The 21st Annual

RESEARCH AND CREATIVE INQUIRY SYMPOSIUM 2026

Tennessee TECH

tntech.edu/research/research-day

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Preface

Abstracts

U.S. House of Representatives Resolution

H. Res. 1654

IN THE HOUSE OF REPRESENTATIVES, U. S.
NOVEMBER 16, 2010

WHEREAS, close to 600 colleges and universities in the United States and thousands of **undergraduate** students and faculty pursue **undergraduate** research every year, providing research opportunities that will shape the trajectory of students' lives and careers and researchers' and institutions' purpose and contributions to academia and the research enterprise;

WHEREAS, students and faculty engaged in undergraduate research contribute to research across many disciplines, including arts and humanities, biology, chemistry, health sciences, geosciences, mathematics, computer science, physics and astronomy, psychology, and social sciences;

WHEREAS, research at the **undergraduate** level provides both students and faculty members opportunities for improving and assessing the research environment at their institution, develops critical thinking, creativity, problem solving, and intellectual independence, and promotes an innovation-oriented culture;

WHEREAS, undergraduate research is essential to pushing the Nation's innovation agenda forward by increasing the interest and persistence among young people in the crucial science, technology, engineering, and mathematics (STEM) disciplines, and to cultivating the interest of would-be researchers who pursue a new aspiration of graduate education after participating in **undergraduate** research; and

WHEREAS, the week of April 11, 2011, would be an appropriate week to designate as "**Undergraduate** Research Week." Now, therefore, be it

Resolved, That the House of Representatives—
supports the designation of "**Undergraduate** Research Week";
(1) recognizes the importance of **undergraduate** research and of providing research opportunities for the Nation's talented youth to cultivate innovative, creative, and enterprising young researchers, in collaboration with dedicated faculty;
(3) encourages institutions of higher education, Federal agencies, businesses, philanthropic entities, and others to support **undergraduate** research and **undergraduate** researchers and their faculty mentors;
(4) encourages opportunities, including through existing programs, for females and underrepresented minorities to participate in **undergraduate** research; and
(5) supports the role **undergraduate** research can and does play in crucial research that serves the Nation's best economic and security interests.

Attest: *Clerk.*

Foreword

Welcome to the 2026 Research and Creative Inquiry (RCI) Symposium – Tennessee Tech University's annual celebration of student scholarship, research, and creativity!

Now in its 21st year, the RCI Symposium is a cornerstone of Tennessee Tech's research enterprise, showcasing more than 200 posters that reflect the depth, breadth, and impact of student scholarship across disciplines.

Higher education is a foundational driver of workforce readiness and innovation, and undergraduate research serves as a key accelerator for student success. Education and research together equip students with the applied skills needed to solve complex, real-world problems. Through research, students develop leadership, communication, collaboration, and advanced analytical and critical-thinking skills essential for success in an increasingly complex world.

To our students: Congratulations on your accomplishments and on sharing your research and creative work with the broader community. For many of you, today represents your first public presentation—an important professional milestone and a formative experience in your academic and career development. Participation in research and creative inquiry builds the interdisciplinary competencies required to address pressing challenges in areas such as human health, sustainable resource management, cybersecurity, energy innovation, food security, and national security. This experience marks an important step in preparing you to contribute meaningfully in your chosen fields.

To our faculty, staff, and campus community: Thank you for your mentorship, leadership, and sustained engagement in student research and creative inquiry. Your commitment directly enhances the quality of the student experience and advances Tennessee Tech's broader research and innovation mission. We encourage you to continue fostering collaboration and experiential learning across disciplines, creating environments where rigorous inquiry, discovery, and meaningful innovation can thrive.

We extend our sincere appreciation to everyone who made this event possible. Special recognition goes to our judges for their thoughtful evaluations, as well as to the staff of the Office of Research and Economic Development and the many volunteers across campus whose time, expertise, and commitment were essential to the success of this symposium. Congratulations to all student presenters, collaborators, and mentors whose work and dedication reflect Tennessee Tech's enduring commitment to academic and creative excellence. Together, we celebrate the achievements on display today and reaffirm our shared commitment to advancing discovery, creativity, and student success. Wings Up.

Michael Aikens, PhD
Vice President for Research & Economic Development
Executive Director, Center for Rural Innovation

Special Appreciation & Acknowledgments

Tennessee Tech Offices, Departments and Staff

Exercise Science

Information Technology Services

Office of Communications & Marketing

Office of Creative Inquiry/QEP

Printing Services

Student Services

Tennessee Center for Rural Innovation

We would like to extend a special thanks to **Kristen Deiter**, professor of English, for coordinating the paper portion of the event.

We especially wish to acknowledge **David and Sherri Nichols** for their endowment to that continues to support student research and creative inquiry.

The 21st Annual Research and Creative Inquiry Day

Memorial Gym
Schedule of Events

Monday, April 20

9:30 a.m. – 6 p.m. ..... **Poster Setup**

Tuesday, April 21

8 a.m. – 4:30 p.m. ..... **Poster Judging**
(Students are not present)

Wednesday, April 22

8 – 10:30 a.m. ..... **Poster Judging**
(Students are not present)

10 a.m. – 1 p.m. ..... **English Papers Presentation and Judging**
(Tech Pride Room - RUC 101)

1 p.m. - 4:30 p.m. ..... **Poster Display for Campus and Community**

5 p.m. – 7 p.m. ..... **Faculty Innovation Showcase Presentations**

Thursday, April 23

8 – 10:45 a.m. ..... **Poster Display for Campus and Community & Faculty Innovation Showcase**

11 a.m. ..... **Awards Ceremony Begins**

1 p.m. – 3:00 p.m. ..... **Poster Pickup/Cleanup**

Abstracts

College of Agriculture and Human Ecology

Agriculture

Undergraduate

The Impact of an Educational Infographic on Homeowner Knowledge and Purchase Intentions for Native Plants in Middle Tennessee

Primary Author: Davie Holloway

Co-Author(s): Ciana Bowhay

Faculty Advisor: Ciana Bowhay, School of Agriculture

As residential development continues to expand into natural landscapes, existing ecosystems are heavily altered by land clearing, construction, and landscaping. Developers and homeowners tend to choose non-native, ornamental varieties to fit aesthetic preferences. Non-native plants offer limited benefit to local wildlife, especially birds and insects that have evolved alongside and rely on native plant species to survive. Habitat loss and the lack of host plants contribute to a decline in biodiversity and negatively affect insect populations. Incorporating native species in residential landscapes can support ecosystem health and potentially mitigate some of the impacts of development. Despite these benefits, many homeowners lack awareness of the native plants in their region and their ecological importance. Additionally, native plants are often less available in commercial nurseries than non-native species, further limiting their adoption. This study surveys Middle Tennessee homeowners to assess their current knowledge and attitudes toward native plants and to evaluate whether increased awareness of their ecological benefits influences their willingness to purchase and incorporate native plants into residential landscapes. The survey uses a pre-post design. Participants respond to baseline questions, view a brief research-based infographic, and then complete post-exposure questions. Key measures are repeated to assess changes in knowledge, attitudes, and willingness to purchase native plants. Findings from this study will provide insight into the effectiveness of simple educational tools in promoting public acceptance of native plants in residential landscaping and supporting local ecosystem health.

University Faculty and Students Helping High School Agriscience Teachers meet their Educational Goals

Primary Author: Morgan Cartwright, Maggie Miller

Faculty Advisor: Dennis Duncan, School of Agriculture

Tennessee currently has over 220 high school FFA chapters and over 30,000 FFA members. FFA advisors train their students for career development events (CDEs) and leadership development events (LDEs). FFA advisors typically have a broad education, and sometimes lack the extensive knowledge and experience needed to prepare FFA members for specific CDEs and LDEs. Faculty and students in the School of Agriculture at Tennessee Tech recognized the many challenges advisors face and developed training clinics structured according to state and national FFA, CDE, and LDE guidelines. University student clubs develop and organize the clinics - specific content and instruction provided by university faculty, volunteers, and experts with extensive FFA experience. The clinics provide FFA members with valuable experience that can prepare them for upcoming FFA events. Since 2012, over 4,000 FFA and 4-H members have attended clinics ranging from horse and livestock judging to floriculture, parliamentary procedure, and veterinary science. In order to gauge the impact(s) of the aforementioned clinics, a study was conducted during multiple clinics and included 66 FFA advisors who have and/or had students who participated in FFA clinics at TN Tech. Results indicate that the majority of advisors strongly agree or somewhat agree that the clinics have supplemented their training, and nearly 75% strongly agree or somewhat agree that the clinics have provided training they don't have expertise in, and over half strongly agree that clinics have made their students more competitive.

Food Insecurity: The Psychological Barriers in College Students

Primary Author: Ella Cutshall

Faculty Advisor: Dennis Duncan, School of Agriculture

This research focuses on how mental health directly

affects a person's ability to be food secure. The research has a specific focus on how mental health impacts food insecurity in college students. The inability to have access to nutritious, affordable, and sufficient food that provides adequate dietary demands in a person's lifestyle is defined as food insecurity. Often people view food insecurity harshly without any understanding of the factors that dictate whether a person is food insecure or not. Specifically in college students, there is a wide range of backgrounds socially and economically that dictate the ability to be food secure. A survey was conducted from a pool of students who currently attend Tennessee Technological University to understand the correlation between mental health affects food insecurity, specifically topics such as anxiety, depression, and panic attacks.

Effects of Combining Mechanical and Chemical Pre-treatments on Germination of Common Mullein

Primary Author: Emily Craig

Co-Author(s): Kenneth Pierce, Ciana Bowhay, Modoluwamu Idowu

Faculty Advisor: Ciana Bowhay, School of Agriculture

Common mullein (Verbascum Thapsus L.) is a medicinal plant native to Europe, Asia, and Africa that was introduced to North America in the 18th century. It is commonly found on roadsides, pastures, and other disturbed environments due to its ability to thrive in nutrient-poor soils. Historically, mullein has been used by natives to treat pulmonary and integumentary ailments, and has also been found to treat minor auditory and musculoskeletal ailments due to its anti-inflammatory properties. Mullein has many medicinal properties that make it attractive for cultivation for commercial and research purposes.
To germinate, mullein seeds must go through a stratification or scarification process. Replicating these natural processes can be time consuming and inconsistent. The objective of this study is to evaluate the effectiveness of combining chemical and mechanical pre-treatments to accelerate germination. Seeds were subjected to five treatment groups, including combination of sandpaper scarification with gibberellic acid (GA_3), potassium nitrate (KNO_3), and indole-3-butyric acid/naphthaleneacetic acid (IBA/NAA). Each treatment consisted of three repetitions of 50 seeds, arranged in two rows of 25 that were placed on germination paper and rolled in a waxy paper. Seedlings were counted and measured to evaluate germination percentage and seedling growth. Findings from this study will provide insight into effective germination strategies for mullein, supporting more efficient cultivation and production practices. Improved propagation methods may encourage growers to produce mullein, making it more accessible to consumers and researchers for medicinal use.

In Vitro Rumen Fermentation to Evaluate Effects of Probiotics on Digestion and Microbial Activity Using Different Feed Types

Primary Author: Emma Broski

Faculty Advisor: Modoluwamu Idowu, School of Agriculture

This study will evaluate the effects of a probiotic supplement containing Enterococcus and Lactobacillus on rumen microbial activity and digestion across different feed types. Rumen fermentation plays a critical role in nutrient utilization, directly influencing growth performance and health in cattle. Therefore, strategies that enhance rumen function, such as probiotic supplementation, may improve feed efficiency. An in vitro fermentation system will be used to assess the impact of probiotic supplementation on two feed substrates: hay, and a total mixed ration (TMR). Fresh rumen fluid will be collected from an Angus beef steer using an orally administered stomach tube connected to a vacuum pump. The rumen fluid will then be incubated with each feed type under probiotic-supplemented and control conditions for 48 hours at 39°C in a water bath. Key fermentation parameters, including gas production, pH, microbial activity, and dry matter digestibility, will be measured to evaluate digestive efficiency and microbial responses. Data will be analyzed using a two-way ANOVA to determine the significance ($p \leq 0.05$) of the effects of probiotic supplementation, feed type, and their interaction. We expect that probiotic supplementation would enhance microbial activity, stabilize ruminal pH, and improve digestibility compared to the control. Findings from this study will provide insight into the functional role of probiotics in ruminant nutrition and their potential to improve feed efficiency. Given that feed costs account for approximately 50-60% of livestock production costs, optimizing nutrient utilization through probiotic supplementation may offer a practical and sustainable strategy for improving profitability.

Digital Inventory Location Tool (DILT): A Spatially Enabled System for Efficient Nursery Inventory Management

Primary Author: Gauge Borum

Co-Author(s): Caleb Rawdon, William Blankenship, Grant Mainord

Faculty Advisor: Abdul Momin, School of Agriculture

The Digital Inventory Location Tool (DILT) is a capstone design project that develops a spatially enabled inventory management system for nursery operations, with a focus on balled-and-burlapped (B&B) plant inventory. Traditional inventory tracking in nurseries often relies on manual searches and operator memory, leading to inefficiencies and increased labor time. This project aims to design, develop, and evaluate a digital, map-based tool that enables users to locate plant inventory by species, size, and planting year using a structured grid or section-based spatial framework. The system integrates QGIS, Google Maps, and web-based technologies to create a mobile-friendly interface accessible from internet-enabled devices. Development includes field-based testing, time data collection, and validation at a working nursery to assess usability and performance. The expected outcome is a functional prototype that demonstrates reduced search time, improved inventory accuracy, and enhanced operational efficiency, with potential for broader application across agricultural and landscaping industries.

A Comprehensive Review of Equine Reproductive Technologies: Cloning by Somatic Cell Nuclear Transfer

Primary Author: Jacqueline Jarosz

Faculty Advisor: Ciana Bowhay, School of Agriculture

This project presents a literature-based review of equine cloning by Somatic Cell Nuclear Transfer (SCNT), an advanced assisted reproductive technology used to produce a genetically identical copy of an existing horse. Since the birth of the first cloned horse, Prometea, in 2003, SCNT has evolved into a limited commercial and conservation tool. This review synthesizes peer reviewed veterinary literature, industry reports, and academic research to examine the cloning process, historical development, efficiency limitations, postnatal health outcomes, and ethical considerations.

Despite technical progress, equine cloning remains highly inefficient, with success rates often below 3%, and ranging from 11% to as little as 0.7%. Significant variability in reported outcomes across studies highlights a need for standardized protocol and system of measurement for cloning success across the industry. In addition to embryonic failure, SCNT produces high rates of fetal and neonatal loss. Common challenges include abnormal placental development and Cloned Offspring Syndrome, which contributes to neonatal complications such as limb deformity, umbilical abnormalities, and increased risk of sepsis. While SCNT offers unique benefits including preservation of elite genetics, reproduction of infertile geldings, and conservation applications, significant welfare concerns remain. Continued research, improved efficiency, standardized methodologies, and greater transparency are essential before broader adoption of this technique can be ethically justified.

Crossbreeding Dairy and Beef Cattle: An Observational Study of Scottish Livestock Production System

Primary Author: Raven Mullis

Co-Author(s): Jon Mulderink

Faculty Advisor: Dennis Duncan, School of Agriculture

This study examines the use of crossbreeding between dairy and beef cattle in Scottish livestock production systems, based on observations made during a visit to Scotland's Rural College in Dumfries. Unlike traditional practices in the United States, where dairy and beef production are often separated, Scottish farmers commonly crossbreed dairy cows with beef sires to improve the value and efficiency of meat production. This approach allows for better utilization of dairy calves while enhancing carcass quality compared to pure dairy animals. Observational comparisons suggest that this system increases overall farm efficiency and may contribute to more sustainable livestock production. The findings highlight key differences between Scottish and U.S. cattle systems and suggest that integrating crossbreeding strategies could provide economic and production benefits in American agriculture.

Influence of Soil Texture and pH on Phosphorus Leaching in Agricultural Soils

Primary Author: Raven Mullis

Co-Author(s): Emma Osborne, Cole Williams, Jackson DiMisa

Faculty Advisor: Michael Nattrass, School of Agriculture

Phosphorus is an essential plant nutrient but can contribute to environmental degradation when lost through leaching into water systems. This study investigated how soil texture and pH influence phosphorus leaching in agricultural soils. Silt loam and sandy loam soils were treated with amendments to alter pH and were subjected to controlled water applications over a three-day period. Leachate samples were collected and analyzed for phosphorus concentration. Results indicated that silt loam soils exhibited greater phosphorus leaching compared to sandy loam soils. Additionally, soil pH played a role in phosphorus mobility, with near-neutral conditions helping to limit nutrient loss. These findings suggest that both soil texture and pH management are important factors in reducing phosphorus leaching and improving nutrient retention in agricultural systems.

Food Insecurity in the 21st Century – The Tale of Two Countries

Primary Author: Sarah Callicott

Faculty Advisor: Dennis Duncan, School of Agriculture

Food insecurity is a challenge that remains rooted even in the richest countries across the globe. Nations including Scotland and the United States attempt to tackle food insecurity amongst their citizens through various programs and community support. There are several key differences in how each nation approaches food insecurity and how effective they are in the fight to end hunger. This project explores the similarities and differences of food insecurity in the United States and Scotland as well as current measures to address food insecurity. The author pulled data from the Trussell Report: Ending Hunger Together (trussell.org.uk) – a national report that outlines the nature, scale, and drivers of hunger across Scotland. The most recent publication was released in September of 2025. Data shows that 15% of adults in Scotland face food insecurity that is often due to lower-than-average salaries, increasing food prices, mental and/or physical limitations, and rising housing costs. Additionally, one in seven households experienced food insecurity, as highlighted in the Trussell Report. These causes are not unique to Scotland or the United Kingdom as a whole. According to data released in 2024 by the United States Department of Agriculture's Economic Research Service, nearly 14% of Americans households faced food insecurity. This represents nearly 34 million adults and approximately 7.3 million children in 2024. Lastly, families living in rural areas of both Scotland and the United States experienced food insecurity at higher levels than families living in urban sectors.

Master's

Gait Tracking Using Digital Image Processing For Enhancing Poultry Welfare

Primary Author: Nathaniel Dace

Faculty Advisor: Abdul Momin, School of Agriculture

This project focuses on improving poultry welfare through the development of an automated gait tracking system using digital image processing. Gait scoring is a critical indicator of chicken health, as abnormalities in movement can signal lameness or injury, directly impacting both animal welfare and farm productivity. Traditional gait assessment methods are manual, subjective, and time-consuming, creating a need for more efficient and objective approaches. To address this, a camera-based system was installed in a poultry facility to continuously monitor chicken movement. High-definition overhead cameras captured video under varying lighting conditions, including low-light environments using infrared capabilities. The recorded footage was processed using image analysis software capable of detecting movement patterns and extracting gait-related metrics such as speed and stride characteristics. Preliminary results demonstrate that the system can successfully track poultry movement and identify behavioral patterns associated with mobility issues. This automated, non-invasive approach enables early detection of health concerns, supports data-driven farm management, and reduces labor requirements. Overall, the system shows strong potential as a scalable solution for enhancing poultry welfare and advancing precision agriculture practices.

Evaluation of Cotton for Resistance to Fusarium Wilt Race 4 Using Machine Learning

Primary Author: Riley Putman

Co-Author(s): Ahmad Tulsi, Nickolas Fuller

Faculty Advisor: Jinfa Zhang, School of Agriculture

Fusarium wilt (FW) caused by Fusarium oxysporum f. sp. vasinfectum (FOV) is a soil-borne fungal disease that affects cotton plants across the Cotton Belt. Developing and growing FW-resistant cultivars is the most cost-effective method for managing FW. Accurate and efficient disease detection is essential for large-scale disease resistance identification. A total of 329 cotton stem segments cut from the soil level of FOV- infested field plots were visually sorted into 6 categories of vascular discoloration (VD), ranging from 0 with no VD, to 5 with >75% VD. This study scanned and annotated cotton stems to automate computer-based predictions. Using machine learning, pre-trained models can be specialized to detect VD and other important visual symptoms of the disease. This study initially screened 8 pre-trained models before proceeding with the 3 best predictors of VD. After training on this novel dataset, the best performing model was based on the pre-trained Feature Pyramid Network (FPN) model which is capable of predicting VD with >99% accuracy. This 2025 study details the positive correlation between VD% by ground truth and VD% by prediction, suggesting that machine learning is a powerful tool that should be further developed for disease resistance identification.

Biology

Undergraduate

The effect of floral morphology on the pollen fertilization of Passiflora Incarnata

Primary Author: Aleksanders Jekabsons

Faculty Advisor: Shawn Krosnick, Biology

Passiflora incarnata, commonly known as the passionflower, is the state wildflower of Tennessee and a vine native to the southeastern United States. This species exhibits four primary floral morphs, including subclasses 4a and 4b, which differ in style position relative to the ovary and in ovary development. Morph 1 is characterized by less developed ovaries and erect styles, while morph 2 displays more developed ovaries with similarly erect styles. In morphs 3 and 4, including subclasses 4a and 4b, the styles progressively shift toward a more horizontal orientation. In morph 4b, the stigma is positioned below the ovary. The objective of this study was to evaluate how variation in floral morph, specifically style position, influences pollen fertilization success. Fluorescence microscopy was used to assess pollen germination and pollen tube growth. Floral samples from each morph were collected, softened using ethanol and sodium sulfite, stained with aniline blue, and examined under ultraviolet light. This method allowed for visualization of pollen grains and tracking of pollen tube progression through the style toward the ovary and ovules. In unsuccessful cases, the point at which pollen tube growth ceased was identified. Results indicated that pollen tube success was highest in morph 4a, with moderate success in morphs 3 and 4b, and minimal success in morphs 1 and 2. These findings suggest that style position significantly influences reproductive success in P. incarnata, with more horizontal orientations facilitating more effective fertilization.

Environmental Studies

Doctoral

Effectiveness of Household Water Filtration Pitchers in Removing Fiber Contaminants from Drinking Water

Primary Author: Emma Stalker

Faculty Advisor: Abdul Momin, School of Agriculture

The presence of microfibers in drinking water has become an increasing environmental and public health concern, particularly as everyday filtration systems are commonly relied upon to improve water quality. This study evaluated the effectiveness of four commercially available water filtration pitchers—Brita, PUR, Culligan, and Great Value—in removing hair fibers from tap water. Water samples were collected from a drinking fountain at Tennessee Technological University and experimentally spiked with hair fibers cut into approximately 0.5 cm segments to simulate fiber contamination. Equal volumes of the prepared water samples were passed through each filtration pitcher according to manufacturer's guidelines. The filtered water from each system was subsequently processed through a secondary laboratory filtration procedure to capture remaining particulate material. After filtration, samples were allowed to dry and were examined under a microscope to quantify the number of retained hair fibers and identify additional deposited particulates. Fiber counts were recorded to compare the relative filtration performance among the pitcher systems. This experimental design provides a controlled approach for assessing the ability of household water filtration devices to remove fiber contaminants from drinking water. The results contribute to a broader understanding of consumer-

level filtration effectiveness and may inform future research on microfiber contamination and removal in domestic water treatment systems.

Human Ecology

Undergraduate

Parental Communication, Emotional State, and Presence in Relation to Children's Coping with Medical Experiences

Primary Author: Adia Byron

Faculty Advisor: Rufaro Chitiyo, School of Human Ecology

When children enter the healthcare setting, they experience an environment that is unfamiliar, disrupts their routine, and involves painful procedures. Children's background relates to their coping with these experiences. This synthesis explores how parental communication, emotional state, and presence during medical procedures are associated to children's distress and coping outcomes.
Eight peer-reviewed studies examining parent-child interactions during venipuncture, cancer treatment, anesthesia induction, and dental procedures were analyzed for emerging themes.
Results indicate that parental communication during procedures, parental emotional distress, and parental presence or absence were key themes across these studies. Additionally, behaviors like reassurance from a parental figure were significantly associated with child distress, while distraction strategies were often linked to improved coping. Research findings suggested a positive relationship between parental anxiety and child distress, indicating that children may respond to their parents' emotional cues during medical experiences. Studies examining parental presence produced mixed results, with some evidence suggesting that parental presence reduces anxiety during procedures like anesthesia induction, while other contexts indicated improved child behavior when parents were absent.
Overall, the literature demonstrates that parental behaviors and emotional states are closely connected to children's coping responses in healthcare environments. Considering these findings, parental education on effective communication and coping support strategies and pediatric medical procedures would be beneficial for children's coping. Further research is needed to examine intervention-based approaches and to include more diverse and representative samples.

Soft Surfaces, Hard Consequences: Microplastics from Interior Textiles

Primary Author: Alexus Solomon

Co-Author(s): Madilyn Depriest

Faculty Advisor: Hannah Upole, School of Human Ecology

The future of textiles in home interiors is put into question by the recent surges in the amount of microplastics found in homes. In today's world, plastics are some of the most frequently used synthetic materials, with sources suggesting global annual production surpassing 430 million tons in 2023 (Liu et al., 2025). While it may be a highly practical material for convenient daily use due to its lightweight and durable nature, plastic has had a negative impact on the environment by polluting natural landmarks and acting as an environmental contaminant. Microplastics are defined as plastic particles with an equivalent diameter of less than 5 mm and nanoplastics (NPs) are smaller plastic particles with equivalent diameters smaller than 100 nm or 1000 nm. The adverse effects of MNPs have been studied and documented as they have led to suffering by aquatic creatures, and they have also been found in several human tissues and biofluids. Many people believe that these biological contaminants come from ingesting food and beverages, but another primary pathway through which these MNPs travel into our bodies is through dust that's collected over time from interior textiles. Considering the large amounts of time that most people spend indoors, the contamination from MPs has the potential to directly impact human health and wellbeing. This synthesis of research is essential for interior designers and homeowners alike to know information that could impact a client's opinions and choices or their health and well-being.

Nutrition Management strategies for Type 1 Diabetic Collegiate Athletes

Primary Author: Analese Milligan

Faculty Advisor: Allison Coutinho, School of Human Ecology

Collegiate athletes with Type 1 Diabetes Mellitus are faced with complex nutritional needs that require precise and intentional management. In the United States alone, there are currently 3796 collegiate athletes who have Diabetes Mellitus. This literature review synthesized current evidence across four nutritional management areas: fluid intake habits, individualized nutrition/insulin plans, glycemic patterns, and continuous glucose monitoring devices. The research included peer reviewed articles dated from 2014-2025, with the exclusion of one article from 2011. Key words used in the search were collegiate athlete, Type 1 Diabetes, blood glucose, nutrition, exercise, performance, glycated hemoglobin, hypoglycemia, and hyperglycemia. The results yielded that the Type 1 Diabetic collegiate athletes demonstrated an adaptive approach to hydration, consuming more fluid volume than the healthy athlete. This was subconsciously done in order to prevent osmotic diuresis. The results also showed that highly individualized and aggressive insulin and dietary regimen show success in a 22% reduction in HbA1c and improvements in overall body composition. CGM devices are most accurate during stable, sustained exercise, but not during rapid exercise due to a physiological time lag. Lastly, glycemic patterns were shown to be dependent on the type and timing of exercise. The greatest risk of hyperglycemia followed high-intensity exercise, while the greatest risk for hypoglycemia was seen during sleep, post exercise. Health professionals can use this information to better create individualized nutrition management plans for Type 1 Diabetic athletes.

Tiny Clothes, Big Impact

Primary Author: Ashley Yearwood

Co-Author(s): Mekhyla Williams

Faculty Advisor: Hannah Upole, School of Human Ecology

From the production of a baby's onesie to a parent throwing that onesie into the trash. The impact that these tiny pieces of clothing can have is great. Children's clothing has to be replaced frequently due to the rapid growth rate that occurs during infancy and early childhood. Parents often find themselves having to replace clothes that their child has only worn one time or might have never worn at all. The accelerated life cycle of children's clothing contributes to an increase in textile production and waste, that when coupled with the fact many of these clothes are made from synthetic fibers, creates a disaster for our environment. This paper goes into detail about the overconsumption of children's clothing and how consumers can use creative solutions to help decrease the negative impact that their children's clothes create. This research will be helpful for parents and caregivers of young children when it comes to making sustainable choices about their children's clothing.

