Faculty Innovation Grant 2017-18

MS Hydrogeological Stream Tables

Grant Recipient: Matt Gallon

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Overview

This grant provided financial support for the purchase of four hydrogeological stream tables and associated supplies for use by the MS Science Department. The grant also funded the development and implementation of new curriculum focusing on erosion and civil engineering. Both the stream tables and the new curriculum enhanced the MS students' study of rivers and erosion by adding greater realism and sophistication to the STEAM (Science, Technology, Engineering, Art, Math) component of the unit on rivers and erosion.

Materials

After receiving the grant in the fall of 2017, I purchased four hydrogeological stream table kits. The kits included a thermoplastic tray supported on a steel carriage with wheels. The trays measure 5.5 feet long by 2 feet wide and have a false bottom that serves as a water reservoir. Each table holds roughly 10 gallons of water and 100 lbs. of sand. At one end of the table is a pump with two outlets. The pump draws water from the false bottom reservoir and drains it on to the surface of the sand. The two nozzles have control valves which enable the students to control the force and volume of water output. When activated, the pump produces a steady stream of water which runs over the surface of the sand to form rivers. Based on the rate of water flow and the landscape features created in the sand, the table models the processes of erosion and the formation of features such as alluvial fans, deltas, and oxbow lakes. In nature, these features take years to form, but the stream table allows students to witness these processes within a single class period.

The Stream table kits also included a transparent polycarbonate plotting grid, which the students placed over the top of the sand. Using the plotting grid, students

The stream table kit

traced the course of the river every five minutes and could then measure and evaluate changes in the width, length, and shape of the river over time. The plotting grids allowed the students to collect qualitative and quantitative data to answer lab questions in several different simulations and to evaluate their civil engineering designs.

In addition to the materials included with the stream table kits, I also purchased additional sand, clear acrylic sheets to cover the tables, turf to model erosion over different types of surfaces, and stop watches.

A sixth grade student uses the plotting grid to track erosion patterns during a simulation in the stream table

Implementation

As part of their Earth Science Unit, sixth graders learn about how the shape of rivers change over space and time, and how they can destabilize the areas around them. They also learn how water plays an important role in the movement of soil through erosion and mass movement (e.g., landslides), and the devastating effects these events can have on the communities living near rivers or other geologically unstable features. They explore several of the strategies civil and environmental engineers use to protect communities from such events and help mitigate the effects of erosion, flooding, and landslides.

Our timing of the erosion and mass movement unit this year coincided with the mudslide disasters in southern California. Students researched the geological causes behind these mudslides and how the people living in southern California were impacted by these events. The students were then able to reconstruct some of the same conditions using the stream tables and then design and test different civil engineering solutions for minimizing the impact of erosion and landslides.

During the fall of 2017, I built and tested the stream tables so that by the time the students returned from winter break we were ready to begin using the tables. The new innovation space provided the ideal location for the stream tables since this provided ample room for the class to work

in the tables as well as utilize the large work tables for building their erosion control systems. They were also able to use the new dry erase walls for drawing and talking through their ideas for their erosion control systems during group brainstorm sessions. For the months of January and February 2018, all 25 sixth grade students spent almost every science class (a total of 3.4 hours per week for six weeks) in the innovation space using the stream tables. This time varied from unguided exploration of how the tables worked, to more formal lab simulating river erosion, to a final STEAM challenge lab that asked students to draw on what they had learned to design and build their own erosion control system.

Students explore eroding banks and delta formation in an old meandering river on a flood plain

