

College of Natural Sciences and Mathematics



UNIVERSITY OF
CENTRAL
ARKANSASTM

25th Annual Student Research Poster Symposium

April 19, 2019
1:00 - 3:00 PM
Farris Center

Welcome from the Dean College of Natural Sciences and Mathematics

Welcome to the 25th Annual College of Natural Sciences and Mathematics Student Research Symposium. Today you will see some of the research that is being undertaken by students in the College. This year we have research by 111 students mentored by 44 different faculty members. We encourage you to drop by the Farris Center to join us in celebrating the accomplishments of our students.

I look forward to seeing you there.

Cordially,

Stephen R. Addison

Stephen R. Addison, Dean
College of Natural Sciences and Mathematics

Table of Contents

Department of Biology	1
Department of Chemistry	11
Department of Computer Science	29
Department of Geography	33
Department of Mathematics	38
Department of Physics & Astronomy	41
Interdisciplinary Research	51
Student Author Index	53
Faculty Mentor Index	54

Department

Faculty Views on Evolution and Teaching Evolution at Several Arkansas Campuses

Student Author: Christie Birdsong

Mosquito Control by Invertebrate Predators in UCA Vernal Pools

Student Author: Caleb Bryan

Faculty Mentor: David E. Dussourd

UCA has five vernal pools behind the softball, soccer, and track complex adjacent to Stone Dam Creek. We tested if mosquito larvae are present in the pools and if macroinvertebrate predators provide adequate control. The five pools were sampled every other week from March 9 to May 10, 2018 to estimate macroinvertebrate diversity and abundance of mosquitoes and mosquito predators. Pools 1, 2a, and 2b had large numbers of alternative prey (mostly water fleas), sizable predator populations, and low numbers of mosquitoes. Mosquito numbers and diversity were higher and predator populations lower in pools 3 and 4. Unlike pools 1, 2a and 2b, pools 3 and 4 receive very little sunlight due to a dense understory of non-native privet together with an overstory of mostly hardwood trees; they also receive pesticide runoff from the adjacent soccer fields. To increase populations of *Macrobrachium ohione* Drew Castleberry S. Reid Adams, Matthew E. Gifford

Ghhgev"qh"Ugngevqpp"cpf" I gpgvke"F tkhv"qp"Rj gpqv{ rke" FkxgtukŁecvkqp"kp"Vjg"

Measuring the Cost of a Novel Symbiont Infection in Other Social Amoeba Species and its Prevalence in Natural Populations

Student Authors: Haley Hensley, Sydney Ulmer

Faculty Mentor: Tamara S. Haselkorn

Microbial symbionts can have dramatic effects on their hosts' ecology and evolution. We use the social amoeba, *Dictyostelium discoideum* as a simplified model system to study eukaryote-bacterial symbioses because it is a single celled eukaryote that houses three naturally occurring bacterial symbionts in the *Burkholderia* genus. *D. discoideum* infected with these *Burkholderia* symbionts are able to carry food bacteria with them upon dispersal in a trait called farming. So far, these symbionts have only been characterized in *D. discoideum*, so it is not clear how host specific these infections are. We have previously determined that the *Burkholderia* can infect other closely-related amoeba species in the lab, however, the consequences of that infection are unknown. When pathogens infect a new host, theory predicts that they will have a greater fitness cost initially, particularly when that host is distantly-related to the original host. To test this, we artificially infected other species of amoeba (*D. purpureum* (closely-related) and *P. pallidum* (distantly-related)) with three strains from two symbiont species, *B. agricolaris* and *B. hayleyella*, and measured the production of spores in these novel hosts with and without *Burkholderia*. We found that contrary to our predictions, the fitness cost is not higher in *P. pallidum*, and the costs vary more by symbiont strain. Furthermore, we used PCR to test the prevalence of *Burkholderia*, and other amoeba symbionts in five natural populations of five social amoeba species. We found a high prevalence of *B. agricolaris*, as well as other species of non-symbiont *Burkholderia*. Other characterized amoeba symbionts species, *Chlamydiae* and *Amoebophilis*, were found in only a couple of individuals. The findings suggest that *Burkholderia* is not host specific, and provide insight into the microbiome of the amoeba to allow it to become a better model organism for studying host-bacteria interactions.

Wound Infection Treatment with Manuka Honey and Alternative Honey Types

Student Authors: Samantha R. Hewett, Shivange Satishbhai

Faculty Mentor: Kari Naylor

Postoperative infections are a major issue in US hospitals, accounting for roughly 20% of all hospital-acquired infections yearly. Wound-infecting bacteria in particular have a high rate of drug resistance (up to 65%), creating life-threatening complications. Manuka honey has been FDA-approved for wound treatment in the US after recent studies demonstrated its ability to inhibit a variety of bacterial species and facilitate wound healing. In this study, we demonstrated that there are several alternative (non-manuka) honey types, particularly raw Arkansas wildflower honeys, that comparably inhibit the growth of the resistant bacterial species specifically implicated in wound infections. Concentrations of 10%-30% honey completely inhibited the growth of the highly antibiotic resistant organisms that WHO declared in 2017 to be in critical need of new antibiotics. No statistical differences in MIC existed between manuka honey and Arkansas wildflower honey for any of the species tested. These results could transform wound care in the United States, where manuka honey can be expensive and difficult to obtain, and where antibiotic resistance remains a troubling concern for wound treatment.