How Classroom Environment Shapes Behavior

Primary Author: Camille Winton

Faculty Advisor: Rufaro Chitiyo, School of Human Ecology

This literature synthesis examines how classroom environments influence student behavior, engagement, and self-regulation. The purpose of this project was to explore existing research on how different aspects of the classroom environment affect student behavior. The guiding research question for this synthesis was: How does the classroom environment shape student behavior? Studies included in this review were selected through searches of academic databases using key terms such as classroom environment, student behavior, classroom management, and learning climate. Peer-reviewed journal articles that focused on classroom design, teacher-student relationships, and classroom management were included, while sources not directly related to behavioral outcomes were excluded. The literature was organized into two main themes: physical classroom design and classroom climate. Across the studies, findings show that both physical factors, such as seating arrangements, lighting, noise levels, and classroom organization, and social factors, such as teacher relationships, expectations, and social-emotional learning practices, can strongly influence student behavior and engagement. While most research agrees that structured and supportive environments improve behavioral outcomes, some studies note that flexible seating can sometimes increase distractions if expectations are not clear. For educators, this suggests the importance of designing organized classrooms and building positive relationships with students. For researchers, future work could explore flexible learning spaces and trauma-informed classroom practices. Overall, the classroom environment plays an important role in shaping student behavior and learning experiences.

Cardiovascular Disease and Food Insecurity in U.S. Adults

Primary Author: Caroline Henderson

Faculty Advisor: Allison Coutinho, School of Human Ecology

Food insecurity has become a growing public health concern in the United States, with visible influence on cardiovascular health. This review explores how limited access to healthy, high quality food contributes to the development and progression of cardiovascular disease (CVD) among adults. Evidence shows that food insecurity is linked to risk factors such as hypertension, diabetes, smoking, obesity, and irregular eating patterns. It also shapes long-term health outcomes related to CVD and premature mortality, by increasing the risk of disease development and subsequent death. Stress, poor diet quality, and restricted access to healthcare appear to be key pathways between food insecurity and cardiovascular harm. Racial and socioeconomic disparities worsen these risks, highlighting the influence of social determinants of health (SDOH) on food-insecure populations. Although intervention studies are limited, current evidence shows that culturally tailored food programs and mental health support could be promising strategies to reduce CVD risk. Overall, the findings identify food insecurity as a core contributor of cardiovascular disparities. This association demonstrates the need for CVD risk screening tools, policy reform, and community-based strategies to improve consistent access to nutritious food and supportive resources.

There's Something in Your Walls
Primary Author: Delaney Kindred

Co-Author(s): Audrey Oldham

Faculty Advisor: Hannah Upole, School of Human Ecology

Your walls may be protecting you from the dangers on the outside, but what if the danger is within the walls themselves? This study seeks to explore topics of sustainability in the textile industry. Focusing on interior design and the production of wall coatings and coverings. This study moves through the knowledge of how textiles are already produced for sustainability and which specific aspects have been affected, such as floors, furniture, and drapery. We want to focus on the gap between what has already been done in these aspects of interior design and what needs to be done within the rest of interior design, specifically regarding walls and what we put on them. Walls offer many options for applications, such as painting or wallpaper. None of these options are nearly as sustainable as other aspects of interior design. Wallpaper is most commonly made of vinyl, which can release chemicals during production and disposal. Other options are acrylic, which still emits some toxins and cannot biodegrade. All of this begs the question: how do we make the safest, healthiest choices for the products in our home, considering the potential negative health effects these walls could be causing? This research will be helpful to interior designers who purchase and design for consumers, helping them make thoughtful decisions on what to put in their homes.

Breaking the glass tradition: ETFE in the architecture industry

Primary Author: Emmalise Raymer

Co-Author(s): Harmony Webb

Faculty Advisor: Hannah Upole, School of Human Ecology

Are your windows being transparent with you? Glass is used so widely in modern architecture that its downsides often go unquestioned. Skyscrapers are covered in glass facades, homes depend on large windows for natural light, and commercial buildings embrace transparency as a symbol of progress and modern design. But this reliance raises important questions. How much energy is lost through inefficient glazing systems? How much carbon is created during the production and transportation of glass? As sustainability and affordability become more urgent priorities in the architecture industry, it is worth reconsidering whether glass should continue to be the default material for light-transmitting structures. The cost of energy loss has pushed consumers and researchers to explore alternatives in the window industry. This paper explores those alternatives and examines why the replacement of glass is beneficial to future architects and consumers.

Is Carbon in Your Cart?

Primary Author: Erin West

Co-Author(s): Autumn Barsumian

Faculty Advisor: Hannah Upole, School of Human Ecology

The rapid expansion of e-commerce and “on demand” consumer culture has reshaped global consumption patterns, while raising numerous questions regarding the environmental impact of modern retail systems. Carbon emissions remain a primary driver of climate change, with significant contributions from global supply chains, transportation networks, and consumer-driven industries (Calvin et al., 2023). Amazon, being one of the world’s largest e-commerce platforms, paves a path towards becoming more environmentally friendly through new and improved practices. Programs created, such as Prime Day and Amazon Day, have further altered consumer purchasing behaviors through a focus on reducing carbon emissions. This move has sparked public debate about whether or not the impact of Amazon’s efforts is effective. This synthesis of current research discusses carbon emissions reduction through sustainable e-commerce practices, while still meeting consumer demands, the contribution of reduced packaging, and how efficiency can be maximized.

Luxury Illusion

Primary Author: Gracie Owen

Co-Author(s): Sandra Gonzalez, Ailish Munoz

Faculty Advisor: Hannah Upole, School of Human Ecology

Would you be willing to spend $10,000 on a handbag if you knew the materials to make it only cost $100? This review explores the evolving definition of luxury within the fashion and textile industry. Our review of literature emphasizes how industry standards, brand "authority," and the consumer perspective collectively shape what is considered "luxury fashion." Luxury fashion and accessories have always been defined by their high price and rarity, but most of all, the exceptional craftsmanship and materials used in the creation of these pieces. However, these standards aren't solely defined by the customers, but by the fashion houses, industry leaders, scholars, critics, and consumer markets, leading to potential differing opinions in what is considered true "luxury." This comparative analysis of Hermes and Prada highlights two well-known interpretations of "luxury," as Hermes reflects traditional industry standards while Prada redefines these standards by elevating materials through design innovations. Both brands illustrate how sustainability is becoming a major factor in luxury, with Hermes focusing on durability and legacy, while Prada's re-nylon reflects a more progressive approach for both innovation and environmental responsibility. From this perspective both brands can be seen as sustainable luxury through their own channels, however, external perception by consumers also plays a key role. In truth, luxury today is not solely tied to craftsmanship or exclusivity, but also by the brand's ability to adapt and evolve to current ethical, environmental, and cultural expectations.

Effect of Mediterranean Diet on Cognitive Decline in Older Adults

Primary Author: Hardi Parikh

Faculty Advisor: Allison Coutinho, School of Human Ecology

The Mediterranean Diet (MD) has gained attention as a potential strategy to reduce cognitive decline in older adults, especially as pharmacological treatments for Alzheimer’s disease continue to show limited success. This literature review examined peer-reviewed studies published between 2015 and 2025 to evaluate how adherence to the MD influences cognitive performance, brain health, and related biological mechanisms. Articles were identified through Tennessee Technological University’s Eagle Search using keywords related to the Mediterranean diet and cognitive health. Studies focusing on diet patterns such as MD, DASH, and MIND consistently showed that higher adherence was associated with slower cognitive decline and better global cognition. Evidence from Randomized Controlled Trials further demonstrated improvements in specific cognitive domains, including delayed recall and working memory. Additional findings suggested that while the MD may not substantially change gut microbiome diversity, weight loss enhanced MD interventions may support cognitive resilience. Overall, the literature indicates that the MD’s nutrient dense, plant-forward pattern contributes positively to brain health in aging adults. These results may help guide Registered Dietitian Nutritionists (RDNs) and other health professionals in counseling older adults on nutritional strategies for maintaining cognitive function. Future research should include more diverse populations, standardized MD scoring tools, and larger, long-term intervention studies.

Correlation Between Intermittent Fasting and Weight Management, Metabolic Health, and Everyday Life

Primary Author: Isabell Ratermann

Faculty Advisor: Allison Coutinho, School of Human Ecology

Intermittent fasting (IF), a dietary approach that cycles between eating and fasting periods, has gained popularity for its potential health benefits in recent years. The purpose of this literature review was to examine IF's effects on weight management, metabolic health, and everyday life in generally healthy adults. Evidence from randomized trials suggests that IF may promote modest weight loss and reductions in waist circumference, though outcomes vary depending on study design, intervention length, and participant characteristics. Metabolic health findings are more consistent, with notable improvements in insulin sensitivity, β -cell responsiveness, and blood pressure regulation. The greatest benefits appear in individuals at risk of diabetes. Everyday life impacts are also favorable, with participants reporting reduced fatigue, improved vitality, and enhanced quality of life, alongside strong adherence linked to consistent eating windows. Overall, IF appears safe and sustainable, offering promise for weight management, metabolic health, and daily well-being. However, further long-term, large-scale studies are needed to confirm its full effects.

Printing the Future: The Power of 3D Printing

Primary Author: Jayden Madison

Co-Author(s): Elizabeth Melton

Faculty Advisor: Hannah Upole, School of Human Ecology

Recent studies have analyzed that small scale buildings or residential homes can be simply 3-D printed. The construction industry is facing growing environmental, economic, and labor-related pressures, including high carbon emissions, material waste, workforce shortages, and ongoing safety hazards. As the demand for housing increases, traditional resource-intensive construction methods are being questioned about their long-term sustainability. As a result, 3-D printed architecture has been made as a digitally controlled additive manufacturing process that creates the structural components of buildings layer by layer. Research highlights benefits such as reduced labor, precise material placement that eliminates human error, and improved efficiency. However, much of the current research emphasizes technical feasibility and the prototypes of 3-D printed architecture rather than assessing where the method would be most appropriate within the construction industry as a whole. Entire buildings are rarely fully printed, and their individual sustainability outcomes depend on the material selection and overall lifecycle. This gap in knowledge shows the scope of additive manufacturing in a practical sense. The research into large scale 3-D printing is important to the field of architectural construction because it examines how these emerging technologies can improve efficiency.

The Gut-Brain Axis and Potential Links Between an Altered Gut Microbiome and Impaired Cognition

Primary Author: Katelyn Young

Faculty Advisor: Allison Coutinho, School of Human Ecology

The gut-brain axis (GBA) is a bidirectional connection between the central nervous system, the brain and spinal cord, and the digestive system. This literature review explores the connection between the gut microbiome and cognitive health, mental health, and brain function. Articles included in this review are all peer-reviewed, original research from 2015-2025 that were found on PubMed, the Journal of the Academy of Nutrition and Dietetics, Tennessee Technological University Eagle search, and Google Scholar. The research suggests that using a probiotic supplement as an add-on treatment for depression, anxiety, and stress helps relieve symptoms in patients. Parkinson's disease, a neurodegenerative disorder, is more likely to be diagnosed in patients with mucosal damage and a less diverse gut microbiome than those without. Diets high in ultra-processed foods are tied directly to poor cognitive health, more brain fog symptoms, and other neurological disorders like chronic insomnia. Limitations that should be noted include a lack of research on long-term use of high-dose probiotics and little regulation in the supplement industry. Health care professionals can use this information to help treat patients with mental health conditions or poor cognitive function.

Does the Material of Bedding Affect Sleep Health?

Primary Author: Lyrin Trotter

Co-Author(s): Gracy Reynolds

Faculty Advisor: Hannah Upole, School of Human Ecology

Not sleeping well? Your bed sheets could be the reason, here is why. Bedding is usually always composed of the same materials, those being fabrics like cotton, polyester, linen, bamboo, satin or silk. While most of these materials are natural fibers, it is the dyeing and bleaching that they go through that is bad for the human body. Sleep is so important to the human body, it can affect things like our hormones and overall quality of life. These materials not only affect human hormones but can also affect things like sleep quality. All materials such as cotton, polyester, rayon, and infused sheets will have a sort of thermal response which will change your sleeping climates. The general idea for better sleep mostly focuses on each individual and their wants and needs. People who struggle with an autoimmune system disorder may be more inclined to take into deeper consideration their sleep needs.

From Fast Fashion to Lasting Fashion: Sustainable Materials and Garment Longevity

Primary Author: Megan Hammock

Co-Author(s): Mia Scruggs

Faculty Advisor: Hannah Upole, School of Human Ecology

Clothing has become one of the most disposable products in modern society, with garments often worn only a few times before being thrown away. The fashion industry produces billions of garments every year and global textile use has reached nearly 100 million tons annually (Shirvanimoghaddam et al., 2020). Over the last 20 years, clothing production and consumption have doubled because of population growth and fast fashion. More than two-thirds of discarded clothing ends up in landfills, with only about 15% being recycled (Shirvanimoghaddam et al., 2020). It is estimated that $400 billion worth of clothing is thrown away each year. Many synthetic fabrics can take up to 200 years to break down, and tiny plastic fibers from clothing can enter oceans and the food chain, causing long-term environmental harm. Because of the growing environmental impact of clothing waste, researchers are exploring sustainable materials that can extend garment lifespan and reduce the environmental footprint of the fashion industry. Sustainable textile materials offer the potential to improve durability, reduce waste, and promote responsible production and consumption practices. By focusing on materials designed to last longer and maintain quality over time, the fashion industry may reduce the amount of clothing discarded each year. This literature review examines how sustainable materials can increase garment lifespan and contribute to a more environmentally responsible fashion industry. Identifying materials that improve garment durability may play a key role in shifting the fashion industry from a disposable model to one focused on longevity and sustainability.

Upcycling: Reinventing Rubbish

Primary Author: Micheal Hutchins

Co-Author(s): Angela Maddock

Faculty Advisor: Hannah Upole, School of Human Ecology

Could the fashion industry reach complete sustainability if we used what we already had instead of creating new textiles? The fashion and textiles industry contributes to a significant amount of water use, waste into landfills, and pollution into our environment.
Upcycling is a process involving reusing materials and clothing to create something new. Through upcycling, this impact on the environment could be reduced. The goal of this analysis is to evaluate the significance of upcycling and how it can be applied by consumers, as well as exploring why consumers don't upcycle more. This synthesis of current research is for consumers, researchers, and educators with an interest in fashion or sustainability.

Nutritional Intervention Strategies for Treatment of Malnutrition in Children

Primary Author: Olivia Brown

Faculty Advisor: Allison Coutinho, School of Human Ecology

There is a high prevalence of children suffering from some form of malnutrition. Undernutrition and inadequate nutrient intake in children promote a cycle of poverty and poor health. Health professionals recognize the issue of childhood malnutrition, so this literature review seeks to investigate the

effectiveness of nutritional intervention strategies for children suffering from undernourishment. Peer-reviewed articles from 2015 to 2025 and studies conducted outside the U.S. were identified using the keywords undernutrition in children, effects of childhood malnutrition, and childhood malnutrition interventions. Articles associated with overnutrition or older adults were excluded. The results suggested that interventions combining high kcal supplements and education had the most significant and longest-lasting growth outcomes. Additionally, if a child had a comorbidity, growth effects were lessened. However, further research is needed to understand the economic challenges of treating children with malnutrition in low-income areas. Health professionals can use this information to investigate and implement the nutritional intervention strategies to prevent and correct malnutrition in children.

Human Behavior In Technology

Primary Author: Sandy Francisco

Faculty Advisor: Rufaro Chitiyo, School of Human Ecology

Technology has been around for quite some time, but its usage has increased significantly over the past few years. It has become more advanced and has shifted people's lifestyles. However, humans don't realize that technology is impacting their behavior. Humans don't see that it's disturbing their sleep, emotions, anxiety, and more. The research question for this project is: What changes in human behavior are associated with increased use of digital technology over time? The purpose is to answer this question based on previous research where the researchers' main objective was to explore how smartphones and other technologies changed human behavior. Multiple research studies collected data by surveys, software, other articles, and cross-sectional research. They analyzed data and concluded that smartphones and other screens have been causing anxiety, depression, and an increase in lack of sleep. Another finding is that students have been doing poorly in school because of the use of technology. Additionally, humans are becoming addicted to technology, and children have become possessive of their smartphones. Results also showed that parents are spending more time on their screens than spending time with their own children, with females being the ones most affected. Smartphones and other screens have caused multiple mental health problems across all ages. Human behavior has changed because of technology usage. Technology didn't just affect one country but the whole world. Future research should explore how technology affects children's growth and how it affects all ages. Professionals can let students know that technology affects their mental health.

Are the Textiles in Your Home Killing You

Primary Author: Tarice McKinney

Co-Author(s): Jessa Dodson

Faculty Advisor: Hannah Upole, School of Human Ecology

Asthma, bronchitis, and cancer can be caused by the utilization and creation of fabrics. Cotton textile workers are at risk of respiratory symptoms such as chest tightness, chronic bronchitis, and loss of pulmonary function due to inhalational exposure to cotton dust in creation of cotton textiles.(Mansouri et al., 2016).Hemp is a cellulosic fiber," which requires "no pesticides, herbicides, fertilizer, or irrigation, making it an environmentally friendly textile option" (Laing & Kean, n.d.). As indicated, we have a mission to inform the users of textiles of the negative impacts that they can cause. Along with the positive effects that textiles host as well. It is important for interior designers to know the negative aspect that textiles can host since they make the decision on which material will be used. Knowledge of this can prevent Sick Building Syndrome, and can be used to improve the health of those it hosts. This current research will be helpful to interior designers working in the field as they make healthier choices about the fiber they choice to use in their renovation projects.

Master's

The Potential Relationship Between Vitamin D3 and PCOS Diagnosis in Women

Primary Author: Brandy Pennington

Faculty Advisor: Darci Bell, Dean of Ag & Human Ecology

Vitamin D deficiency is common in women diagnosed with poly cystic ovarian syndrome(PCOS). PCOS is characterized by anovulation, irregular menstruation, amenorrhea, hirsutism, and infertility. There is a growing body of evidence on vitamin-D3 and its role in the regulation of hormone, symptoms, and metabolic risk factors associated with PCOS. The

aim of this study was to determine the potential relationship between vitamin-D3 and PCOS diagnosis in women.
Results: Deficient vitamin D levels can exacerbate symptoms of PCOS. The literature provides a strong, convincing argument that there is a significant relationship between vitamin D deficiency and hormonal levels evidenced by an increase in androgen hormones, LH, and FSH levels in PCOS patients. There is also a significant relationship between vitamin D deficiency and metabolic factors as evidenced by the exacerbation of insulin resistance, insulin, and fasting glucose levels. Upon supplementation, the same hormonal levels and metabolic factors saw improvement as seen in studies that conducted 8–12-week trials.
Conclusions: Vitamin D has a positive relationship with PCOS diagnosis. Supplementation of this vitamin has the ability to better manage symptoms through regulating hormonal levels and decreasing metabolic factors associated with PCOS diagnosis like insulin resistance and high glucose levels.
Implications: Current research shows that vitamin D supplementation, for patients with a deficiency, would be a valuable therapy to aid alongside the current management plan to help manage PCOS symptoms. By supplementing vitamin D, PCOS patients can improve insulin resistance, support reproductive health, manage hyperandrogenism, reduce inflammation, and lower their risk for other diseases like type-2 diabetes and cardiovascular disease.

Health Outcomes of Childhood Overnutrition

Primary Author: Gabrielle Nutt

Co-Author(s): None

Faculty Advisor: Darci Bell, Dean of Ag & Human Ecology

Background: Overweight and obesity rates during childhood are increasing in low-income and high-income nations around the world. A potential factor in these rising rates could be due to overnutrition, which is malnutrition from an overconsumption of specific nutrients that could lead to an increase in body weight. Unfortunately, a high body weight status during childhood can cause the development of poor health outcomes during childhood and adulthood.
Objective/Purpose Statement: Research was conducted to evaluate childhood (2-19 years old) overnutrition health outcomes.
Results: Findings from research illustrated how nutritional intake and a high weight status can impact the anatomical structure and metabolic functioning of the cardiovascular system during childhood and adulthood. Additionally, findings showed trends in non-alcoholic fatty liver disease in children with a high weight status and poor liver health outcomes in adulthood. Lastly, research exhibited increasing rates of type 2 diabetes in children with a high weight status. Research also showed that a high weight status during childhood had higher rates of type 2 diabetes and/ or pancreatic cancer in adulthood.
Conclusions: Conclusions from the research conducted correlated poor cardiovascular, liver, and endocrine health outcomes with dietary intake and high weight status during childhood.
Implications: Findings in the review may provide a foundation for general knowledge on this topic, policy change, and intervention formation.

The Role of electrolytes on Performance in Endurance Athletes

Primary Author: Jadyn Norman

Faculty Advisor: Darci Bell, Dean of Ag & Human Ecology

Carbohydrates have been heavily studied in the field of athletes and nutrition plans, but there has not been much research conducted on electrolytes even though they play a crucial role in homeostasis, contractions, and sweat loss during extended periods of exercise. It is important to determine correlations as ultra-racers are at risk experiencing exercise-associated hyponatremia and dehydration. The purpose of this literature review is to review the possible correlation between electrolytes and performance in endurance athletes using research from the past 15 years. The results of this literature review showed improved fatigue with electrolyte supplementation, although there were inconsistent results on speed, race finish times, and cardiovascular drift, serum electrolyte stability, and improved endurance. To conclude this paper, there were mixed results, and the evidence cited does not establish a cause-and-effect relationship between electrolyte supplementation and improved performance. On the contrary, sodium supplementation in some studies showed improved interventions when individualized. Implications of this paper show that future research should include larger sample sizes with a variety of participants to encompass a broader biological makeup of the population. It is essential to continue focusing on hydration status in practice to prevent illnesses

related to exercise.

Artificial Sweeteners and the Risk of Cardiovascular Disease in Adults

Primary Author: Lily Jackson

Faculty Advisor: Darci Bell, Dean of Ag & Human Ecology

Background: Artificial sweetener consumption has increased in recent years, and nutrition and medical professionals are beginning to question if there are any long-term health implications, especially with prolonged consumption patterns. Cardiovascular disease is a leading cause of death, and researchers are considering whether there is a potential correlation between artificial sweetener consumption and the risk of cardiovascular disease in adults.
Purpose statement: The purpose of this literature review is to examine the possible connection between the consumption of artificial sweeteners and the prevalence of cardiovascular disease in adults through reviewing current, available literature.
Results: Artificial sweeteners are potentially linked to neurological disorders, stroke, and metabolic risk factors. In addition, research has shown that those who consume a higher amount of artificial sweeteners are potentially at a heightened risk for developing cardiovascular disease in their lifetime.
Conclusions: Due to the non-experimental nature of the research articles within and the literature itself, causality cannot be determined at this time. However, the results of the articles referenced and the literature review set the foundation for future experimental research projects.
Implications: Individuals involved in all areas of public health should consider the potential impact of artificial sweetener consumption on the general adult population to guide their platforms for change, education, and the dissemination of nutrition information.

The Potential Relationship between Ultra-Processed Food Consumption and Food Insecurity

Primary Author: Morgan Mingle

Faculty Advisor: Darci Bell, Dean of Ag & Human Ecology

Background: Food insecurity is a public health concern that has been impacting families within the United States for decades.
Objective/Purpose Statement: This literature review aims to identify patterns and observations that indicate a connection between food insecurity and the consumption of ultra-processed foods within families in the United States.
Results: Adults with very low food security consume a higher percentage of calories from ultra-processed foods at 55.7% as opposed to those with very high food security counterparts at 52.6%. Ultra-processed foods are typically more affordable and shelf-stable, making them an essential resource for combating food insecurity. The possible relationship between ultra-processed food consumption and food insecurity can be highlighted by SNAP participants presenting with poorer diet quality and inadequate cardiometabolic health outcomes.4
Conclusions: Increased risk factors for food insecurity, nutrition concerns related to the consumption of ultra-processed foods, the classification of ultra-processed foods, the impact of food insecurity and ultra-processed food consumption on families, and the increased risk factors for adverse health outcomes were found to be impacted by increased ultra-processed food intake.
Implications: These findings provide justification for further research and the need for government program reform to provide equitable care and support access to healthy foods for Families in the United States.

College of Arts and Sciences

Biology

Undergraduate

JNK3 Inhibition and Possible Alzheimer's Treatment

Primary Author: Aiden Wallace

Faculty Advisor: Derek Cashman, Chemistry

The research I have been working on is for how specific compounds bind to and interact with the JNK3 and MKK complexes in a possible treatment for Alzheimer's disease. This has been done by using programs such as Alpha Fold and MOE to create 15 compounds and simulate the docking interactions of these compounds with JNK3 and MKK. I then compared the docking habits of these compounds

in five different docking models. These models were created with the use of Alpha Fold. After this, a comparison of what residues where binding occurred was made and the top three compounds that had the best binding characteristics were taken and refined further to increase their binding affinity. The main purpose of this research is to investigate JNK3 receptor inhibition and its application for possible treatment for Alzheimer's. Several compounds show promise due to their high affinity binding with JNK3 in a possible use for Alzheimer's treatment and are being looked into further. This research is still ongoing and will hopefully bear fruit in addressing the challenges that are associated with the treatment of Alzheimer's disease.

Using Native Wildflowers as an Alternative to Pesticides

Primary Author: Alexis Mears

Faculty Advisor: Hannah Kinmonth-Schultz, Biology

Pesticide usage is a growing problem in the agricultural industry due to the biological damage that can result and the financial burden it puts on farmers. Native wildflowers have been used in earlier research projects as a habitat for beneficial insect predators and have shown promising results in lessening insect pest damage in nearby crop plants. This research investigates whether growing native wildflowers alongside crops is an effective alternative to pesticides. Using radishes as the test crop, a total of 16 plots were used at TN Tech's Shipley farm. These plots were twenty-five feet by fifteen feet, and each separated by a five-foot wide grass buffer. Eight of the plots contained three-foot by twenty-five-foot strips of wildflowers native to TN. The other eight contained only grass and served as controls. Once every two weeks, two leaves were harvested at random by an unbiased party from each plot. These leaves were then analyzed, using, image J to find the total area of the leaves, total area of insect damage, and total number of holes within the leaves. We expect to see a lower amount of insect damage in the plots containing wildflowers. This study is important because it is testing a potential biologically safe and less expensive option for farmers to use for insect pest control.

Investigating the Correlation Between Flight Feather Regrowth and Physiological Features in Canada Geese

Primary Author: Alexis Mears

Faculty Advisor: Richard Pirkle, Biology

Canada geese (Branta canadensis) go through a synchronous molt causing them to be flightless from May to early June. It would be expected that the geese would regrow their feathers at a similar rate since they molted at the same it but that is not the case.
In this project I have to find the correlation between physiological features and flight feather regrowth.
I will complete this by catching Canada geese documenting leg band data to determine an age range, obtain their weight, body size, sex, and flight feather growth. The collected data will be analyzed using R to identify potential correlations and to better understand how these physiological factors influence feather regrowth.

A Study on Hydrolysis Behavior of Aqueous Ferric Iron (FeCl3) Using a Redox Analysis

Primary Author: Elisabeth Casey

Faculty Advisor: Hong Zhang, ASC - Chemistry

Iron species (ferric iron or Fe(III) and ferrous iron or Fe(II)) play a unique, important role in environmental chemistry. Fe(III) is known to spontaneously hydrolyze in an aqueous solution and the hydrolysis products then polymerize. The kinetics of the Fe(III) hydrolysis process was studied by following the change of [Fe(III)] species in aqueous solutions. This experiment was conducted using a set of aqueous FeCl3 solutions at a micro-molar level (100 μM); at time intervals desired, the Fe(III) in the solutions was reduced to Fe(II) by adding hydroxylamine (NH2OH•HCl) and then analyzed for [Fe(II)] spectrophotometrically. It was found that the [Fe(II)] decreased with time at various times of the addition of hydroxylamine to the FeCl3 solutions. We hypothesize that the Fe(III) species are polymerizing into hydroxylamine-irreducible forms of Fe(III) in the aqueous FeCl3 solutions before addition of hydroxylamine.

Living Indicators: A Bioassessment of Blackburn Fork Using Macroinvertebrates

Primary Author: Leslie Foster

Faculty Advisor: Nikki Carter, Biology

Freshwater streams are important ecosystems but are vulnerable to pollution and environmental disturbance. Aquatic macroinvertebrates are

commonly used as indicators of stream health because their presence and community composition reflect changes in water quality and habitat conditions. In particular, taxa within the Ephemeroptera, Plecoptera, and Trichoptera (EPT) orders are sensitive to environmental stress and are often associated with high-quality streams. The Tennessee Macroinvertebrate Index (TMI) combines measures of taxonomic diversity and pollution tolerance to evaluate overall biological condition. This study assessed the ecological condition of Blackburn Fork River, a watershed composed of first- to fourth-order streams flowing through a mixture of forested and agricultural land. Two sampling sites were selected along the river, and three macroinvertebrate collections were taken at each site. Sampling followed procedures outlined in the U.S. Environmental Protection Agency Rapid Bioassessment Protocol, with collections conducted monthly over three months. Macroinvertebrate communities were analyzed using the Tennessee Macroinvertebrate Index. Preliminary results suggest borderline to healthy biological conditions, though final assessments should consider additional habitat and water quality metrics. These findings highlight the usefulness of macroinvertebrates as biological indicators for evaluating stream health.

