



Saving Rivertown: Using Computer Simulations in an Earth Science Engineering Design Project for Pre-Service Teachers

Dr. David Mitchell, California Polytechnic State University, San Luis Obispo

David Mitchell is an Associate Professor in the Physics department, and an affiliated faculty in the Liberal Studies department, at Cal Poly, San Luis Obispo. Originally from the Seattle area, Dr. Mitchell is an astronomer working on the detection of extrasolar planets orbiting giant stars. He teaches introductory and advanced astronomy courses, when not preparing future elementary teachers.

Dr. John M. Keller, California Polytechnic State University

John Keller is a planetary scientist with an emphasis in astronomy education and K-12 science teacher preparation. He co-directs the Cal Poly Center for Excellence in STEM Education and is an Associate Professor in Physics.

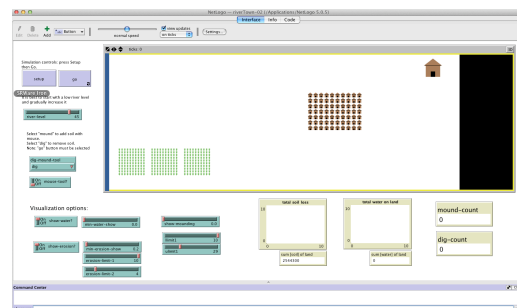
Dr. Victor M Castillo Jr, California Polytechnic State University

On Professional Research and Teaching Leave from Lawrence Livermore National Lab.

Saving Rivertown: Using Computer Simulations in an Earth Science Engineering Design Project for Pre-Service Teachers (Curriculum Exchange)

Target grade level: Pre-service teachers,
K-12 applications, Elementary 3rd-6th

David Mitchell, Cal Poly State University, dsmitch@calpoly.edu
John M. Keller, Cal Poly State University, jmkeller@calpoly.edu
Victor M. Castillo, Lawrence Livermore National Lab,
castillo3@llnl.gov



In preparation for the Next Generation Science Standards (NGSS), a team of teachers, science educators, science professors, and engineering professors at a comprehensive polytechnic university are collaboratively developing engineering modules for pre-service teachers in the Liberal Studies major. These engineering modules are designed to expose future teachers to the field of engineering and to serve as examples of hands-on activities that could later be used in their K-12 classrooms. The associated pedagogy of **open-ended design challenges in meaningful context and the iterative engineering design cycle** are also part of the curriculum. Hands-on engineering design activities are to be integrated into four of the six existing science courses for Liberal Studies majors. The third course in the science sequence is an Earth science course. The engineering module for this course is called Saving Rivertown. This module is broken into four activities, each taking 45-60 minutes of class time.

The emphasis of this activity is computer modeling, with most of the activities done as simulations using NetLogo. NetLogo is a free, downloadable program that is used here to model environments. Students use several pre-made models, within which various environmental parameters can be adjusted. Students can play with the parameters, transform the environment, and see the consequences as they run the simulation.

Activity #1: Stream Tables

The first activity has students use stream tables to investigate the erosion of a streambed and the associated geologic features it creates. Students make observations about the erosional features that appear in the streambed. A class discussion about their observations follows, embedded in the larger context of the course. This is the only activity that uses an actual stream table.

Activity #2: Introduction to NetLogo

The first computer-based erosion simulation is a virtual stream table, very similar to the actual stream tables students used in the first activity. Students can adjust parameters for the model such as table slope, soil properties, and water flow rate. They then make observations of the resulting erosion patterns, and discuss similarities and differences to the real stream table. Students also reflect on the utility of a computational model.

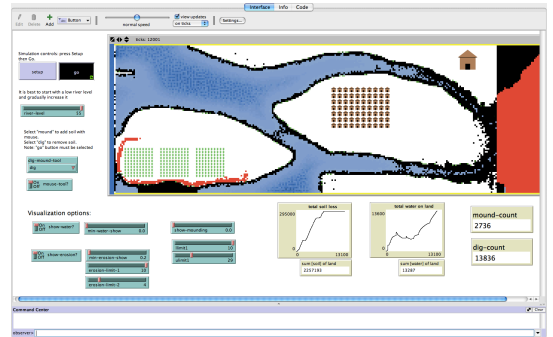
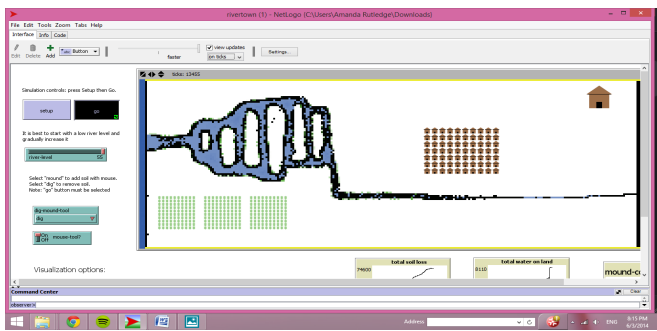
Activity #3: Rivertown

The second computer-based activity introduces students to Rivertown, a fictional town within the NetLogo simulation, in a flood plain next to a river. The river can overflow its banks, which will flood the town's fields, homes, and businesses, unless the students can create a diversion plan to keep the water out of sensitive areas and routed around the town. Students are able to dig trenches and make mounds within the

simulation. During class, students take their first attempts at saving Rivertown, testing ideas and redesigning their diversion plan within the computational model. After becoming familiar with the scenario, and brainstorming ideas, students complete the project at home. They must create a diversion plan, make the digs and mounds, raise the river to the appropriate flooding level, and see how well their diversion plan worked. They must then go back and do a redesign, attempting to keep the sensitive parts of Rivertown completely dry, using the fewest resources possible (digs and mounds).

Activity #4: Student Presentations

The final part of this engineering project is for student groups to present their Rivertown projects, including all failed and successful designs, to the class. Students look for common and innovative solutions, and discuss challenges associated with the project. The engineering design cycle is discussed in the context of the project. Images below show the Rivertown simulation. The image at the beginning is the starting point, the images below show two student solutions to the flooding from the river on the left. Black regions are lower (digs), red regions are higher (mounds), and blue regions are flooded.



Classroom Adaptation

This set of engineering activities could easily be adapted for use in schools. The stream table activity can be eliminated if they are not available. NetLogo is free for Windows and Mac, and can be installed in five minutes, so the simulations can be easily available for students in a computer lab, and all activities done at school.

Using NetLogo

To download and install, go to <http://ccl.northwestern.edu/netlogo/>, then click on download. Click on the downloaded file to install.

To use, open the NetLogo program file (Mac: NetLogo.jar, PC: NetLogo 5.1.0.exe). You can open models by choosing File/Models Library and selecting any of the models that come with NetLogo.

To download the Rivertown model, go to <http://stem-dev.github.io/RiverTown/>, then click on Downloads: zip at the top. In NetLogo choose File/Open and select RiverTown.nlogo to load the RiverTown model.

To run the model, click on Setup, then Go. The Info tab at the top tells you about the model, and Code lets you see and edit the code.