Fall 2022 MD-DC-VA Section Meeting Abstracts

Abstracts are in chronological order. All talks are Saturday, except the workshop and banquet talk.

Workshop

Intentionally using student thinking to connect teaching and learning

George Kuster (on behalf of MD-DC-VA COMMIT) , Christopher Newport University

Friday 4:00-6:00, Henkel, Hester Auditorium

Traditional teaching methods assume learning is a natural consequence of teaching, and focuses on the teacher as opposed to the student's learning. In this workshop we will discuss how to turn this on its head and place the focus on student learning. By placing the focus of education primarily on student learning we can intentionally engage in teaching practices that better support our students in constructing meaningful understandings of the important mathematical ideas. This shift in focus requires a careful analysis of what exactly we desire our students to understand, how that understanding develops in our students, and how we as teachers can support its development. In particular, we will discuss the principles and practices of Inquiry-oriented Instruction, a student-centered form of instruction that relies almost entirely on student thinking. During the second half of the workshop we will provide instructors with assistance in developing and/or implementing lessons that foster and utilize student thinking to support learning.

Banquet Talk

Mathematics + Magic = Mathemagic

Dave Taylor, Roanoke College

Friday 8:00-9:00, Brandt Student Center

What do you get when you combine some mathematical principles from the undergraduate mathematics curriculum with a deck of cards? Fun is what some people say. Amazement is what others might exclaim. But what you do get is a "real world" example of how some principles that all of us have learned at one time work. Building on work from Martin Gardner, Fitch Cheney, and Colm Mulcahy, this banquet ~~talk~~ show with highlight concepts from calculus, discrete mathematics, and abstract algebra to bring magic tricks alive that you can perform yourself in the future! And it may feature some magic tricks that are entirely non-mathematical in nature and left for you to figure out what the BLEEP happened. With any luck, the ~~talk~~ show will end with one of the world's largest games of . . . heads or tails.

Extension of the Lobachevsky Integral Formula

Hongwei Chen, Christopher Newport University

8:50-9:10, Henkel 106-22

Lobachevsky's original work dates back to 1842. Since then it has fueled the attention of many mathematicians including A. C. Dixon and G. H. Hardy. In this talk, by using higher derivatives of the partial fraction expansion of $\csc x$ and their derivative polynomials, we extend and find Lobachevsky's integral formula in explicit form for all odd powers. We also show that this approach works for all even powers as well.

Dispersal Driven Instabilities and Pattern Formation in Metapopulations

Kubilay Dagtoros, Norfolk State University; Ozgur Aydogmus

8:50-9:10, Henkel 107-24

Diffusion-driven instabilities in systems of reaction-diffusion equations has been studied since the seminal work of Turing. These conditions are widely used in ecological applications to model pattern formation. In this study, we consider spatial dynamics of two species on a 2D lattice and obtain conditions for observing dispersal-driven instabilities in such a system. We numerically validate our results by considering a Holling-Tanner type predator-prey meta-population model.

Analyzing Aspects of a Tumor Virotherapy Model

Ashlee Edwards, Old Dominion University

8:50-9:10, Henkel 108-37

Oncolytic viruses are presumed to target, infect, and kill harmful cells. Upon infecting the tumor cells and killing them, the virus particles are released to infect other tumor cells. These types of viruses have great potential in cancer therapy. In fact, a variety of viruses have shown positive results in clinical trials. Success is inconsistent, however. The immune response plays a vital role in the success of this type of cancer therapy. The effectiveness of this therapy is jeopardized because the immune system can target and destroy not only tumor cells that are infected with the virus but also the virus itself. We present a mathematical analysis of models of cancer tumor growth that describe the interaction between an oncolytic virus, tumor cells, and the immune system. Stability analysis of the ODE tumor virotherapy models are performed and we explore equilibria and their biological meaning.

Digital Image Processing in College Mathematics

Yevgeniy Galperin, East Stroudsburg University of PA

8:50-9:10, Henkel 109-28

We provide meaningful context for reviewing key topics of the college mathematics curriculum by studying a variety of methods for digital image processing. In the process, we help students gain confidence in using concepts and techniques of applied mathematics, improve student awareness of recent developments in mathematical sciences, and help students prepare for graduate studies.