Master's

Functional Analysis of Silent Information Regulator 2 (SIR2) in Pyricularia oryzae

Primary Author: Ari Mortensen

Co-Author(s): Justin King, Sahar Salimi, Astha Mishra, Mostafa Rahnama

Faculty Advisor: Mostafa Rahnama, ASC – Biology

Silent Information Regulator 2 (SIR2) is a conserved NAD^+-dependent histone deacetylase that plays a central role in telomere maintenance, heterochromatin formation, and transcriptional silencing. Despite its importance in model organisms, the function of SIR2 in filamentous phytopathogenic fungi remains largely unexplored. Here, we investigated the biological role of SIR2 in Pyricularia oryzae, the causal agent of rice blast disease. Deletion of SIR2 resulted in striking developmental and pathogenicity defects: the mutant exhibited a severe reduction in conidiation and complete loss of virulence, which we found to be caused by the failure of conidia to germinate. Transcriptome analysis revealed widespread gene-expression alterations in the sir2 mutant, with strong enrichment for subtelomeric and stress-responsive genes. In parallel, chromatin profiling revealed marked changes in the distribution of the activating histone mark H3K27ac, indicating that SIR2 is required to maintain proper epigenetic landscapes at telomeric and gene-regulatory regions. Consistent with this, multiple subtelomeric gene clusters became aberrantly activated, suggesting a breakdown of telomere-proximal silencing normally maintained by SIR2. Moreover, genes involved in conidiation, germination, and early infection stages showed pronounced expression changes, reflecting the broad regulatory disruption caused by loss of SIR2 rather than simple repression. These chromatin and transcriptional abnormalities point to a global loss of epigenetic stability, potentially altering higher-order chromosome organization and telomere-associated regulatory circuits. Together, these findings demonstrate that SIR2 is essential for fungal development, chromatin integrity, and infection capability. Our study strengthens the broader understanding of how telomere-linked chromatin regulation influences genome function and pathogenicity in P. oryzae.

Lineage-specific Dynamics of Telomere-targeted MoTeR Elements and Structural Variation in the Host Diversification of Magnaporthe oryza

Primary Author: Astha Mishra

Faculty Advisor: Mostafa Rahnama, Biology

Magnaporthe oryzae is a filamentous ascomycete that infect more than 50 grass species and causes major diseases such as rice blast and wheat blast. Genomic plasticity in this species is tightly linked to transposable elements (TEs), which are highly enriched in subtelomeric regions that harbor diverse avirulence genes. Previous population-level studies have shown that TE insertion polymorphisms shape gene gain and loss, regulatory diversification, and the emergence of host-specialized lineages. Here, we focus on a family of telomere-targeted non-LTR retrotransposons known as MoTeRs (Magnaporthe oryzae Telomeric Retrotransposons). These elements are known to destabilize chromosome ends, promote ectopic recombination, and drive rapid evolution of subtelomeric sequences. To examine how MoTeRs activity and structural variation (SV) contribute to host diversification, we analyzed complete M. oryzae genome assemblies from eight host-specialized lineages. We found that Triticum- and Lolium-associated lineages show pronounced MoTeR

accumulation at chromosome ends despite having lower genome-wide TE content. These lineages also exhibit a reduced overall SV burden compared with high-TE lineages, suggesting more localized rather than genome-wide structural remodeling. Mapping MoTeRs-associated SVs identified 81 Magnaporthe Effector Protein (MEP) genes impacted by rearrangement, linking MoTeR activity directly to effector diversification. Finally, analysis of Illumina assemblies from 29 additional lineages revealed strong lineage-specific patterns of MoTeR expansion and contraction across the species complex. Together, these findings support a model in which MoTeR-driven telomere instability and subtelomeric SVs generate highly dynamic genomic niches that facilitate effector diversification and contribute to the evolution of multiple host-specialized lineages within M. oryzae.

Controlling Gene Expression in the Rice Blast Fungus to Understand Gene Function

Primary Author: Justin King

Faculty Advisor: Mostafa Rahnama, Biology

Understanding how genes function often requires the ability to turn them on or off. This is particularly challenging for genes that are essential for survival or only active under specific conditions. In this study, we developed a method to precisely control gene expression in the plant pathogenic fungus Magnaporthe oryzae, the causal agent of rice blast disease. Our approach replaces a gene's natural regulatory region with a nitrogen-responsive switch, allowing gene activity to be controlled simply by changing the fungus's growth conditions. Using this system, we can effectively "turn" genes on or off depending on the available nitrogen source. As a demonstration, we applied this method to a gene involved in melanin production, which is important for fungal development and infection. By controlling this gene, we observed clear and visible changes in fungal pigmentation, providing an easy way to monitor gene activity. This work provides a practical and flexible tool for studying gene function, especially for genes that cannot be easily analyzed using traditional methods. More broadly, it helps advance our ability to investigate how plant pathogens grow, adapt, and cause disease.

Doctoral

Evolutionary Mechanisms Shaping Chromosome Architecture in Fusarium

Primary Author: Sahar Salimi

Faculty Advisor: Mostafa Rahnama, Biology

The genus Fusarium comprises ecologically diverse filamentous fungi that include major plant and animal pathogens. One interesting observation is the association with horizontally acquired accessory chromosomes (ACs) and host-specific virulence. Although it plays a central role in shaping genomic architecture and virulence among species, karyotype evolution—changes in chromosome number, structure, and organization—remains poorly characterized in Fusarium. In this study, we investigate genome and karyotype evolution in Fusarium through comparative genomics, synteny analysis, and structural variant profiling using genomes from a set of species representing the breadth of phylogenetic diversity within the genus. Our work focuses on detecting and validating chromosome fusion and fission events, identifying conserved syntenic blocks, and examining the contribution of centromere dynamics and transposable elements to chromosomal rearrangements. Preliminary evidence from published Fusarium genomes indicates substantial variation in genome size, GC content, and TE composition, reflecting repeated cycles of genome expansion and compaction. Such processes, coupled with inter-centromeric recombination and segregation errors, are likely major drivers of karyotypic[RP1.1]. By integrating structural variation with phylogenetic analyses based on single-copy genes, we aim to elucidate evolutionary relationships that are not adequately resolved by sequence-based phylogenies alone. This research will generate a comprehensive assessment of chromosome-level evolution in Fusarium, providing insights into how genome dynamics influence adaptation, pathogenicity, and speciation. Understanding the mechanisms underlying karyotype diversification in Fusarium will not only enhance evolutionary and genomic frameworks for this complex genus but also support improved strategies for managing Fusarium-related diseases in agriculture and public health.

Chemistry

Undergraduate

Measuring Oxidation Kinetics of 1-Hexadecene in Gas Phase

Primary Author: Angelina Robertson

Faculty Advisor: Kristen Johnson, Dean of Arts and Science Office

Oxidation is one of the main factors when it comes to quality degradation of materials. It is a natural process of a chemical or substance chemically combining with oxygen. When a substance or chemical goes through the process of being oxidized it creates a new product with separate characteristics and properties from the original substance. The issue of oxidation primarily affects the automotive industry by affecting the performance of paraffinic lubricants, which consist of both branched and straight chain alkenes and are primarily in liquid phase. However, research for the gas phase interface through oxidation is a less researched topic, even though the interface is more relevant in indoor environments where lubricated mechanisms are exposed to air. This research will study the kinetics of 1-Hexadecene through oxidation, an alpha-olein that is primarily in automotive lubricants, by ozone and hydroxyl radicals. In order to examine the kinetics of 1-Hexadecene, this research will use the two methods of gas chromatography-mass spectrometry (GC-MS) and attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR). With the use of these methods, the hypothesis is that the kinetics of 1-Hexadecene will not be homogeneous across the film and that there will be small deposits of high-density deposits that will then lead to further insight of the aging process of the paraffin lubricant films. The outcomes of the research will contribute to understanding the oxidation mechanisms at the gas-lubricant interface, improve existing models of lubricant aging, and aid in the development of hydrocarbon-based products.

The potential use of Red Dye 40 in determining unknown protein concentrations

Primary Author: Arly Mize

Faculty Advisor: Jeffrey Boles, Chemistry

The Bradford protein assay is a widely used technique for protein quantification that is based on the binding of a specific dye to protein, leading to a color change measurable at a wavelength of 595 nm. This study tested the efficacy of Red Dye 40 as a substitute for Coomassie Brilliant Blue G-250, the standard dye used in the assay. The Dye was evaluated to see any potential gain Red Dye 40 would have over Coomassie Brilliant Blue G-250. It was selected for their distinct structural and spectral properties in the presence and absence of protein. Proteins such as bovine serum albumin (BSA) and Albumin Human (HSA) serve as test proteins. Red Dye 40's linearity in standard curves, and sensitivity to protein concentration were analyzed using scanning and single-point UV-Vis spectrophotometry. Results will be presented in this presentation. We hypothesize that it will perform sufficiently and potentially provide more accurate results. The findings will likely highlight the potential for alternative dyes in the Bradford assay since the linear region utilizing Coomassie Brilliant Blue G-250 is often small. Optimization will be necessary for achieving consistency and precision. This study broadens the scope of protein quantification techniques and introduces a potential cost-effective alternative.

A Study on Application of AI in Environmental Chemistry Education and Research

Primary Author: Bella Cable

Co-Author(s): Chance Bacon, Cohen Williams, Emma Anderson, Fitzgerald Anderson, Kiri Stengele, Mary Yambert, Perry Rodgers, Spencer Curington, Thomas Roberts, Alex O'Neal

Faculty Advisor: Hong Zhang, Chemistry

Artificial intelligence (AI) has become increasingly prevalent in research and education. It is well-recognized that AI can provide known information available in overwhelming quantity, speed, and presentation capacity. Yet, the application of AI in handling open-ended questions and reasoning questions and its effectiveness remain to be further explored. Here, we report a study focused on these two critical aspects of the AI application using ChatGPT. This study uses two questions in environmental chemistry: (1) an open-ended question on CO2 sink in global biogeochemical cycle of carbon and (2) a reasoning question on photochemical smog in atmospheric chemistry. These two questions were used to examine the performance, capacity, and accuracy of AI in providing answers to these types of questions. Our study shows that the AI can deliver highly impressive success and competency and possesses significant potential in handling open-ended inquiry questions and reasoning questions such as those we explored. This study joins the efforts to fathom the capacity, potential, and nature of AI.

Establishing Heat Treatment Temperatures of Charcoalified Materials by Analysis of Aromaticity

Primary Author: Bella Cable

Faculty Advisor: William Carroll, Chemistry

The analysis of volatile compounds in charcoalified material can give insight into the conditions under which the sample was produced. The degree of aromaticity can be a way to determine the burn temperatures of wildfires that produce charcoalified material. Small molecules are extracted from the sieved sample via a Soxhlet extractor. The Soxhlet extraction effectively brings volatile organic compounds into solution, leaving larger aliphatic molecules behind. Extracted material is characterized by solution-state 13C NMR and mass spectrometry. Degree of aromaticity is measured by the percent of signal present within the aromatic region of the 13C NMR spectra (between 120 and 150 ppm). Fragmentation patterns characteristic of aromatic molecules in the mass spectrometry data also give insight into aromatic content and show compositional similarities between samples. Samples with known heat treatment temperatures (HTT) will be analyzed, and a calibration curve will be constructed from these results. This will create a model to establish HTT of charcoalified material, providing a tool for understanding wildfire conditions.

Oxidation Rate Changes in Organic Thin Films using FTIR-ATR Spectroscopy

Primary Author: Daniela Amaya

Faculty Advisor: Kristen Johnson, Dean of Arts and Science Office

The oxidation of hydrocarbon thin films plays an important role in material stability, indoor air chemistry, and lubricant degradation. However, oxidation processes involving gas-surface interfaces remain less understood than bulk liquid systems. This research investigates the changes in oxidation rates in hydrocarbon thin films and examines the heterogeneous reactions between organic thin films, composed of long-chain alkenes (C15-C18) with one carbon-carbon double bond, and ozone. Thin films are deposited onto an attenuated total reflectance (ATR) crystal and then exposed to ozone generated in a controlled flow system. Attenuated Total Reflectance Fourier Transform Infrared (FTIR-ATR) spectroscopy is used to monitor the chemical changes within the films during oxidation. Changes in the infrared spectral peaks are monitored to track the formation of oxygen-containing functional groups and to quantify the reaction process. Spectral analysis and peak-fitting methods are used to determine the oxidation rates from the FTIR data. Additional analysis may include the characterization of chemical changes occurring within the oxidized films using mass spectrometry or atomic force microscopy (AFM). If successful, this research could improve the understanding of oxidation processes occurring at gas-film interfaces and could contribute to improved models of hydrocarbon film degradation. A greater understanding of heterogeneous oxidation reactions could help explain the aging and stability of hydrocarbon materials. It can also support predictions of lubricant lifetime and indoor chemical processes.

Microbially Mediated Redox Cycling of Fe(III)/Fe(II) in Soils: Effect of Disaccharides and Starch on Formation of Floating Fe(III) Films

Primary Author: Emma Anderson

Co-Author(s): Bella Cable, Chance Bacon, Spencer Curington, Alex O'Neal

Faculty Advisor: Hong Zhang, Chemistry

Iron(Fe) is ubiquitous. It has two main environmental species, (i) ferrous Fe (Fe(II)), soluble and mobile, and (ii) ferric Fe (Fe(III)), insoluble. Fe(II) can be oxidized to Fe(III) by oxygen (O2), while Fe(III) can be reduced to Fe(II). This redox cycling between Fe(III) and Fe(II) is important in soil and water chemistry. The environmental Fe(III)/Fe(II) redox occurs abiotically and also microbially. Previous research reported Fe(II) formation via microbial reduction of soil Fe(III) oxides, stimulated by sugar (glucose, a monosaccharide) in a laboratory setting; this was followed by oxidation of the Fe(II) back to Fe(III) to generate iridescent Fe(III) films floating on water, exhibiting a unique environmental phenomenon of microbially mediated Fe(III)/Fe(II) redox cycling, which has been observed widely in natural environments.
We further investigated this phenomenon by studying the effect of disaccharides (maltose, sucrose, lactose) and starch (polysaccharide) on the Fe(III) film formation using the soils collected locally. We found that the three disaccharides all resulted in the Fe(III) films in the soil systems, indicating that the soil microbes were able to use these sugars directly to engage in microbial reduction of soil Fe(III) oxides; yet, the Fe(III) films failed to occur at certain low

disaccharide levels. We also found that starch was able to result in the Fe(III) films, but in much less pace and extent. This study indicates that soil microbes are able to use sugars from monosaccharide (glucose) to the disaccharides to polysaccharide (starch) as energy source to engage in microbially mediated redox cycling of Fe(III)/Fe(II).

Purification of Wild Type and Selenomethionine DHFR and Analysis by Circular Dichroism

Primary Author: Hannah Pruett

Faculty Advisor: Jeffrey Boles, Chemistry

The utilization of selenomethionine (SeMet) as a phasing tool coupled with multi-wavelength anomalous diffraction has yielded the solution of a multitude of three-dimensional structures. Studies on structural stability have typically been carried out via kinetic analysis under varying conditions. These results are then compared to those of the wild-type protein. Some purified recombinant selenoproteins have been proven to have reduced activity and/or altered three-dimensional structures. This project involves furthering the understanding of protein stability when proteins contain bio-incorporated unnatural amino acids through the investigation of the secondary structure stability of DHFR in the presence of bound methotrexate. This goal will be achieved through the comparison of wild-type and selenomethionyl-DHFR secondary structures at varying pH and temperature via Circular Dichroism (CD) spectra. The varying pH and temperature will induce unfolding or refolding of the respective protein. CD signals between 190 and 250 nm will be collected and used to determine changes in helical, sheet, and random coil content.

Development of Gold-Plated Spray Paint Electrodes for use in Electrochemical Time of Flight

Primary Author: Jacob Hasting

Faculty Advisor: Jonathan Moldenhauer, Chemistry

Electrochemical time of flight (ETOF) is a test that determines the time taken for an electrical current to pass between the gap of two electrodes in a given solution to determine a diffusion coefficient. ETOF is a calibration curve-based method, that has fewer variables in the slope than other electrochemical methods of diffusion coefficient determination. However, it requires expensive metals and equipment to produce electrode arrays used for ETOF. Using nickel-based spray paint to create the electrodes and then electroplating gold over the top of the layer of paint could produce a more cost-efficient electrode array. After painting multiple electrodes onto a plastic substrate, the electrodes are then plated with 24-karat gold using a solution and electroplater made by Becker Industries. To determine effectiveness, cyclic voltammetry tests are taken in triplicate to compare the gold-plated nickel to bare nickel electrodes. The goal is to determine if these electrodes will perform better than bare nickel electrodes. If successful, an inexpensive electrode could be produced for use in performing ETOF. Our next steps include optimization of the electroplating process and starting proof of concept ETOF to evaluate these electrodes.

Discovering Suitable Dyes for Protein Staining

Primary Author: Natalie Stone

Co-Author(s): Jeffrey Boles

Faculty Advisor: Jonathan Moldenhauer, Chemistry

An important aspect of science is work carried out under efficient and affordable conditions. The current standard when determining unknown protein concentrations with a dye is Coomassie Blue and although effective, it can be costly. My research is to discover a suitable protein dye that is effective and less costly than the Coomassie Blue. There are many compounds that are known to bind proteins and this also includes food colorings. For the reasons of cost and impact to the environment, I've chosen to focus on Yellow dye No. 5 (Tartrazine) and Tumeric (Curcumin). Several experiments are being conducted using these two dyes using Bovine Serum Albumin (BSA) as a standard protein. Varying concentrations of BSA are selected and incubated with the dye for varying time periods, followed by analysis by a UV/IS spectrophotometer in order to create standard curves. Each will be plotted and fit by linear regression and compared to the commercially available Coomassie Blue commonly used to produce such standard curves. If successful, I will be able to provide a more cost efficient dye that can do the same job of Coomassie Blue, if not better.

Synthesis of a Cu-based metal-organic framework for lanthanide separation

Primary Author: Thomas Mount

Co-Author(s): David Dan

Faculty Advisor: David Dan, Chemistry

Lanthanides are notoriously difficult to separate using conventional chemical methods because of their similar chemistries across the series. To remedy this, we aim to use a tunable Cu-based metal-organic framework (MOF) to separate lanthanides by atomic radius. This works by capturing the smaller of the two lanthanides within the MOF, allowing the larger one to flow around it with the MOF acting as a sieve. In order to test this, a MOF with copper nodes and terephthalic acid linkers was synthesized and then contacted with neodymium and samarium. All MOFs were tested via powder X-ray diffraction to assess structural continuity, and experimental samples were tested using inductively coupled plasma optical emission spectroscopy (ICP-OES) to determine residual concentrations and assess efficiency.

Master's

Physicochemical Kmer Encoding for the Enhanced Evaluation and Expansion of Artificial Intelligence Protein Structural Prediction Models

Primary Author: Christopher Hardy

Faculty Advisor: Jeffrey Boles, Chemistry

The accuracy of artificial intelligence protein structural prediction models often relies on the evaluation of genetic context found within the intra- and inter-sequence relationships of multiple sequence alignment (MSA) files. However, depending on a protein's family and the relevance of its constituent domains, sequence databases may produce sparse results for an MSA query. Additionally, the complex deep learning architectures used to interpret MSA files can obscure the exact nature of internal amino acid relationships resulting in a black box. Instead of forgoing MSA-based models, we propose a machine-learning based data pipeline for the refinement and human-interpretable evaluation of MSAs generated by two popular protein structural prediction models, AlphaFold and RoseTTAFold. For contrast, we compared our approach to workflows utilizing the MSA-free models OmegaFold and ESMFold. Within the pipeline, each sequence within an MSA is organized into overlapping contiguous fragments (termed Kmers) that are arranged according to a predetermined set of physicochemical values. Then, standard vector similarity and statistical metrics are used to evaluate various intra and inter-sequence relationships in a human-interpretable manner. Current results suggest that this novel pipeline is useful for both evaluating the quality of MSAs and for exploring the energetic and conformational spaces of various proteins. While the accuracy of the individual protein predictions was often similar between all four tested models, the inclusion of an MSA within AlphaFold's and RoseTTAFold's inference processes provides researchers an opportunity that overshadows the potential downfalls that models like OmegaFold and ESMFold are attempting to circumvent.

Identification of Novel Binding Partners of NJ38, a Unique N-terminal Motif of JNK3 by BioID

Primary Author: Clara Reichter

Co-Author(s): None

Faculty Advisor: Xuanzhi Zhan, Chemistry

c-Jun N-terminal Kinase 3, a neuron-specific isoform of JNKs, controls essential neuronal cell physiological functions, including development, differentiation, regeneration, and apoptosis. JNK3 contains a unique N-terminus, named NJ38 here, compared to the ubiquitously expressed JNK1 and 2. Very minimal information is known about the structure or function of this sequence, but it has the potential to mediate JNK3-specific interactions, as it is not found in the other two JNK isoforms. A systematic strategy is proposed here to identify the potential binding partners of this motif by biotin identification (BioID), a protein-proximity labeling approach. The NJ38 was fused to the "promiscuous" biotin ligase (Turbo). The fusion protein biotinylates proximal proteins. The biotinylated proteins will be further identified by mass-spectrometry and Western-blot analyses. There are no current JNK3 inhibitors that are either FDA-approved or being produced, but research around JNK3, especially on the extended N-terminus region, identifies it as a strong, attractive target to exploit novel binding partners as potential drug pathways.

Cysteine-Rich Peptide Design for Targeted Mercury Remediation in Tennessee Lakes

Primary Author: Clement Opoku Acheampong

Co-Author(s): Michael Tetteh

Faculty Advisor: Xuanzhi Zhan, Chemistry

Mercury(Hg) contamination in freshwater systems poses a significant environmental challenge due to its toxicity, persistence, and ability to bioaccumulate in aquatic food webs. In Tennessee lakes, monitoring studies have identified mercury concentrations in fish exceeding the advisory threshold of 0.3 mg/kg, raising concerns about ecosystem health and human exposure. This project explores the design of cysteine-rich peptides as a targeted strategy for mercury remediation in contaminated freshwater environments.
The approach leverages the strong chemical affinity between Hg2+ ions and thiol (-SH) groups present in cysteine residues. By designing peptide sequences enriched with cysteine, selective binding sites are created to capture mercury ions from aqueous systems. Additional amino acids are incorporated to enhance solubility, structural stability, and resistance to environmental conditions. Sequence variations are evaluated to understand how composition and structure influence mercury-binding efficiency and selectivity. To translate this concept into a practical system, the designed peptides will be expressed as fusion proteins and immobilized onto a solid support to form a reusable column for mercury removal. Laboratory experiments will assess binding performance, removal efficiency, and the ability to regenerate the system for repeated use. This strategy aims to provide a scalable and environmentally relevant solution for mercury mitigation.
This presentation highlights progress toward integrating molecular peptide design with environmental remediation strategies to address mercury contamination in Tennessee freshwater systems.

Analyzing Fish Mercury (Hg) Trends and Patterns across Tennessee Lakes using the Tennessee Department of Environment and Conservation (TDEC) Fish Hg Database

Primary Author: Clement Opoku Acheampong

Co-Author(s): Michael Tetteh

Faculty Advisor: Hong Zhang, Chemistry

Mercury (Hg) contamination in freshwater ecosystems remains a persistent environmental and public health concern due to its toxicity, environmental persistence, and ability to bioaccumulate in aquatic organisms. Long-term environmental monitoring programs generate extensive datasets that can provide valuable insights into contamination patterns across time and space. However, these datasets are often underutilized for systematic analysis. The Tennessee Department of Environment and Conservation (TDEC) has conducted statewide monitoring of Hg concentrations in fish collected from lakes across multiple counties. This open-access database provides an opportunity to apply data-mining approaches to identify spatial and temporal trends in Hg contamination and evaluate potential environmental risk indicators.
In this study, Hg concentration records obtained from the TDEC fish tissue monitoring database were compiled and organized to examine patterns across lakes in TN. Statistical visualization and exploratory data analysis techniques were applied to evaluate the distribution and variability of mercury concentrations relative to the commonly referenced fish consumption advisory threshold of 0.3 mg/kg. Future work will focus on applying rational molecular peptide design, particularly cysteine-based sequences that selectively bind Hg^{2+} via sulfur coordination chemistry, as a potential strategy for removing Hg from lake systems that exceed the advisory limit.

Raman Spectroscopy Detection of Clandestine Drugs

Primary Author: Madelyn Coons

Faculty Advisor: Jeffrey Boles, Chemistry

The illicit drug trade poses significant challenges for law enforcement, necessitating the development of rapid, non-destructive analytical techniques for substance detection. This thesis investigates the application of Raman spectroscopy as a tool for identifying clandestine drugs, particularly when packaged in plastic materials that may obscure spectral signals. Laboratory experiments were conducted using a range of common drugs of abuse, including pseudoephedrine and epinephrine, measured through plastic packaging with different cutting agents that could affect spectral signals. Results indicate that Raman spectroscopy can reliably detect target compounds through thin transparent plastic, with limitations observed in opaque materials. The findings demonstrate the potential for Raman spectroscopy to complement existing forensic tools by providing rapid drug identification, though optimization of spectral preprocessing and instrument sensitivity is required for robust field application. This work contributes to advancing analytical methods in forensic science, with implications for law enforcement and public safety.

Counseling & Psychology

Doctoral

Caregiving After Childhood Trauma: A Literature Review of Parenting Styles and Attachment Behaviors

Primary Author: Jamellia Potts

Faculty Advisor: Tony Michael, Counseling and Psychology

This literature review reflects on the attitudinal expression of parenting styles and attachment behaviors by parents who had backgrounds of childhood trauma. The review is based on the modern attachment theory and combines the empirical and qualitative studies released within the period of 2015-2025. PsycINFO, PubMed, Google Scholar, and other databases were scoured. To make the inclusion criteria, peer-reviewed articles about the topics of trauma, attachment, reflective functioning, and parenting were required. Findings showed that there were four major themes, including the effects of childhood trauma on parenting patterns, trauma and a parent-children relationship, the subjective experiences and narratives of parents, and the patterns of intergenerational transmissions. Empirical research associate's trauma with heightened emotional responsiveness, disturbed inner working models, and decreased parent-child responsiveness. Nevertheless, most trauma-exposed parents practice deliberate cycle-breakage, reflective sense-making, and growth-focused parenting. One of the syntheses made during the discussion is that trauma does not necessarily negatively affect parenting; the capacity of regulation, reflective functioning, contextual support, and access to therapeutic interventions determines the effects. The review also has implications for counselors, counselor educators, and supervisors, as there is a need to understand trauma-related dynamics to become more trauma-informed. The review highlights that more qualitative studies by far, including more fathers, should be conducted, as well as more trauma-informed therapy that enhances the reflective abilities of the parents and attachment security.
Keywords: childhood trauma; parenting styles; attachment theory; reflective functioning; intergenerational transmission; parent-child relationship; trauma-informed parenting; attachment security.

Earth Sciences

Undergraduate

Provenance of Carboniferous Strata in the Cumberland Plateau, Tennessee: Insights from Detrital Zircon U-Pb Geochronology and Lu-Hf Isotopic Constraints in the Southern Appalachian Basin

Primary Author: Abigail Morris

Co-Author(s): Kaci Schelling

Faculty Advisor: Gourab Bhattacharya, Earth Sciences

The Appalachian Basin is a composite retroarc foreland basin that developed in response to three major Paleozoic orogenic events: the Taconic, Acadian, and Alleghenian–Ouachita orogenies. This extensive basin system parallels the western margin of the Appalachian fold-thrust belt and preserves a complex record of sedimentation spanning hundreds of millions of years. Eleven Mississippian-Pennsylvanian sandstones were sampled from the Cumberland Plateau in Tennessee for Detrital Zircon U-Pb geochronology (n = 2885) to investigate sediment provenance in the southern Appalachian Basin. The resulting detrital zircon U-Pb age spectra reveal consistent patterns across samples, with prominent age peaks at ~435 Ma, 900–1000 Ma, and ~1650 Ma, and minor peaks at ~2700 Ma. Notably, several samples contain rare but significant Archean zircons (~3200–3600 Ma), representing some of Earth's earliest continental crust. Consistent with extensive sediment recycling, cross-correlation and similarity coefficients show 50-97% inter-sample similarity. Further supporting this interpretation, Lu–Hf isotopic analyses of 275 detrital zircons return predominantly positive β Hf values suggesting derivation from evolved crustal sources subjected to multiple recycling events. These detrital zircon U–Pb age spectra from the Southern Appalachian Basin closely match those from the Northern and Central Appalachian Basin, indicating basin-wide consistency in sediment sources and recycling processes. Our results highlight the fundamental role of sediment recycling in shaping the stratigraphic architecture of the Appalachian Basin through multiple generations of exhumation, transport, and redeposition during its prolonged tectono-sedimentary evolution.

