2015 CTI Seminar Proposals -- STEM

Math -- Untitled
Harold Reiter, Professor of Mathematics, UNC Charlotte
'The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important “processes and proficiencies” with longstanding importance in mathematics education. The first of these are the NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections. The second are the strands of mathematical proficiency specified in the National Research Council’s report *Adding It Up*: adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently and appropriately), and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one’s own efficacy).'

The seminar aims to model these standards using as a vehicle some elementary concepts of mathematics: whole numbers, divisors, fractions, rational and irrational numbers, sets of numbers, one-to-one correspondences among sets of numbers, and puzzles. Topics include fractions, place value and modular arithmetic. The modular arithmetic is accessible to elementary teachers and is a great catalyst for learning more algebra among the more advanced teachers.”

Exercise & the Brain (or Neuroscience of Exercise)
Barbara Lom, Professor and Chair of Biology, Davidson College
The benefits of exercise on physical health have long been recognized, but more recently a large and rapidly expanding body of literature now reveals that physical activity can also exert powerful effects on the brain. This seminar will investigate the ways that physical activity influences the brain through molecular, cellular and behavioral perspectives. We will examine basic, clinical and applied research studies investigating how exercise may facilitate attention and learning and may help treat neurological conditions such as depression, anxiety, addiction, and aging. Seminar Fellows will have opportunities to explore the neuroscience of exercise in contexts that are most meaningful to their students, experiences, and intellectual interests, while also enhancing their understanding of how the human brain develops and functions. For example, one Fellow might develop a curriculum unit examining how physical fitness scores correlate with reading or math performance, while another Fellow might develop a curriculum unit examining how exercise affects physiological responses to stress.
Anchor book = Spark: The Revolutionary New Science of Exercise and the Brain by Ratey & Hagerman supplemented with readings from the popular press and journal articles

Creating the Body (or Egg to Embryo)
Barbara Lom, Professor and Chair of Biology, Davidson College
Developmental biology is a field of study with the ultimate goal of determining how a single cell has all the instructions and abilities to give rise to an immensely complicated and functional individual. At the same time it also seeks to understand the similarities and differences between the diverse animal forms that have arisen through evolution. In the quest to uncover the complicated directions that guide a wide variety of developmental processes such cell division, differentiation, and growth developmental biologists examine molecules, genes, cells, tissues, and the environment in which an embryo develops. The biological processes uncovered in the search to understand how animals come to life also powerfully inform our understanding of

genetics, birth defects, cancer, stem cells, fertility, evolution, and teratogens (environmental factors that compromise development). Seminar Fellows will be encouraged to explore classical and contemporary experimental strategies in developmental biology in specific areas that are most closely aligned with their students and intellectual interests. For example, one Fellow might develop a curriculum unit examining how muscles develop and why myostatin inhibitors may become the next drug of abuse by athletes, while another Fellow might develop a curriculum unit examining limb development that helps explain how bat wings, seal flippers, and human hands have evolved different forms using a similar framework.
Anchor book = Coming to Life: How Genes Drive Development by Nusslein-Volhard
Supplemented with readings from the popular press and journal articles

Insects and Humans
Chris Paradise, Professor of Biology, Davidson College
Insects are intimately connected to human society, history, and science. How do insects affect human lives and society? How have they affected the outcome of historic events? How have they affected the development of nations? How do they affect us in everyday life, from the food we eat to the jewelry we wear to the movies we watch? How have we affected them, in terms of their evolution and ecology? This seminar will examine the incredible diversity of insects and how insects affect human society in a myriad of ways. We will examine a diversity of topics including forensic entomology, pollination, competition between insects and humans for resources, consumption of insects, insects in mythology, cultural entomology and art, and insect-vectored diseases. Teachers of biology, environmental science, history, social studies, and art may find this an engaging seminar.

Integrating Concepts in Biology
Chris Paradise, Professor of Biology, Davidson College
Looking for a new approach to teach science and math? My colleagues and I have been working for several years on a new approach to teaching introductory biology, which would translate well to AP Biology and other science and math courses. Our approach is concept- and data-driven, and uses results from scientific studies to teach critical thinking, data interpretation, and quantitative reasoning skills to students. We emphasize the core concepts of biology, the process of doing science (including experimental design), the applications of mathematics to biology, and the relationship between science and society. These characteristics parallel recent changes in the AP Biology curriculum. Although the approach was developed to accompany an introductory biology text that we wrote (*Integrating Concepts in Biology* (ICB)), the approach could be developed and used in any of the sciences. The seminar would be useful to science and math teachers, primarily, but those interested in the interplay of science and society may also be interested.

