SUNRISE

SCHOOLS UNIVERSITY 'N' (AND) RESOURSES IN THE SCIENCES AND ENGINEERING

A NSF/GMU GK-12 FELLOWS PROJECT

National Science Foundation, George Mason University's Volgenau School of Information Technology and Engineering, College of Education and Human Development, and College of Science, and Schools Divisions in Northern Virginia

Project Objective

The objective of SUNRISE project is to build a unique model of collaboration among elementary and middle schools, school division administration, and GMU to foster systemic efforts in implementing Information Technology (IT) rich STEM content-knowledge into G4-6 education by graduate Fellows, with the potential to fundamentally change the delivery of science instruction and long term professional development of science teachers.

The most exciting aspect of the SUNRISE project is that it provides an opportunity to all its participants to discover, widen and deepen knowledge within their own field, as well as a very important mechanism to deliver that knowledge through the graduate Fellows into the K-12 environment.

The end goal of SUNRISE project is to become institutionalized as a university wide program that is sustained through internal and external support. As a continuing project beyond NSF support years the goal of the project will be to reach out to more schools and continue to provide the transformative experience to all its participants.

Fellow Disciplines

Christina Henderson - Physics and Astronomy
Frank Andreani- Mathematics
Golala Arya-Chemistry
Jennifer Ambler – Environmental Science and Policy
Lane Nixon– Computational Sciences and Informatics
Manisha Shrestha - Biochemistry
Meghan Durham-Colleran– Biosciences, Microbiology, and Infectious Disease
William Brehm IV - Physical Sciences

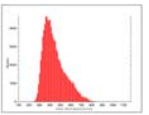
Investigating the Solar Wind

Research Topic - Analysis of Ulysses data to confirm or reject models/ideas about the solar wind and heliospheric current sheet.
- Christina Henderson

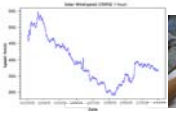
In this lesson, students use knowledge gained from simple hands-on experiments to predict whether or not the Sun has wind. Then, they analyze real solar wind data to better understand how the solar wind changes over time.

The lesson's premise is to predict whether or not the Sun has wind.

Image Credit: NASA/ESA's SOHO



Histogram of 36 years of solar wind speed data accessed at virbo.org.



Line plot of one week of solar wind data accessed at virbo.org. Students experiment with balloons to create effects of wind.

Modular Arithmetic and Encryption

Research Topic - Enumerative combinatorics and Ehrhart polynomials.
- Frank Andreani

Since the children were familiar with clocks (arithmetic modulo 12), clocks with a different number of hours were shown to explain modular arithmetic. In conjunction lessons with some basic encryption schemes were presented. Afterwards there was a discussion on the application to computers and the internet.

SUNRISE GMU Team

GMU Team Members, Left to right, back row:
Lane Nixon, Fellow; **William Brehm**, Fellow; **Frank Andreani**, Fellow; **Dr. Donna Sterling**, co-PI, College of Education and Human Development; **Rajesh Ganesan**, PI, Systems Engineering and Operations Research; **Dr. Phil Henning**, Program Evaluator

SUNRISE members not in picture:
Christina Henderson, Fellow; **Dr. Bruce McDade**, Assistant Superintendent, MPCS, **Ms. Myra Thayer**, Science Curriculum Specialist, FCPS, **Ms. Melissa Hamilton**, Science Specialist, ACPS.

GMU Team Members, Left to right, front row:
Nivedita Nagare, Project Manager; **Manisha Shrestha**, Fellow; **Golala Arya**, Fellow; **Jennifer Ambler**, Fellow; **Meghan Durham-Colleran**, Fellow

SUNRISE members not in picture:
Sandra Hadley, Teacher; **Beverly Welch**, Teacher; Alexandria County Public School , **Lucy Dwyer**, Teacher; **Ross Baker**, Teacher; **Sandra Haley**, Teacher; **Felicia Eley**, Teacher; Fairfax County Public School, **Kelly Beatty**, Teacher; **Kelly Dumermuth**, Teacher; Manassas Park City School.

Participating Schools

Fairfax County Public Schools
Mt. Vernon Woods Elementary
Lynbrook Elementary
Annandale Terrace Elementary
Hutchinson Elementary

Alexandria City Public schools
Cora Kelley Elementary
Patrick Henry Elementary

Manassas Park City Schools
Manassas Park Elementary
Manassas Park Middle

Approach

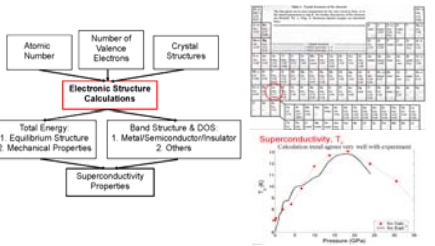
- Regular classroom assistance in both preparation and teaching by the Fellows along with teachers
- Fellows serve as resources for the teachers and work toward improving the content of science and mathematics taught in their classes
- Fellows lead the post-experiment discussion about the science behind the experiments
- Fellows encourage the use of Technology for teaching, incorporate the use of graphics and computer based models, to increase level of perception.
- Develop new IT rich STEM modules and lessons from Fellow research areas and infuse them into elementary school environment through hands on experiments
- Engage in after school programs, Discovery clubs, School science days, Judge County Science Fair projects, answer questions dropped off in the "Question Box", and participate in field trips.