Lunar South Pole Boulders: An Analysis of Distributions and Geomorphology

Primary Author: Anthony Lamantia

Co-Author(s): Gillian Racek

Faculty Advisor: Jeannette Luna, Dean of Arts and Science Office

Understanding surface features at the Lunar South Pole (LSP) is essential for deciphering the Moon's geological history and supporting future Artemis exploration missions. This study analyzes an established database of over 90,000 individual boulders and 750 boulder fields mapped across more than 9,870 km^2 of the LSP. We also utilized high-resolution imagery derived from the Lunar Reconnaissance Orbiter (LRO) Narrow Angle Camera (NAC) mosaics and Lunar Orbiter Laser Altimeter (LOLA) digital elevation models (DEMs).
This research tests the hypothesis that boulder placement is not random but significantly correlated with specific geomorphic features, such as scarps, depressions, and craters, and specific slope thresholds. Here, we aim to refine the current classification system of the boulder database to be more specific to the boulder's potentially correlated parent feature. Using ArcGIS Pro, we performed spatial density analyses and statistical correlations between boulder locations and slope gradients derived from LOLA DEMs.
Preliminary results aim to identify "slope thresholds" for boulder stability and provide quantitative assessments of rockfall potential. We can differentiate between boulders currently in situ and those displaced by seismic or impact events by mapping boulder tracks as linear features and generating slope-frequency histograms. This work refines the existing LSP database, offering a critical framework for hazard analysis and landing site selection by identifying stable versus unstable terrain. Ultimately, these findings contribute to a deeper understanding of lunar surface evolution and provide an important step towards remote analysis of surface features for human exploration.

Hydrogeologic Investigations in a small watershed on the Highland Rim Escarpment

Primary Author: Gary Claywell

Faculty Advisor: Evan Hart, Earth Sciences

The Highland Rim escarpment is an extremely dissected region separating the Highland Rim from the Central Basin. Here hundreds of tributary hollows have been cut into the edge of the Highland Rim, and these drain to the master streams of the Central Basin, including the Caney Fork and the Cumberland River. The Highland Rim escarpment is underlain by soluble carbonate rocks that produce numerous sinking streams, dry stream reaches, and springs. Despite the importance of Highland Rim hollows in controlling runoff to the master streams of the Central Basin, the hydrogeology of these watersheds has not been investigated thoroughly.
We are conducting a study of the streamflow properties, geomorphology, and karst groundwater movement of Ferguson Hollow in southeastern Smith County, Tennessee. The main focus of this project involves dye tracing to better understand the movement of groundwater through Ferguson Hollow. In addition to dye tracing, we measured spring water conductivity, temperature, and spring discharge, as well as rainfall. Finally, ground penetrating radar (GPR) was used to characterize the subsurface near locations where streams sink in Ferguson Hollow.

Boulder Distribution and Preservation in Permanently Shadowed Regions of Shackleton Crater, Lunar South Pole

Primary Author: Gillian Racek

Co-Author(s): Emma Baughman, Anthony Lamantia, Jeannette Luna

Faculty Advisor: Jeannette Luna, Dean of Arts and Science Office

Permanently shadowed regions (PSRs) at the lunar south pole experience little to no direct solar radiation, creating environmental conditions that differ significantly from nearby illuminated terrain. These conditions may influence the size, preservation, and spatial distribution of surface boulders, rock fragments that measure greater than 1-2 meters. This study investigates boulder distribution and potential origin within Shackleton Crater using high-resolution imagery from ShadowCam and geospatial analysis in ArcGIS. The working hypothesis is that reduced solar radiation in permanently shadowed regions leads to decreased thermal weathering, allowing larger boulders to persist compared to those found in illuminated areas.
Boulders within the study were systematically mapped using several feature types to characterize their occurrence and morphology. Individual boulders were digitized as point features, clusters of boulders were mapped using polygon features, and visible boulder tracks were recorded using line features to

identify potential movement pathways. In addition, unusually large boulders were outlined as polygons to distinguish them from the general population. Preliminary mapping has identified 4,762 individual boulders, 9 boulder clusters, and 24 significant boulders within the Shackleton Crater region. The largest observed boulder measures approximately 70 meters in length, which is significantly larger than typical boulders documented in nearby illuminated terrain.
Preliminary observation suggest that permanently shadowed regions may preserve larger, and potentially older boulders due to reduced solar-driven weathering processes. Continued analysis will examine spatial patterns, cluster formation, and possible source regions to better understand the processes controlling boulder distribution in permanently shadowed environments.

(U-Th)/He Zircon Thermochronology of the Cumberland Plateau, Tennessee: Insights into the Thermal History of the Southern Appalachian Basin

Primary Author: Kaci Schelling

Co-Author(s): Abigail Morris, Gourab Bhattacharya

Faculty Advisor: Gourab Bhattacharya, Earth Sciences

A composite retroarc foreland basin shaped by compressive forces from three successive Paleozoic orogenies (the most recent being the Alleghenian-Ouachita Orogeny), the Cumberland Plateau in Tennessee, Kentucky, Alabama, and Georgia represents the southernmost extent of the Appalachian Basin. While the thermal evolution of the Northern Appalachian Basin is well documented, the post-depositional thermal history of the Southern Appalachian Basin, particularly the Cumberland Plateau, remains poorly constrained. We collected ten sandstone samples from exposed Mississippian and Pennsylvanian strata across the Cumberland Plateau in Tennessee to reconstruct the region's post-depositional thermal history. Fifty zircon grains (five per sample) were analyzed using (U-Th)/He detrital zircon (ZHe) thermochronometry. ZHe results show significant variability in thermal resetting across different stratigraphic units: 21 of the 50 grains were reset. We used the thermal modeling software HeFTy to reconstruct time–temperature paths of the reset grains under geologically plausible constraints. Maximum burial temperatures from our results varied across the plateau, reaching ~140–200°C, followed by cooling during ~320–250 Ma. This cooling likely reflects regional exhumation in the Southern Appalachian Basin during the late stages of the Alleghenian–Ouachita Orogeny.

Spatial Analysis of Emergency Service Accessibility and Demographic Vulnerability in Putnam County, Tennessee

Primary Author: Makanaka Kangere

Faculty Advisor: Peter Li, Earth Sciences

This project uses GIS to examine access to emergency services in Putnam County, Tennessee, and how it relates to different population groups. A 5 km buffer was created around hospitals, fire stations, police stations, and other emergency facilities to represent areas with service coverage. Census tracts located outside of these buffers were identified as underserved.
Demographic data, including poverty rate, elderly population percentage, and youth population percentage, were analyzed within these underserved areas. The results show that poverty levels vary across the county, with some underserved tracts having much higher poverty rates than others. In comparison, both elderly and youth populations are more evenly distributed, with many underserved areas having consistently high percentages of these groups.
These findings suggest that a significant number of vulnerable populations, especially elderly and youth residents, may have limited access to emergency services. This highlights potential gaps in service coverage and the need for better planning to improve accessibility in Putnam County.

An analysis of the Clay Mineral Makeup of Miocene Paleosols to Reconstruct the Rusinga Island Paleoenvironment

Primary Author: Maya Seitz

Co-Author(s): Lauren Michel

Faculty Advisor: Lauren Michel, Earth Sciences

The Early Miocene deposits on Rusinga Island, Lake Victoria, Kenya are famous because of the presence of the early catarrhine, Ekembo. The island, known for its exquisite fossil preservation of both plants and animals, has been important in understanding ape evolution. In particular, the fossiliferous Hiwegi Formation has been extensively studied using a

variety of proxies, and past paleoenvironmental reconstructions have resulted in a variety of interpretations. The Hiwegi Formation contains fossil soils (paleosols) which are valuable records of the past terrestrial climate and environment. By analyzing the clay mineralogy through x-ray diffraction of oriented aggregates, we can understand variations in weathering and time of landscape stability for the Hiwegi Formation paleosols. Fifteen samples were analyzed and b oth smectite and illite were identified in all the samples. This suggests while there was a variation in paleoenvironmental reconstruction of different proxies, weathering and the stability of the landscape was consistent during periods of soil-formation.

English

Undergraduate

Protective Nonbinary Performance within the Rape Class: The Gendered Ethnocultural Logic of Capitalism and Exploitation

Primary Author: Morgan Henderson

Faculty Advisor: Jennifer Gray, English

Through the critical lenses of feminist and postcolonial theories that compliment Jamesonian critiques of the cultural logic of capitalism and exploited classes of gender and ethnocultural identity, a close reading of "The Hungry Tide" will show that Piyali Roy's nonbinary performances of dehumanization, victim blaming, sex and intimacy, and resource imbalances are not only a direct result of rape culture but also a necessary form of self-protection. Specifically, victim blaming discusses both behavior and appearance, and resource imbalances examine the hierarchy of privilege that education, wealth, and power provide in multinational settings. Just as Judith Butler stated "gender is performative" in "Performative Acts and Gender Constitution: An Essay in Phenomenology and Feminist Theory" and the explication of continual upkeep of gendered social perception, Gayatri Chakravorty Spivak's essay "Can the Subaltern Speak" discusses the classism, racism, and sexism in Western imperialist perspectives towards unrepresented voices, especially of Indian women. This combination of silenced voices and mutable-yet-incessant behaving is the basis for my neologism rape class, which is as essential as the working class for the perpetuation of exploitative capitalist systems.
This blend of socioeconomic, postcolonial, and feminist-gender critical theories highlights the pervasiveness of rape culture as Piyali travels through Bengal's Sundarbans as she not only searches for the subject of her marine biology research but also as she navigates the binaries that attempt to subjugate her to the rape class by taking advantage of Foucauldian power-knowledge.

Master's

"Elizabethan Men in Drama: Securing One's Possessions While Attacking Another's"

Primary Author: Destiny Wanamaker

Faculty Advisor: Kristen Deiter, ASC - English

In this analysis of two plays from the Elizabethan period, "A Woman Will Have Her Will" and "Look About You," I examine the role of the males in two different relationships using research that addresses society's expectations of men during this time. The first relationship is between a father and his three daughters. I analyze the different manipulation tactics he uses to persuade his daughters to do his bidding instead of following their hearts. In addition, research discussing a woman's ability to express her anger is embedded within this analysis to provide an understanding of expected behaviors women were supposed to display toward the male head of their household. The second relationship I study is between a husband and wife. The husband expresses a common fear within Elizabethan society which causes him to become very watchful over his wife: cuckoldry. The act of being cuckolded diminished a man's reputation and made others question his ability to maintain his household. However, while the husband in the play guards his wife from other men, he persuades another woman to cuckold her own husband. In these works, men use their authority and control to suppress their vulnerability while simultaneously manipulating others.

Thomas Dekker's Eden: The Unattainable Virtue

Primary Author: Lana Lowe

Faculty Advisor: Kristen Deiter, English

In Thomas Dekker's "Old Fortunatus," Virtue and Vice are personified with a tangible impact on the lives of the characters within the play. Dekker uses these figures as well as the personification of Fortune to consider themes of morality. I explore the religious

symbolism of the trees planted by Virtue and Vice and how the actions of the characters, particularly those of Andelocia and Ampedo, lead to their downfall. In particular, I argue that Dekker constructs an alternative to the biblical story of Adam and Eve in the Garden of Eden, where Andelocia is the new Eve. Andelocia's shame mirrors Adam and Eve's, but the consequences for eating the fruit in Dekker's alternative Eden differ.

Analyzing the characters affected by Virtue and Vice, I argue that virtue within the play is performative in nature, and just as the knowledge of good and evil is meant to be out of reach to Adam and Eve, so too are the characteristics of virtue meant to be unattainable to Andelocia and Ampedo. Likewise, the characters misunderstand and retain a superficial knowledge of what it means to attain virtue. There are no truly virtuous characters within the play, not even Virtue herself. And the play suggests that the only potential path towards virtue is through wisdom.

Authentic and Artificial: Walter Benjamin's Aura and the Nashville Parthenon

Primary Author: Megan Trotter

Faculty Advisor: Erin Hoover, English

Using the Nashville Parthenon as a sample subject, I revisit Walter Benjamin's idea of "aura" from "The Work of Art in the Age of Mechanical Reproduction." By comparing visitor responses to the full-scale replica in Tennessee and the original Parthenon in Athens, I explore whether reproducing a building truly strips it of aura, or whether reproduction creates new, context-driven forms of it.

Drawing on travel reviews, historical records, and current debates over the Elgin Marbles, I argue that aura is not a fixed quality embedded in an object. Instead, it emerges from the meeting point between the object, its history, and the person standing before it. The ruined state of the Athenian Parthenon intensifies its sense of authenticity, rooted in age and historical continuity. The Nashville structure, though remarkably precise in its measurements and design, prompts more mixed reactions, suggesting that replication cannot reproduce the original's presence in time and place.

At the same time, the Nashville Parthenon has developed its own historically shaped aura, tied to the Tennessee Centennial Exposition and the city's Confederate memory. Yet that aura depends on what viewers know. When history is overlooked or erased, meaning shifts. Extending Benjamin's framework to present-day conflicts over monuments and historical representation, I argue that aura is not singular or stable. It is multiple, contested and political, formed through overlapping interpretations rather than secured by originality alone.

Codifying Gender in The Two Angry Women of Abington

Primary Author: Tyler Schrichte

Faculty Advisor: Paulina Bounds, English

This paper examines how gender is created on the early modern English stage despite the all-male casting practices of the period. While it has been widely mentioned in scholarship that males played female roles, less attention has been given to the ways that gender is materially and performatively constructed on stage by way of speech, costumes, props, and means other than explicit acknowledgement. This paper draws on Judith Butler's theory of gender as a repeated set of actions and beliefs that collectively create our understanding. Focusing on Henry Porter's 1599 play The Two Angry Women of Abingdon, I argue that the "femaleness" of the male actors on stage is codified through a network of performed markers – props, speech, and even emotion – rather than being a static, given identity. Through an analysis of key scenes from the play, I demonstrate how objects and behaviors, such as gambling and the emotion of jealousy, work as repetitive signs to guide the audience's understanding of these male actors as female. This paper seeks to complicate and expand assumptions about gender on the early modern stage by suggesting that gender was understood through specific signs and was not necessarily a given for the early modern spectator. This paper seeks to contribute to larger conversations about embodiment, the line between stage and spectator, and the historical evolution of gender norms over time.

History

Undergraduate

A Comparative Study of the Roles of Native American Women in Plains and Southeastern Tribes and Changing Expectations for Women after Colonization.

Primary Author: Alix Stoddart

Faculty Advisor: Troy Smith, History

The implementation of gender roles, in any society, is telling of social values and changes. In this case, both the Southeast and the Great Plains shifted societal expectations to reflect Western patriarchal norms. To observe the changing roles of women, social roles, domestic activity, involvement in agriculture and trade, as well as religious representations before and after the effects of colonization, are important aspects to discuss. There lies the assumption that Native women were valued equally and as functioning members of society before colonization, as Western patriarchy thrives on the subordination of women. Both Southeastern and Plains tribes adopted Western values, which in turn disproportionately affected Native women. Many Native American tribes were matrilineal, tracing their heritage through the mother. Patrilineal tribes were highly concentrated in the Great Plains region, perhaps due to the nomadic nature of these societies, compared to the Southeast. However, even patrilineal tribes were hesitant to discredit women as influential members of society. Women still maintained spiritual and social relevance and power, they were not discarded as in Western patriarchal society. Until European arrival, women had social obligations to improve the community, and men were expected to perform the same. The aim of my research is to compare the shift in gender roles between Southeast and Plains tribes in the context of colonization.

Physics

Undergraduate

Testing the response of the IceCube surface detector array within the Telescope Array's low energy infill scintillator array

Primary Author: Ethan White

Faculty Advisor: Mary Kidd, Physics

As a part of the IceCube Gen2 expansion, a Surface Array Expansion (SAE) would add an array of scintillator detectors and radio detectors on the ice surface above the in-ice neutrino detectors. The primary purpose of these is to detect muons and other particles resulting from a cosmic ray induced air shower which could contaminate the neutrino signal. The array will also allow the study of these high energy cosmic ray events. To better understand the performance of these new detectors, we have embedded a full sub-array (8 scintillators on a 72 m equilateral triangle and 3 radio detectors) within the Telescope Array's Low Energy (TALE) Infill scintillator array, which is a well understood array of 50 scintillator detectors on a 100 m square grid complemented by fluorescence telescope observations. We analyze SAE detector data through calibration, time-matching, and filtering, and compare lateral distribution flux results with TALE infill data.

Coupling a Quadrupole Beam Deflector to a Laser Ablation Ion Source at the Tennessee Tech Ion Beam Lab

Primary Author: Jack Seger

Faculty Advisor: Mustafa Rajabali, Physics

A quadrupole beam deflector has been designed and fabricated to operate with a laser ablation ion source [LAIS], which is in development at the Tennessee Tech Ion Beam Lab. The design conditions required the ion beam from the LAIS to be bent 90 degrees while allowing a high-power laser beam to pass through to the LAIS. The deflector also needed clearance to allow an additional commercial source to pass through without deflection. To satisfy these requirements, we decided to use a quadrupole beam deflector. Simulations were performed using SIMION 8.1 to test the electrode spacing and the range of electric potentials to be applied on both pairs of electrodes. The analysis performed on the simulated data was used to determine the deviation of the beam from the central axis, its emittance from, and acceptance to the beam deflector. The final fabricated design as well as the results from the analysis will be presented in this work.

Sociology & Political Science

Undergraduate

Revenge and Justice in Shakespeare's The Merchant of Venice

Primary Author: Trenier Phillips

Co-Author(s): None

Faculty Advisor: Kristen Deiter, English

In Shakespeare's "The Merchant of Venice," the play's conflict centers on two major concepts: Revenge and Justice. Both concepts, despite their differences, are based on the same idea: imparting one's will

onto another for the purpose of rectifying a wrong committed by the other. In my paper, I demonstrate how this assessment of actions within the play is the product of bias. Though the Venetians proclaim a moral justice within their actions and a perverse revenge within the actions of Shylock, the play shows that both parties' actions have narrow differences in conduct and cruelty. In truth, the actions of both parties serve the same purpose and same moral guidance, be it from the sole Jewish character or the multitude of Christians. The only notable difference is that the Christians hold the majority and legal power within Venice to judge what is and is not just.

College of Business

Business Analytics

Undergraduate

Half-Life and Intensity of Cu70 in a 35Mg Beam from a Decay Spectroscopy Experiment

Primary Author: Yaran Hassan

Faculty Advisor: Mustafa Rajabali, Physics

An experiment was conducted at TRIUMF National Laboratory to investigate the decay scheme of the exotic isotope Magnesium-35 (35Mg). The decay data had an ion beam contaminant present that was interfering with the modelled total fit that is able to find 35Mg's decay scheme. This beam contaminant was identified to be the unstable isotope Copper-70 (70Cu). The purpose of this research was to fit the 35Mg decay accurately following the identification and determination of the half-life and the intensity of this the beam-contaminant in the data.
Gamma spectroscopy was used to locate and isolate gamma rays in 70Cu. Once isolated, the gamma-rays were used to gate the ion beam implantation cycle to find its half-life and intensity of the contaminant. 70Cu has three different isomeric states, each with differing half-lives. Therefore, the method used and detailed above gives an average weighted estimate of the 70Cu's half-life in TRIUMF's data. We have found the 70Cu in our data to have an effective half-life of 11.5 seconds +/- 1.1 seconds and populated approximately 36.5% of the incoming ion beam. The analysis also suggests that the most abundant 70Cu isomeric state in our data is the 1+ state.

Finance

Master's

Do TN based retailers exhibit similar stability and diversification patterns compared to national peers?

Primary Author: Alexis Dean

Co-Author(s): Ella Baker

Faculty Advisor: Sid Bundy, Accounting

The COVID-19 pandemic created widespread economic disruption across the U.S. retail sector, and its effects were especially pronounced among smaller and regionally concentrated companies. Tennessee-based retailers such as Cracker Barrel, Dollar Tree, and Tractor Supply experienced sharper swings in performance compared with larger, nationally diversified competitors whose broader market reach helped cushion the shock. To better understand the financial risk and instability these firms faced during and after the pandemic, Bloomberg data were examined for a sample of 15 U.S. specialized retail companies representing a range of product mixes, geographic footprints, and strategic models. Using horizontal, trend, and common size analyses, the study traced changes in key financial indicators over time to identify patterns in how different types of retailers responded to the crisis. The results show that companies with limited product diversification were more vulnerable to volatility, particularly in asset related measures such as inventory turnover, fixed asset utilization, and working capital stability. Specialized retailers that benefited from temporary surges in demand—often due to pandemic specific consumer behavior—also experienced the steepest declines once market conditions normalized. This boom-and-bust pattern highlight the complex relationship between product variety, short term resilience, and longer-term exposure to risk. Overall, the findings contribute to a deeper understanding of how structural characteristics shaped financial trajectories during an unprecedented economic shock. They also offer practical insights for strengthening risk management practices and supporting more sustainable recovery strategies, especially for retailers operating in rural regions where economic conditions tend to be more sensitive to sudden disruptions.

Deposit Behavior of Large and Regional Banks During 2023 Banking Crisis

Primary Author: Jillian Moore

Faculty Advisor: Sid Bundy, COB - Accounting

The collapse of Silicon Valley Bank (SVB) in the first quarter of 2023, due to the sudden withdrawal of deposits, cast a cloud of uncertainty over the industry. The negative effects seemed to affect regional banks, while the positive effects affected large banks. The effects in the industry raise the question of whether large banks experience deposit inflows and regional banks experience outflows. The crisis is significant to analysts, depositors, investors, and regulators because it affects their confidence and stability within the banking system. The SVB failure had major impacts on the banking industry, including enhanced liabilities and revealed differences in stability and depositor confidence across bank sizes. The implication that larger banks are safer because they are viewed as 'too big to fail' may influence customer behavior. The analysis of this relationship will provide insight into how bank size influences deposit behavior during periods of financial uncertainty. The focus of the analysis will be on examining multiple banks of differing sizes to consider the impact of deposits during a period of insecurity. Data will be collected from FDIC call reports and additional financial statements for 2022-2024 to determine whether a correlation exists between larger bank inflows and regional bank outflows of deposits. Using trend analysis, peer comparison, and key ratios, a deposit comparison will be conducted. It is expected that, due to customer's trust in larger banks, large banks experienced an increase in deposits, while regional banks experienced a decrease.

College of Education and Human Sciences

Counseling & Psychology

Undergraduate

"I just want to do my job and be left alone." A Phenomenological Examination of Quiet Quitting

Primary Author: Anna Donalies

Co-Author(s): Matthew Zagumny

Faculty Advisor: Matthew Zagumny, Counseling and Psychology

This study assesses employees who self-identify as quiet quitters to explore their reasoning and its relation to meaning in life. Participants revealed 4 themes, including interpersonal relations, input/output, ideal-self comparison, and role-related issues as reasons for quiet quitting. We propose that quiet quitting is a contextual (vs. dispositional) phenomenon.

Communicating Tone Through Text: Does Punctuation Influence Emotional Perception in Text Messaging Between Supervisors and Employees

Primary Author: Gracey Bryant

Faculty Advisor: Stephanie Kazanas, Counseling and Psychology

As technology advances, online communication has become essential. In the United States, 97% of Americans own a cell phone (Olia, 2024), and 80% use SMS (short messaging services) as their primary communication method (SMS statistics, 2025). Increased accessibility has shifted professional communication, with employers using less formal text-based platforms such as Instant Messaging (Cameron et al., 2005). Unlike face-to-face dialogue, digital messages lack non-verbal cues–body language and facial expressions–which convey meaning. Instead, we attempt to draw inferences from what is physically present, such as punctuation. However, studies show that text messages ending with periods appear less sincere (Gunraj et al., 2018), with punctuation conveying negativity, in the absence of physical expression (Houghton et al., 2018), potentially fostering misinterpretations. The current study examines how punctuation and emotional valence influence perceived sincerity of text communication with workplace supervisors. We hypothesize that both punctuation and emotional valence will affect evaluations of the supervisor. Participants will complete a mood scale and view 45 fictitious text message scenarios between themselves and their "boss." After each scenario, participants will rate their perceived sincerity of the message and identify the emotional tone of the scenario. The goal of this research is to bring attention to the evolving nature of digital communication methods and the resulting shifts in how individuals convey thought and emotion in the absence of physical cues. Furthermore, this study offers insight into alternative texting strategies

that can be used to convey more positive or neutral tones, reducing the likelihood of misinterpretations.

Meaning-construction for socially transitioning transgender and gender queer individuals: Application of the tripartite model.

Primary Author: Scarlett Martin

Faculty Advisor: Matthew Zagumny, Counseling and Psychology

This qualitative study investigates the lived experience of meaning-construction for transgender and gender queer individuals who are actively or continually socially transitioning. This proposes a novel use the tripartite model of meaning in life. The tripartite model proposes the interconnectedness of three components of meaning: coherence or the feeling that our life makes sense, purpose or our direction and goals, and significance or the belief that our lives matter and are valuable. Responses will be analyzed for the construction of meaning through the tripartite model. Purposive sampling will be employed to recruit 10-15 people who are in the have or are in the process of socially transitioning. Individuals will be contacted through the organization Lambda Gender and Sexuality Alliance. Capta will be collected through an online survey, in which participants will respond to four open-ended, access questions. Data will be analyzed using a two-phase approach: first, identifying meaning units within participants' responses and second, developing a structural description involving the construction of meaning for socially transitioning people. Participants will be contacted for an optional follow-up in-depth interview. Interviews are held in hopes of gaining a deeper understanding of lived experiences of transgender and gender queer individuals. This study hopes to better understand the gap of individuals living in society with both implicit and explicit discrimination towards their identity, and how this affects their construction and experience of meaning in life. The current study addresses a gap in the scientific research concerning meaning-construction of non-cis individuals during their social transition.

Master's

Exploring the Impact of an Intervention to Reduce Smartphone Notifications

Primary Author: Livia James

Faculty Advisor: Nicole Henniger, Counseling and Psychology

Smartphone notifications can interrupt attention, increase social disconnection, and cause frustration. Previous studies found that a no-notification intervention increased levels of anxiety and fear of missing out. This study tests a more nuanced intervention by allowing participants control over which application notifications are silenced.

Dichotomy and myth acceptance among Tennessee Tech college students

Primary Author: Spencer Moore

Co-Author(s): Natasha Wilkerson

Faculty Advisor: Stephanie Kazanas, Counseling and Psychology

Myths and other false beliefs can have detrimental effects on relationships, communities, and societies, leading to divisive effects like social stigma, discrimination, and mental and physical harm (Furnham & Hughes, 2014). Many factors influence the adoption and belief of myths (Kahan et al., 2012; Lauriola et al., 2015; Scheffer et al., 2022), but one key factor may be dichotomous thinking: the tendency to view the world in binary opposition. Dichotomous thinking is a useful heuristic because it allows for quick thinking and decision making, but it might contribute to certain cognitive biases and distortions (Oshio, 2009). Previous research has addressed myth acceptance in relation to various cognitive traits involving dichotomy (absolutism, ambiguity intolerance, etc.), but importantly, no research has directly measured dichotomous thinking and myth acceptance (Forsberg et al., 2019; Roets & Van Hiel, 2011). The current study aimed to further explore this connection by questioning participants' acceptance of common psychological myths (Lilienfeld et al., 2010) while measuring their dichotomous thinking using the Dichotomous Thinking Inventory (Oshio, 2009). The primary hypothesis of this study was that myth accepting attitudes, or believing myths to be "true," would be strongly positively correlated with high levels of dichotomous thinking. A secondary hypothesis posited that the acceptance of psychology myths would decrease with education in psychological science. Preliminary results show that dichotomous thinking and myth acceptance are significantly positively correlated ($p < .001$) and that students who took a psychology course geared towards critical

thinking and myth correction believed significantly fewer psychological myths.