Characterization of Smoke Particle Emissions from Rocket Stoves Versus V j tgg/Uvqpg"Hktgu

Student Authors: Mackenzie Hoogshagen, Elizabeth Versluis

Faculty Mentor: Leah Horton

Citizens of third world countries around the globe are negatively impacted by environmental factors such as smoke inhalation. Our research is centered in the small village of Kanembwe, Rwanda. This people group is limited by a lack of resources and recurrent sickness.

The residents traditionally cook over open three-stone fires. When smoke is inhaled into the lungs, some of the particles can become imbedded into the soft tissue and cause damage. This can result in lower elasticity which ultimately causes lower pulmonary functioning and chronic obstructive pulmonary disease (COPD). Rocket stoves, improved cook stoves, were introduced to the village, and tested to measure if rocket stoves' impact on human health via reduction in inhaled smoke. We conducted trials in which smoke particles from both rocket stoves and three-stone fires were collected onto filters using a Siotus cascade impactor. We then examined particles by using scanning electron microscopy (SEM) to characterize the abundance of the particles with respect to their size distribution.

We hypothesized that rocket stove intervention would have a positive impact on human health by releasing fewer inhalable particles by being exposed to fewer particles, residents should experience less respiratory illnesses. Further, peak expiratory flow rate was measured among residents who utilize either three-stone fires or rocket stoves as their primary cooking method to quantify direct impact on user health.

**Fgvgt o kpcvkqp"qh"Dcv"Urgekguø"Wug"qh"CtvkLekcn"Dctm"Gpj cpegf" Jcdkvcv"kp"
Northern Arkansas**

Students

Kpvgi tcvkqp"qh" Okzgf" Ogvjqfu"Kpvq"Eq o o wpkv{/Dcugf"Rctvkekr cvqt{"

Energetic Cost of Girdling in a Notodontid Caterpillar, *Oedemasia Leptinoides*

Student Author: Brianna Trejo

Faculty Mentors: David Dussourd, Matthew Gifford

Some caterpillars use their mandibles to cut a ring around the petiole, rachis, or stem before feeding on the distal leaf blade. This girdling behavior has been observed in multiple notodontid species. In one study, final instar larvae of *Oedemasia leptinoides* spent up to 11% of their time girdling over a 12 hour observation period, whereas another notodontid, *Lochmaeus manteo*, did not girdle at all (Ganong et al., 2012). Girdling may improve leaf nutrition or reduce plant defensive responses. Using *O. leptinoides* and *L. manteo* as model notodontids, a combination of behavioral observations and respirometry data were used to produce overall energy allocation budgets for each species. Preliminary results indicate that the energetic cost of behaviors (feeding, walking, inactivity) was similar for the two caterpillar species, and that the cost of girdling in *O. leptinoides* was similar to the cost of feeding. *L. manteo* spent more time inactive. As a result, its overall energy expenditure was less, but it also grew more slowly than *O. leptinoides*, which spent more time feeding.

Dwvcpqpg"Cuuqekcvkqp"Ngctpkpi"kp"Y knf/V{ rg" cpf"Rqn{/S"Caenorhabditis elegans

Student Author: Whitney Wilkins, Priya Rana, Stefani Hall

Faculty Mentor: Mindy Farris

C.elegans change their behavior in a Pavlovian-like response to a conditioned stimulus (food) paired with an unconditioned stimulus (butanone). We compared wild-type (N2) and the Huntington disease (HD) model poly-glutamine (poly-Q) *C. elegans* for learning association and short-term memory experiments, reflecting early cognitive deficiencies. The poly-Q strain serves as a model for HD, as polyglutamine expansion in the neurons causes increased proteotoxicity with age and HD patients typically have a decrease in cognitive functioning before motor dysfunction occurs. Chemotaxis assays were conducted on media without food (OP50 *E. coli*) with ten percent butanone vs diluent control spotting over 0.4M sodium azide, following one-hour long exposure to ten percent butanone with OP50 *E. coli*. Larval and young adult populations were used for each assay. Results suggest that N2 animals are capable of butanone association after butanone inoculation, and poly-Q animals are less so by a Learning Index of 0.637. The ages in which assays were conducted were before typical neuronal degradation occurs in poly-Q animals, suggesting the mechanism(s) for learning are severely inhibited before full proteotoxicity of the neurons. Further experimentation has been conducted using glucose supplementation for analysis of learning rescue, with no significant rise in learning index of diseased populations. Experimentation has moved forward toward 10 μ M rapamycin supplementation as previous literature suggests rapamycin reduces protein aggregation of cellular HD models by slight reduction in protein synthesis.

