The Fulcrum Flash

Applications for Cohort 3 due November 15, 2008

Improve Science Education by Strengthening Teacher Content Knowledge and Teaching Strategies

In the June 2008 report of Governor Patrick's Education Action Agenda, entitled, "Ready for the 21st Century: The New Promise of Public Education," it is explicitly recommended to:

- Improve teaching in science, technology, engineering and math disciplines by strengthening content knowledge and teaching strategies.

By strengthening the skills of teachers through training and education programs, their students may achieve greater results in math, science, and technology.

Tufts University is now recruiting in-service K-8 teachers for the third cohort of 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 for Leadership in Science Education is located at Tufts University and brings together university scientists, curriculum specialists, educational researchers, and K-8 teachers for the express purpose of improving K-8 science education. The Fulcrum Institute aims to advance K-8 teachers' understanding of physical science and increase their pedagogical content knowledge through a mixture of online courses and face-to-face events, which include a week-long summer institute. Nearly sixty K-8 Massachusetts teachers have completed the one and a half year institute and are changing their practice of teaching science as a result.

Learning Science Online

The three online courses, which include two face-to-face Saturday classes and a one-week Summer Institute, engage teachers in inquiry-based learning about the properties of matter, heat and temperature, and the phenomena behind the earth's energy balance. The creators of the Fulcrum Institute curriculum practice what they preach; science content and pedagogical content knowledge are taught by having teachers make predictions, investigate phenomena, collect data, draw graphs, make sense of the data, reflect on their understanding, and report and argue their reasoned analysis to their peers. Teams of teachers meet in their virtual classrooms to share their work and understanding, to probe each other's thinking, and to debate possible reasons for experimental outcomes. By experiencing this way of learning themselves, the teachers build a new understanding of what it means to teach and to learn science. Valerie Carlson, a teacher at Eliot Elementary School in the Boston Public Schools, explains it this way:

photo credit: Pearl Emmons

Fulcrum Cohort 2 graduates, Stacey Militello and Ruth Crowley, play with physics toys at a face-to-face Fulcrum event.

The investigations, reading, and group discussions have increased my confidence as a science teacher in an astronomical way. I came into my position as a new teacher with very limited and uninspired science experience. I wasn't sure I was going to make it, especially given the task of teaching grades K-6 all at the same time. My work with Fulcrum has allowed me to focus and reflect. I am much more conscious of my teaching and listening skills and I really feel quite scientific in my thinking now. I have always been intuitively scientific but now I have the ability to align my instincts with true scientific evidence. It is very exciting to have gotten to this place. My next goal is to influence the other teachers in my school to embrace science in their own classrooms and look to me for support. This experience has been exhausting and challenging, but most importantly, it has been truly rewarding and beneficial to my success as a science teacher.

Inquiry science, learner-centered classrooms, and formative assessment characterize the Fulcrum Institute model which makes extensive use of multi-media to highlight how students experience some of the same challenges learning science that teachers themselves encounter. In the online discussion forums, where teachers meet to present and discuss their work, teachers are active learners who collaborate to build rational arguments, ask questions, and share experiences. If scientific knowledge is socially constructed as educational researchers argue, then these opportunities to work in groups to co-construct knowledge of scientific phenomena provides teachers with a model for practicing this in their classrooms.

