



# SUNRISE

SCHOOLS UNIVERSITY 'N' (AND) RESOURCES 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, CREST- Center for Restructuring Education in Science and Technology, College of Education and Human Development, College of Science, and School 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

Christopher Ruck - Environmental Science and Policy  
Frank Andreani - Mathematics  
Golala Arya - Chemistry  
Jennifer Ambler - Environmental Science and Policy  
Lane Nixon - Computational Sciences and Informatics  
Alexander Koufos - Computational Sciences and Informatics  
Meghan Durham-Colleran- Biosciences, Microbiology, and Infectious Disease  
Tammy Henry - Environmental Science and Policy (Science Track)

### How Old Is This Fish?

**Research Topic** - Population Structure of River Herring (*Alosa aestivalis* and *A. pseudoharengus*)  
- Christopher Ruck

My research attempts to determine the population structure and dynamics among Atlantic coast river herring (*Alosa* spp.) and will address questions of river herring as bycatch in other directed fisheries. I intend to use both genetic and phenotypic determinants to classify population subdivisions.



Students were asked to determine the age of a river herring (*Alosa pseudoharengus*) by measuring the fish length and applying it to a length at age plot. Students experienced the annular properties of hard body parts, similar to ageing trees by counting annuli (rings) on images of the fish's otolith (earstones) and prepared slides of fish scales.

This lesson incorporated three ways a fisheries biologist determines fish age, which is critical when assessing population structure, growth, and stock status.

### Modular Arithmetic and Encryption

**Research Topic** - Enumerative Combinatorics and Ehrhart Polynomials.  
- Frank Andreani

Ehrhart polynomials count the number of integer points of a polytope. In addition, they encode information such as volume.



Students were exposed to the idea that 'mathematician' is a viable career path. In addition, Pick's theorem (a 2-D version of Ehrhart Polynomials) was presented in the form of an activity.

**Area = #(interior integer points) + 1/2 #(boundary integer points) - 1**  
Students were given graph paper and allowed to draw any shape such that there were no curved lines. They were then shown how to compute the area by using the above formula.



## SUNRISE GMU TEAM

**GMU Team Members, Left to right, back row:**

Lane Nixon, Fellow; William Brehm, Past 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:** Christopher Ruck, Fellow; Tammy Henry, Fellow; Alexander Koufos, Fellow; Dr. Bruce McDade, Assistant Superintendent, MPCs; Ms. Myra Thayer, Science Curriculum Specialist, FCPS; Ms. Melissa Hamilton, Science Specialist, ACPs; Audarya Sarkar, Project Manager



**GMU Team Members, Left to right, front row:**

Nivedita Nagare, Past Project Manager; Manisha Shrestha, Past 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; Christina Pentress, Teacher; Kelsey Pope, Teacher; Felicia Eley, Teacher; Fairfax County Public School, Kelly Beatty, Teacher; Kelly Dumermuth, Teacher; Sarah Bianco, Teacher; Manassas Park City School.



## PARTICIPATING SCHOOLS

**Fairfax County Public Schools**  
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

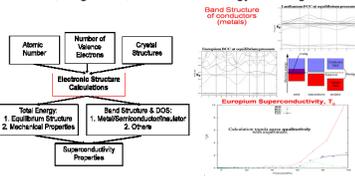
### Electronic Structure and Superconductivity

**Research Topic**- Computational Solid State Physics and Electronic Structure Calculations of High Pressure Systems

- Lane Nixon

An investigation of the Pressure-induced Superconductivity Transition Temperature  $T_c$  and Related Properties in Elemental Superconductors.

In this extensible lesson students are shown how the fundamental concepts they are learning are used in Electronic Structure calculations to help explain and predict superconductivity and other material properties. Students revisit, review, and reinforce their knowledge of fundamental concepts discussed with hands-on lessons on electric circuits and how a material's electronic band structure helps explain its use and function, magnetism, and forms of energy including friction.



### Biodiversity and the Use of Light & Sound

**Research topic** - Conservation Genetics Of The endangered San Joaquin Kit Fox

- Tammy Henry

This endangered subspecies of kit fox lives primarily in scrubland habitat in central California but has also adapted to living in the city of Bakersfield. I am examining mate choice, population genetic structure, and immune system diversity to see how the San Joaquin kit fox is thriving throughout an urban habitat without being influenced by disease or inbreeding.



After discussing the abundance of biodiversity on Earth, I showed examples of how light and sound are used differently by animals. For example, many birds only visualize the environment within a certain UV spectrum and this coloration of prey is perceived differently than we do. Additionally the male Red-capped Manakin claps its tails wings together to make a beating sound while doing the "moonwalk" to court the female during breeding season. These animal examples were also joined with a brief explanation of how we use tags of UV light colors to visualize differences in DNA, thereby allowing us to tell between species or sexes or individuals.



### The Building Blocks of Life

**Research Topic** - Methionine Biosynthetic Pathway as a Target for Novel Antibacterial Drugs

- Golala Arya



The primary goal of this research is to demonstrate that the enzymes of the methionine biosynthetic pathway is very complex. Next, determine their complex structure and identify modulators of complex formation.

Students were introduced to amino acids as the twenty building blocks of life. Methionine, which I work with in my research, was introduced as one of the amino acids.

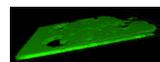


### Water Purification

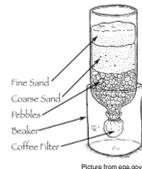
**Research Topic**- Biofilm Formation In The Environmental Pathogen *Francisella*

- Meghan Durham

Part of my research focuses on environmental persistence in waterways by the biothreat pathogen *Francisella tularensis* which causes the disease tularemia. We have shown that this pathogen is able to form a biofilm which could aid in persistence in water environments or in arthropod vectors.



3D confocal microscopy image of *Francisella* biofilm



Students use water from local storm maintenance pond to demonstrate water purification. Aeration, coagulation, sedimentation, and filtration are used to purify water.

Animals and humans may become infected with gastrointestinal tularemia through the infected meat of game or contaminated water. This lesson teaches students how communities purify water for drinking and why this has contributed to public health.

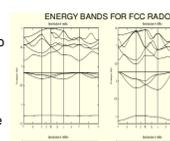
### Computers In Science

**Research Topic** - Electronic Structure Calculations of Heavy Elements: Radon (Z=86) and Francium (Z=87)

- Alexander Koufos

Electronic structure calculations allow scientists to predict the properties of solids. The study consists of two heavy elements, Radon and Francium, the last elements from the noble gas and alkali metal groups, respectively. The mechanical and electronic properties of these elements were calculated.

The school lesson consisted of comparisons between real-life video and animated computer based simulations of car crashes. These simulations were performed using finite element methods to model and compute the deformation of the vehicles. This lesson showcased the ability computational scientists have to model and visualize complex systems. I model quantum mechanical systems of bulk materials.

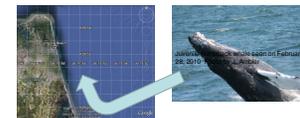


### What Do Baleen Whales Eat and Where Do They Feed Off The Coast of Virginia?

**Research Topic** - The Distribution of Baleen Whales Off The Coast of Virginia In Relation to Oceanographic Parameters

- Jennifer Ambler

A study of the distribution and habitat use of migratory baleen whales off the coast of Virginia and the educational and conservation potential of whale watching.



This lesson asks students to plot actual coordinates of whale sightings from my research and to compare these locations to satellite derived chlorophyll data that shows concentrations of phytoplankton. This lesson was created to assist discussions of marine food web dynamics.