Understanding Nanoscale Science and its Role in our Lives
Marcus Jones, Assistant Professor of Chemistry, UNC Charlotte
This seminar program will explore recent scientific advancements and everyday technologies that have developed from the interdisciplinary field of nanoscale science. From next generation solar cells to more effective cancer treatments and ultra-efficient lighting, nanoscale technologies have infiltrated many areas of our lives, often without our knowledge and billions of dollars are being spent worldwide to develop products that utilize some of the remarkable phenomena that occur in nano-sized materials. We will start our discussions by developing an understanding of what exactly “nanoscale” means and how it fits with both our macroscopic

world and the microscopic world often frequented by chemists, physicists and biologists. We will talk about some of the amazing properties often found in nanoscale systems and we will explore how these properties are used in many modern technologies. We will also go into several laboratories at UNC Charlotte for demonstrations of some of the ways that nanoscale materials are produced.

We will also address some of the fears that have been expressed about nanotechnologies, such as the “grey goo” hypothesis, which was a hypothetical end-of-the-world scenario involving nanotechnology that was put forward by some early pioneers in which out-of-control self-replicating robots consume all matter on Earth while building more of themselves. The reality of nanotechnology is very different and a 2004 report declared the possibility of self-replicating machines to lie too far in the future to be of concern to regulators. There are, however, serious concerns about the environmental and societal impact of sonanotechnologies that we will talk about.

Finally, to expose teachers to research in nanoscale science, funding is available for up to two CTI fellows to spend up to 6 weeks to pursue research in our laboratory at UNC Charlotte during the summer following the seminar series. During this period they will be able to work on a specially designed short-term project, present their results at group meetings and contribute to a peer-reviewed publication. Hopefully the experience will inspire the participants to transfer some of this practical experience to the classroom.

IYour Reflexes are in Control
Mark Barsoum, Biology, Davidson College

When we hear the word “reflex,” we often picture our leg extending involuntarily after a doctor whacks our patellar tendon with an orange triangular mallet. This is indeed a reflex – an anatomically simple motor reflex known as the stretch reflex – but it is only one example of a motor reflex, which is in turn only one example of the general phenomenon of physiological reflexes that control nearly all bodily functions. Indeed, physiologists use the term “reflex” broadly to describe the communicative loops of information flow within and between our organ systems that allow us to maintain homeostasis, a state of normalcy and relative constancy in our internal environment.

In this human physiology seminar, we will examine the wide variety of reflexes that govern how our bodies work and detail the cellular and molecular principles that underlie these systemic processes. We will ask what the complexity and sensitivity of various reflexes reveal about our nervous, endocrine, muscular, cardiovascular, respiratory, and urinary systems and even about our evolutionary history.

And we will demonstrate, and in some cases practice measuring, many of the reflexes we discuss in a hands---on manner, including: motor reaction times, sensory discrimination and illusion, vestibular (equilibrium) compensation, blood pressure and heart rate responses to exercise and simulated diving, respiratory regulation, and urinary water and electrolyte balance. The content and skills covered in this seminar will be scalable and adaptable for use with a wide range of student levels and ages.

The Biology and Chemistry of Human Health and Disease
Nicole L. Snyder, Ph.D. Assistant Professor of Chemistry, Davidson College

Is cholera a zoonosis? Why did so many healthy individuals die from the 1918 influenza? Is Ebola the next emerging disease? In this seminar you will use basic biology and chemistry principles to learn about historically relevant and emerging diseases from amoebic dysentery and the medieval plague to the great influenza and superbugs. Your journey will begin with a basic overview of the human immune system where we will focus on the important molecular

interactions that take place between macromolecules such as the proteins, lipids and carbohydrates found on cell surfaces. With a firm foundation of the immune system in hand, you will begin studying infectious diseases using a series of case studies. Each study will introduce you to the history, pathology, diagnosis, prevention, treatment and public health impacts of various bacterial, fungal, viral and parasitic infections. In addition, modern mainstream literature will be used to provide you with additional historical context, social impacts and cutting edge developments, as well as an opportunity to observe and analyze the way science is presented to the general public. Diseases we will study may include: plague, dysentery, cholera, syphilis, tuberculosis, leprosy, rheumatic fever, multidrug resistant bacterial infections, mad cow disease, legionnaires disease, ringworm, athletes foot, oral thrush, invasive fungal infections, small pox, Epstein-Barr virus, herpes virus, hepatitis, measles, dengue fever, Marburg and Ebola viruses, Nipha virus, Hendra virus, certain cancers, HIV and AIDS, influenza, yellow fever, malaria, leishmaniasis, Katayama fever, Chagas, toxoplasmosis, West Nile virus, hantavirus and hepatitis.