Curriculum Enrichment and Integration Of Fellow's Research

Electronic Structure and Superconductivity

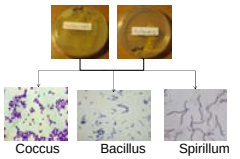
Research Topic- Computational solid state physics and electronic structure calculations of high pressure systems
- Lane Nixon

In this lesson students are introduced to the properties of most superconductors. Students are shown how the fundamental, underlying concepts they are learning are used in Electronic Structure calculations to help explain and predict the quantum mechanical superconducting trend. To simulate and appreciate equilibration, students observe, record, and average the damping oscillations of two marbles, of different color and size, in a smooth chip/dip tray.



Monera-Kingdom

Research topic – Cloning expression and in Vitro refolding of human beta defensin -2 and -3 and mutant peptides
- Manisha Shrestha



Students are introduced to the kingdom "Monera", characteristics of organisms in this kingdom, and how bacteria can be used in research. Different strains of bacteria have been used in research as a host for cloning and expression of proteins. In this lesson, students learn one of the techniques to grow bacteria including optimal temperature, growth condition, and incubation time. Students obtain agar plates and swab different surfaces to observe bacterial growth. Students observe slides of coccus, bacillus, and spirillum under the microscope to learn that bacteria can be categorized based on their shapes.

Integration of Methionine Biosynthesis into Grade 5

Research Topic – Cloning of methionine biosynthesis enzymes
-Golala Arya

Image Credit: www.3dchem.com

This integration of research was applied in the macro to micro unit. At the beginning of the five kingdoms of the living things, amino acids were introduced.

Students were introduced to amino acids as the twenty building blocks of life. Methionine was introduced as one of the amino acids.

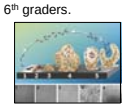
Biofilm Formation

Research Topic- Quorum Sensing and Biofilm formation using two-component systems – **Meghan Durham**

In our lab, we study the genes that control biofilm formation with the goal of designing antimicrobial agents that could target an *in vivo* biofilm (a biofilm that forms inside the human body). Although the approach we take in studying biofilm formation is highly molecular, this lesson seeks to study biofilms at an observational level which is more appropriate for 6th graders.

Part 1: Build background knowledge on biofilms
- Biofilms are structured bacterial communities which are protected by a bacterial-produced extrapolymeric matrix
- Biofilms play an important role in the ecology of water systems

Part 2: Grow Biofilms from Pond Water
- Collect pond water and mix with any basic bacterial growth media (ex: LB broth)
- Put mixture into petri dishes
- Incubate for 48 hours
- Stain with food coloring



In this lesson, students will grow their own biofilms from pond water and understand the role of biofilms in the health of the water system.

Lab: Growing Biofilms

Question: **Biofilms play an important part of the ecology of water systems. Can we grow a biofilm from local pond water?**

Hypothesis: **We can grow a biofilm from local pond water**

Materials and Methods:

Graduated Cylinder, Pond water (10 milliliters), Bacterial Growth Media (10 milliliters), Petri dish

1. Using the graduated cylinder, measure 10 milliliters of pond water.
2. Mix the pond water with 10 milliliters of bacterial growth media.
3. Carefully pour the mixture into your petri dish.
4. As a negative control, we will also make a plate using tap water mixed with bacterial growth media.
4. We will incubate your plate for 48 hours (2 days).
5. After your plate has incubated, we will use food coloring to see if there is a biofilm.

Results/Data Analysis:

Could we see biofilm in our pond water sample?

Could we see biofilm in our tap water sample?

Conclusion:

1. Why were we able to grow biofilms from our pond water?
2. Discuss ways in which biofilms can be good for the ecology of the water systems and harmful.

Galactic Evolution in the Classroom

Research Topic – Analysis of Hubble data to determine bulge properties of low-bulge galaxies –**William Brehm**

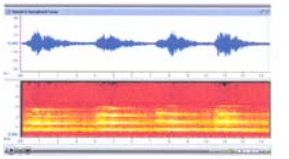
Picture Credit: NASA, The Hubble Heritage Team and A. Riess (STScI)

Some topics simply capture a child's interest. For example, telling them that we suspect that there is a giant whirling machine of death in the center of every galaxy is always a good way to capture their attention. After that, explaining the difficulties in detecting super massive black holes in low-bulge galaxies went over very well, even though the methods that we employ in analyzing the bulge itself are a bit beyond the fifth-grad curriculum.

In this lesson, we were able to go over the different types of galaxies and the effects that a black hole has on the space surrounding it. The effects of the black hole were, not surprisingly, what the children tended to remember most when asked about what they had learned later.

Marine Animal Sounds
A lesson on sound waves

Research Topic – Habitat use of large whales in Virginia near-shore and marine conservation opinions of the whale-watching public in Virginia beach, VA **-Jennifer Ambler**



Students listened to and saw spectrograms of marine animal sounds, including sounds made by humpback whales. They were then asked to determine which were high and low frequency sounds. This lesson complimented their studies on compression waves and my research interests in marine mammal ecology and conservation. Spectrograms and sounds courtesy of Ocean Conservation Research, available at www.ocr.org.