Curriculum and Instruction

Undergraduate

Not For Me: Examining The Pitfalls of Homonormativity Through On Earth We're Briefly Gorgeous

Primary Author: Malcolm Gora

Faculty Advisor: Brian Williams, English

The rapid advancement of LGBTQ+ rights in the west has led to an ever-growing subset of LGBTQ+ individuals happy to exist within the heteronormative standards of yesteryear. Coinciding with this progress has been debate over the term "queer," and what it truly means; some use it as a blanket term of anyone who is not cisgender and straight, while others attach a connotation of resistance, wherein to be queer one must reject the heteronormative status quo. My paper contributes to the larger argument that queerness and resistance are inherent to one another, and that in denying queerness, the "homonormative" LGBTQ+ incurs a new breadth of traumatization which overshadows the "benefits" of queer assimilation. My paper highlights the damages of homonormativity by contrasting being "gay" and being "queer" as they are portrayed in Ocean Vuong's "On Earth We're Briefly Gorgeous." The novel's titular character, the Vietnamese-American Little Dog, grapples with the experiences and trauma of being queer. Vuong contrasts this with Trevor, whose white American identity allows him to accept his homosexuality while refusing any elements of queerness, and I argue this refusal contributes to his ultimate demise. My paper uses queer theory to examine the nature of their relationship as it relates to the importance of the continued existence of the queer community as a space of resistance, as well as the dangers of "homonormativity" to the standards of the entire LGBTQ+ community.

Doctoral

Finding Myself in this Scholarship: Reviewing Extant Literature on International Students' Journeys and Struggles

Primary Author: Anna Sule

Faculty Advisor: Andrea Arce-Trigatti, C & I Two Plus Two

As an international student from Nigeria, my movement from an MBA program to a Ph.D. in Applied Behavior Analysis represents more than a disciplinary shift. It reflects a deeper negotiation of identity, belonging, gendered expectation, and intellectual legitimacy. In academic settings that often render international students both visible and invisible, the pursuit of scholarship becomes layered with power and perception. There is also the uncertainty many of us face when leaving our home country. My journey resonates with what most international students experience: the fear of leaving home and entering a cultural environment that is unfamiliar. From the beginning, it can feel intimidating, especially with the fear of the unknown.
This literature review focuses on examining extant literature exploring international students' lived experiences with cross-cultural transitions. Using a structured approach (Galvan, 2009) to exploring current research on international students' experiences, multiple databases were searched for relevancy on the following categories: cross-cultural transition, academic struggle, emotional exhaustion, and identity negotiation. Specific attention was given to autoethnographic contributions that were published within the last 10 years to better understand the similarities and differences of students experiences as related to these categories. As higher education institutions continue to welcome international student populations, this literature review is relevant to student support services who work with international students as they seek to understand their struggles to offer better support to navigate challenges (Martirosyan et al., 2019).

Mentorship as Partnership: A Qualitative Study of the BRIDGE Framework and Professional Learning Across a School–University Collaboration

Primary Author: Cassie Kohlmeyer

Co-Author(s): McKenna Day

Faculty Advisor: Amber Spears, Curriculum and Instruction

This abductive qualitative case study explored how structured mentorship and the BRIDGE framework influenced the professional development of K–2 classroom teachers and teacher candidates in an **undergraduate** literacy methods course and

corresponding field experience. The BRIDGE framework incorporated mentor training, co-planning and co-teaching between teacher candidates and their mentors, explicit role expectations, shared governance, institutional alignment, gradual release of responsibility, and structured reflection opportunities. This framework was created in response to mentorship and co-teaching being recognized as central to teacher candidate learning, yet often these relationships have been assumed rather than intentionally structured or supported. Across Spring and Fall 2025, the study included 43 teacher candidates, 50 mentor teachers, and 17 administrators. Data collected were focus groups, candidate reflections, co-teaching observations, student artifacts, mentor/administrator reflections, co-planning observations, and surveys to support cross-stakeholder triangulation. Data were analyzed using in-vivo coding followed by descriptive coding to generate cross-stakeholder themes; researcher consensus and a documented audit trail ensured analytic rigor. Cross-stakeholder analysis indicated that teacher identity must be intentionally cultivated, instructional skill develops through structured co-teaching opportunities, and ongoing reflection increased instructional refinement in both teacher candidates and mentors. Furthermore, framework elements such as shared instructional responsibility, gradual release, and reciprocal relationships encouraged continual mentor attention to instruction and long-term instructional coherence. These findings provide actionable insights for designing mentorship programs in educator preparation programs, highlight best practices for structuring training modules and collaborative meetings, and offer practical guidance for mentors and administrators working with teacher candidates.

Interrogating Potential Bias in IRB Processes Through a Poststructural Lens: A Qualitative Content Analysis of Institutional Policies and Researcher Experiences at Tennessee's R2 Public Universities

Primary Author: Hannah Willis

Faculty Advisor: Amber Spears, Curriculum and Instruction

Institutional Review Boards (IRBs) play a central role in research oversight, yet questions remain about whether their own policies, procedures, and training adequately account for potential biases related to protected classes such as gender, race, and ability. This study examined that question across Tennessee's four R2 public universities: East Tennessee State University, Tennessee State University, Tennessee Tech University, and Middle Tennessee State University. These institutions are particularly notable for navigating research oversight with fewer resources than R1 universities while serving diverse regional populations with distinct needs.
Using a poststructural qualitative approach, the study employed a dual analysis method combining conceptual content analysis and deconstruction of IRB policies, procedures, and training requirements across all four institutions, triangulated with semi-structured interviews and qualitative surveys conducted with eight researchers. Data were analyzed using two codebooks developed specifically for this study, enabling systematic identification of patterns, contradictions, and silences within institutional language and practice.
Findings surfaced notable gaps across all four institutions with implications for equitable decision-making, particularly in research involving marginalized populations. From these findings, the Block to Bridge Framework was developed as a transformative model to help institutions identify structural barriers and build pathways toward more equitable review practices, offering guidance for policy reform, reviewer training, and procedural redesign. This work advocates for IRB systems that are more inclusive, transparent, and accountable to the communities they serve

Artificial Intelligence in Applied Behavior Analysis: Promises, Use Cases, and Ethical Guardrails (A Narrative Literature Review)

Primary Author: Heba Soliman

Co-Author(s): Julie Howard, Krystal Kennedy

Faculty Advisor: Krystal Kennedy, Curriculum and Instruction

Particularly in areas like prediction tools, data process automation, and technology-assisted intervention supports, artificial intelligence (AI) is becoming more prevalent in ABA than our sector is prepared for. This project is a non-empirical narrative literature review that compiles the opinions of current ABA-relevant sources regarding (a) the areas in which AI is already being used in the provision of ABA services, (b) the types of benefits that can be realistically promised, and (c) the ethical "guardrails" that must be in place before using AI tools with clients. I concentrate on three clusters of literature: examples of AI-enabled applications (e.g., large-scale outcome prediction models and human-robot interaction design

requirements in autism intervention contexts; Cox et al., 2023; Schadenberg et al., 2017); generative AI concerns like accuracy, accountability, and potential misuse (Twyman, 2024); and ethical guidance in behavior-analytic practice (Jennings & Cox, 2024). The most recurring theme across sources is that while AI may increase productivity and decision support, it also brings with it risks that ABA cannot categorize as "tech problems." These risks include privacy/confidentiality, bias, transparency, accountability for decisions made by AI, and the potential for an excessive reliance on automated outputs (Jennings & Cox, 2024; Twyman, 2024). A useful checklist of questions to ask before implementing an AI tool, things to record, and things to avoid is provided at the conclusion of this article for ABA researchers and practitioners. Since this study is only based on literature, no human nor animal subjects are used.

Paraprofessional Perspectives on Implementing ABA in Rural Tennessee Public Schools: A Qualitative Case Study

Primary Author: Heba Soliman

Co-Author(s): Holly Portia Anthony, Krystal Kennedy

Faculty Advisor: Krystal Kennedy, Curriculum and Instruction

In PreK–12 special education classrooms, paraprofessionals often spend the most time with pupils. They are expected to assist with aspects of behavior plans for students and to set up applied behavior analysis (ABA)-aligned supports, such as prompts, rewards, and images. Studies have shown that paraprofessionals are often given difficult tasks without being given sufficient guidance or regular training and are seldom closely monitored (Giangreco et al., 2001; Broer et al., 2005; Biggs et al., 2016).
In this study, located in a rural Tennessee public school system, I asked paraprofessionals about their experiences supporting students with ABA, what training and guidance they had received, what challenges they faced, and what they thought would make support better. This in-depth case study (Yin, 2018) used semi-structured interviews, classroom observations, field notes, and reports as key data sources. Data from one participant was analyzed inductively using constant comparison to identify prevalent categories and themes. Analysis showed some of the challenges faced: learning by watching others do the job (Lave & Wenger, 1991); not being clear about roles and getting enough practical training; using ABA strategies in everyday life; and problems with time, staffing, materials, and lack of authority. The participant also described strong commitment to students and motivation when they saw progress. The goal is to use these results to develop practical training and teaching suggestions that work best in rural schools.

Generative Artificial Intelligence Integration for Faculty Development: A Research-Based Program Planning Model

Primary Author: Mallory Matthews

Faculty Advisor: Andrea Arce-Trigatti, Curriculum and Instruction

Generative Artificial intelligence (GenAI) is increasingly influencing instructional practices in higher education, yet institutional approaches to faculty GenAI integration remain uneven and often lack formal program planning structures. To address this potential gap, this project presents the Artificial Intelligence Integration Model for Higher Education (AIIM Higher), a theory-informed framework grounded in Program Planning and Evaluation (PPE), adult learning theory, cognitive load theory, and instructional design principles.
AIIM Higher was developed through an iterative model design process informed by a structured review of over 50 scholarly and professional sources published between 2022 and 2025. The literature synthesis examined faculty development, emerging technology adoption, instructional alignment, and institutional readiness for GenAI integration. Drawing on these foundations, the model organizes GenAI-related faculty development into five iterative phases—Preparation, Planning, Analysis, Implementation, and Evaluation—each embedding stakeholder engagement, alignment mechanisms, and continuous evaluation processes.
Moving beyond empirical intervention outcomes, this work advances an innovative and fully developed program planning model intended to structure institutional responses to GenAI integration. AIIM Higher contributes to ongoing scholarship by demonstrating how PPE models can be extended to contemporary technological innovations in higher education and by offering a scalable planning structure for systematic and sustainable GenAI integration.

College of Engineering

Chemical Engineering

Undergraduate

Thermophysical Properties of Terpenoid Mixtures for use in Deep Eutectic Solvents (DES)

Primary Author: David Lawrence

Faculty Advisor: Kevin West, Chemical Engineering

The growing global energy demand has led to the need for renewable sources and strategies that increase the energy efficiency of current industrial and commercial processes. Increased utilization of data centers for AI in the past few years has only increased this demand, putting strains on local energy grids and water supplies. This has created a need for environmentally benign and energy efficient process solvents and heat transfer fluids, used in power generation and in the dissipation of heat from industrial sources, such as data centers. One class of materials which offer promise in this area are deep eutectic solvents (DESs). DESs are formed when two compounds are combined to create a liquid that has a significantly lower melting point than the individual components, allowing its use over a larger temperature range. Among many potential mixture components, terpenoids are a potential bio-derived, bio-degradable option. Terpenoids are modified isoprene molecules that contain functional groups other than hydrocarbons; naturally occurring examples of terpenoids are menthol and thymol.
For terpenoid-based DESs to be considered as process solvents, their thermophysical properties must first be measured and characterized. Among these properties are their melting points, heat capacities, densities, and viscosities. This work focuses on characterization of the density, molar volume, excess molar volume and thermal expansivity of the binary mixtures of terpenoids. With this and other thermophysical property data, we will be able to evaluate the ability of these DESs to function as environmentally benign process fluids.

Guiding Students' Learning Via a Taxonomy of Conservation Principles: Conceptual Aspects, Implementation, and Examples

Primary Author: Emily Ender

Co-Author(s): Shanae Tyree, Pedro Arce

Faculty Advisor: Chemical Engineering faculty

A review of current literature used in engineering courses to convey conservation principles indicates that the material seems highly unsystematic. This usually generates confusion among students when applying conservation principles, especially when choosing system scales, control volumes, and understanding how different conservation laws (mass, momentum, and energy) relate to each other. A proposed taxonomy guides the students' learning through foundational concepts for conservation principles, scales and control domains, accounting and balance equations for each conservation property, i.e., mass, energy and momentum. In this contribution after a brief description of the taxonomy, it'll be applied to the case of species mass conservation with the presence of chemical reactions. Specifically, we will describe the learning mechanics that students systematically follow to derive the proper balance equations for a CSTR with a first order reaction and apply the results to the reactor analysis.

Dye Diffusivity Determination in Hydrogels: Experimental Design via the Foundry Model

Primary Author: Hannah Rains

Co-Author(s): Fabiana Ramirez Espana, Megan Dawson

Faculty Advisor: Pedro Arce, Chemical Engineering

The measurement of the rate in which macromolecules diffuse through soft materials such as hydrogels is very relevant for technological applications like drug delivery and tissue engineering. In order to achieve this objective, we need to identify and possibly design a diffusion cell that consists of two compartments, i.e. a "donor" with a high concentration of the solute and a "receptor," with the lowest concentration of the solute, connected by a bridge that houses the hydrogel material. By using this diffusion cell, we will take samples from either or both of the compartments to measure the time variation of the concentration of the solute. Based on Fick's Law of Diffusion, we will extract the diffusion coefficient of the dye through the hydrogel material. It is proposed to measure solute concentrations by using a spectroscopic technique via implementation of a calibration curve. This information will be utilized in conjunction with Fick's Law to determine the diffusion coefficient of the dye in the hydrogel.

Several experimental runs will be conducted to collect sufficient data to perform statistical analysis. Selection of dye samples will be made according to the type of protein molecules we want to characterize in the experiment. The key focus of this research project is the experimental design of the laboratory experiments so that data can be collected, accordingly. Also, we will identify an efficient protocol for the successful data analysis. To assist with the strategy, in this contribution, we will utilize the Renaissance Foundry Model.

Molecular Docking, Pharmacophore Modeling, and Quantum Mechanical Analysis of Methylxanthine Binding to the Adenosine Receptor

Author: Jeffrey Snyder

Co-Author(s): Derek Cashman

Faculty Advisor: Derek Cashman, Chemistry

This study focuses on computational explorations into methylxanthines, including caffeine, theobromine, and theophylline, in combination with interactions of the adenosine receptor by combining molecular docking with ab initio quantum mechanical analysis. Regarding ligand recognition, minor consideration was given to the consensus amino acid sequence of adenosine receptors and their relationship to potential binding sites. Using MOE 2024 and Gaussian 16, each ligand was docked into the receptor active site, generating five low-energy conformations ranked by binding Gibbs free energy (ΔG, kcal/mol). Quantum mechanical calculations were performed using G16 at the B3LYP/6-31G level of theory to evaluate electronic structure and density functional theory. The HOMO and LUMO orbitals were calculated to identify regions of electron donation and acceptance. Pharmacophore models were derived from docking to assess orbital distribution and binding interactions. Noncovalent contributions to ligand receptor stability (London dispersion forces and electrostatic interactions) were defined by Coulomb's law and analyzed. This study aims to demonstrate the correlation between electronic structure, ligand binding behavior, and differences among methylxanthines and their influence on receptor affinity. The results will include five docked confirmations, ligand interaction maps, HOMO and LUMO maps, quantum mechanical calculations, and various insights into receptor affinity.

Understanding Kidney Filtration via Electrokinetic-Hydrodynamic Concepts - A Foundry Guided Study

Primary Author: Jeffrey Snyder

Co-Author(s): Pedro Arce

Faculty Advisor: Pedro Arce, Chemical Engineering

The human kidney functions by continuously filtering waste through nephrons. Each nephron allows not only filtration, but also homeostasis in the body. Filtration is a complicated process, but it begins in the glomerulus. A dense cluster of capillaries surrounded by Bowman's capsule allows blood pressure to push water and small dissolved particles and substances such as ions, glucose, and urea out of the bloodstream, through a filtration barrier, and into a fluid known as filtrate. After this filtrate is established, it moves into the renal tubules, where the body, using this advanced renal network, selectively reabsorbs useful substances and secretes additional waste, eventually transforming the filtrate into urine. Bowman's capsule serves as the initial collection site for this fluid and directs it into the rest of the nephron for further processing. To understand this system, and more importantly, mathematically model it, we must use electrokinetic-hydrodynamics (EKHD). EKHD allows us to understand and enables fluid flow and electrically driven solute transport as they occur across the filtration membrane. In combination with the Renaissance Foundry Model (RFM), it becomes possible to develop a simplified mathematical model that captures how electrophoretic and electroosmotic processes contribute to transport within the glomerulus.

Exploration of Strategies for Amplifying DNA Using a PCR Microfluidic Chip

Primary Author: Makenzie Peters

Faculty Advisor: Robby Sanders, Chemical Engineering

DNA amplification is an important part of many different fields of science and engineering. Improving the tools researchers use to amplify DNA is important, and currently this is achieved through polymerase chain reaction (PCR). This process takes about an hour to complete, going through multiple stages and cycles to produce billions of copies of DNA molecules through thermal regulation to achieve denaturation, annealing, and elongation. A newer strategy is to use a PCR chip to decrease the time, improve accuracy,

and enhance portability to help monitor infectious diseases in real time. As such, a microfluidic set up has been developed to explore optimal values for operational parameters (e.g., location of the heating source, current applied to the heating source, flow characteristics, and chip design) to maximize amplification. After placing a temperature probe onto the chip and pumping the PCR materials through the meandering channel of the chip, the material coming out at the end is collected in a vial for subsequent analysis using agarose gel electrophoresis. Preliminary findings and recommendations for next steps will be shared with comparison to a standard tube-based approach. It is anticipated that having these portable chips can help infectious diseases be better diagnosed and treated in areas where proper medical care is not as easily available.

Comparison of Single-Atom Alloy (SAA Pt-Ir) with Single-Atom Catalyst (SAC Pt and SAC Ir) for Sustainable Hydrogen Production from Ammonia

Primary Author: Yulieth Mercado

Co-Author(s): Emily Taylor

Faculty Advisor: Ali Estejab, Chemical Engineering

As global energy demands shift away from limited and polluting fossil fuels, hydrogen has emerged as a critical clean energy carrier. Ammonia (NH3) presents a promising solution for hydrogen storage and transport, particularly because it can be recovered from wastewater, providing an avenue for both environmental remediation and energy production. However, the efficiency of extracting hydrogen through ammonia electrolysis depends heavily on the catalyst used. This research contributes to broader goal of using multiscale modeling to evaluate how these catalysis alter reaction kinetics and solvation free energies, ultimately aiming to optimize industrial electrolyzer design.
This study utilizes Density Functional Theory (DFT) through the Vienna Ab-initio Simulation Package (VASP) to perform geometry optimizations and calculate the adsorption energies of NH3 and its dissociation products (NH2, NH, and N). Performing geometry optimizations on two single-atom alloys (SAA) 1)a 4-layer Platinum-Iridium with a single Ir atom (Pt-Ir) surface and 2)a 4-layer Iridium surface with a single Pt atom (Ir-Pt) and compare the results with two single-atom catalysts (SAC) of 3)Pt and 4) Ir. This study identifies the most stable adsorption sites, specifically top, bridge, and hollow positions, for ammonia and its dehydrogenated intermediates. The calculated adsorption energies on these surfaces provide the essential foundation for determining reaction thermodynamics in the presence of solvent and electric field effects. These atomic insights are vital for refining the solvation free energy models, moving closer to the development of highly efficient catalysts for green hydrogen production from ammonia.

Master's

Evaluating Recycled PLA Filaments in Material Extrusion

Primary Author: Christopher Hudak

Faculty Advisor: Ismail Fidan, Manufacturing & Engineering Technology

Additive manufacturing (AM) has emerged as a transformative production technology for next-generation manufacturing systems. As global concerns surrounding resource scarcity and climate change intensify, the development and adoption of sustainable materials have become increasingly critical. Material extrusion, one of the most widely used AM processes, enables the rapid fabrication of complex geometries compared to conventional manufacturing techniques.
In this context, polymer-based filaments, particularly polylactic acid (PLA), offer significant opportunities for recycling. Failed prints and support structures can be reprocessed using shredding and extrusion systems to produce recycled filament, promoting a more circular manufacturing approach.
This study aims to evaluate and compare the performance of three types of PLA filaments: virgin PLA, commercially available recycled PLA, and in-house recycled PLA. The materials are systematically characterized in terms of dimensional accuracy, mechanical strength, surface roughness, and hardness. The results provide insights into the viability and effectiveness of recycled PLA as a sustainable alternative to virgin materials in material extrusion AM. Findings from this work will be presented in a poster format.

Microplastics Transport in Karst Groundwater Systems: Findings from a Multidomain Lab-Scale Model

Primary Author: Claire Myers

Co-Author(s): Holly Stretz, Robby Sanders

Faculty Advisor: Robby Sanders, Chemical Engineering

Microplastics (1-1000 micron diameter (ISO/TR 21960:2020)) are emerging contaminants known to be persistent in various environmental matrices. One area of interest when considering microplastics pollution is groundwater, which accounts for a significant portion of the world's freshwater resources and is a vital source of drinking and living water for individuals in rural areas without access to municipal water. Domestic use of groundwater is prevalent in the Appalachian region of Tennessee, which encompasses all east Tennessee and some of middle Tennessee. In east Tennessee alone, 36% of people rely on groundwater sources, 12% of which are self-supplied. The aquifer of this region consists of a carbonate rock matrix with numerous areas of secondary porosity via caves, conduits, and fractures, also known as karst. These features foster rapid and largely unpredictable flow regimes that can lead to contamination. Microplastics are a known contaminant in karst aquifers, but studies of transport phenomena in karst topography are limited. This work investigated microplastic transport in a lab-scale model of a karst aquifer with distinct matrix and conduit domains representing the dual porosity of karst systems. The goal is to provide insight into microplastics transport in areas of karst hydrogeology, including the Appalachian region of Tennessee.

Doctoral

Multiscale COMSOL–DFT Modeling of Sulfur Poisoning in Ni-Based Desulfurizer Beds

Primary Author: Ademola Adeoye

Faculty Advisor: Ali Estejab, Chemical Engineering

This work presents a multiscale computational framework to study sulfur poisoning of Ni-based desulfurizer beds, with emphasis on mechanistic interpretation of existing experimental data. The desulfurizer consists of NiO catalyst beads that are activated in situ to metallic Ni prior to exposure to sulfur-containing fuel streams, particularly H_2S). We combine continuum transport modeling with molecular-scale calculations using density functional theory (DFT) to connect observed breakthrough and capacity-loss behavior to the underlying elementary chemistry of sulfur adsorption, dissociation, and sulfide formation on Ni.

At the reactor scale, a one-dimensional axially dispersed packed-bed model is implemented in COMSOL to predict sulfur breakthrough and spatially resolved sorbent utilization. Sulfur uptake kinetics are formulated using a dynamic surface-coverage approach in which H_2S interacts with free Ni sites to form adsorbed sulfur species. At the molecular scale, DFT calculations on representative Ni surfaces are used to determine adsorption energies, activation barriers, and preferred reaction pathways for sulfur-bearing species, providing physically grounded parameters and constraints for the kinetic form used in the COMSOL model.
The combined workflow is used to reconcile and explain trends already observed in prior experiments, including breakthrough curve shape, effective sulfur capacity, and progressive loss of active sites. By embedding mechanistic insights into a transport-resolved reactor model, the approach provides a predictive tool for interpreting experimental outcomes and for identifying optimized operating conditions and regeneration strategies that minimize irreversible sulfur damage and extend sorbent life, in a bid to support the design and analysis of regenerable Ni-based desulfurizers.

Enhanced Solar Photocatalytic Degradation of Acetaminophen Using TiO2–CdS Heterojunction Composites

Primary Author: Dipendra Wagale

Faculty Advisor: Pedro Arce, Chemical Engineering

Titanium dioxide (TiO2) is a widely studied photocatalyst due to its non-toxicity, photo-stability, low cost, and strong oxidative potential (2.9 eV vs NHE), making it suitable for wastewater photo-degradation of organic pollutants (Fujishima, Zhang, & Tryk, 2008; Chen & Mao, 2007). However, its wide band gap (~3.2 eV) restricts its activity to the UV region, limiting its efficiency under natural sunlight (Chen & Mao, 2007). To study this limitation, this project, guided by the Renaissance Foundry Model (Arce et al., 2015) as a research framework, developed two photocatalyst systems: pure TiO2 synthesized via the sol-gel and TiO2–CdS composites (at different molar ratios) prepared through chemical precipitation methods.
Characterization using X-ray diffraction (XRD) and scanning electron microscopy (SEM) confirmed successful heterojunction formation and favorable morphology for enhanced light absorption. Photodegradation experiments were conducted

under natural sunlight (11:00 am–6:00 pm) using acetaminophen (ACE) as a model pharmaceutical contaminant. Among the different experimental conditions, minimal degradation (4.6%) occurred in the control, while pure TiO2 achieved 9.1% removal, reflecting its limited visible-light activity and rapid charge recombination. In contrast, TiO2–CdS composites demonstrated improved performance, achieving 34.3%, 39.6% and 42.3% degradation for 1:0.25, 1:0.5 and 1:1 ratios, respectively, over 7 hours of reaction.
The enhanced performance is attributed to heterojunction-driven charge separation and improved visible-light harvesting. These findings highlight TiO2–CdS composites as promising candidates for solar-driven photocatalytic removal of pharmaceutical contaminants. Future work will emphasize on optimizing catalyst composition, pollutant concentration, catalyst dosage, and surface modification to further improve degradation efficiency.

Nitrate Reduction to Ammonia for Renewable Energy Storage and Wastewater Remediation

Primary Author: Ekele Dinneya-Onuoha

Faculty Advisor: Ali Estejab, Chemical Engineering

Ammonia is increasingly recognized as a next-generation energy vector because it can transport hydrogen in a stable, carbon-free form while also serving as an essential industrial commodity. Yet conventional ammonia synthesis remains resource-intensive, prompting strong motivation for alternative, sustainable pathways. One promising route is the electrochemical conversion of nitrate (an increasingly pervasive contaminant from agricultural runoff and industrial discharge) into ammonia. This approach not only recovers value from a harmful pollutant but also creates a platform for storing renewable electricity in chemical form. Electrochemical nitrate reduction offers a sustainable alternative by enabling simultaneous green ammonia production and remediation of nitrate-polluted wastewater. However, achieving high selectivity and reaction rates requires an understanding of how catalyst surfaces mediate each elementary step of the multi-electron nitrate-to-ammonia pathway. Kinetic insight is therefore essential for identifying the factors that control activity and guide the design of more efficient electrocatalysts.
This study delivers a computational analysis of nitrate reduction on Pt (111) surfaces. Platinum is examined because it remains one of the most active and well-characterized metal catalysts for multi-electron nitrogen-oxygen transformations, providing a reliable benchmark for mechanistic analysis. Using density functional theory and transition-state searches, we evaluate adsorption energies, activation barriers, and elementary-step rate constants for all relevant intermediates. The results reveal the dominant reaction pathways, rate-determining steps, and the influence of surface structure on ammonia formation. We present mechanistic insights while positioning the work within our broader research effort that integrates computational predictions with experimental validation to advance electrochemical nitrate-to-ammonia conversion for renewable-energy storage.

Sustainable Photocatalytic Reactor Engineering for Water Treatment: Comparative H_2O_2-Enhanced Degradation of Acetaminophen under UVA-LED and Mercury Lamp Irradiation

Primary Author: Hoda Ghassab

Faculty Advisor: Pedro Arce, Chemical Engineering

Emerging pharmaceutical contaminants like acetaminophen persist in water systems because conventional wastewater treatment fail to fully remove them. Their persistence in water effluents raises concerns about ecosystem damage, bioaccumulation, and potential human health risks. Therefore, there is a need for investigating advanced treatment methods such as TiO_2-based photocatalytic Advanced Oxidation Processes (AOPs), which can degrade contaminants more effectively.
This study compares the performance of a suspension-type photocatalytic reactor operated under two irradiation systems: a UVA-LED source and a traditional medium-pressure mercury lamp, based on prior research from Tennessee Tech's Environmental Catalysis Laboratroy. Titanium dioxide (TiO_2) nanoparticles are used as the photocatalyst, while hydrogen peroxide (H_2O_2) is added as an AOP enhancer to increase radical generation, reduce electron-hole recombination, and improve degradation efficiency. The LED system is investigated as a potentially more sustainable alternative because it reduces reactor overheating, lowers cooling demand, and decreases energy consumption compared with conventional mercury-lamp systems. In addition, H_2O_2 may enhance degradation while limiting byproduct formation.
Guided by the Renaissance Foundry Model (RFM), and innovation-driven centered strategy, this contribution integrates literature review and experimental

design of research to optimize process parameters and support the development of sustainable, high-efficiency Prototypes of Innovative Technology. Overall, the study aims to highlight the potential of TiO_2 suspension photocatalysis with AOP enhancement and LED irradiation for sustainable wastewater treatment.