How to Extract the Cube Root of a Nine-digit Number in Seconds

Cherng-tiao Perng, Norfolk State University

9:15-9:35, Henkel 106-22

Assuming that a given nine-digit integer is a perfect cube, I will present a method to find its cube root quickly. This was based on a note I wrote more than two years ago that was inspired by movie clips featuring Shakuntala Devi (https://www.imdb.com/title/tt10964468/).

The Use and Abuse of Probability Theory in Evolutionary Biology

Jason Rosenhouse, James Madison University

9:15-9:35, Henkel 108-37

Everyone knows that Darwin's "Origin of Species," published in 1859, led to a revolution in biology. Less well-known is that it led directly to tremendous progress in the use of probability in biology.

For example, many developments in statistics were the direct result of trying to experimentally test Darwin's conclusions, and probabilistic models in population genetics were instrumental in the establishment of the Neo-Darwinian synthesis in the 1940s. At the same time, modern anti-evolutionists, whether the old-school Biblical creationists or the superficially more sophisticated intelligent design proponents, routinely use poor probabilistic arguments to advance their agenda. In a time of rampant pseudoscience and malicious misinformation, mathematicians should pay attention to this abuse of our discipline. We will consider a few highlights of this fascinating subject.

Nahm-like gradient flows in Lie algebras
Andre Mas, James Madison University
9:15-9:35, Henkel 109-28
(student talk)

We analyze a family of Lie algebra gradient flows that are closely related to Nahm's equations. For a special case, we construct an exact solution that converges to a non-trivial zero. In the process, diagonal trajectories and the zero locus of these flows are discussed.

Invited address

Some unusual mathematical images and the math behind them
Brian Heinold, Mount St. Mary's University
9:45-10:55, Armstrong Concert Hall

When I first learned about fractals in college, I was fascinated by the imagery and set about trying to write programs to generate them. I generated many images that are considerably different from what was already out there. After I got my PhD, I spent some time trying to understand why the images look the way they do. In this talk, we will look at many of the images, talk about how to generate them, and try to understand a little of the mathematics about why they look the way they do.

Hook shape crystals of type A_n
Molly Lynch, Hollins University
11:05-11:25, Henkel 106-22

Crystal bases were introduced by Kashiwara when studying modules of quantum groups. These crystals are combinatorial structures that mirror representations of Lie algebras. Each crystal has an associated crystal graph. Many of these graphs have a natural poset structure. We study crystal posets associated to hook shape crystals of type A_n. We realize these graphs using a tableaux model introduced by Kashiwara and Nakashima. We study the structure of these crystal posets, namely understanding relations among crystal operators.

Harmonic graph morphisms and the "Moonlight of Mathematics"
Caroline G. Melles, United States Naval Academy
11:05-11:25, Henkel 107-24

This talk tells the story of how a question about counting maps between graphs is related to combinatorial methods from the Moonlight of Mathematics (Ganita Kaumudī), a work by the

Indian mathematician Nārāyaṇa the Learned (Nārāyaṇa Paṇḍita) from the year 1356. (Joint work with David Joyner.)

Strategies for roulette, and craps
James T Sandefur, Georgetown University
11:05-11:25, Henkel 108-37

We first run simulations of roulette and craps to gain insight into our chances of winning given some simple strategies. We will then develop a model to give a more exact probability of winning using these strategies. We then end with some related anecdotes from the speaker's past.