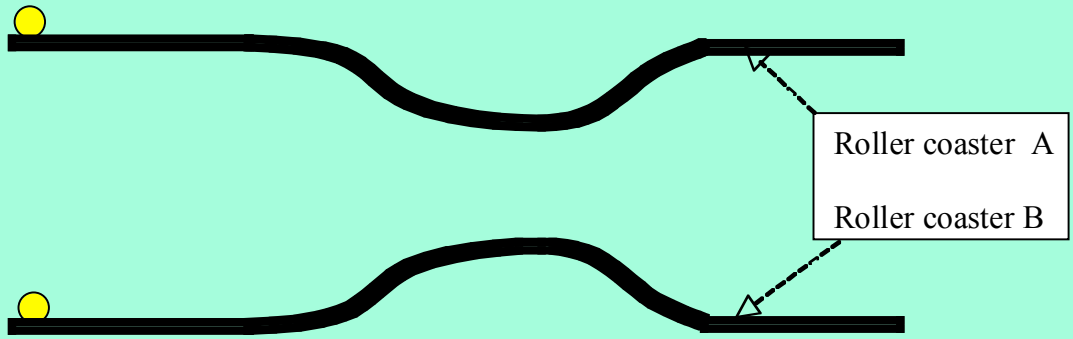
Each of the three Fulcrum online courses consists of fourteen sessions. Half of the sessions are pedagogy sessions in which the teachers increase their pedagogical content knowledge by practicing inquiry learning and formative assessment in their classrooms, guided by their own curriculum. They are introduced to children's understanding of science ideas through research and literature and by interviewing their own students. The teachers are also introduced to curriculum planning tools such as volumes I and II of the *Atlas of Scientific Literacy*, *The Benchmarks for Science Literacy*, the *National Science Education Standards*, and the *Massachusetts State Science and Technology Frameworks*. In this way, learning is situated in the classrooms and curriculum of the individual teachers.

The second half of each course consists of science content sessions where teachers use hands-on investigations or computer modeling software for collecting data and interacting with course content materials. Teachers then interpret and attempt to understand the data they collect, so that they can explain their findings to their peers. Each online discussion group is made up of 4-6 teachers and one facilitator. The online discussion groups consist of elementary and middle school teachers with a wide range of science experiences and educational backgrounds. All of the teachers who participate in a Fulcrum cohort are able to view all of the other

Something to Think About

Below are views of the starting sections of two roller coasters next to each other in an amusement park. On each roller coaster a car (yellow dot) starts moving to the right at the same time and at the same speed.

On which roller coaster does the car arrive at the right end earlier? How do you know?



online discussion groups in their cohort allowing all the participants the opportunity to see and compare the experimental data and to "hear" the thinking and reasoning of their teaching colleagues. In the virtual classroom, teachers make their thinking visible and propose new ideas. This arrangement allows for peer-to-peer learning and teaching.

The Fulcrum courses are arranged so that the teachers begin by working directly with observable properties of matter. They focus on the subtle concepts of density in course one, gradually shifting to phenomena that require the elaboration of models about microscopic mechanisms during the summer institute. In course two, the teachers investigate their own ideas about heat transfer. Through videos and interviews teachers are exposed to scientists' and students' ideas about heat transfer. They learn to create classroom assessments that inform instruction and from these assessments they use strategies they have acquired in the Fulcrum Institute to provide feedback and to encourage further development of students' scientific understanding. During course three, participants work with scientific models, maps, satellite images, and quantitative data. In hands-on investigations, they use physical models, light probes, temperature probes and spectroscopes to investigate light and its interaction with matter. As teachers investigate flows of energy in and out of systems, they gain greater understanding of equilibrium, an overarching theme in the second and third Fulcrum courses.

The accomplishments of the teachers who have completed the program have truly been significant. They have learned science content, strategies for teaching and assessing science that have an immediate impact on their classroom practice. The Institute's emphasis on understanding science and how to teach it, builds on the belief that to lead and mentor others, teachers must first be leaders in their own classroom. They need to be proactive problem solvers, support the learning of all children, and have expertise to share and model with their colleagues in their school. The Institute's goal is for teachers to infuse their school with intellectual rigor and positive attitudes toward teaching and learning science.

To learn more about the program visit:
http://fulcrum.tufts.edu/
To view the latest video at the Tufts Department of Education website visit:
http://ase.tufts.edu/education/projects/projectFulcrum.asp

My involvement with the Fulcrum Institute has increased my time spent teaching science, my approach to teaching science, and my use of formative assessment. I've always used hands-on activities when teaching science, but now I have a clearer focus of what I want the students to get out of the activities and I've added science discussions as a part of my classroom. I've also been using more formative assessments to determine what my students' understanding is and what the next steps should be. This year, Callie and I have been given the opportunity by our district to offer a professional development workshop on using an inquiry-based approach to teaching science.