Advancing Microplastic Mitigation Using Corona Plasma: A Renaissance Foundry Approach

Primary Author: Jennifer Nwafor

Co-Author(s): Pedro Arce, Robby Sanders, Sabrina Buer, Andrea Arce-Trigatti

Faculty Advisor: Pedro Arce, Chemical Engineering

Microplastics are persistent contaminants in wastewater effluents and freshwater systems across Kentucky and Tennessee. Conventional treatment processes often fail to fully remove microplastics such as polyethylene (PE), polypropylene (PP), and polyethylene terephthalate (PET), allowing their discharge into major river systems and posing long-term environmental challenges (Alava et al., 2022; Amini et al., 2023).

This research is centered on the Renaissance Foundry Model (RFM), which provides the primary framework for identifying challenges and guiding innovation in wastewater treatment (Adams et al., 2021; Arce et al., 2015). Through its Knowledge Acquisition and Knowledge Transfer Paradigms, the Foundry structures the evaluation of corona discharge as a potential Prototype of Innovative Technology for regional application.

Corona discharge, an atmospheric-pressure non-thermal plasma, generates reactive oxygen and nitrogen species such as hydroxyl radicals, ozone, and hydrogen peroxide, enabling oxidation of organic contaminants without chemical additives (Misra & Rao, 2021; Wang & Ning, 2023). Prior studies demonstrate strong performance in degrading dyes and organic pollutants, achieving near-complete removal under optimized conditions (Krause et al., 2021; Zhang & Jones, 2023).

Emerging evidence suggests similar potential for microplastics, including measurable degradation, surface oxidation, and polymer fragmentation, with possible formation of intermediate nanoplastics (Velasquez et al., 2024; Sima et al., 2024).

By placing the Foundry Model at the center of analysis, this work identifies key research gaps and innovation pathways, supporting the development of scalable, chemical-free technologies for microplastic mitigation in wastewater systems.

Quantitative and Qualitative Analysis of Microplastics in City Wastewater Treatment Plants

Primary Author: Sahera Abumariam

Co-Author(s): Emilee Toombs, Shafieh Karami, Pedro Arce, Robby Sanders, Andrea Arce-Trigatti

Faculty Advisor: Pedro Arce, Chemical Engineering

Microplastics (MPs) are becoming a concern for society due to their widespread use or presence may lead to potential health & environmental impacts. MPs, in different concentrations, have been detected in oceans, rivers, protected areas, food, drinking water, and virtually every environment. Therefore, there is a need to conduct research in urban wastewater treatment plants (WWTPs) that serve as critical points where waterborne MPs can accumulate at high concentrations. These locations can be used for studying the removal efficiency of MPS in WWTP.

In this study, utilizing the Renaissance Foundry Model as our research methodology (Arce et al., 2015), we collected, processed, and analyzed wastewater samples from three locations within a typical city wastewater treatment plant. Our research aims to obtain information about the type and concentrations of MPs in selected process units within WWTP. Samples collected from the influent unit, aeration tanks (biological reactor), and effluent unit were used to perform quantitative and qualitative analyses of microplastics and evaluate the plant's retention ability. These samples were processed through two-phase filtration and digestion steps, followed by classification and characterization using microscopic techniques. During analysis, fewer microplastics were observed in the effluent compared to the influent of the WWTP; however, a high concentration was found in the aeration tanks, suggesting sludge captures most MPs. This indicates that sludge, often reused as fertilizer, may still introduce microplastics into the environment. Future work will focus on advanced oxidation processes, such as photocatalysis, to evaluate their effectiveness in degrading microplastics in wastewater systems.

Recovering Lithium from Desalination Reject Brine through Pretreatment and Controlled Crystallization

Primary Author: Seyed Mohammad Javad Seyed Sabour

Faculty Advisor: Bahman Ghorashi, Dean of Engineering Dept

Desalination reject brine is a promising but underutilized source of lithium. However, lithium recovery from these streams is difficult because Li^+ remains dissolved at low concentration in the presence of competing ions such as Ca^{2+} and Mg^{2+}. This work presents a literature-guided framework for recovering lithium as lithium carbonate through integrated chemical conditioning and controlled crystallization. The proposed process uses upstream softening followed by soda ash addition to introduce carbonate ions and promote Li_2CO_3 formation under controlled pH and temperature conditions. Because lithium carbonate exhibits decreasing solubility with increasing temperature, it offers a favorable target for downstream thermal crystallization. A compartmental sieve-plate crystallizer is proposed to improve hydrodynamic control during nucleation, crystal growth, and slurry development. This framework provides the basis for future experimental validation of lithium recovery from desalination waste streams.

Computer Science

Undergraduate

Electric/Waste Reduction

Primary Author: Alden Pounders

Co-Author(s): Bryant Koester, Srivishnu Yadali, Vidhula Oviya Vasanthan, Daniel Getahun

Faculty Advisor: William Eberle, Computer Science

This project examines campus-wide electricity and waste usage to identify peak demand periods, the buildings with the highest consumption, and patterns that explain why usage fluctuates. By analyzing building-level energy data alongside statewide Tennessee electricity trends, we aim to identify the primary drivers of campus energy use and waste production and propose data-driven strategies for reduction.

RUC Foot Traffic

Primary Author: Brynn Rogers

Co-Author(s): Alexander Redd, Ethan Kerley, Dylan Smith, Ryan Leacock

Faculty Advisor: William Eberle, Computer Science

It has been observed that the cafeteria in the Roaden University Center (RUC) often struggles to correctly predict how much food or how much manpower would be needed for any particular day. Our solution is to use performance data provided by Chartwells Higher Ed., as well as weather data provided by the National Oceanic and Atmospheric Administration, to build a time-series prediction model. This model should accurately predict foot traffic through the RUC given, at least, a time of year and potential weather to help influence decisions related to food and manpower.

Carrier Safety Rating Prediction

Primary Author: Evan Mcintyre

Co-Author(s): Ryan Prax, Osvaldo Rodriguez, Cesar Vargas Cabellero

Faculty Advisor: William Eberle, Computer Science

This project focuses on predicting motor carrier safety ratings assigned by the Federal Motor Carrier Safety Administration (FMCSA). During Compliance Reviews, carriers are classified as Satisfactory, Conditional, or Unsatisfactory based on factors including roadside inspection violations, out-of-service (OOS) events, hazardous materials compliance, and safety management practices. With only 1.86% of 3,189,814 carriers holding an official FMCSA rating, freight brokers — who may face legal liability for negligent carrier selection have limited tools for evaluating safety. A predictive model trained on existing ratings would provide a data-driven foundation for carrier vetting.
We integrated multiple FMCSA public datasets, including company profiles, inspection records, violation history, OOS orders, and SMS BASIC scores, linked by DOT number. Inspection data only went back to December of 2023, so we plan to restrict our working dataset to 2,980 carriers rated since June 2024. This gives the model data at least six months prior to a company's rating. Exploratory data analysis identified key predictors such as active OOS events, driver violations, and vehicle maintenance issues.
We plan to evaluate supervised machine learning approaches including logistic regression and random forest classifiers. Because failing to identify an unsafe carrier has far greater consequences than a false positive, we will prioritize recall for Conditional and Unsatisfactory carriers. Prior work by Lantz (1994) achieved an AUC of 0.640 using only four features and

simple logistic regression. By using richer, more recent data and better models, we aim to outperform prior benchmarks and more accurately predict carrier safety.

Modeling Pedestrian Mobility Using Wireless Network Connection Data

Primary Author: Isaiah Chastain

Co-Author(s): Trejan Gannod, Lucas Starkey, Trigg Lampkins, Mikel Gonzalez

Faculty Advisor: William Eberle, Computer Science

Universities make big operational decisions—cleaning schedules, event locations, promotional placement—without actually knowing how people move through campus spaces. That's a problem. This project explores whether anonymized Wi-Fi access point (WAP) data can be used to realistically model pedestrian movement at TN Tech. We will start with the engineering quad and analyze timestamped device connections to uncover when and where traffic patterns emerge. Each anonymized device becomes a movement timeline—a sequence of WAP connections over time. We model the building as a spatial graph: access points are nodes, walkable paths are edges, and distances become weights. When a device switches access points, we compute the shortest path between them to estimate how movement likely occurred. These transitions are aggregated into directed edge flows and transformed into time-based flow matrices and spatial vector fields that show both movement intensity and direction. We then model patterns across multiple time scales—semester-wide trends, weekday vs. weekend differences, day-of-week variation, and hourly fluctuations—to detect statistically meaningful traffic behavior. The system is built using Python (Pandas, NumPy), NetworkX for graph routing, GeoPandas for spatial modeling, and a FastAPI backend that powers interactive visualizations. The result: dynamic heatmaps, connectivity graphs, and time-aware movement fields that clearly reveal congestion zones and spatial linkages. Ultimately, this project tests whether existing Wi-Fi infrastructure can double as a privacy-preserving mobility sensor—turning passive network logs into actionable, data-driven insight for smarter campus planning.

The Effects of Lifestyle Patterns on the University Student Academic Performance

Primary Author: Justin Hortopanu

Co-Author(s): Connor Sherrill, Mia Guzman, William Donovan, William Denning

Faculty Advisor: William Eberle, Computer Science

This study investigates the influence of self-reported lifestyle, mental health, and health-related factors on the academic performance of university students. Utilizing data from the Healthy Minds Study, a comprehensive nationwide dataset of college students from the United States, we examine the relationship between student well-being and academic outcomes. To ensure modeling efficiency and interpretability, the original feature set was refined from approximately 1,600 variables to 500 key indicators. These indicators focus on demographics, mental health, eating disorder tendencies, self-harm factors, etc. The analytical framework employs linear and multiple linear regression as baseline models to identify significant predictors of academic standing. Model performance is evaluated using Mean Squared Error, Root Mean Squared Error, and R-squared. By identifying the specific health and lifestyle patterns most correlated with academic success, this research provides critical insights into the non-academic factors that shape student trajectories in higher education, offering a foundation for more targeted institutional support.

Inferring Occupancy and Traffic Flow from Unlabeled Smart Building Sensor Data

Primary Author: Samuel Hartmann

Co-Author(s): Dalton Sloan, Fengjun Han, Garrett Green

Faculty Advisor: William Eberle, Computer Science

Understanding occupancy and movement patterns in smart buildings is essential for improving energy efficiency, space utilization, and user comfort. This project presents a data-driven approach to predicting traffic flow in the Ashraf Islam Engineering Building using unlabeled, multimodal sensor data. In addition to environmental sensing, we leverage vibration-based sensors mounted on structural elements such as steel beams and embedded in concrete to detect footsteps through small structural deflections. These signals provide insight into movement patterns by capturing the timing and intensity of foot traffic within the space.
Because the data is unlabeled, occupancy is inferred

indirectly using a physics-based model that converts carbon dioxide (CO_2) concentration into estimated occupant counts based on room volume, airflow, and average human CO_2 output. These occupancy estimates are integrated with humidity and passive infrared (PIR) sensor data to capture presence and environmental variation, while vibration data is processed using Fast Fourier Transforms (FFT) to extract frequency-domain features associated with footstep activity. To model temporal relationships and align patterns across sensor modalities, we apply Long Short-Term Memory (LSTM) networks, enabling the system to learn sequential dependencies and match periodic behaviors between environmental and structural signals.

By fusing these heterogeneous data sources, we develop a model that characterizes and predicts traffic flow patterns throughout the room. This work demonstrates how combining structural vibration sensing, environmental data, and temporal modeling techniques enables accurate occupancy and movement estimation without labeled datasets, offering a scalable and non-intrusive solution for smart building analytics.

Modern Store of Value: A Quantitative Analysis of Alternative Safe Haven Assets

Primary Author: Taylor Turner

Co-Author(s): James McDavid, Matthew Hazelwood, Brence Moore, Connor Buttrey

Faculty Advisor: William Eberle, Computer Science

In the modern economic landscape, traditional safe haven assets, such as precious metals, have demonstrated unexpected volatility during recent market disruptions, eroding investor confidence in their ability to preserve capital. This study investigates alternative investment vehicles to identify reliable stores of value that offer stability, provide reasonable returns, and minimize exposure to systemic economic shocks. Spanning a timeframe from January 2021 to March 2026, the research evaluates diverse asset classes, including equities, commodities, and cryptocurrencies.

To establish a benchmark for genuine wealth preservation, the analysis utilizes the Consumer Price Index for All Urban Consumers (CPIAUSL) to quantify the erosion of the US Dollar's purchasing power over time. The methodology employs a multi-faceted quantitative framework structured around volatility assessment, crisis performance evaluation, and risk-adjusted return analysis. Specific success metrics calculated include standard deviation, maximum drawdowns, cross-asset correlations, and Sharpe ratios. Furthermore, event study methodologies and downside capture metrics are applied to evaluate asset resilience during specific market stress events and broad market downturns. Ultimately, this ongoing research aims to formulate actionable portfolio strategies for risk-averse investors seeking modern alternatives to traditional safe havens.

Interpretable Machine Learning for Modeling Metabolic Burden and Healthcare Access in County-Level Mortality

Primary Author: William Ward

Co-Author(s): Nicholas Atkins, Jacob Hernando, Kaden Santos-Hien, Kristian Obrusanszki

Faculty Advisor: William Eberle, Computer Science

Metabolic syndrome is a major driver of cardiovascular disease and mortality rates, yet regional differences in metabolic risk and healthcare access remain poorly characterized. This study constructs a county-level Metabolic Burden Index (MBI) for the state of Tennessee using principal component analysis of obesity, diabetes, hypertension, and hypercholesterolemia prevalence rates, and examines its relationship with underlying socioeconomic and behavioral factors. A multilinear regression model is used as a baseline to predict MBI, followed by an Explainable Boosting Machine to capture nonlinear relationships while preserving interpretability. The index is evaluated against cardiovascular outcomes, including coronary heart disease and stroke. Two healthcare access composites are developed to capture distinct dimensions of care availability: outpatient access, reflecting provider availability and insurance coverage, and healthcare infrastructure, reflecting system capacity. Regression analysis is used to determine how these dimensions influence mortality and moderate the relationship between metabolic burden and mortality. Results indicate that higher metabolic burden is associated with increased mortality, while outpatient access and infrastructure exhibit protective effects. This framework provides a data-driven approach for identifying high-risk communities and may support targeted public health interventions.

Master's

Feature-Space Analysis of Misclassifications in Object Detection Through Clustering

Primary Author: David Pesin

Faculty Advisor: Mike Rogers, Computer Science

Object detection models based on convolutional architectures perform well on standard validation datasets, yet remain prone to hard false positives. These misclassifications often occur due to feature sharing between classes, causing hard false positives during inference. Presently, literature primarily represents misclassifications in confusion matrices or through other performance metrics, but the specific attributes in the feature space are unclear. In this work, we will investigate the geometry of misclassifications in Faster R-CNN and You Only Look Once (YOLO) models by extracting per-object region-of-interest (RoI) feature embeddings from a model pretrained on COCO and applying unsupervised clustering techniques to analyze where misclassified examples exist in feature-space relative to correct classifications and visualize confusion boundaries.

Seeing the Spark Before the Flame: Wildfire Risk Detection via UNets

Primary Author: Jamie Boyd

Faculty Advisor: Doug Talbert, ENG - Computer Science

Wildfires pose a significant threat to human lives, infrastructure, and ecosystems, with increasingly devastating consequences each year. As climate change drives the frequency and intensity of these events, accurate and timely risk prediction becomes critical. In this project, I developed a U-Net-based deep learning model to generate wildfire risk maps. Using weather data, NDVI (normalized difference vegetation index), elevation data, and historical fire records, a U-Net model was trained to segment regions with high fire susceptibility, generating fire risk heatmaps from spatially aligned NDVI, elevation, and weather input. The results demonstrate that the model successfully captures meaningful spatial fire-risk patterns, identifying high-risk regions that align with historical fire occurrences and environmental conditions. The U-Net architecture enables precise localization of risk at the grid-cell level, allowing the model to distinguish between low- and high-susceptibility areas across diverse landscapes. Generated risk maps provide interpretable, continuous wildfire risk estimates that support early-warning capabilities and proactive fire management. These findings highlight the potential of deep learning–based spatial models as effective tools.

Reward-Guided Fine-Tuning of Language Models with Social Feedback

Primary Author: Jared Scott

Co-Author(s): None

Faculty Advisor: Jesse Roberts, Computer Science

Large language models (LLMs) are increasingly used in assistive conversational systems, yet they often struggle to adapt their responses to the tone and context of human interactions. While prior work has focused on improving accuracy and safety, less attention has been given to context-sensitive conversational behavior. This work explores using feedback derived from real-world online discussions to guide more adaptive responses. We introduce a framework that leverages Reddit conversation data to train a reward model that predicts the effectiveness of replies within their conversational context. This reward signal is used to fine-tune a language model with Proximal Policy Optimization (PPO). Experimental results show significant reductions in toxicity and improvements in humor-related metrics while maintaining comparable reasoning performance, suggesting that conversational feedback can improve the adaptability of assistive language models.

Multimodal Machine Learning for Student Retention Prediction: Integrating Temporal, Textual, and Tabular Features

Primary Author: Kashaina Nucum

Faculty Advisor: William Eberle, Computer Science

Student retention remains a significant challenge in engineering programs due to academic rigor and structural barriers. At Tennessee Technological University's College of Engineering, approximately 20% of students do not persist beyond their first year, highlighting the need for early identification of at-risk students to enable timely, targeted interventions. This work addresses two key research questions: (1) which academic, demographic, and advisement-derived features most strongly influence retention predictions at the individual level, and (2) which factors are broadly associated with attrition across the

student population to inform institutional planning and evaluation.
To support these goals, we present a web-based tool for predicting first-semester, first-year, and multi-year retention. The system integrates socio-demographic attributes, academic performance indicators, and advisement notes as predictive features. Advisement notes are analyzed using Aspect-Category Sentiment Analysis, leveraging a combination of rule-based methods, sentence-transformer embeddings, zero-shot inference, and a RoBERTa-based sentiment classifier. These NLP-derived features are combined with structured data in a hybrid modeling framework, using XGBoost for short-term predictions and a bidirectional LSTM for multi-term forecasting. Model interpretability is incorporated through SHAP, enabling identification of the most influential factors driving retention predictions and supporting actionable insights for intervention strategies.

Prediction of Drought Onset And Severity Using Data Mining

Primary Author: Megan Hendrickson

Faculty Advisor: Amr Hilal, Computer Science

Climate change has been an issue of concern for centuries. However, human activity has caused most of the earth's warming, especially in recent years. The impacts of climate change are already being felt through health concerns, impacts on food production, rising sea levels, and an increase in extreme weather events. Furthermore, extreme heat events have become more common in the 21st century, adding a new factor beyond lack of precipitation contributing to an increased risk of droughts. Droughts can cause water shortages and crop failures, and increase the risk of wildfires. Therefore, it is important to be able to predict the possibility and potential severity of a drought that may occur in order to adequately prepare and lessen the possible impacts. Using drought data from the U.S. Drought Monitor (USDM) and weather data from the Global Historical Climatology Network (GHCN) from NOAA's National Centers for Environmental Information, the goal of this project is to see how data mining methods and additional weather context can be used to assist with short-term drought prediction in the continental United States. In particular, the goal is to determine which weather variables contribute to accurate prediction, as well as how far out a drought and the severity of that drought can be predicted.

Comparative Analysis of Clustering Methods for User Behavior Segmentation in Financial and E-commerce Data

Primary Author: Om Solanki

Faculty Advisor: Maanak Gupta, Computer Science

Understanding user behavior is important for improving decision-making in financial and e-commerce systems. In this project, we apply clustering techniques to identify patterns in user behavior across two different datasets: credit card usage data and e-commerce activity data. After preprocessing and normalizing the data, we use clustering algorithms such as K-Means, hierarchical clustering, and DBSCAN to group users based on their behavior.
We evaluate the quality of the clusters using metrics like silhouette score and analyze the characteristics of each group. The results show that clustering can effectively identify distinct user segments with different spending, payment, and engagement patterns. We also compare how clustering methods perform across the two datasets and observe differences in how user behavior is structured in each domain.
This study demonstrates that clustering is a useful data mining approach for discovering meaningful patterns in user behavior and provides insights into how these patterns vary across different types of data.

Smart Grid Digital Twin: Physics-Grounded AI-Assisted Trust Scoring for Cyber-Resilient Grid Monitoring

Primary Author: Thomas Robertson

Co-Author(s): Kashaina Nucum, Jamie Boyd, Carter Brady

Faculty Advisor: Muhammad Ismail, Cybersecurity Educ Research Center

Modern electric utilities increasingly rely on SCADA telemetry systems vulnerable to cyber attacks that can corrupt sensor readings and destabilize grid operations. This project presents a data-anchored, simulation-augmented digital twin framework for smart grid monitoring that demonstrates how artificial intelligence can detect compromised telemetry, forecast zone-level demand, and automate resilience responses, all without requiring the ground-truth data unavailable during a real attack.
The framework ingests real or synthetic system-

level load and generation data and decomposes it into physically-constrained, zone-level time series while enforcing conservation laws at every timestep. Five attack types (spike, drift, spoof, replay, and dropout) are injected, corrupting reported telemetry while preserving hidden ground truth for evaluation. A zero-trust validation engine applies four independent physical checks per zone per timestep: bounds compliance, ramp-rate limits, conservation consistency, and peer-group deviation. Each failed check reduces a zone's trust score, producing an interpretable signal that identifies not just whether telemetry is suspect but which physical law it violates. Those scores drive a layered automated response: clamping anomalous readings, substituting AI-generated forecasts, or isolating compromised zones entirely.
Zone-level demand forecasting uses baseline models and a hyperparameter-tuned LSTM, while anomaly detection combines rule-based scoring with an unsupervised Isolation Forest trained on clean data. A stress-based controller manages capacitor allocation in real time. Results are accessible through an interactive Streamlit dashboard enabling scenario comparison across baseline, stress, and attack conditions. The framework offers a replicable architecture for interpretable, ground-truth-free grid security monitoring.

Doctoral

Hybrid Topological and Semantic Approach for Citation Recommendation

Primary Author: Arefin Niam

Faculty Advisor: Amr Hilal, Computer Science

In this project we aim to formulate citation recommendation as a link prediction problem on academic citation networks. Papers are modeled as nodes and citations as directed edges. The rapid growth of scientific literature makes it increasingly difficult to identify relevant prior work using keyword-based discovery alone, while structure-only graph methods perform poorly on newly published or low-degree papers due to lack of connectivity. The proposed approach combines topological signals mined from the citation graph with semantic signals mined from paper content vectors. This study will compare topology-only, text-only, and fused models under standard link prediction evaluation, with additional analysis focused on cold-start cases and practical runtime considerations.

Explaining the Unexplainable: Can AI Explanations Be Trusted?

Primary Author: Maraz Mia

Faculty Advisor: Mir Pritom, Computer Science

Explainable Artificial Intelligence (XAI) methods such as SHAP, LIME, and Integrated Gradients have become essential tools for transparency and regulatory compliance in high-stakes machine learning deployments. However, the integrity of these explanation methods is increasingly under threat from a growing landscape of adversarial attacks. In this research, we present a comprehensive study that spans both the attack and defense dimensions of XAI security. On the attack side, we investigate six adversarial techniques targeting post-hoc explanation methods, including fairwashing explanation, manipulation explanation (i.e., MARKUT attack), backdoor-enabled manipulation, output shuffling, scaffolding out-of-distribution (OOD), and biased sampling attacks, evaluated across cybersecurity applications such as phishing, malware, intrusion, and fraudulent website detection. Notably, data-driven attacks such as blackbox and data poisoning are identified as adversary-expertise-dependent and can be substantially mitigated when the underlying model maintains sufficient robustness against outliers and OOD inputs. On the defense side, we propose a framework grounded in a zero-trust architecture that embeds continuous verification into the XAI explanation supply chain, replacing the implicit assumption of auditor trustworthiness with a structured verify-then-trust paradigm. Our defense approach shows promise to neutralize most of the studied attacks, with the exception of MAKRUT, which remains an open challenge. Together, this work provides a unified view of the XAI adversarial threat landscape and a principled path toward resilient, trustworthy explanations.

A Landscape of Trustworthy AI Frameworks and Metrics: Mapping to the NIST AI Risk Management Framework

Primary Author: Marlana Hatcher
Co-Author(s): Mir Pritom, Maraz Mia, Seyed Mohammad Sanjari Pirmahalleh

Faculty Advisor: Mir Pritom, Computer Science

As Artificial Intelligence Systems (AIS) are increasingly

deployed in critical domains, the need for standardized frameworks and quantifiable metrics to evaluate their trustworthiness has become essential, particularly in cybersecurity engineering. However, the large number of proposed metrics in existing literature often makes practical implementation difficult for security analysts. This study presents a systematic review of trustworthy AI frameworks and associated evaluation metrics for assessing trust in AI-assisted systems. Peer-reviewed literature was analyzed to identify conceptual frameworks and metrics related to AI trustworthiness, which were then mapped to the National Institute of Standards and Technology (NIST) Trustworthy AI framework. Based on this analysis, we identify commonalities and differences among existing approaches and develop a structured taxonomy of evaluation metrics. Finally, we propose a concise set of metrics aligned with the NIST framework to support analysts in assessing trust in cybersecurity detection tasks such as intrusion, phishing, and malware detection.

Detecting Psychological Manipulation Techniques in Text Using Data Mining

Primary Author: Shivam Arvind Adke

Faculty Advisor: Amr Hilal, Computer Science

Even though many people know about online scams and cyber fraud, they still get tricked because messages often use psychological pressure to influence decisions. In this project, the goal is to detect psychological manipulation techniques directly from text. The project will use the Cognitive-Bias-Approach labeled dataset, which contains 483 text samples and 10 manipulation technique labels, where one message can contain multiple techniques. The planned approach is to clean and prepare the text data, extract features using TF-IDF, and train a baseline multi-label machine learning model using a one-vs-rest classifier. The model will be evaluated using precision, recall, and F1-score, both overall and for each technique. After evaluation, the project will analyze which techniques are easier to detect and which techniques are harder, especially when some labels appear less often than others. The expected outcome is a simple baseline system that can take a new message typed by a user and predict the most likely manipulation techniques present in that text.

Electrical & Computer Engineering

Master's

Investigating the Vulnerability of Ring-Oscillator Based Physical Unclonable Functions to Machine Learning Attacks

Primary Author: Abraham Perkins

Faculty Advisor: Syed Hasan, Electrical and Computer Engineering

Ring-Oscillator based Physical Unclonable Functions (ROPUFs) offer a unique solution to many hardware security problems, such as authentication or key generation, but remain susceptible to Machine Learning (ML) attacks. ROPUFs are classified as a weak PUF, meaning they supply a limited number of Challenge-Response Pairs (CRPs) compared to strong PUFs. To improve the number of CRPs we can extract from a board, we look to partial reconfiguration, an approach where parts of the Field Programmable Gate Array (FPGA) design are dynamically reconfigured. This reconfiguration allows the shifting of the PUF around the FPGA, a technique known as Moving Target Defense (MTD), modifying the extracted CRP on the fly. MTD, along with partial reconfiguration, allows for vulnerabilities caused by compromised CRP sets to be mitigated, as the affected CRPs can be reconfigured into a completely new set. This work analyzes the application of ML techniques in an attempt to learn the CRP set, a vulnerability mentioned by many ROPUF works. We analyze the effectiveness 4 different ML models on many different CRP sets, along with the ability of the models to predict on data affected by MTD. Our work shows that the accuracy of ML models at predicting CRPs diminishes proportionally with the number of times the PUF is moved around the FPGA fabric. We show that after 3 PUF layout changes, our tested models approach 50 percent accuracy, essentially a random guess with regard to the data used.