Wukpi "c" Oqngewncf/ I gpgvke "Crrtqcej" vq "Kpxguk i cvg" vjg "Kpvgtc evkqpu" Dgyggp "Tkeg" cpf "Rncpv" I tqyvj/Rtq o qvki "Dcevgtkc." C | qu rktknw o

**Student Authors: Charles Wilson, Allee Haynes, Randall Rainwater, Grant Wiggins,
Skpskpi [cpi."Connor Deen, Jacklyn Thomas**
Faculty Mentor: Arijit Mukherjee

Major non-legume crops can form beneficial associations with nitrogen-fixing bacteria like *Azospirillum brasilense*. Our current understanding of the molecular aspects and signaling that occur between important crops like rice and these nitrogen-fixing bacteria is limited. In this study, we used an experimental system where the bacteria could colonize the plant roots and promote plant growth in wild type rice and symbiotic mutants (*dmi3* and *pollux*) in rice. Our data suggest that plant growth promotion and root penetration is not dependent on these genes. We then used this colonization model to identify regulation of gene expression at two different time points during this interaction: at 1 day post inoculation (dpi), we identified 1622 differentially expressed genes (DEGs) in rice roots and at 14dpi, we identified 1995 DEGs. We performed a comprehensive data mining to classify the DEGs into the categories of transcription factors (TFs), protein kinases (PKs), and transporters (TRs). Several of these DEGs encode proteins that are involved in the flavonoid biosynthetic pathway, defense and hormone signaling pathways. We also identified genes that are involved in nitrate and sugar transport and are also implicated to play a role in other plant-microbe interactions. Overall, findings from this study will serve as an excellent resource to characterize the host genetic pathway controlling the interactions between non-legumes and beneficial bacteria which can have long-term implications towards sustainably improving agriculture.

Thiyl Radicals: What Could be the Harm?

Student Author: Kyle Burgener

Faculty Mentor: Nolan Carter

Free radicals are key intermediates in the damage of biomolecules such as proteins and DNA. Radical-induced damage reactions are often initiated by reactive oxygen species such as hydroxyl radical. Thiols such as glutathione are believed to exert a protective antioxidant effect via donation of hydrogen atoms to radicals. This converts the radical to a stable molecule and halts the cascade of reactions involved with radical damage. However, a byproduct of this “repair” reaction is a sulfur (thiyl) radical. Since thiyl radicals are significantly less reactive than their oxygen counterparts, they have generally been considered benign. While it is true that sulfur radicals are much less reactive in processes such as hydrogen atom abstraction, they do readily react by pathways such as addition to carbon-carbon double bonds. This goal of this project is to examine the degree to which thiyl radicals may be involved in the damage of biological molecules such as DNA. To study this problem we are synthesizing a cysteine derivative which contains a photolabile disulfide functional group. This will enable the selective generation of thiyl radicals in the presence of nucleosides. Reaction products formed in this model system will provide insight into the possible role of thiyl radicals in DNA damage.

Vjg"K o rng o gpvcvkqp"qh"Gf rw | |ng"Xkfgqu"kp" c"Htguj o cp/Ngxgn"Ejg o kuvt {" Classroom to Address Student Performance on Lewis Structures, VSEPR, VB Theory, and Polarity

Student Author: Morgan Burke

Faculty Mentor: Faith Yarberry

Lewis Structures, VSEPR theory, VB theory, and molecular polarity prove to be difficult concepts for students in freshman-level chemistry courses. Split-screen lecture videos on these topics have been developed with the overall goal to improve student success in the classroom and on the nationally standardized American Chemical Society (ACS) exam. Student success will be evaluated using their test scores on the end-of-course exam and the ACS exam after completion of an online lab dedicated to viewing the lectures through EdPuzzle.

EdPuzzle is a useful online tool because of its unique ability to embed questions into videos. In addition to the percent correct, it provides a variety of analytics that can be used to determine student use of the tool. This tool is not only useful for its analytics, but it also gives students the opportunity to identify concept errors and re-watch components that address those concepts.

For two years, videos on these topics have been implemented in the freshman-level chemistry classroom. The goal of the research is to determine if scoring above or below 60% on the EdPuzzle video quizzes will help student performance on the End-of-course

Ecnkdtcvkqp"Ogvjqfu"Wukpi"Oketqłwkfke"Rcrgt/Dcugf"
Analytical Devices

Student Authors: Nicole Gaile, Spencer Mallett

Faculty Mentor: Nathan A. Meredith

Impact on the Student Cohort

Student Author: Aaron Gaul

Faculty Mentor: Faith Yarberry

Previous research illustrates a direct correlation between mathematics ACT exam scores and success in freshman-level chemistry courses. Currently, at UCA, a 21 mathematics ACT score is the pre-requisite for College Chemistry I with an alternative of a pre-requisite/co-requisite of College Algebra. Under the current requirements, there is still a 33.4% DFWI rate in College Chemistry I. It is therefore necessary to re-evaluate the prerequisite requirements for this course in order to increase student success. One possible option is to increase the Mathematics ACT score or, as an alternative pathway, make a course grade of C or better in College Algebra as a pre-requisite. Alterations considered to the Mathematics ACT requirement must be informed by data and be reasonable with respect to student impact on chemistry majors as well as majors for which College Chemistry I is a service course.

