer, T. A. (2009). Looking forwar leh, & M. S. Khine (Eds.), Fostering scientific habits

Role of Digital Technology

Three major reasons behind why digital technology should be used to teach 21st century scientific thinking skills:

- 1) Situated Learning: Learning is situated in the same digitally rich culture in which the thinking skills are developed and used by the scientific community
- 2) Creative Thinking: Digital technologies lend well to support creative thinking
- 3) Digital Fluency: Digital fluency is critical in our mediarich participatory culture

New Media Literacy Skills	21 st Century Scientific Thinking Skills
Play	Systems Thinking
Performance	Quantitative Thinking
Simulation	Mechanistic Thinking
Appropriation	Mechanistic Thinking
Judgment	Interdisciplinary Thinking
Transmedia Navigation	
Negotiation	
Distributed Cognition	Distributed Thinking
Collective Intelligence	
Multitasking	
Networking	

Lesson Plan: Day 3 nism cards nt notebooks or in Jack Review lesson plan, background information and understanding goals Pholocopy Designing a New Microbe worksheed (p. 28) Cut out organism cards (each group of 3-4 students will have a set of card card group of 3-4 students will have a set of card Explore Step 1: Designing a New Microbe Introduce today's activity by saying, "You will be simulating how synd Introduce today's activity by doing an the activity that is actually modeled after a scientists in 2007." Designing a New Microbe work at te cells that convert one molecule into another (e.g. the make-believe n ed to the molecule *Home* by Protein T in bacteria). ards. Each studes Following the directions of the bandout, have students i an exceptal, ingene proteins from difference analout, have students return a kind of assembly line that ultimately produce hydrogen (output). Possible answers to Designing a New Microb tre two possible pathways that can lead to hydrogen production: Starch & water → Protein G → Protein P → Protein D → Protein R → Protein T → Protein F → Protein H →Hydrogen 2. Starch & water \Rightarrow Protein $G \Rightarrow$ Protein $P \Rightarrow$ Protein $D \Rightarrow$ Protein $H \Rightarrow$ Hydroge indeb sudents along by encouraging students who have steady fained out how to astrong to the reveal and share with a creases how they are thinking and the provide fained out how to students index in the start of the start quentially (on-start or backward or fill in the worksheet to be estier. ote to teachers: The hydrogen production path ersion of the actual 2007 experiment for learning for learning purposes. The organism

Dec. 9, 2009

Scratch Lessons for Mechanistic Thinking

- 1) Help students understand how modern scientists think mechanistically
- 2) Have practice thinking mechanistically by simulating how synthetic biologists think in the field
- 3) Help students recognize mechanistic thinking even when it is not in the context of science, as in their own work via Scratch.

Lesson 1

Familiarize students with Scratch programming language. At this point, Scratch presented simply as medium for creative expression.

Lesson 2

Expose students to creative field of synthetic biology to illustrate how scientists think mechanistically via case study of Jay Keasling, one of the pioneers of synthetic biology. Analyzing how modern scientist work and think provide students with broader view of scientific inquiry.

Ask students to demonstrate their understanding of what they have learned so far by creating a Scratch project.

Lesson 3

Have students practice thinking mechanistically by simulating how synthetic biologists think in the field via activity adapted from actual synthetic biology experiment (designing a microbe that can use starch and water to make hydrogen gas).

Have students reflect on experience with Scratch, and recognize they have been engaging in mechanistic thinking while working on their own Scratch projects. Encourage students to transfer their understanding of mechanistic thinking across different domains. Gain an appreciation of how studying trends in scientists' way of thinking can help students in their own thinking.

Lesson Plan: Day 1 Materials > Computers with Scratch installed > Scratch Resources

 Prep Step

 > Review lesson plan, background information and understanding

 > Obtain computers with Scratch installed for students to work or

 > Obtain computers with Scratch installed for students to work or

 > Make copies of Scratch Resources (not provided)

EXPLORE Step 1: Introduction to letwoon introduce the known by giving students a sense of what they will be doing and where they are based, and the students. This will be a three-day, known where we will be exploring how interaction of the students. This will be a three-day, have not been been been setted in the students of the students of the students of the students. The setted is not setted we will also be learning Scratch. We will use everything together at the end of the three day. rch Your students and any fazere goals you wish to achieve wish Scratch Mathematic conformable navigating around the Scratch environment. Step 2: Playing with Scratch

on the level of your students and any state any state of the characteristic of the state of the acture the class s tudents with a esources/search) for more into. Some sectembers) include: (video tutorials, PowerPoints, and worksheets) include: prop. Benjew lesson plan, backg edia.mit.edu http://scratched.media.initiation Having Fun with Computer Programming and Games

- (http://www.lefo.ie/educationoutreacti-secunary control Started with control of the security o
- Scratch Lessons: Shall We Learn Scratch Programming for Series (http://www.shallwelearn.com/scratchprogrammingfortidscareport) Designing Animations and Games—A Creative In Animations and Games—A Creative Inter- Animation A Creativ
- Make sure to also introduce students to the Scratch online com they can download the source code of any project to help them Scratch programming language to create projects.

Review, Extend, and Apply

or or momenting students that they will apply what they have the start of the start Step 3: Scratch Assignment End the day by informing students that they mini-Scratch project for an assignment after mini-Scratch project for an assignment after

genetirRigarch interact

lings from case analysis: Ja biology-a field that desig

MAS.714J / STS.445J Technologies for Creative Learning Fall 2009

For information about citing these materials or our Terms of Use, visit: http://ocw.mit.edu/terms.