Model-Based and Learning-Based Pursuit-Evasion Control: A Benchmark Comparison of Linear-Quadratic Game Theory and Deep Reinforcement Learning

Primary Author: Blaine Swieder
Faculty Advisor: Syed Ali Asad Rizvi, Electrical and Computer Engineering

Intelligent Transportation Systems (ITS) and Connected Automated Vehicles (CAVs) increasingly operate in environments where safety-critical decisions emerge from strategic interactions between

multiple agents. This thesis investigates pursuit–evasion as a controlled benchmark for comparing two fundamentally different control design philosophies: model-based linear-quadratic (LQ) dynamic game theory and deep reinforcement learning (DRL).
A discrete-time, two-player pursuit–evasion problem is formulated in relative coordinates, capturing the geometry of aggressive following, cut-in, and collision-avoidance scenarios relevant to autonomous vehicle operation. The model-based baseline is derived as a closed-form Nash equilibrium solution to a finite-horizon, zero-sum LQ dynamic game, computed via coupled Riccati equations. The learning-based pursuer is trained using a continuous-control DRL algorithm against a fixed Nash-optimal evader, receiving no explicit knowledge of the system model. Both controllers are evaluated on identical dynamics, state spaces, and performance metrics, enabling a direct and principled comparison.
Beyond nominal conditions, three structured perturbation classes are examined: model mismatch, additive process noise, and hard input saturation. These perturbations are chosen to probe distinct structural vulnerabilities in each design philosophy — the LQ controller's dependence on an accurate plant model and unconstrained inputs, and the DRL policy's dependence on sufficient training data and reward alignment. Performance is assessed across capture rate, mean capture time, cumulative state-and-control cost, control effort, and sample efficiency. The findings of this study aim to clarify when analytical optimality translates into practical reliability and when a learned policy offers a meaningful advantage under uncertainty.

From C++ to FPGA: Accelerator Development with Vitis HLS and CFU-Playground

Primary Author: Cameron Smith

Co-Author(s): Abraham Perkins, Syed Hasan, Nan Guo

Faculty Advisor: Syed Hasan, Electrical and Computer Engineering

Custom hardware accelerators have long promised order-of-magnitude performance and efficiency gains over general-purpose processors, but their adoption has been limited by the specialized knowledge required to design them. This paper presents a practical, accessible workflow for accelerator development using two complementary tools: Vitis High-Level Synthesis (HLS) from AMD-Xilinx and the open-source CFU-Playground framework. Vitis HLS enables hardware designers to write accelerator logic in standard C or C++, then automatically synthesizes that code into Verilog RTL suitable for implementation on any device in the broad AMD-Xilinx FPGA portfolio (low-cost Artix-7 boards to high-performance Ultrascale+ devices) without changing the source algorithm. CFU-Playground provides a ready-made infrastructure for connecting these generated accelerators to a soft RISC-V processor, handling the communication protocol, software interface, and FPGA build system automatically. Together, the two tools form a workflow where an engineer writes an algorithm in C++, applies synthesis directives to control hardware resources, and deploys a working accelerator onto real hardware in a fraction of the time required by traditional RTL design. This paper demonstrates the methodology with a 2D convolution accelerator. The workflow's simplicity, portability, and alignment with software engineering practices make it well suited for rapid prototyping in embedded machine learning and signal processing applications.

Demonstration of Hardening a Design with an Open-source ASIC Flow

Primary Author: Carter Brady

Co-Author(s): Quy Le

Faculty Advisor: Syed Hasan, Electrical and Computer Engineering

We present a demonstration of hardening a custom 4×4 systolic array (SA) matrix-multiplication accelerator using only open-source tools and an open Process Design Kit (PDK). The design implements a SA with input and output FIFOs and a simple SPI interface so that it can be integrated into a TinyTapeout-style shuttle environment with limited I/O. We walk through the full flow from register-transfer level (RTL) to Graphic Data System II (GDSII). This includes writing synthesizable Verilog, building testbenches, performing functional simulation with Icarus Verilog and GTKWave, and then applying formal verification with SymbiYosys to check FIFO behavior under corner cases such as overflow, underflow, and simultaneous read/write. We also use the Covered tool to obtain code-coverage metrics. For hardening, we use the LibreLane flow with the SkyWater 130 nm open PDK, add a custom Synopsys Design Constraints (SDC) file to constrain the SPI clock domain, and iterate on timing constraints to resolve hold-time issues at slow process corners. The final hardened layout passes design rule check (DRC) and layout versus schematic

(LVS) and meets timing at the nominal corner. This work provides a concrete example of how moderately complex accelerator IP can be implemented, verified, and hardened with open-source ASIC tools and is intended as a practical reference for others pursuing similar shuttle-compatible designs.

Self-Tuning QWiC Power Transfer Supply

Primary Author: Conor Orr

Faculty Advisor: Charles Van Neste, Electrical and Computer Engineering

Single Wire power systems are used to reduce the material and maintenance costs of power distribution systems by eliminating the need for a return conductor. These systems are highly dependent on load and environmental properties, and need to be controlled to operate at a specific frequency to achieve maximum power transfer. This frequency is unique for every use case and iteration of each case, making the design of a standard power delivery system a uniquely challenging task. This project proposes a system that is self tuning and capable of being deployed in many different environments and situations to ensure maximum efficiency.

Multi-Port Solid State Transformer Optimization for Smart-Grid

Primary Author: Garrett Armstrong

Faculty Advisor: Indranil Bhattacharya, Electrical and Computer Engineering

This work presents a comprehensive design, optimization, and validation framework for high-frequency, multi-port solid-state transformers (SSTs) for Smart Grid applications. A two stage genetic algorithm (GA) based strategy is developed to efficiently explore and refine transformer designs. In Stage 1, a Python based GA evaluates over 1000 high-frequency transformer (HFT) designs from a geometric and parameterized perspective, incorporating both randomly generated and literature informed candidates. Top performing designs are validated in ANSYS Maxwell 3D and compared with Finite Element Method Magnetics (FEMM) results to assess core loss accuracy and verify the methodology. In Stage 2, a second GA directly interfaces with ANSYS Maxwell to optimize inductance characteristics and mitigate flux crowding. This includes optimal winding placement, air-gap tuning to achieve desired leakage and magnetizing inductance, and geometric corner rounding to reduce localized magnetic field concentrations.
The proposed framework establishes a generalizable and customizable HFT design methodology, effectively integrating optimization algorithms with high-fidelity electromagnetic validation for next-generation transformer systems.

LiDAR Spoofing Detection With External Optical Sensors using Supervised Learning

Primary Author: James Jones

Co-Author(s): Nan Guo, Syed Hasan

Faculty Advisor: Syed Hasan, Electrical and Computer Engineering

LiDAR spoofing attacks pose a significant threat to autonomous vehicle perception by blocking targets using synchronized IR pulses to suppress or block legitimate target reflections. These synchronized spoofing attacks are pose more of a threat than unsynchronized jamming as the interference is controlled and able to remain stealthy by modulating the interference. This paper presents an external photodiode sensor array adjacent to the Ouster LiDAR module to detect spoofing activity and to classify spoofer distance when spoofing is detected. Optical waveforms captured by this sensor exhibit distinct statistical deviations during spoofing, which are leveraged to extract lightweight features for supervised learning. Multiple classifiers, including Random Forest, Decision Tree, and Support Vector Machine (SVM), are evaluated to demonstrate accurate spoofing detection and distance classification. Another contribution of this work is that such an approach is feasible and can be implemented with traditional supervised learning models and feature extraction. The test bed constructed is a flexible setup for machine learning interference detection with an external sensor array. The external sensor permits a cost-effective way to add spoofing detection to LiDAR modules, allowing flexibility to work with different types of modules.

Doctoral

CBF-Based Safe Model-Free Q-Learning in Koopman Eigenfunction Coordinates

Primary Author: Md Nur-A-Adam Dony

Faculty Advisor: Syed Ali Asad Rizvi, Electrical and Computer Engineering

Reinforcement learning methods for optimal control face a fundamental tension: Q-learning achieves model-free policy design but applies only to linear systems, while safe reinforcement learning handles nonlinear systems with safety constraints but requires knowledge of the system dynamics. This work resolves this tension by introducing Koopman eigenfunctions as a coordinate transformation that enables model-free safe Q-learning for nonlinear discrete-time systems. We show that the safe optimal value function, augmented with a control barrier function penalty, becomes quadratic in eigenfunction coordinates. This quadratic structure permits the definition of a Q-function whose kernel matrix absorbs both the system dynamics and the safety cost, yielding an optimal policy that depends on neither the drift dynamics nor the input matrix. The approach proceeds in two data-driven phases: first, principal eigenfunctions are learned from uncontrolled trajectory data via least-squares regression; second, a safe Q-learning policy iteration learns the optimal controller from input-state measurements under an exploration policy. We establish convergence of the policy iteration to the optimal safe gain, a bias-free property ensuring exploration noise does not corrupt the solution, and forward invariance of the safe set via the barrier function argument. Two numerical examples validate the method: a linear vehicle lane-keeping problem, where the algorithm recovers the standard result with added safety margins, and a nonlinear system with analytically known eigenfunctions, where the learned policy is genuinely nonlinear in the original state — a result unattainable by conventional Q-learning.

Data Mining Effects on Precipitation Classification With GHCN Dataset

Primary Author: Mohammad Mahruf Mahdi

Faculty Advisor: Amr Hilal, ENG - Computer Science

This paper examines how simple preprocessing choices affect next-day wet or dry precipitation classification using GHCN-D station data from the southeastern United States. We compare two quality control pipelines, one using official GHCN flags and one adding station- and season-specific outlier filtering, along with two missing-data strategies, deletion and interpolation. Using fixed predictors with logistic regression and random forest, we measure changes in station-day counts and classification performance across four datasets. We also test whether stations with weak precipitation-anomaly correlation to nearby stations are harder to classify and more sensitive to preprocessing changes. Results will highlight the importance of data preparation.

Manufacturing & Engineering Technology

Undergraduate

Smart Waste Management Optimizing

Primary Author: Abhi Patel

Faculty Advisor: Ayantha Umesh Senanayaka Mudiyanselage, Manufacturing and Engineering Technology

Household waste generation continues to grow, placing increasing pressure on landfills and the environment. To address this issue, this work proposes a novel trash bin design to reduce household waste and extend the usable life of trash bags. Traditional trash bags are often discarded prematurely when the contents reach the top of the bag, leaving unused space that contributes to unnecessary waste. The proposed design addresses this inefficiency by incorporating a shredding mechanism that breaks trash into smaller pieces, allowing the bag to be fully filled without overflowing. By maximizing the effective capacity of each bag, the design not only reduces the frequency of bag replacement but also decreases the volume of waste sent to landfills. While the concept is straightforward, its implementation involves intricate engineering to ensure safe and efficient operation, offering a practical and sustainable solution for household waste management.

“MoodStep” TPU Insoles for Varying Activities

Primary Author: Colby Davis

Faculty Advisor: Ismail Fidan, Manufacturing and Engineering Technology

Combining the process of Additive Manufacturing and the goals of the joy of living, the MoodStep insoles are the product of these two visions. MoodSteps are customizable, 3D-printed insoles made with the flexible and comfortable physical properties of TPU,

featuring a 95A shore hardness. Utilizing varying printing parameters, four diverse types of soles were made to appeal to a customer's "mood" or feel profile for specific activities. This style of fabrication enables manufacturers to create soles that match the foot geometry of any individual. The initial prototype was a men's 11.5 size sole that demonstrated strong durability, optimizing clear differences in overall feel. This success can further expand into other forms of footwear with TPU applications. This poster reports the current findings of this research study.

Design and Development of a Low-Cost Desktop CNC Milling Machine Using 3D-Printed Components

Primary Author: Jackson Yerbich

Co-Author(s): Camden Walker

Faculty Advisor: Ismail Fidan, Manufacturing and Engineering Technology

Computer Numerical Control (CNC) technology enables the automation of manufacturing processes such as milling, turning, and drilling with high precision and repeatability. However, conventional CNC machines are often costly, typically ranging from $5,000 to $10,000, and are primarily utilized in industrial environments, limiting accessibility for small businesses and individual users.
This research focuses on the design and development of a portable, desktop-scale CNC milling machine that is both cost-effective and user-friendly. The proposed system incorporates a significant number of 3D-printed components to reduce manufacturing costs while maintaining functional performance. By leveraging additive manufacturing techniques, the project aims to create an affordable alternative to traditional CNC systems.
The long-term goal is to promote the widespread adoption of CNC technology in residential and small business settings, similar to the accessibility achieved by desktop 3D printers. Increased availability of such systems can empower users to automate fabrication tasks, enhance productivity, and reduce operational time. This study contributes to the advancement of low-cost digital manufacturing solutions and explores the potential of expanding CNC applications beyond conventional industrial use.

Industrial Automotive Paint Improvement

Primary Author: Jason Roach

Faculty Advisor: Ismail Fidan, Manufacturing and Engineering Technology

Automotive manufacturers have faced increasing challenges in maintaining consistent paint quality and durability, leading to customer dissatisfaction as surface finishes degrade over time. Improving robotic painting efficiency while maintaining sufficient paint coverage remains an important objective in modern automotive manufacturing. This study investigates the impact of robotic path-planning strategies on painting cycle time and coverage efficiency. Using FANUC ROBOGUIDE, four different robotic painting trajectories were designed and evaluated to determine their influence on process performance. Each path plan was simulated under identical operating conditions, and the resulting cycle times were measured to identify the most efficient strategy. The experimental results indicate that the horizontal missing-point trajectory achieved the lowest cycle time of 27.08 seconds, outperforming the other evaluated path plans. This method effectively increases paint distribution by introducing a wider horizontal sweep while omitting intermediate path points, which mimics the effect of a larger nozzle spread without significantly increasing process time. The findings demonstrate that optimized robot trajectory planning can improve painting efficiency and coverage, highlighting the importance of path-planning strategies in robotic automotive finishing processes.

Design Angle Optimization: Investigating the Relationship Between Orientation and Product Efficiency for Environmental Sustainability

Primary Author: Kaylee Easter

Faculty Advisor: Vivekanand Naikwadi, Manufacturing and Engineering Technology

Household gutters often get clogged by leaves when it rains, causing issues such as water damage, structural stress, and reduced efficiency. This project evaluates two 3D-printed solutions and analyzing the hardness and roughness of each design. Examining the optimal angles, hardness, and surface roughness of the current designs help determine the most environmentally sustainable option, and work towards the most efficient solution.

Mechanical Engineering

Undergraduate

Assessment of Noise Radiation Near Residential Areas

Primary Author: Rohith Vadapalli

Faculty Advisor: Mohan Rao, ENG - Mechanical Engineering

The Cardinal Glass facility in Church Hill, Tennessee received multiple residential noise complaints from a nearby homeowner. The homeowner reported a persistent low-frequency noise, especially during nighttime hours, that caused a disturbance to his everyday life.
This noise disturbance is originating from a recently installed VSA oxygen generation machine that operates 24 hours every day. However, the disturbance is in compliance with the local noise regulations.
Noise control in residential environments is important due to its effects on comfort, sleep quality, and overall quality of life. Low-frequency noise is especially challenging because it can travel long distances and easily penetrate nearby structures, making it more noticeable indoors.
This investigation highlights the importance of proper noise assessment and control when industrial equipment operates near residential areas.

Learning New Parts Without Retraining: Few-Shot Learning for Manufacturing Vision

Primary Author: Stephen Bishop

Faculty Advisor: Stephen Canfield, Mechanical Engineering

Industrial vision systems often implement CNN-based approaches, such as transfer learning, for recognition tasks like classification and defect detection. These methods struggle when new parts are introduced due to their need for frequent retraining using extensive labeled datasets. This study compares a transfer learning baseline with Prototypical Networks that utilize Few-Shot Learning (FSL). Both approaches are evaluated on their ability to perform embedding-based K-Nearest Neighbor (KNN) classification on novel classes. Results of this study show that transfer learning does achieve higher accuracy, but FSL enables significantly faster training and generalization. The findings being presented highlight a trade-off between accuracy and adaptability in dynamic manufacturing settings.

Doctoral

Evaluating the Durability of Carbon Nanotube-Infused Polymers in Additive Manufacturing

Primary Author: Elijah Hudson

Faculty Advisor: Ismail Fidan, Manufacturing and Engineering Technology

Additive manufacturing (AM) has evolved into a viable production technology, driven in part by the development of engineering-grade polymeric materials that enable fabrication of functional, end-use components beyond prototyping applications. Among these emerging materials, carbon nanotube (CNT)-reinforced polymers have gained attention due to their potential to provide enhanced stiffness and electrostatic discharge (ESD) resistance. However, despite these promising attributes, the mechanical performance of CNT-infused polymers, particularly under cyclic loading conditions, remains insufficiently characterized. This study systematically investigates the fatigue behavior of CNT-reinforced polymer materials fabricated via material extrusion AM. Specimens are produced under varying process parameters to evaluate the influence of manufacturing conditions on mechanical performance. Cyclic loading tests are conducted across a range of stress amplitudes to assess fatigue life and failure mechanisms. The results aim to establish process–structure–property relationships and provide critical insights into the durability and reliability of CNT-based AM materials for industrial applications.

Advancing Robotic Predictive Maintenance via Multichannel Acoustic Feature Fusion and Convolution Neural Networks

Primary Author: Md Omar Al Javed

Faculty Advisor: Ayantha Umesh Senanayaka Mudiyanselage, Manufacturing and Engineering Technology

Predictive maintenance plays a critical role in modern robot-based manufacturing by reducing unexpected downtime and improving system reliability. Conventional predictive maintenance in manufacturing relies on intrusive, high-cost sensors, such as vibration and torque meters, which increase installation complexity. While acoustic signal-based monitoring offers a non-invasive, cost-effective alternative, current time-domain methods often

struggle with suboptimal event understanding and fail to capture the complex relationship between robot operating conditions and their environment. Therefore, this study introduces Multichannel Acoustic Feature Fusion (MCAFF) framework, which integrates multi-location sensors to generate multichannel, time-frequency feature-fused images for a robotic condition-identification that improves predictive maintenance strategies. Validation was performed using a FANUC M-1iA/0.5A robot equipped with strategically positioned condenser microphones. High-speed pick-and-place trajectory experiments were executed at 500, 1000, and 1500 mm/s under a constant payload. The resulting acoustic signals were transformed into two-dimensional representations using the Short-Time Fourier Transform (STFT) and integrated using the MCAFF framework. These fused representations served as inputs for a Convolutional Neural Network (CNN) classifier. The MCAF approach achieved a 12% performance improvement over single-microphone baselines. It outperformed standard data-level fusion configurations by 9%. These findings demonstrate that integrating spatially distributed acoustic sensor data through MCAFF significantly enhances the discriminative capability of learned representations. This research establishes acoustic feature fusion as a superior, scalable strategy for improving condition identification and system reliability in modern industrial robotic environments, offering a robust alternative to traditional, hardware-heavy monitoring systems.

Hybrid Manufacturing of Topology-Optimized Structures Using Additive Manufacturing and Casting

Primary Author: Mushfig Mahmudov

Co-Author(s): Omer Faruk Ozcan

Faculty Advisor: Ismail Fidan, ENG - Manufacturing and Engineering Technology

Topology-optimized structures are highly important for reducing unnecessary material in a component while preserving its mechanical strength. This approach enables the design of lightweight parts without significantly compromising structural performance. However, the complex and intricate geometries generated through topology optimization are often difficult or even impossible to manufacture using conventional manufacturing methods. To address this challenge, hybrid manufacturing offers a promising solution by combining additive manufacturing (AM) with casting processes. In this approach, polymer patterns of topology-optimized parts can be produced using AM and then used to create molds for investment casting, lost foam casting, or lost PLA casting. To evaluate the feasibility of these hybrid manufacturing routes, simulation-based casting analysis will be conducted to determine the compatibility of topology-optimized structures with casting processes. In addition, mechanical strength analysis will be performed to assess whether the optimized parts can maintain sufficient structural integrity while achieving weight reduction. This study aims to investigate the manufacturability and structural performance of topology-optimized parts produced through hybrid manufacturing methods.

Hybrid Manufacturing and Simulation-Based Design of Lattice Energy-Absorbing Structures for Investment Casting

Primary Author: Omer Faruk Ozcan

Co-Author(s): Mushfig Mahmudov

Faculty Advisor: Ismail Fidan, Manufacturing and Engineering Technology

Lightweight energy-absorbing structures play a critical role in automotive crash management systems. Lattice architectures have demonstrated significant potential for improving energy absorption while reducing structural mass; however, their manufacturability using conventional metal casting processes remains a major challenge. This study investigates the feasibility of producing lattice-based energy-absorbing structures through a hybrid manufacturing approach that integrates additive manufacturing and investment casting.
A representative automotive crash box geometry is redesigned using a Kelvin lattice topology to create a lightweight energy-absorbing structure. Additive manufacturing is employed to produce sacrificial patterns using SLA printing, enabling the fabrication of complex lattice geometries through investment casting of aluminum alloys. The manufacturability of the lattice structures is evaluated using casting simulations to analyze filling behavior and solidification characteristics.
Special attention is given to the influence of lattice geometry on casting feasibility. Parameters such as strut thickness are iteratively modified to mitigate premature solidification and improve metal flow within the lattice network. Following the manufacturability assessment, impact simulations are conducted to evaluate the energy absorption

performance of the optimized lattice crash box. The results provide insight into the relationship between lattice topology, casting feasibility, and structural performance. This work demonstrates a simulation-driven framework for designing lattice crash structures using a hybrid manufacturing strategy that combines additive manufacturing patterns with conventional investment casting processes.

Experimental Investigations of Melting Behavior of Functionalized Nanodiamond Enhanced Phase Change Materials (fND-PCM) for Electronic Thermal Management

Primary Author: Rajendra Tadakhe

Faculty Advisor: Ethan Languri, ENG - Mechanical Engineering

Phase change materials are widely used in passive cooling of electronic systems, such as solid-state devices and lithium-ion batteries, because of higher latent heat. However, they suffer from the lower thermal conductivity, which slows down the melting process and reduces overall performance. To overcome this challenge, many researchers have tried to improve the thermal conductivity by adding high thermal conductivity nanoparticles. While this approach helps, it also brings challenges such as sedimentation and agglomeration, where particles settle or form clusters, reducing their effectiveness. In this study, functionalized nanodiamond (fND) particles are used as an additive. Nanodiamond have very high thermal conductivity, and their surface is treated with oleic acid to improve stability. This helps the particles stay well dispersed in the PCM and prevents clustering. Experiments were carried out to study the melting behavior of fND-PCM at different concentrations 0.1wt%, 0.2wt%, 0.3wt%, and 0.4 wt%. A controlled setup with thermocouples was used to monitor temperature changes during the melting process. The results show that adding fND improves the melting performance of PCM. Higher concentrations lead to faster melting and more uniform temperature distribution compared to pure PCM. Even at low concentrations, noticeable improvement in heat transfer is observed. Overall, this study shows that fND-PCMs can be a promising solution for effective thermal management in electronic applications where fast heat dissipation is required.

Optimizing Industrial Compressed Air Systems for Energy Savings and Efficiency

Primary Author: Rajendra Tadakhe

Co-Author(s): Muhammad Zubair Farrukh, Nathan LeCates, Ethan Languri

Faculty Advisor: Ethan Languri, Mechanical Engineering

Compressed air systems are among the most widely used utilities in industrial facilities, playing a critical role in powering equipment, control systems, and precision operations across manufacturing processes. In many facilities, compressed air accounts for approximately 10–30% of total electricity consumption, making it one of the largest energy consumers in industry. Despite its importance, compressed air is also one of the least efficient energy carriers; typically, only about 10–20% of the electrical energy input is converted into useful compressed air, while the remaining 80–90% is lost as heat. This highlights the need for efficient operation and management of compressed air systems. This study presents an analysis of energy savings opportunities identified in an industrial compressed air system through a detailed energy assessment conducted by the Industrial Training and Assessment Center (ITAC). Key inefficiencies such as air leaks, inappropriate end uses, excessive system pressure, and suboptimal compressor operation were evaluated. Various energy conservation measures (ECMs) were investigated, including leak detection and repair, optimization of system pressure, installation of a master controller for multiple compressors, increased air storage capacity, and waste heat recovery for space heating. A comparative analysis of energy consumption before and after the implementation of these ECMs demonstrates a significant reduction in energy usage. The results highlight the potential for substantial energy and cost savings through systematic optimization of compressed air systems in manufacturing facilities.

Experimental Investigations of Melting Behavior of Functionalized Nanodiamond Enhanced Phase Change Materials (fND-PCM) for Electronic Thermal Management

Primary Author: Rajendra Tadakhe

Co-Author(s): Muhammad Zubair Farrukh

Faculty Advisor: Ethan Languri, Mechanical Engineering

Phase change materials are widely used in passive cooling of electronic systems, such as solid-state devices and lithium-ion batteries, because of higher latent heat. However, they suffer from the lower thermal conductivity, which slows down the melting process and reduces overall performance. To overcome this challenge, many researchers have tried to improve the thermal conductivity by adding high thermal conductivity nanoparticles. While this approach helps, it also brings challenges such as sedimentation and agglomeration, where particles settle or form clusters, reducing their effectiveness. In this study, functionalized nanodiamond (fND) particles are used as an additive. Nanodiamond have very high thermal conductivity, and their surface is treated with oleic acid to improve stability. This helps the particles stay well dispersed in the PCM and prevents clustering. Experiments were carried out to study the melting behavior of fND-PCM at different concentrations 0.1wt%, 0.2wt%, 0.3wt%, and 0.4 wt%. A controlled setup with thermocouples was used to monitor temperature changes during the melting process. The results show that adding fND improves the melting performance of PCM. Higher concentrations lead to faster melting and more uniform temperature distribution compared to pure PCM. Even at low concentrations, noticeable improvement in heat transfer is observed. Overall, this study shows that fND-PCMs can be a promising solution for effective thermal management in electronic applications where fast heat dissipation is required.

College of Emerging & Integrative Studies

Environmental Studies

Undergraduate

Organizing an Earth Day Community Event
Primary Author: Alexis Shawula

Co-Author(s): Henry Cropp, Sultan Basheer S Alenezi, Robert Melton

Faculty Advisor: Lisa Brown, Emerging and Integrative Student Success

This project focuses on the planning and organization of an Earth Day community event designed to raise awareness about environmental issues and encourage sustainable practices. The process began with identifying the purpose of the event, which was to educate the community while promoting involvement in protecting the environment. After establishing clear goals, the next step involved creating promotional materials such as flyers and social media posts to spread awareness and attract attendees.
A major part of the planning process included reaching out to local businesses and organizations for sponsorships and support. This required effective communication, persistence, and teamwork. While not all businesses were able to contribute, securing even one sponsor demonstrated the importance of community partnerships. Additionally, distributing flyers throughout the community helped increase visibility and engagement.
Logistical planning was also essential to ensure the event would run smoothly. This included considering the location, schedule, and activities that would both educate and engage participants. Collaboration among team members played a key role in dividing responsibilities and staying organized throughout the process.
Overall, planning this Earth Day event provided valuable experience in leadership, communication, and problem-solving. It highlighted the challenges of organizing a community event, as well as the importance of persistence and adaptability. Most importantly, the project emphasized how individual and group efforts can come together to make a positive impact on environmental awareness and community involvement.

eDNA and Field Surveys of Molluscs in Meadow Creek Park

Primary Author: Christopher Daniel

Faculty Advisor: Tammy Boles, School of Environmental Studies

Meadow Creek Park is a 300 acre park surrounding Meadow Creek. Originally, this land was a coal mining site until in 1980 when Monterey, TN acquired the land and water as a water source. There are some indicators that this water is experiencing acid mine drainage, which alters the pH of water systems heavily thus damaging ecosystems. Molluscs may be particularly affected, as they rely on calcium carbonate to form their shells, a compound that can be degraded under acidic conditions due to elevated hydrogen ion concentrations.
Aquatic Molluscs are notorious cryptic species, being hard to both identify and monitor. Though this is the case, molluscs provide many environmental services

and can act as environmental indicators of their respective ecosystem. Due to their evasive nature, traditional field surveys may not fully encapsulate species diversity, which in itself can act as a monitoring tool for conservation plans. To supplement these struggles of field surveys, Environmental DNA (eDNA) may be used to detect what DNA is within the waters of Meadow Creek. Using water samples to extract DNA, then undergoing PCR and sequencing, it is possible to identify DNA detected within samples, making monitoring cryptic species far more possible. By combining field surveys with eDNA analysis, this study aims to assess the presence and extent of acid mine drainage in Meadow Creek Park while also improving methodologies for monitoring cryptic mollusc species.