Biology majors are required to enroll in College Chemistry I through Organic Chemistry II for their Academic Map. This cohort of students is easily the largest group served by these chemistry classes. We, therefore, wanted to analyze the impact of potential pre-requisite changes on this group of students. College Chemistry I data, from Academic Years 2007-2017, collated with College Algebra data was evaluated. Potential changes of the current 21 to a 23, 24, or 25 Math ACT score were considered and cross-

The Effect of Retinoid Receptor Agonists on K562 Cellular Proliferation

Student Authors: William Higgins, Sidney Freyaldenhoven

Faculty Mentor: Melissa Kelley

Aqueous Solvation of Alkaline Earth Metal Ions Using Combined Explicit and Continuum Solvent

Student Author: Madison E. Martin

Faculty Mentor: Makenzie Provorse Long

Aqueous solvation of alkaline earth metal ions plays an important role in biological and environmental processes. The water molecules most tightly bound to the cation constitute the first solvation shell. The size and flexibility of the first solvation shell affects the physical and chemical behavior of these ions. In general, the size and flexibility of the first solvation shell increases as the cation radius increases. However, the literature values for the number of water molecules within the first solvation shells of Ca^{2+} , Sr^{2+} , and Ba^{2+} can vary widely based on the method used. Physically, both short-range quantum mechanical interactions and long-range electrostatic interactions are expected to contribute to the aqueous solvation of alkaline earth metal ions. A promising computational approach that includes both of these interactions is to explicitly model the first solvation shell with quantum mechanics and treat the bulk solution as a dielectric continuum. There are many computational aspects that may affect the reliability of this combined solvent model. We use density functional theory to explicitly model the alkaline earth metal ion and its first solvation shell. This quantum mechanical system is then embedded in a continuum defined by the dielectric constant of bulk water. Several computational aspects are investigated: basis set size, effective core potential, empirical dispersion model,

Concentrations of Tetracycline in Agricultural Settings

Student Author: Erica Lane Smith

Faculty Mentor: Nathan A. Meredith

Tetracycline is commonly used in concentrated animal feeding operations, where overuse of antibiotics contributes to the issue of

Uswetc okfg/Dcugf"Cpvk/Rctcukvke"Ftwiu"Vqyctf"vjg"Fkueqxtg{"qh"Pqxn" **Treatments for American Trypanosomiasis**

Student Author: Emily N. H. Tran
Faculty Mentor: Gregory R. Naumiec

American trypanosomiasis, or Chagas disease, is a neglected tropical disease caused by the parasite *Trypanosoma cruzi*. This illness is known to affect over one sixth of the world's population, most prevalently in Central and South America. The two current treatments for Chagas disease utilize the drugs Nifurtimox and Benznidazole, potent anti-parasitic medications that eliminate *T. cruzi*. Though effective drugs, their side effects are extremely harsh. Some of these effects include difficulty eating, passing stool, and cardiac complications which could result in sudden death. Our research project focuses on the production of a library of drug candidates that are inexpensive yet innocuous to treat Chagas disease. Squaramide-based drug derivatives synthesized from 3,4-dihydroxycyclobut-3-ene-1,2-dione (squaric acid) have shown to have anti-parasitic properties against *T. cruzi*. Our target compounds are synthesized in three short synthetic steps. Squaric acid is first converted to the squaric ester diethyl squarate via condensation with ethanol. Diethyl squarate is subsequently converted to the targeted squaramides when reacted with a variety of amines. This class of compounds have demonstrated low toxicity in humans and high affinity for the *T. cruzi* parasite. Through a series of condensation reactions, potential drugs are being created from alkyl and aryl amines. The availability of these compounds will enhance the chances of discovering a novel and safer remedy for Chagas disease. Currently, significant progress has been made in the synthesis of a diverse drug library. Future research involves testing the potency of these drug candidates and synthesizing a new generation of drug derivatives.

The Synthesis of a Fluorophore for the In Vivo Diagnosis of Neglected Tropical Diseases

Student Authors: Emily Trinh, Colton Andrews
Faculty Mentor: Gregory Naumiec

Due to inadequate water sanitation and poor hygiene, NTDs are becoming a world-wide crisis affecting more than 1 billion people in developing countries. The symptoms of NTDs are asymptomatic or similar to other diseases which creates an issue in misdiagnosis. The current diagnostic techniques for NTDs are lab blood tests that are not widely accessible due to limited infrastructure, cost, difficulty in tracking patients, and lack of fieldwork. Therefore, there is a critical need for a quick, accurate, and cost-efficient method for diagnosing and monitoring the level of infections.