A Mathematical Model for the Dynamics of Spread of Crime in Virginia
Ana Vivas, Anne Fernando, Norfolk State University
11:30-11:50, Henkel 106-22

Incarceration rate in the state of Virginia is the highest among all the states in the US. Incarceration is a social phenomenon that can be spread within social communities who share a common demographic identity that includes race, ethnicity, economic opportunity, education, and political socialization. Relevant literature indicates that criminality and re-incarceration can be largely attributed to structural social disparities embedded in the legal, political, and economic institutions. This work aims to provide an understanding of this social science phenomena through a mathematical lens. Our model is specifically tailored to understand at-risk population flow dynamics using compartmentalized modelling methods. Accordingly, the model assumes that the total population is divided into five compartments. The compartments include S: Susceptible (no violent criminal behavior), E1: Latent 1 (violent criminal behavior, never-incarcerated), E2: Latent 2 (repeat offenders), I: infectious (incarcerated), and R (recovered). In the analysis, we compute the reproduction number, the disease-free equilibrium, and the endemic equilibrium. Additionally, we performed simulations using parameters for Virginia and include some stability results.

Mathematics of a genetic-ecology model for assessing the impacts of pyrethroid resistance and temperature on population abundance of malaria mosquitoes
Jemal Mohammed-Awel, Morgan State University
11:30-11:50, Henkel 107-24

This study presents a genetic-ecology modeling framework for assessing the combined impacts of insecticide resistance, temperature variability, and insecticide-based interventions on the population abundance and control of malaria mosquitoes by genotype. Rigorous analyses of the model we developed reveal that the boundary equilibrium with only mosquitoes of homozygous sensitive (resistant) genotype is locally-asymptotically stable whenever a certain corresponding ecological threshold is less than one. The model exhibits the phenomenon of bistability when the thresholds associated the boundary equilibria with only mosquitoes of homozygous sensitive and resistant genotypes are less than one. Furthermore, the impact of varying temperatures and insecticide coverage on the mosquito population by genotype in the context of the moderate and high fitness cost scenarios have been explored numerically.

A one-sentence proof of the Extreme Value Theorem: what proofs should be in Calculus anyway?
Sam Ferguson, Metron, Inc. and Georgetown U
11:30-11:50, Henkel 108-37

What do we want students to take away from a first calculus course? Certainly, intuition about limits, derivatives, and integrals, and how to apply them—but what do we want students to get out of the proofs? And which proofs should be in Calculus anyway? While pondering this, the speaker shares his one-sentence proof that a continuous function on an interval [a,b] attains a maximum, published in the Monthly. Discussion ensues about which proofs can be included in a calculus course and how they can play a role in learning.

Invited address

A fun exercise in probability
Ray Cheng, Old Dominion University
2:05-3:05, Armstrong Concert Hall

At an MAA Section Meeting some years ago, an interesting problem came up during discussion of one of the contributed papers. This kicked off a flurry of activity, resulting in several dramatically different solutions, involving conditional expectation, Markov chains, Martingales, the Fibonacci sequence, and other ideas. We will work through six of these solutions. The only prerequisites are basic undergraduate probability and a sense of adventure.

Roots of unity – an empowering theme in a transition to higher math course
Bob Sachs, George Mason University
3:15-3:35, Henkel 106-22

Roots of unity provide a rich area for a large set of student explorations. I will illustrate some of the topics that arise in the context of a "transition to higher math" course centered on complex number topics. There are connections to algebra, number theory, combinatorics, complex analysis, and Fourier analysis that are quite accessible and beautiful.

Rethinking Developmental Mathematics
Spencer Hamblen, McDaniel College
3:15-3:35, Henkel 107-24

Having inherited a developmental mathematics program rapidly becoming obsolete, and lacking the resources to effect a co-requisite model, we are attempting a new (to us) type of course for our students who need additional support in mathematics. We will talk about the philosophy and motivation behind the course, and report on how the first couple of years of implementation have gone.

Replacing the Mean for the Median: Boostrapping the "Traditional" 2-Sample t-Test
Allen G. Harbaugh-Schattenkirk, Longwood University
3:15-3:35, Henkel 108-37

Perhaps you're one of those students that wondered why the mean is so important in statistics when the median is so much easier to calculate (and interpret). Then this talk is for you. Using

techniques from simulation research, this talk will explore statistical inference problems in a manner that wasn't available to the forefathers of statistics. In so doing, we will encounter some interesting graphs, and hopefully gain a better understanding of the true meaning of the P-value. And, along the way, we'll uncover a little bit of the reasoning for why the 2-sample t-test is the way it is... mean and all.