

# The Fulcrum Flash

## Cohort 2 Places Capstone in the Bridge to Understanding Science Teaching and Learning



*When constructing a block building, the capstone tops off the structure; the final touch or the crowning achievement. In an arch, the capstone is also called the keystone which is the last block to be put in place and makes the structure of the arch complete or whole.*

Teachers in the Fulcrum Institute further their understanding of science and science teaching by engaging in three online courses and a face-to-face summer institute. The teaching focus throughout the program is investigation-based science and formative assessment in the inquiry science classroom. Fulcrum teachers are called upon to rethink their science teaching practice in the light of current research in the fields of learning, cognitive development and science education and bring their learning together in a Capstone Project.

The Capstone Project asks teachers to knit together their new knowledge about teaching in the context of their own science classrooms. They plan, carry out, and analyze two formative assessments that have been integrated into their regular science curriculum, one where students' ideas and thinking are revealed in the course of a classroom discussion and the other where students express their understanding through writing or drawing. Teachers use evidence from transcriptions of discussion to pinpoint the development of students' understanding of key science concepts and make evidence-based decisions about next steps in their teaching. Similarly, they analyze two pieces of student writing/drawing to assess students' progress. They provide student with feedback comments based on research findings about the characteristics of feedback that motivates students' learning. Teachers share drafts of the projects online and apply their knowledge of constructive feedback to improve their own work.

Collectively, these projects are a treasure trove of classroom examples of exemplary teaching strategies at work in K-8 classrooms. For example, the reader can find carefully developed, open, concept-focused questions to facilitate discussions where students share and debate their scientific ideas and explanations. Assessment is not formative unless it includes a response, either direct feedback to students or adjusted teaching plans; the Capstone collection provides an array of specific examples of what this means in practice at various grade levels in diverse settings.

These projects are the crowning touches at the end of a rigorous course of study. A capstone makes a structure complete or whole; in this case the structure is a strong framework for teaching science that supports Fulcrum teachers as they go forward in their science leadership roles.

*Sally Crissman, TERC*

Find an example of a formative assessment on page 2.

# Experimenting with Pulleys: Force, Work, And Creating a Fair Test

(a small portion of the Capstone Project) by Fulcrum Institute Teacher Griselda George

## Purpose of the written formative assessment:

"I hoped that the evidence from the students' drawings and writing would let me know how many students were able to discover that pulleys do make work easier. I wondered how many students were still unsure about this science fact, and if their ideas would change once we shared the results from our experiments. I also wanted to know if the students have become more proficient in using "force" as a scientific term, or if they were still confusing force with weight."

*Griselda George, 4th grade teacher, Arthur Healy School, Somerville*

"Having watched my students' progressive understanding of simple machines, work and force, I wondered if they could design an experiment to answer the question: Do pulleys make work easier?"

Inside the Yellow Boxes: What the teacher learned about her student and questions she still has about her student's understanding of force and work.

Name  Date 4/18/08

Marvin Martian has come to visit our planet. He sees you using a pulley to lift a tape dispenser. How would you explain to Marvin Martian whether or not pulleys make work easier? You can use pictures, numbers and words.

B draws and labels an example of a single and compound pulley.

B correctly uses her data from the spring scale to compare the force used with and without the pulleys.

*The real force to lift up the tape dispenser was 360g/3.6N. With the single pulley it was 340g/3.4N which is 20 grams less and .2N less. With the double pulley is 160g/1.6N which is 200g less and 2N less. That is proof that the double pulley makes work easier.*

Why does B write about a "real force"? What is she referring to?

I should have asked "Is there such a thing as a real or fake force?"

Is there such a thing as a fake force? What do you mean by the real force?

B mentions that the grams and Newtons are less when using the pulley. Does she realize that the force is changing?

I see that your data shows it takes 360G/3.6N of force to lift the tape dispenser without any simple machines. With the single pulley it was 20grams/.2N less. What was less?

Feedback from the teacher to the student.



## Area K-8 Teachers Invited to Apply to Teacher Leadership in Science Education Program

**MEDFORD/SOMERVILLE, Mass.** --**Tufts University**, in collaboration with TERC and Malden Public Schools, is now recruiting teachers for the **Fulcrum Institute for Leadership in Science Education**, a National Science Foundation Math and Science Partnership (MSP) designed to build school and district capacity for quality science teaching.

The Fulcrum Institute, a series of three graduate-level Tufts University courses, helps develop K-8 teacher leaders of science in their schools. Participating teachers are part-time graduate students at the University.