The goal of this research is to develop a cost-efficient and accurate method of diagnosing NTDs by fluorescent emissions. Near-infrared (NIR) spectroscopy is a non-destructive and qualitative imaging technique that works within the NIR region. When a fluorophore is tethered to a substrate capable of binding to NTD microscopic organisms, the interactions of the substrate with the disease can be observed on a molecular level. Based on these observations, current drug therapies could be improved to counteract the constant evolution of drug resistance in NTDs.

The Eu(III)-doped fluorophores display intense peaks in the NIR region when absorbing UV light (365 nm). This provides evidence for the photoluminescence properties of Eu(III) and its capability for biological fluorescent labeling. Since both compounds are based on commercially MRI contrast agents, the toxicity of the ligands is negligible. The second fluorophore designed is based on the naturally-occurring fluorophore chlorin, a compound found in chlorophyll, which is responsible for photosynthesis via absorption of light. Chlorin displays a strong fluorescent emission in the NIR region. Due to its permeability and low toxicity, both fluorophores are an ideal candidate to tether to substrates for the in vivo diagnosis and treatment monitoring of NTDs.

U{pvjguku"qh"Gurkpvcpqn/Dcugf"Pcvwtcn"Rtqfwevu" for the Treatment of Leishmaniasis

Student Author: Kayla Vinh

Faculty Mentor: Gregory Naumiec

Neglected tropical diseases (NTDs) are a group of parasitic and bacterial infections that affect developing nations near the equator. Many of these countries struggle to fight NTDs because they are hard to detect, easily communicable, and costly. One NTD of particular interest is leishmaniasis, which is caused by protozoan parasites carried by sand flies. Currently, more than twenty strains of leishmania species that cause disease in humans have been identified. 1.6 million new cases of leishmaniasis occur every year, and 350 million people are at risk for infection in Africa, Asia, and the Americas. Common treatments, such as pentavalent antimonial compounds, have harsh side effects and are not immune to resistance, thus the development of new drugs is crucial to fighting leishmaniasis where drug resistance is becoming a large concern. A class of cyclic, unsaturated hydrocarbon compounds, called terpenes, has shown strong anti-leishmanial capabilities across several strains. Our target molecule, espintanol, is a natural product found in the bark of the Bolivian spruce tree, *Oxandra espintana*, can be easily functionalized at 5 positions on the aromatic ring. Our research focuses on the optimization on the synthesis of terpenes as well as developing more analogs to determine their effectiveness on the parasite. We are currently one synthetic step away from the completing espintanol. All products have been purified by using column chromatography and fully characterized by ¹H and ¹³C NMR spectroscopy. Once complete, espintanol will then be functionalized with different substituents to create a library of potential anti-parasitics targeting leishmaniasis. Our proposed development of novel treatments helps combat the problem of drug resistance among the strains of leishmaniasis.

**Department
of
Computer Science**

Rtgfkevki "Y kpg" Swcnkv {"Wukpi "Ugpvk o gpv"Cpcn{uku"

Student Author: Zeqing Dong

Faculty Mentor: Bernard Chen

Wine has been popular with the public for centuries. In the market, there are a variety of wines to choose from. However, few studies have applied sentiment analysis to wine reviews to benefit consumers. In this paper, we collect all wine reviews about

Department of Geography

A Statistical and Geographical Analysis of Hispanic Voting Patterns in the 2016 Election

Student Author: Hunter Crockett

Faculty Mentor: Stephen O'Connell

The 2016 election seemed to initially favor Democratic candidate Hillary Clinton. One of the potential explanations for why she would win was that she was thought to have a large majority of the Hispanic vote, and in 2012, Barack Obama won the Hispanic vote in key swing states. Clinton was able to secure the Hispanic vote but had a lower percentage of Hispanic votes than Barack Obama did in 2012. This study investigates the voting patterns of the 2016 election to determine if the Hispanic vote substantially affected Hillary Clinton's results. The three key swing states of Colorado, Nevada, and Florida were examined to determine the effect Hispanic voting had on overall outcomes. These states were chosen because all of them have sizeable Hispanic populations, and Hispanic voters, and in recent election cycles, tended to vote Democrat. The statistical analysis compares county-level percentage of Hispanic voting-age population to the percentage of 2016 Democratic votes cast using linear regression. Additionally, the Hispanic population was divided into four groups: Mexican, Cuban, Puerto Rican, and Other. This was done in order to determine whether Hispanic populations should be viewed as a homogenous voting group. The results of this analysis explain the Hispanic voting patterns in 2016 and examine whether Hispanic populations reflected a homogenous voting group in the election.