Aquatic Biodiversity Assessment of Buck and Meadow Creeks at Meadow Creek Park

Primary Author: Ellianna Masters

Faculty Advisor: Tammy Boles, School of Environmental Studies

Biodiversity assessments were conducted in Buck and Meadow Creeks within Meadow Creek Park to evaluate potential impacts from acid mine drainage and pesticide usage, specifically imidacloprid. The objective was to determine the presence of pollution-tolerant and pollution-intolerant species as indicators of stream health. Sampling was performed in mid-February across multiple habitat types, including riffles, runs, and pools. At Buck Creek Site 1, 10 runs were conducted, and the organisms identified included undescribed crayfish, stoneflies, mayflies, and a bluegill. We sampled in mid-February. On Buck Creek, we conducted 10 runs at Site 1, three runs at Site 2, and four runs at Site 3. At Site 1, we found undescribed crayfish, stoneflies, mayflies, and a bluegill. At this site, we sampled riffle, run, and pool habitats. At Site 2, we sampled pool habitats and found no species. At Site 3, we sampled riffle, run, and pool habitats and also found no species.

Imidacloprid Analysis of Meadow Creek Park

Primary Author: Emma Anderson

Co-Author(s): Kacey Elliott

Faculty Advisor: Tammy Boles, School of Environmental Studies

Imidacloprid, a widely used insecticide, poses several risks to the environment due to its adverse effects on non-target organisms and high water solubility. It is currently being used on a property close to Meadow Creek Park in Monterey, Tennessee. The eastern hemlock trees on the property are being treated due to the infestation of hemlock woolly adelgid threatening their population.
This study will determine whether Imidacloprid used on nearby properties is leaching into surrounding areas, based on water and soil analyses of Meadow Creek Park. The samples of both soil and water will be extracted through solid phase extraction and analyzed using liquid chromatography tandem mass spectrometry. Concentrations detected will be compared to environmental standards to assess the possible risk to the area. The results of this study will help to understand insecticide pathways as well as their environmental risks.

Salamander Population Distribution and Health in Meadow Creek Park

Primary Author: Hannah Quinter

Faculty Advisor: Tammy Boles, School of Environmental Studies

After the survey and sampling of many salamander species across the Meadow Creek Park area and waterways, I used this data to provide a scientific analysis of the health of the ecosystem including the water quality, and analyzing the abundance of the salamander species as well.

Evaluation of different rooting hormone application methods for butterfly bush propagation

Primary Author: Kacey Elliott

Co-Author(s): Cameron Douglass

Faculty Advisor: Tammy Boles, School of Environmental Studies

Fungicides and biofungicides may enhance rooting of stem cuttings due to reduced stress factors. This study investigated the effects of rooting hormone and fungicide/biofungicide on propagation of butterfly bush. Rooting hormone (IBA + NAA), biofungicides (Obtego and RootShield Plus), and fungicide (Pageant) were delivered to cuttings via quick dip, foliar spray, or substrate drench then placed under intermittent mist.

Root development was quantified using WinRHIZO image analysis software and root and shoots were dried for biomass measurement. Rooting hormone had a negative effect on rooting when applied as a spray or drench. Obtego had increased root and shoot dry weight compared to all products. For the dip method, root growth was greatest for Obtego but similar to Pageant and RootShield for spray and drench. Biofungicide and fungicide products enhanced rooting and growth of butterfly bush especially when applied as a drench or spray.

A Preliminary Survey of Lichen Flora in Meadow Creek Park, Tennessee

Primary Author: Kaitlyn Landrem

Co-Author(s): Caleb Simmons, Heath Teasdale

Faculty Advisor: Mark Green, School of Environmental Studies

Lichenology is an understudied and often misunderstood discipline despite the ecological importance and diversity of lichens. Lichens function as primary colonizers during early ecosystem succession, provide food sources for wildlife, and serve as indicators of air and water quality. In Tennessee, few floristic studies have documented lichen diversity across the state. This study aims to expand upon existing work by documenting lichen species within the Meadow Creek Park area.
This study employs an opportunistic sampling approach to collect and identify lichen species along hiking trails in Meadow Creek Park. For each specimen, key characteristics—including growth form, substrate, habitat, associated species, and GPS location—are recorded to support identification. These observations are (1) submitted to iNaturalist as part of the Biodiversity of Meadow Creek Park project and (2) cataloged within ArcGIS Pro to generate an informational map of lichen diversity within the park. Through this study, it is hoped that an increased interest in the ecological importance of lichens will arise, while also helping to fill gaps in the incomplete understanding of lichen diversity within the Meadow Creek Park area.

Hidden Exposure: Imidacloprid Movement into Non-Target Flowering Plants

Primary Author: Ragan Liner

Faculty Advisor: Tammy Boles, CEI - School of Environmental Studies

Imidacloprid is a systemic neonicotinoid insecticide widely used in agriculture, landscaping, and seed treatments to control insect pests by disrupting their nervous systems. Despite its effectiveness, increasing evidence highlights its unintended environmental impacts. Due to its chemical persistence and water solubility, imidacloprid can move through soil and leach beyond treated areas, allowing uptake by nearby non-target plants, including wildflowers. Once absorbed, it is distributed throughout plant tissues and can accumulate in nectar and pollen.
This creates a significant exposure pathway for non-target pollinators such as bees and butterflies. Even at low concentrations, imidacloprid can impair basic functions like foraging behavior, while higher levels may cause mortality. Because pollinators rely on nectar and pollen for food, repeated exposure increases the risk of chronic effects at both individual and population levels.
In this study, imidacloprid translocation is investigated in flowering plants located near treated hemlock trees in Monterey, Tennessee. Plant samples are collected and analyzed using liquid chromatography coupled with mass spectrometry to quantify trace concentrations of imidacloprid. By assessing residue levels in nearby vegetation, this research aims to evaluate the potential exposure risks to pollinators, providing insight into localized environmental impacts of imidacloprid use.

Assessing the Impacts of Acid Mine Drainage on Stream Water Quality and Macroinvertebrate Diversity in Meadow Creek

Primary Author: Tamber Inman

Co-Author(s): Lillie Pearce, Rachael Means

Faculty Advisor: Lisa Brown, Emerging and Integrative Student Success

This study evaluates the impact of acid mine drainage (AMD) on stream ecosystem health by analyzing water quality parameters alongside aquatic macroinvertebrate community composition. The designated waterways analyzed in this study are Meadow Creek, which is impacted by acid mine drainage, and Blackburn Fork, which is not impacted. Macroinvertebrates are widely used as biological indicators because their presence, abundance, and diversity reflect long-term water quality conditions.

Pollution-sensitive taxa tend to decline in degraded systems, while tolerant organisms often thrive in impaired streams.
Surface water sampling was conducted in the field at selected stream sites. Samples were collected and analyzed for several key water quality parameters, including dissolved oxygen, specific conductance, turbidity, nitrate and nitrite concentrations, total phosphorus, pH, and temperature. These parameters provide insight into chemical conditions associated with AMD, such as increased ionic concentrations, altered acidity, and nutrient levels.
Macroinvertebrate sampling was conducted to assess biodiversity of the streams. Specimens were classified by order and family.
By comparing biological community structure with measured water quality conditions, this study aims to assess the ecological effects of acid mine drainage and identify patterns. The results will help determine whether shifts in macroinvertebrate diversity correspond with changes in water chemistry associated with AMD-impacted systems.

Master's

Natural History Observations for an Undescribed Species of Faxonius in the Barrens Region of Tennessee

Primary Author: Ellianna Masters

Faculty Advisor: Hayden Mattingly, School of Environmental Studies

Crayfishes are important components of freshwater ecosystems. On a global scale, crayfish biodiversity is especially high in the Southeastern United States, including Tennessee. The undescribed "Sculpin Crayfish" is a member of the genus Faxonius known only from Cannon and Coffee counties in the Barrens Plateau region of Tennessee. The objectives of this study were to collect preliminary life history information and estimate the abundance of sculpin crayfish populations in two headwater streams. Quadrat sampling and mark-recapture surveys in McMahan Creek and Liberty Creek were conducted to measure population density, size structure, and reproductive traits. Sculpin crayfish were more abundant in McMahan Creek than in Liberty Creek. Pool habitats had the highest densities of Sculpin Crayfish. Individual Sculpin Crayfish ranged from 10–28mm carapace length (CL). There was a male-to-female sex ratio of approximately 2:1. Sexual maturity was observed at 12-13 mm CL and reproduction occurred within the first year of life. Mean clutch size was around 17 eggs in smaller females and 30 eggs in larger females. Age classes were difficult to distinguish from length-frequency histograms. These preliminary findings provide the first quantitative population and life history data for Faxonius sp. Additional research is needed for a more comprehensive understanding of its distributional range, abundance, and conservation status.

A Survey Report and Economic Impact Analysis of Locally Produced Agricultural Products in the Upper Cumberland Region of Tennessee

Primary Author: Nickolas Fuller

Faculty Advisor: Lianqun Sun, School of Agriculture

This project has conducted surveys of local retailers, both in direct-to-consumer farmer's market settings and small local retail stores in the rural, agricultural Upper Cumberland region of central Tennessee. These surveys were utilized in a robust economic analysis of local food systems in the Upper Cumberland region. The top selling products at farmer's markets are vegetables, fruits, and baked goods. Eighty-nine percent of participants reported selling direct-to-consumer at farmers' markets only once or twice a week. Seventy-seven percent of farmers reported earning less than $500 per market day. Vegetables and fruits surpassed all other categories of foods being sold at stores. Of the stores that sell local foods, most stores sold more than 50% of their products originating from local sources. From the surveys collected from farmers selling at farmers markets, an IMPLAN input-output economic analysis estimated a total economic output of farmers markets between $2,996,878.15 and $7,977,337.19 for the Upper Cumberland Region of Tennessee. Results will provide insight into the economic contribution of local food systems, identify key marketing and production challenges faced by farmers and retailers, and highlight opportunities to strengthen linkages between producers, retailers, and consumers.

Doctoral

Adsorptive Interactions of 1,4-Dioxane with Microplastics: Implications for Vector Transport in Aquatic Environments

Primary Author: Dushmantha Koku Hannadige Abeysooriya

Co-Author(s): Lilla Tidwell, Oluwasola Ifedayo

Faculty Advisor: Tammy Boles, School of Environmental Studies

1,4-Dioxane is a synthetic and highly persistent organic contaminant classified by the U.S. Environmental Protection Agency as a probable human carcinogen. It has been frequently detected in groundwater and surface waters across the United States, raising growing environmental and public health concerns. At the same time, microplastics are recognized as ubiquitous contaminants in aquatic environments and as potential vectors for the transport of co-occurring organic pollutants. Despite the co-occurrence of 1,4-dioxane and microplastics in aquatic environments, their sorptive interactions have not yet been investigated.
This study addresses this knowledge gap by examining the adsorption behavior of 1,4-dioxane onto two common microplastics, polyethylene terephthalate (PET) and polystyrene (PS).
Surface morphology and particle size were characterized using scanning electron microscopy (SEM). Adsorption and desorption were quantified by gas chromatography–mass spectrometry (GC–MS), and kinetic and isotherm models were applied to elucidate the governing sorption mechanisms. Sorption performance was further evaluated under varying environmental conditions and microplastic aging.
SEM images indicated that PET exhibited rough, fibrous surfaces, whereas PS displayed smoother, rounded morphologies with grooves.Isotherm analysis indicated that the Langmuir model provided the best fit for both PET (R^2 = 0.9998) and PS (R^2 = 0.9978) microplastics, while adsorption kinetics were best described by the pseudo-second-order model.
These results provide the first experimental evidence of 1,4-dioxane adsorption onto microplastics under environmentally relevant aquatic conditions. The findings advance current understanding of microplastic-mediated contaminant transport and provide important insights for ecological risk assessment, human exposure evaluation, and mitigation strategies for emerging aquatic contaminants.

Long-Term Patterns of Mercury (Hg) Bioaccumulation in Tennessee: County-Level Trends and Species-Specific Dynamics from the Tennessee Department of Environment and Conservation Fish Mercury Database

Primary Author: Michael Tetteh

Co-Author(s): Justin Murdock, Hong Zhang

Faculty Advisor: Hong Zhang, Chemistry

Mercury (Hg) contamination remains a persistent environmental and public health concern due to its toxicity, bioaccumulation, and long-range atmospheric transport. This study integrates county-level and species-specific analyses to evaluate long-term patterns of mercury concentrations in freshwater fishes across Tennessee using archived monitoring records from the Tennessee Department of Environment and Conservation (TDEC) fish Hg database. We compiled and analyzed four decades (1985-2025) of the publicly available fish mercury monitoring data to assess long-term trends, inter-county variability, shifts in contamination intensity over time, emerging areas of concern and counties demonstrating significant Hg declines.
In parallel, species-level differences were evaluated across taxa, trophic guilds, and feeding strategies to quantify bioaccumulation patterns and biomagnification. Predatory species were compared with omnivores and forage fishes to assess relative mercury burdens and long-term stability of contamination profiles. Statistical approaches, including trellis plots, histograms, and box plots, were used to characterize both geographic and ecological variability without reliance on geospatial mapping.
By linking four decades of monitoring data with species-specific bioaccumulation patterns, this study reveals where mercury risk is greatest – and which fish are most likely to carry it into the human food chain. These findings provide a science-based foundation for targeted environmental monitoring, fishery management strategies and species-specific consumption guidelines.

Enhanced Mercury (Hg) Remediation of Freshwater Systems via Recombinant Peptide Fusion Technology

Primary Author: Michael Tetteh

Co-Author(s): Xuanzhi Zhan, Hong Zhang

Faculty Advisor: Hong Zhang, Chemistry

Traditional heavy metal remediation often relies on energy-intensive physical processes or non-selective chemical precipitation. To address these limitations, this research explores a novel biotechnological solution: Recombinant Peptide Fusion (RPF) technology. By genetically engineering microbial hosts to express high-affinity, mercury-binding peptides – such as those derived from metallothioneins or de novo synthetic motifs – we intend to develop a highly

selective biosorbent system. These peptides are fused to anchor proteins, allowing for stable expression and increased surface area for mercury sequestration with high binding affinity even in the presence of competing divalent cations. This "designer" approach not only can improve the efficiency of mercury removal from aqueous solutions but also offer a cost-effective and environmentally friendly alternative to conventional remediation. This study is focused on a theoretic framework of the design of the Hg-remediation peptides. Our research demonstrates the potential of synthetic biology to solve persistent environmental challenges through the precision engineering of molecular interfaces.

Whitson-Hester School of Nursing

Nursing

Undergraduate

What are the ethical challenges nurses face related to caring for patients on prolonged mechanical ventilation?

Primary Author: Abigail Webb

Co-Author(s): Abigail Morton, Taylor White, Ryleigh Cook, Blair Ford

Faculty Advisor: Lynette Harvey, NUR - School of Nursing

Prolonged mechanical ventilation presents significant ethical challenges on nursing staff caring for critically ill patients. Some of these ethical challenges include: conflicts with family members versus the patient and their wishes for critical or end of life care. Additionally, we hope to explore the impact that mechanical ventilation has on patient quality of life and care, ethical concerns with invasive procedures on someone whose prognosis is poor, moral distress experienced by nurses while giving care to those on prolonged ventilation and the ethical concerns of end-of-life decision making including withdrawal of life sustaining treatment. This focused review will examine publications from 2016-2026. We plan to exclude articles that are not peer reviewed, not in English, not within the last 10 years, articles that do not answer our inquiry, and studies that do not specifically include patients on prolonged mechanical ventilation. For our focused literature review, the search terms are ethical decision making, critical care, nursing ethics, intensive care unit, prolonged mechanical ventilation, ventilator weaning, extubation, futility of care, quality of life, patient autonomy, and surrogate decision making. Through this literature review, our goal is to identify ethical dilemmas that nurses face when caring for patients on mechanical ventilation, identify recurrent themes, and determine whether research addresses the ethical concerns of nurses. Our hope is to gain a better understanding of the evidence-based approaches that support nurses when dealing with these ethical dilemmas.

The Effects of Pre-Existing Diabetes on Maternal and Fetal Health

Primary Author: Allie Qualls

Co-Author(s): Victoria Carter, Addison Griffith, Jayden Jenkins, Gracy Wood

Faculty Advisor: Lynette Harvey, School of Nursing

Gestational diabetes and its effects to not only the fetus, but also the mother have been thoroughly reviewed and researched. However, there is a lack of research regarding pre-gestational diabetes, especially in the southeast region of the United States. In this focused review, we aim to find out how pre-gestational diabetes affects this population and if it differs from other research and other populations. This focused literature review will use CINAHL, MedLine, and Google Scholar databases. Key search terms include pregestational DM, effects on pregnancy, and diabetes mellitus. Our review includes information from the last five years covering 2021-2026. We have chosen to exclude women with complications with DM—retinopathy, neuropathy, etc—other comorbidities or chronic illnesses, and any women who have participated in dangerous activities during their pregnancy such as smoking or consuming alcohol. Exclusion criteria were chosen because we wanted any complications to be soley explained by pregestational DM, not other co-morbidities or contributing factors. From this focused literature review, we hope to educate ourselves and others on the negative effects of pre-gestational diabetes on women trying to conceive, carry, and deliver a baby while having a previous diabetes mellitus diagnosis. We also strive to identify the potential impacts that the mother's pre-gestational diabetes may have on the infant's

overall health such as birth weight, complications, and chronic illnesses.

The influence of social media on parental vaccine hesitancy in pediatric immunizations

Primary Author: Eva Jacobs

Co-Author(s): Essinam Adekplor, Kalyn Killian, Halle McNaught, Kennedy Westmoreland

Faculty Advisor: Lynette Harvey, School of Nursing

Social media has become a primary source of health information for many parents; however, vaccine misinformation circulating online contributes to increased hesitancy and declining immunization rates among children. Increased hesitancy places the pediatric populations at a higher risk of outbreaks of vaccine preventable diseases. The purpose of this study is to explore the relationship between social media exposure and parental hesitancy and examine its impact on pediatric vaccine compliance.
This study will use Google Scholar, Cumulative Index to Nursing and Allied Health Literature (CINAHL), the National Center for Biotechnology Information (NBCI), PubMed, and Medline. Literature included in this review will be peer reviewed and published between 2021-2026. The search terms selected are vaccine hesitancy, social media misinformation, parents, pediatrics, vaccination rates, and health education. Articles selected for review focus on children ages 0-18 years. The exclusion criteria for this review includes literature that is not peer reviewed, articles with data collected before 2021, studies that do not focus on pediatric vaccines, studies that are not published in English, studies that do not mention social media as a factor in declining vaccination rates, and studies that focus on populations other than children and parents. The aim of this focused review is to investigate the correlation between rising vaccine hesitancy and the spread of misinformation through social media. Our goal is to examine how exposure to social media misinformation influences parental vaccine hesitancy and pediatric immunization rates and to identify nursing strategies to improve the patient education approach to vaccinations despite controversy.

Screen Time Effects on Childhood Development

Primary Author: Jewel Krantz

Co-Author(s): Norah Hill, Kaitlyn Gee, Taylor Roberts, Gwendalyn Franklin, Audrey Downing

Faculty Advisor: Lynette Harvey, School of Nursing

Exposure to so many different forms of screen time is increasing at younger ages than ever before, causing concerns about its impact on children's cognitive and social development. This, in turn, can delay language development, reduce parent-child interaction, reduce attention spans, and cause difficulty regulating emotion. Children who spend excessive time on screens may also show increased irritability and decreased ability to engage in imaginative or social play. Understanding how screen time influences the development of young children is important for guiding parents and healthcare providers in promoting healthy growth and developmental outcomes of children. A literature search will be conducted using Google Scholar, CINAHL, and ProQuest Health & Medical Collection databases. Search terms to be used are: pediatric screen time, early childhood media exposure, language delay and screen use, behavior problems and screen exposure, and preschool cognitive development. Our search is for peer-reviewed articles published in the last decade in order to stay relevant, which focus on pediatric populations aged 12 years and younger. Articles are excluded if they are outdated, focused on another population other than pediatrics, or do not evaluate language or behavioral outcomes and connections. The purpose of examining this topic is to find and use the patterns and connections between screen time and the development of children to better our quality of care and education as nurses, especially in pediatrics. This focused literature review aims to find a correlation between higher screen time in pediatrics and adverse outcomes, including cognitive, behavioral, and developmental delays.

Alternative Pain Management During Labor

Primary Author: Kadie Hire

Co-Author(s): Isabella Jolly, Carley Grissom, Taylan Hobbs, Kailee Whitlock

Faculty Advisor: Lynette Harvey, School of Nursing

Labor is a life altering experience for women and their families. Labor can be very painful, and uncontrolled pain can prolong labor progression which can negatively affect the mom and baby. Therefore, pain management is very important, with many different

options. Some pharmacological options that include opioids that can adversely affect the newborn, thus leading to the possibility of respiratory depression or decreased alertness at birth. Due to these risks, we would like to explore alternative types of pain management during labor. Some of which include breathing techniques, acupuncture, massage, hydrotherapy and any modality that will provide the women support and safety for her and the newborn. The aim of our focused review is to evaluate non-pharmacological pain management strategies used in labor and delivery settings. This literature review strives to display the impact these alternative strategies mays have on mothers and babies in terms of labor progression, maternal comfort, and overall birthing outcomes. The search engines used within this study were Google Scholar, CINAHL, and Eagle Online. Our search criteria consisted of laboring women, non-pharmacological pain management, and opioid pain management – all within the labor and delivery setting. This review covers studies completed between 2016-2026. This review excluded studies that did not focus on pregnant women and pain alternatives. Non-peer reviewed articles, including opinion-based articles, were excluded. Articles created before 2016 and after 2026 were also excluded.

Alarm Fatigue Migration through Nurse Empowerment: a pre- and post-intervention study in intensive care units

Primary Author: Kaitlyn Mann

Co-Author(s): Kenlee Duncan, Ashlynn Phillips, Jennifer Hansard, Christopher Dickens

Faculty Advisor: Lynette Harvey, School of Nursing

Alarm fatigue in the ICU is a significant patient safety concern that can result in missed alarms, delayed responses, and increased staff burnout. Excessive and non-actionable alarms contribute to desensitization among healthcare providers, potentially placing critically ill patients at risk. Recent research suggests that empowering nurses to independently adjust bedside monitor alarm thresholds may help reduce alarm fatigue and improve overall alarm management. This focused literature review will use the databases CINAHL, PubMed, and Google Scholar. Peer-reviewed studies published between 2015 and 2025 are included based on their relevance to ICU settings and alarm management practices. Articles are excluded if they were not peer-reviewed or did not specifically address ICU alarm management. Key search terms include alarm fatigue, intensive care unit, nurse empowerment, alarm management, and patient safety. The purpose of this review is to evaluate whether delegating alarm threshold-setting authority from physicians to nurses increases nurse confidence and enhances patient safety outcomes. This review aims to explore how nurse empowerment may improve attentiveness to alarms, strengthen clinical judgement, and ultimately contribute to improve patient outcomes in the ICU setting.

What is the correlation between nursing burnout and quality of patient care in the ICU/CCU?

Primary Author: Maya Greene

Co-Author(s): Kathryn Wilkins, Samuel Morgan, Alexis Johnson, Jillian Taylor

Faculty Advisor: Lynette Harvey, School of Nursing

Nursing burnout is a prevalent issue in our nation. Any over-worked professional is doomed to produce lower quality work. This has life and death sized stakes in the context of critical care nurses. Understanding the relationship of nursing burnout in the ICU and its effects on patient care outcomes will allow preventative measures to be placed. The purpose of this study is to evaluate the correlation between nursing burnout and quality of patient care in the ICU/CCU. The search engines that will be utilized in this focused literature review include Eagle Search through the Tennessee Tech University Library and Google Scholar. The key terms used are infection rates, death rates, patient care errors, causes of burnout, ICU burnout and critical care nurses. The literature utilized will be published between 2016-2026. Articles that will be excluded from this study are those of which are not peer-reviewed, not written/conducted in the United States, not written in English, from any hospital unit that is not ICU or CCU, and from before 2016. The aim of this study is to examine the effects of nurses working with burnout on patients who are critically ill, assess what may be done to prevent these negative outcomes from occurring, and determine where resources and efforts may be best applied for the betterment of patient care and nurse well-being.

Psychological Effects of Pediatric Oncology Nursing

Primary Author: Mckayla Human

Co-Author(s): Sarah Sotelo, Alexander Gordon, Arissa Ripley, Sarah Bell

Faculty Advisor: Lynette Harvey, School of Nursing

Pediatric oncology nurses work in daily exposure to high levels of stress and emotions, due to the occupation being associated with encounters of children suffering, poor prognosis, and end-of-life care. The demands of this occupation, unlike others, place pediatric oncology nurses at a higher risk for psychological effects like moral distress, burnout, compassion fatigue, post-traumatic stress symptoms, and emotional exhaustion. Understanding the psychological effects that come with this occupation is important to promoting nurses' well-being, retention, and highest quality of patient care. This literature review utilizes CINAHL, Google Scholar, and nursing and allied health databases. The search terms used were pediatric oncology nursing, psychological effects, and nurse burnout. The articles used in this review are all peer-reviewed literature published from 2016 to 2026, to ensure the information used correlates with current clinical practice. Exclusions to this literature review include studies not specific to pediatric oncology nurses, articles written in different languages, non-peer-reviewed articles, and studies that focused on adult oncology rather than pediatric. This review aims to understand the psychological effects associated with the emotionally heavy demands of pediatric oncology nursing. By demonstrating the impact of the psychological stressors that pediatric oncology nurses experience, we hope that this awareness will highlight the importance of supportive care and organized support systems to improve nurses' well-being and patient outcomes in this profession.

Impact of Emerging Healthcare Technologies on Contemporary Nursing Practice and Patient Care

Primary Author: Micha Pierce

Co-Author(s): Elijah Tillett, Tyler Myers, Willie Clark, Raven Carpenter, Michael Dillon

Faculty Advisor: Lynette Harvey, School of Nursing

Nursing practice has continually evolved as technological advancements have modernized the field. This evolution has been particularly evident in intensive care settings, where technologies such as telehealth have significantly transformed the nurse-patient relationship by enabling remote patient monitoring, clinical decision making and evaluation of patients, and interdisciplinary collaborations. Technology integrated care has become integral to many intensive care units (ICUs), supporting advanced management of high acuity patients with complex clinical needs. It is essential that the impact of these technologies and subsequent innovations on nursing practice in the ICU is thoroughly understood. This study will utilize Google Scholar, Cumulative Index to Nursing and Allied Health Literature, and PubMed/MEDLINE: National Library of Medicine. The search terms to be used are: tele-ICU, tele-critical care medicine, tele-ICU technology, ICU technology, tele-ICU nurses, tele-ICU nursing interventions, and tele-ICU caring practices. This focused literature review will search for peer-reviewed literature between 2016-2026. Exclusion criteria for this search include: studies that did not include technology in the ICU or tele-ICU components, studies that did not include tele-medicine in nursing interventions or clinical responsibilities, studies that did not include tele-medicine in patient care, articles written before 2016, articles that have not been peer-reviewed, and studies that did not include critical care settings. The goal of this focused review is to evaluate the impact of developing technology within ICUs and have influenced nursing practices, quality of care, and patient outcomes.

Does Parental Divorce as an ACE, Lead to a Higher Prevalence of Postpartum Depression?

Primary Author: Savannah Winfree

Co-Author(s): Isabella Lintz, Mary Martin, Ison Boles, Kelby Harmon

Faculty Advisor: Lynette Harvey, School of Nursing

Postpartum depression is a condition experienced by nearly 20% of all women after pregnancy. Some common symptoms of Postpartum Depression are overwhelming sadness, anxiety, emotional detachment from the baby, and extreme mood swings. Out of the women who experience postpartum depression, 60% of these women had an Adverse Childhood Experience (ACE). An ACE is potentially traumatic incidents, such as abuse, neglect, and dysfunctional households, that take place before the age of 18. Specific examples of an ACE are parental divorce, emotional abuse, physical abuse, or sexual abuse, financial insecurity, the use of drugs by a family member, suicide attempt be a loved one, or neglect by a guardian. The purpose of this review is to

explore if parental divorce as an ACE leads to a higher prevalence of postpartum depression. This study will use CINAHL, Eagle Search, and Journal of Obstetrics, Gynecologic, and Neonatal Nursing (JOGNN) search engines. The search terms being used are Post Partum Depression, ACEs, and parental divorce. This literature review will search for peer reviewed literature between 2015-2025. Exclusions for the search criteria are studies that do not use parental divorce as an ACE, studies that do not focus on PPD related to ACEs, and articles written before 2015. The purpose of this focused review is to see if parental divorce is linked to a higher prevalence of postpartum depression when compared to other ACEs.

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