Tufts University currently offers the courses tuition-free to teachers admitted to the program and who agree to share their classroom practice with researchers, colleagues, and Tufts pre-service teachers. The Fulcrum Institute also provides all books and required investigation materials. Cost to participants is the registration fee (\$75.00) for each course. Participants are eligible to receive a stipend for their feedback, for participation in the project's research component, and for successful completion of the courses.

"We are looking for school-based teams of three to five K-8 teachers," explained Professor Judah Schwartz, a professor of physics and education at Tufts University and principal investigator of the Fulcrum Institute. "Our program is for teachers who are 'new to science' and want to increase their confidence and skill in teaching it, as well as those who have extensive science backgrounds. We welcome the opportunity to work with interested communities to improve science learning and teaching in schools."

Courses are offered in a mixed online/face-to-face format and include meetings with scientists, science educators and researchers. The online coursework typically requires 6 – 9 hours per week but takes place in asynchronous time so that teachers can balance serious attention to coursework with their busy schedules. High levels of communication and collaboration with colleagues in and beyond their own school take place in structured online seminar-styled discussions.

The Institute's curriculum includes observing and making sense of scientific phenomena, learning how scientists and students grasp the same phenomena, sharing and gaining insights with Institute participants, and learning how to plan and support inquiry-based learning experiences in classroom settings. The teachers' personal experiences are enriched by the reflections of practicing scientists.

School-based teams from Malden, Boston, Somerville, Shrewsbury, Natick, Methuen, Wareham, Beverly, and Acton currently are participating in the program.

The Fulcrum Institute is currently recruiting teachers for the next institute that begins January 2009, and runs through December 2010. Applications are due October 15<sup>th</sup>, 2008. For more information, and instructions about how to apply call 617-627-3039 or visit

<http://fulcrum.tufts.edu/> and <http://ase.tufts.edu/education/projects/projectFulcrum.asp>



*Jean Oviatt, 4th grade teacher at McCarthy-Towne School in Acton, participates in a discussion about science leadership.*

Please copy this page and distribute to K-8 teachers you know!

## Have you seen Pearl in your school?



*Pearl Emmons shoots video and photos for the Fulcrum Institute and the Department of Education at Tufts University.*

The Fulcrum Institute is privileged to have videographer and photographer Pearl Emmons working to document the science teaching and learning that occurs during the face-to-face sessions of the Fulcrum Institute, and in the classroom of Fulcrum teachers.

Once at the start of the Fulcrum Institute and once just before completing the final Fulcrum course, Pearl videotapes a science class taught by a Fulcrum Institute teacher. These videotapes help the Research Team study the processes of science learning in real classrooms. They help the external evaluators of the grant to study changes in teaching over time. The videotapes also serve the teachers as a tool for self-assessment. Participants themselves determine whether or not tapes will be shown to

others outside the institute. Some teachers like to share the videos with their students; others may wish to discuss them with colleagues or show examples of their classroom activities to the parents of their students. As teachers collect examples of teaching over the years they may wish to keep them together as a portfolio of their own teaching and development.

Teachers are provided with filming consent forms to send to the parents of their students in order to identify any student that should not be filmed. Pearl is careful to respect parents' wishes.

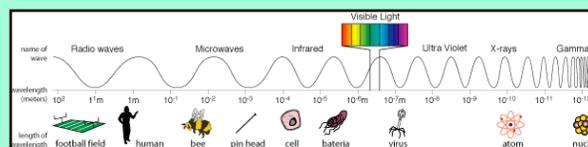
The Fulcrum teachers receive a DVD with video and photos that Pearl has shot. The tapes are used exclusively for research and professional development; they are not released to principals, superintendents or others involved in the hiring or evaluation of the respective teachers.

Please say hello to Pearl if you see her in your building!

## Something to Think About

Imagine you're sitting in a room without windows. You turn off the lights. You can't see anything, but you can listen to the radio!

We say that radio waves are another kind of light, and somehow they are transmitted from the radio station through the opaque walls of the room to the radio that you are sitting and listening to in the dark. On the other hand, the sunlight from the outside can't get through those walls. Can you think of why this might be the case?



*Reproduced from The Electromagnetic Spectrum. IMAGERS Program, NASA Goddard Space Flight Center*

# Fulcrum Institute goes to NSTA in Boston

In March, The National Science Teachers Association national meeting was held in Boston, and the Fulcrum Institute was there. Fulcrum course developers Sara Lacy and Sally Crissman, and facilitators Eric Kemp-Benedict, Jackie Crowe, and Karen Spaulding, offered a half day short course called *Shedding Light on Global Warming: Physics Concepts and Technology Tools that Help Teachers Better Understand a Complex Process*.