Fire History of an Unlogged Shortleaf Pine Forest in the Ouachita Mountains, Arkansas

Student Authors: Lillian McDaniel, Cathleen McNutt, Alexander Russell

Faculty Mentor: William Flatley

Shortleaf pine-bluestem ecosystems are a fire adapted vegetation community in the Ouachita Mountains that has declined drastically since fire suppression started in the 1930s. Managers recently began carrying out prescribed burning treatments with the goal of using fire to restore this important habitat. However, little is known about the historical fire regime in the Ouachita Mountains and managers lack site-specific information to guide prescribed burns. Our objective was to characterize the historical fire regime, specifically frequency and seasonality; and to understand how the fire regime changed through the following land use periods: pre-EuroAmerican settlement (pre-1830), post-EuroAmerican settlement (1830-1930), and fire protection (post-1930). We sampled in the Lake Winona Research Natural Area, an unlogged shortleaf pine forest in the eastern Ouachita Mountains of Arkansas. We collected, processed, and crossdated 41 fire-scarred cross sections in order to identify historical fire years. Our samples spanned the years 1561 to 2018 and fires were identified during both the pre- and post-EuroAmerican settlement periods. Fires were most frequent during the post-EuroAmerican settlement period. The majority of fires occurred during the dormant season indicating that they burned in the late fall, winter, or early spring and suggesting that ignitions may have been anthropogenic in origin. There have been no fires recorded at the site during the recent 90-year fire protection period. This project provides site-specific data to help guide the re-introduction of fire to the Ouachita Mountain landscape and help perpetuate shortleaf pine-bluestem ecosystems.

Department of Mathematics

A Tax System Based on the Scale Advantages of Wealth

Student Author: Stefano Battisto

Faculty Mentor: Fred Hickling

Buffered Fourier Spectral Method

Student Author: Monica Davanzo

Faculty Mentor: Yinlin Dong

Standard Fourier spectral method is efficient for solving problems with periodic boundary conditions, but oscillations occur for problems with non-periodic boundary conditions. This can be corrected using a buffered Fourier spectral method. For non-periodic functions, a buffering polynomial will be added to the right end boundary, making it smooth and periodic on the boundaries, before applying FFT. Then the buffering zone can be removed to compute maximum error and order of accuracy.

Divergent Thinking or Problem Posing: Creativity at its Best

Student Author: Demetrius Moore

Faculty Mentor: James Fetterly

Historically, a long-standing connection exists between creativity and problem posing. One way to understand creativity is through divergent thinking. It has been noted in the past that one of the most efficient and effective ways to foster creativity is to be exposed to creativity. This study desires to understand if mathematical exposures and experiences with problem posing and/or divergent thinking affect mathematical creativity in the classroom. By using a sample population of Algebra students, this study seeks to answer which treatment will enhance mathematical creativity, if any. For this study, three treatment groups are considered. The first treatment exposes students to mathematical problem posing activities, the second treatment explores divergent thinking in mathematics, and the third combines both experiences of problem posing and divergent thinking. Over a six-week period, three problem-posing treatments will be administered every other week and, on alternate weeks, three divergent thinking treatment will administered, where the duration of each treatment is one 50-minute class. The collection of pre- and post-test data will test for significant differences in mathematical creativity, beliefs, and knowledge among the three groups to discover which treatment is effective.

Impact of Historical Mathematical Problems on Student Metaperspectives of Mathematics

Student Author: Scarlett Nestlehut

Faculty Mentor: Todd Abel

Jankvist (2009, 2011) distinguishes between mathematical in-issues and meta-issues. In contrast with in-issues, meta-issues are concerned with mathematics as a whole (Jankvist, 2009, 2011), including the nature of mathematics as a discipline and the social and cultural-situatedness of mathematical work (Bishop, 1988, 2002; D'Ambrosio, 1985). Student conceptions of these meta-issues are termed metaperspectives, and are important in shaping how they interact with and understand mathematics.

Work of the past few decades has established a number of potential benefits for integrating the history of mathematics into mathematics curriculum (Clark, 2012; Clark, Kjeldsen, Schorcht, Tzanakis, & Wang, 2016; Fauvel, 1991; Swetz, 1995). This project considers undergraduate metaperspectives as students engage with historical problems grounded in primary sources (Barnett, Lodeer, & Pengelley, 2014), investigating the research question: How do students' meta-perspectives change as they engage with historical mathematical problems?

Twelve undergraduate STEM majors enrolled in a history of mathematics course completed a series of journal entries reflecting on meta-issues in mathematics and their own experiences encountering historical mathematics. Initial journals included prompts such as "Describe a mathematician", and "Is mathematics invented or discovered?" As the semester progressed, prompts addressed reactions to class work more specifically. All journals were completed online. In addition, five students were interviewed two times each. One interview asked students to expound on passages from their journals, while a follow-up interview at the conclusion of the course prompted reflection on their views of the meta-issues described above. Themes within these journal entries emerged using open coding (Charmaz, 2014).