Jean L. Oviatt, 4th grade teacher, McCarthy-Towne School, Acton, MA

National Science Foundation
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http://nsdl.org/
http://www.msteacher.org/science.aspx

My involvement in Fulcrum Institute has made me a better teacher. I have learned through the inquiry model and by being a student myself the value of working the problems out and discovering the answers. However, the most valuable tool that I have learned through Fulcrum was working with my colleagues and the scientists during the summer institute. This is where I realized that a safe environment was the most important piece for my learning experience to take place.

When I felt comfortable I was able to take risks about solving the problem without being laughed at or looked upon as being wrong or stupid. Here in this safe environment every question and statement was a valuable tool for solving the problem and everyone's input was valuable; this piece I took back into my classroom and every day I inform my students that their thoughts and ideas are important in science and the world. I realized that when students feel safe to take risks, they begin to use a higher level of inquiry skills as well as analytical skills in solving problems and become excited about learning new things.

Janice Lentine, Malden High School, Special Education Science, Malden, MA

Pentucket Regional teacher continues to learn science during the summer

by Nancy Wile

photo credit: Devon Ross, Barrington High

Here we are at the Joggins Fossil Cliffs in Joggins, Nova Scotia. It is a UNESCO site due to the extensive fossils held within the coal deposits. Our group was studying the human and natural history of the Tantramar Marshes. Included in the photo from left to right are Andrew Kennedy, Wildlife technician with CWS, John Halloran, team leader from Newburyport, Helen Goreham, team leader from Nova Scotia, Student from Newburyport, me, two students from New Brunswick, one from Nova Scotia, and Colin MacKinnon our guide and Senior Wildlife Biologist from the Canadian Wildlife Service.

Over the past year and a half, my thinking about science and my teaching of science has gone through a profound change. This change all hinges on having taken the opportunity to take part in the Fulcrum Institute for Leadership in Science Education.

As a participant in the Fulcrum Institute, I was encouraged to approach intriguing scientific questions by gathering data on carefully designed investigations, and then share my data with colleagues and research scientists. In both online and face-to-face environments, we talked about our data, compared and contrasted our findings, and eventually developed an understanding of a complex scientific concept (such as radiation) and how that concept both influences and is influenced by other phenomena.

My time working with so many talented people exposed me to many different points of view and those experiences broadened my view of life in the education world. I ended my time with Fulcrum determined to take the lessons I learned: to look for deeper understanding of concepts; to use data to support thinking; and to use formative assessments to know where to spend more time with my students. I learned about the value of having a journal to show the growth in my thinking and now my students use journals to record their ideas and understandings.

My experience in the Fulcrum Institute also taught me how important it is for teachers to continually seek out opportunities that nourish our intellectual lives. From a link sent out by the Fulcrum list-serve, I signed up for a summer institute called the Gulf of Maine Institute (GOMI). Through the efforts of John Terry (Tufts University, AS'60) and John Halloran at GOMI and Linda Beardsley at Tufts University, the Jessie B. Cox Charitable Trust had funded an opportunity for teachers with a Tufts' affiliation to participate in fieldwork along the Gulf. GOMI represents a collection of schools and youth groups all along the Gulf of Maine from Nova Scotia to eastern Massachusetts. These students and their teachers are working on local environmental projects, reflecting the mission of GOMI, "to inform and inspire" young people to become stewards of the environment and aware of the fragile balance of areas like the Gulf of Maine. The students develop questions, carry out investigations, and collect data, which they then present annually to local government boards.