For this session, we selected some examples of physics concepts that help explain global warming that many teachers (and their students) find particularly elusive and we shared some investigations and tools – both low-tech and high-tech -- that Fulcrum teachers have worked with in depth. Short course participants had a chance to work with spectrometers, light probes, and computer simulations and to engage in the kind of data driven discussions that Fulcrum teachers routinely hold on-line and incorporate in their classrooms.

Some questions that the short course addressed were: How do we draw on core concepts in physics to understand global warming? How can we use a combination of technology, hands-on activities, and discussion to investigate a complicated phenomenon through science inquiry?

The short course was fully subscribed well in advance. Participants included K-12 and college teachers and administrators from across the United States and from as far away as Angola and Honolulu. They appreciated experiencing some innovative approaches to learning physics and the model of collaboration that the Fulcrum teachers experience every week as well as new insight into the core physics concepts of light and heat transfer that are central to the process of global warming.

Sara Lacy, TERC

**IDEA! Share this Newsletter with an Elementary Teacher.**

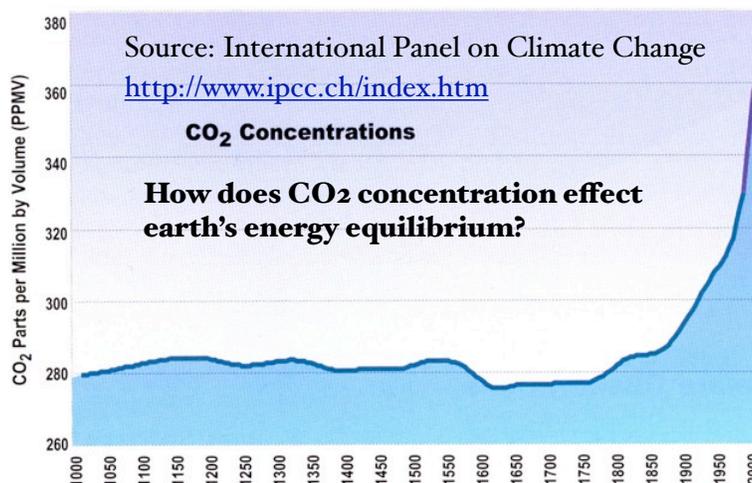
How is the leaky-bucket equilibrium analogous to Earth's energy



What if energy flowing in increases?  
What happens to the equilibrium level?



What are the strengths and limitations of the analogy?



## Solutions to Average Temperatures (Jan/Feb issue)

### How do the “record high” and “record low” data differ from the “average high” and “average low” data?

These data are compiled on the basis of temperature records that go back about one hundred years. In order to try to understand how these data are compiled, let's focus on one month, say June. There are four temperature points (all in Fahrenheit) plotted for the month of June – they are 42 degrees (record low), 58 degrees (average low), 78 degrees (average high) and 100 degrees (record high).

The record low temperature of 42 degrees is the lowest temperature ever reached in June. It is a single temperature measurement. Similarly the record high temperature of 100 degrees records the highest temperature ever reached in June, which also occurred in a single year. It too is a single temperature measurement.

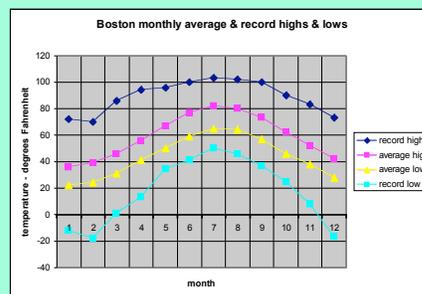
### How do you think the “average high” and “average low” data were calculated?

On the other hand, the average high of 78 degrees for June is the average of the highest temperatures in June for the one hundred years for which there are temperature data. It is the average of 100 temperature measurements. Similarly the average low of 58 degrees is the average of the lowest temperatures reached in June for all the years for which there are data. It too is the average of a large number of measurements.

### What is the justification for joining the data points with smooth lines in the case of average highs and lows? In the case of record highs and lows?

Averaging data tends to smooth the data. You can see that there is less variability in the “average” graphs than there is in the “record” graphs. I, for one, am much more convinced of the plausibility of the lines joining points in the “average” graphs where the lines join points each of which is the average of many measurements than I am in the corresponding lines in the “record” graphs where the lines join points each of which is the result of a single measurement.

*-Professor Judah Schwartz*



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leveraging leadership in science education