Results indicate that students initially viewed mathematics as "discovered" - existing independently of any human knowledge of it. Furthermore, an archetypal mathematician was described as an "old, white Greek man". Initial meta-perspectives indicated widespread exposure to a modified Eurocentric perspective on mathematics history (Joseph, 2011), with some awareness of historical mathematical work in Asia. As the semester progressed, students began to describe mathematics as arising from practical needs within a culture and recognize differences in mathematical communication. The proposed poster highlights themes

Assessing Sensitivity and Robustness Index of Propensity Score Estimation for Causal Inference

Student Author: Cdfgn/C|k|"Uqw o c jqtq"

Faculty Mentor: Sharif Mahmood

**Department
of
Physics & Astronomy**

A Real Time Automated Microclimate Ecosystem

Student Author: Kayce Conville

Faculty Mentor: William Slaton

The goal of the project is to create an automated microclimate which recreates any given ecosystem in real time. The ecosystem is controlled with a Raspberry Pi and the program is written in Python. The user is able to give the program a given weather station ID associated with Weather Underground, which the program then pulls the HTML code from the website providing the program with the real time weather information for that particular station. The program then processes the data and pulls the information wanted, like current temperature, solar radiation, hourly precipitation, and daily precipitation. The focus of the project as of now is mimicking solar radiation. The environment will be equipped with a semiconductor photodiode sensor which will give off a voltage proportional to the amount of energy given off by the light source. To create the scale of voltage versus light, data is collected with the photodiode sensor inoff[ciniculle aven weather stannd, whirepropsghticulradi station.3

Fgxgnqr o gpv"qh" Y knfŁtgu"cpf" Fgdwpmkpi "Vjgkt" O {vju

Student Authors: Monica Davanzo, Luke Ogle

Faculty Mentor: Debra Burris

Weather can potentially play a prominent role in the start and spread of fires. Dry weather, droughts, and higher temperatures are prerequisites for wildfires. Higher winds provide oxygen to the fires which act as fuel. Lightning strikes can ignite foliage, or strong winds can uproot power lines which can ignite vegetation and surrounding buildings. Recent wildfires in the California area have bred some unusual conspiracy theories such as the government testing directed energy weapons (DEWs) on civilians despite scientific evidence that proves otherwise. Weather patterns and scientific inquiry will be used to explain the potential ignition and intensity of wildfires. The Oklahoma Mesonet will also be utilized to provide an example of how daily fire hazard conditions can be used to predict where wildfires are most likely to occur. Mesonet is network of environmental monitoring stations that are designed to measure the environment at the size and duration of mesoscale weather events. The Oklahoma Mesonet consists of 121 automated stations capable of collecting large volumes of useful data for this research.

Rqkpvkpi "Kupøv" Twfg<"C" Rtqqh/Qh/Eqpegrv" JCD" Rc {nqcf" Uvcdknk | gt

Student Author: R. D. Jeffery

Faculty Mentor: William Slaton

High-Altitude Balloons (HABs) are excellent platforms for research projects in physics, meteorology, engineering, and other related fields because of their low cost in comparison with other platforms that offer similar capabilities. One of the major drawbacks of HAB platforms, however, is their instability; lack of any fixed attachment point makes it practically impossible to use directional instruments in any controlled manner. While several HAB payload stabilization methods have already been developed, they all have limitations that leave something to be desired. For example, gyroscopes necessarily take up a large portion of the payload mass, leaving little room for instruments within the legal weight limits; servo motors promise low-cost, high-precision control, but it is difficult to design adequate control algorithms to compensate for the lack of stable attachment

Rgvkv"Lgcp"Ecxcg"Ctv"cpf"kvu"Cvvtqppq o kecn"Uk i pkLecpeg

Student Author: Luke Ogle

Faculty Mentor: Debra Burris

Cave paintings have a very important part in Native American culture. Many of their religious leaders looked to the skies for guidance. There was one cave painting at Petit Jean that proved to be particularly interesting. The painting appears to a comet like object traveling through the sky with some objects in the background. My hypothesis is that the Object traveling through the sky in the painting is Halley's Comet, which would match up with previous records from the Chinese Astronomers. The other surrounding objects we believe to be the stars of Orion, Taurus, and Gemini. We believe this to be of some great cultural significance to the Mississippian people. But it may be possible that what they were observing was a rare phenomenon that very little people have witnessed called a supernova. We will explore all the possibilities and how Astronomy played a central role among the Mississippian people.

An Investigation of Thermoelectric Element Power Generation and Heat Pumping Ability

Student Author: Isaac Raphael

Faculty Mentor: William Slaton

The purpose of this research project was two fold: to first quantify the cooling ability of three different CPU cooling units and then to characterize the power generation and heat pumping ability of a Peltier device in the context of a model CPU and CPU cooling unit. A Peltier device is a thermoelectric device that can work in two ways. Firstly, it can act as a power supply when the two sides of the device are at different temperatures. Secondly, the device can work as a heating/cooling device where one side

The Optimal Locations for Sweet Corn and Soybeans to be Grown in Oklahoma Based on Historic Rainfall Patterns

Student Authors: Erica Smith, Marissa Watson

Relative Strength of Rat Bones

Student Author: Daniel Toomer

Faculty Mentor: Rahul Mehta

For this research project, I was supplied with 4 different groups of rat leg bones. A control group, a group that was Hind Leg Suspended (HLS), a group that was irradiated (IR), and a group of both HLS and IR. I was tasked with cleaning these bones, cutting them, and then bending them using a homemade cantilever bending set up in order to determine the effects on the relative strengths these different techniques had on the bones. The HLS is used to signify the effects of a zero gravity environment, while the IR is used to signify the effects of space radiation. These are applied to the rats in order to learn more about the effects that spacelike conditions have on the relative leg bone strength.