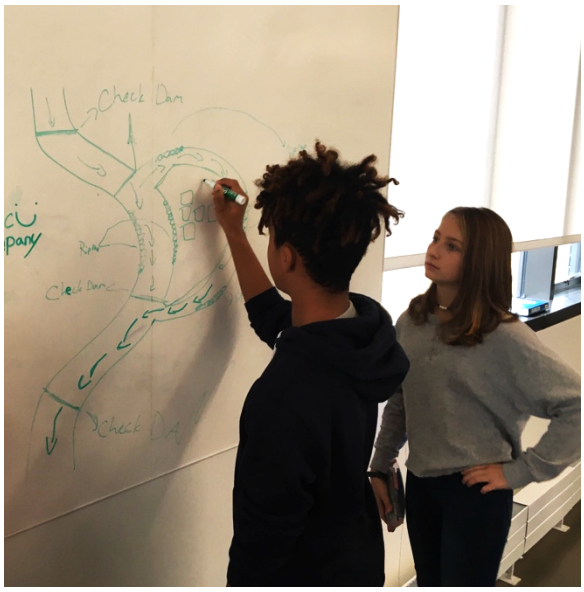
I researched examples of a wide range of stream table activities and labs targeting age groups ranging from the LS to university level. I compiled these articles in a resource folder for the development of future lab activities if teachers from other divisions are interested in using the tables. Based on this research I then designed three labs on river erosion to be piloted by the sixth grade students. The first lab modelled a new river with a straight course and steep valley walls. The students ran water through this river for 20 minutes and plotted the changes in the course of the river and the growth of the river delta. After the simulation in the table, students produced graphs on their iPads depicting the changes in river width over time, as well as wrote a brief lab report on the results of the stream table simulation.

In the second lab, the students ran a similar simulation but for an old meandering river in a wide flat flood plain. They were able to see the drastic differences between these two types of rivers and were able to map where erosion had the greatest effect on the outside of the river bend. We had discussed this process in class, but the stream table brought it to life with a tangible example that was far more effective at demonstrating how and why erosion occurs at different rates along the

course of the river. As part of their report for this lab, students reflected on the impact of the erosion and flooding they witnessed on the communities who live along the banks of these types of rivers.

The final lab was a STEAM design challenge in which the students had to design and construct an engineering solution for protecting a small community ("Gatorville") of plastic houses placed along the banks of the river. The students had geotextile, metal mesh, gravel, pipe and wooden sticks at their disposal for creating their designs. Each team had to make detailed drawings of two designs solution. After the planning stage each team built their solutions and tested them in the stream table. Based on these tests they had to decide which solution their engineering team would pitch to the residents of Gatorville for protecting their endangered community. They had to consider differences in the cost, environmental impact, and effectiveness of the two designs.

A lab group's erosion control design consisting of Gabion baskets (mesh filled gravel blocks) backed by geotextile



Students use the dry erase walls in the new Hastings Innovation Space to brainstorm designs for the stream table STEAM challenge lab

Impact

The sixth grade students were extremely enthusiastic about the stream tables and loved the hands-on aspect of molding the sand and watching the river change its course right before their eyes. In contrast to showing animations or slides in class, the ability to directly observe these processes made the content more accessible and engaging. Many of the students became heavily invested in the final STEAM lab. By enabling the students to actually test and redesign their engineering solutions, the stream tables made it very clear what solutions worked and why others failed. This real-time feedback allowed students to self-critique their designs and adjust them to be more successful. The table simulations also allowed the students to

observe the various real-world engineering solutions that we studied in class and come to their own conclusions about their strengths and weaknesses. The stream tables enabled the sixth grade Earth Science Unit to incorporate a STEAM component, something that is relatively rare in earth science curricula.

Future Innovations

Next year I plan to introduce two additional sixth grade labs using the stream tables. The first lab will model the effects of coastal erosion and how it can be controlled; and the second lab will model the effects of deforestation on run off and erosion. Like the connection to the mudslides in southern California, these labs will allow students to use the stream table to model the geological process that they may read about in the news and that impact communities throughout the world. I also plan to add an additional STEAM challenge lab where the sixth graders will partner with second graders to design and build an erosion control system. The hands-on interactive nature of the stream tables makes them an ideal tool for encouraging meaningful collaboration between students from different grades and divisions. It was an honor to receive this generous grant and be given the opportunity to implement this project this year. In the coming years, I look forward to continuing to develop new activities and curricula that utilize the stream tables.

Students construct Gabion baskets from wire mesh and gravel during the stream table STEAM challenge lab

Sixth graders test their erosion control system consisting of Gabion baskets, a check dam, and geotextile

A lab group observes their erosion control system consisting of rip-rap and geotextile

Expenses

Item	Total Cost
Hydrogeological Stream Tables (4 kits)	**$ 5,238.45**
Stream table sand (4 buckets)	**$ 302.94**
Acrylic Sheets (4 sheets)	**$ 297.46**
Storage supplies	**$ 28.56**
Stopwatches (4)	**$ 34.01**
Turf	**$ 19.55**
Lab Manual	**$ 11.39**
Faculty Stipend	**$4,000.00**
Total	**$9,932.36**