The GOMI experience was a terrific opportunity to work with people committed to improving the learning experience for students. We had the opportunity to see how different communities deal with place-based education and had a commitment to learning about the environment around them and their responsibility toward that environment. It was a serendipitous experience following up with our final Fulcrum study of global warming to have the opportunity to look at climate change and the historical and environmental change of the Upper Bay of Fundy region.

It was also quite interesting to participate in such a blended learning community. There were scientists, educators, hobbyists, professionals, school students, and layman all participating in striving to come up with questions, synthesizing information, and making conclusions. It was quite fascinating to watch young students blend so easily with other students from different areas of North America and realize that they are all part of the same community (The Gulf of Maine). We were also able to see how the students really took ownership for their learning and then were quite committed to presenting their information to a panel of adults. It was a very unique and special experience. I am sure it is going to be a lasting memory for me as well as for the students who had the opportunity to be part of a learning team. Based on my experiences with both Fulcrum and GOMI I think I will have a much different perspective on my teaching. Both experiences have given me more knowledge, enthusiasm for teaching, and practical skills to improve my teaching.

The week I spent in New Brunswick and the Bay of Fundy with so many passionate educators and students was a great way to wean myself away from the camaraderie I lost once my Fulcrum classes were over. I came away from my GOMI experience knowing that I wanted to make environmental consciousness the cornerstone of understanding as my fifth graders studied weather, simple machines, and ecosystems. This would be done in a way that would be modeled after my experiences at Fulcrum.

As good fortune continued to smile on me, I was able to sit in on a two- day workshop on climate change at the Massachusetts Audubon. In August I attended the Forest Ecology Training Institute for teachers of grades 2-12 and learned from professional Harvard ecologists how to implement field studies of vernal pools with my students. While there I ran into another "Fulcrumite", Kara Frankian, a grades 1 and 2 teacher at the Floral Street School in Shrewsbury, Massachusetts. It felt like things were coming full circle. When I returned to the Elmer S. Bagnall School where I teach, I investigated a vernal pool on town property behind our school and found that it would work for a field study.

Nancy Wile's 5th grade students make field observations near the vernal pool that they will be studying this year.

This year my fifth graders and I are like the explorers we study in social studies. We are in uncharted territory as we leave the indoor classroom and do real field work as a learning experience for all of us. The students are using real tools. We are gathering real data, which will be studied and evaluated. We are guided by basic questions that we are looking for answers to, all the while finding that as we answer one question, we ask more. The students are excited about learning and science. Does it get any better than this?

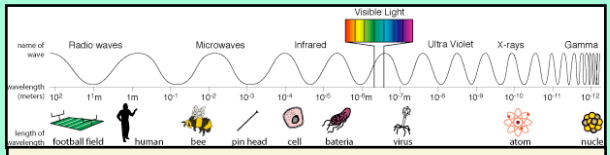
Nancy Wile, 5th grade teacher, Elmer S. Bagnall School, Groveland, Massachusetts mrswile@hotmail.com.

FOR MORE INFORMATION ON GOMI GO TO HTTP://WWW.GULFOFMAINEINSTITUTE.ORG

Remember this from the last issue?

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

Resolving the puzzle

Visible light is a form of electromagnetic radiation. So are X-rays, microwaves, radio waves and ultra-violet rays. These various forms of electromagnetic radiation differ from one another by the size of their wavelengths.

Electromagnetic radiation of all wavelengths travels freely in vacuum. On the other hand in material media the story is different. Different materials like glass or plaster or wood impede the flow of electromagnetic radiation differently. In particular, materials like wood and plaster impede the flow of electromagnetic radiation like visible light but have little effect on electromagnetic radiation with much longer wavelengths like radio waves.

Calendar

October 31, 2008 STEM SUMMIT
http://www.massachusetts.edu/stem/

November 15, 2008 Fulcrum Final Deadline for Cohort 3 Application

January 24, 2009 Fulcrum Cohort 3, Course 1 Launch: Tufts University

Tufts UNIVERSITY | School of Arts and Sciences

Fulcrum Institute
leveraging leadership in science education