Once the bones were cleaned, they were cut at the knee joint to analyze both the effects on the femur and the tibia independently. A small square mirror was then glued to one side of the bone in order to reflect a laser in the bending mechanism. The bending mechanism had a clamp where the bone would be placed and secured. Then a string would be tied around the bone and run through a series of two pulleys with mass at the end of the string. This caused a force on the bone in order to bend it. A laser was shot at the mirror so that it would reflect on the back wall where measurements would be taken as extra mass was added on increasing the force on the bone. This data allowed for the determination of the relative bone strength, or the (stress/strain). The stress is calculated by the (force/area) and the strain is calculated by the (bend/length).

Native American Astronomy

Student Author:

Use of Drones in Weather

Student Authors: Sonja Wagner, Matthew Kalkbrenner

Faculty Mentor: Debra Burris

Drones have the possibility of being used to collect meteorological data and more accurate forecasts. Drones will be able to collect data in locations that have in the past been too hard to collect data in or in areas that are not easily accessible. Drones also allow for more risk to be taken during severe weather by allowing people to send the drones directly into the storm. The data that can be collected from this would allow for a better understanding of these storms and help make predictions on future storms more accurate. In addition to taking data in risky environments, the Oklahoma Mesonet is working on adding drones to their weather stations to help build a 3D model of their mesonet system. With this new influx of data we can have questions answered that we have long had unanswered.

Weather's Effect on Sporting Events

Student Authors: Chris Walker, Raleigh Wood

Faculty Mentor: Debra Burris

Weather has affected our lives, in numerous ways. Outdoor sporting events is such a way in which weather can effect our lives. In order to protect our athletes, the NCAA and other professional associations have taken measures so that the players, the coaches and everyone involved remains safe. The most dangerous threat to athletes who participate in summer sports are categorized as External Heat Related Illnesses (EHRI). This term characterizes any condition that effects an athlete during conditions of high temperature and or humidity. Of these include, heat stroke, muscle cramps, heat exhaustion, heat rash, etc. In recent years the NCAA, and the NFL has restricted the amount of practice hours during the summer months to avoid any serious injury or any fatalities. The NFL and NCAA are also passing rules that prevent athletes from practicing if the temperature and or humidity is too high. Another threat that weather has on sporting events is thunderstorms. Since thunderstorms mostly occur during the fall, and spring seasons this effects every outdoor sports. According to the National Oceanic Atmospheric Association (NOAA) 62 percent of all lightning related fatalities occur during sporting events. Because of this there are regulations that state if lightning strikes within a 10 mile radius of a location, then the event is postponed for thirty minutes. Weather can effect, the athletes, coaches and everyone present during a sporting event. So in order to make sure that everyone remains safe, we should continue researching so that we can understand weather patterns.

Investigating Relationship Between Stress Applied to Leg Bones of Rat and its Mechanical Strength

Student Author: [gnc o cp" \ jgpku"

Faculty Mentor: Rahul Mehta

The purpose of this research is to investigate elasticity of the rat bone utilizing cantilever beam bending setup. The bone is fixed at one end and a string attached at the other end with a pulley allowing for applying a stress using a hanging weight. A mirror glued to the free end allows measurement of bending of the bone as force is applied along the major axis of the cross section of the bone. The position change of a Laser beam incident on the mirror as stress is applied is recorded . To consider the elliptical shape of the bone's cross section the bending procedure is repeated after the bone is rotated by 90 degrees and stress is applied along the minor axis of the cross section. The amount of bending as a function of applied weight is used to ascertain the relationship between stress and strain and determine the elastic modulus of the bone.

Interdisciplinary Research

Phytoremediation in *Helianthus annuus*: Seedling Establishment Inhibition and Translocation of Cadmium in a Simulated Bioswale System

Student Author: Ashley R. Barto

Faculty Mentors: Robert Mauldin, KC Larson

Bioswales are a type of green infrastructure many cities are utilizing to mitigate the environmental impact of urbanization. Specifically, bioswales are a means to mitigate urban pollutants from washing into waterways, and they are designed to use phytoremediation to sequester those pollutants. While research shows bioswales effectively sequester heavy metals associated with urban impervious surfaces like parking lots, there is also evidence that removing heavy metals from aquatic ecosystems

UCA Faculty Mentor Index

A

Todd Abel 32

Ikpp{"Cfcou"4."9

U0"Tkf"Cfcou"4."5."9

B

Mark Bland 2

Fgdtc"Dwtku"58."59."5:."5;."63."64."65

C

Nolan Carter 13

Bernard Chen 25

D

