2022 - 2023
AP RESEARCH
FINAL SHOWCASE

Featuring student research posters from varying perspectives

HOMESTEAD HIGH SCHOOL
Homestead Cafeteria

Wednesday, February 15
6 - 7 p.m.

AP Research Course Description: AP Research, the second course in the AP Capstone experience, allows students to deeply explore an academic topic, problem, issue, or idea of individual interest. Students design, plan, and implement a yearlong investigation to address a research question. Through this inquiry, they further the skills they acquired in the AP Seminar course by learning research methodology, employing ethical research practices, and assessing, analyzing, and synthesizing information. Students reflect on their skill development, document their processes, and curate the artifacts of their scholarly work through a process and reflection portfolio. The course culminates in an academic paper of 4,000 – 5,000 words and a presentation with an oral defense.

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Wednesday, February 15
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<u>**6- 6:25 presentations**</u>

Mira Boegel: Comparing the Energy Expenditure of Green Tea Catechins to the Energy Expenditure of Energy Drinks for Teenage Athletes (15-18)

The increased consumption of energy drinks has resulted in a rise in medical cases for teenagers. These cases have reported dehydration, liver damage, dependence on caffeine, a large amount of caffeine consumption, and adverse effects on cardiovascular health (Maya, 2017). Natural green tea catechins have been proven to be a good source of energy, a boost that can support the immune system, and a factor that can improve a person's metabolism. These health benefits are more instrumental in the long run, compared to the temporary yield of commonly consumed energy drinks with at least 100 mg of caffeine. To determine the effect that green tea catechins have on energy, researchers have been focusing on the energy expenditure of teenage athletes (15-18) after they consume a supplement with catechins and polyphenols from natural green tea. Ultimately, there was no sign of significance in regards to physical performance; however, athletes who consumed the catechins reported a more positive mental and physical recovery.

Megan Carr: Statistical Water Usage Comparison of a Brown Alginate Polymer Bio-textile Versus Cotton in Textile Production
With the speed of trend cycles in fashion being influenced by the influx of social media, fast fashion has been created. Fast fashion refers to the fast speed at which clothing is produced. This production is a result of consumerism, and it will only continue to grow. The demand this speed has ultimately brought upon this industry required a fast-growing, cheap, and abundant resource: cotton. Cotton is the leading textile, and has been used for years as the best choice compared to synthetic fabrics, such as nylon, because it has been proven to be more sustainable; however, cotton still consumes the most amount of water out of any textile. Few researchers across the globe have experimented with this, yet there is little information on how it compares to the current practices in the fashion industry and if it will be feasible. They have derived alginate from brown algae and created a thin string-like material as a result. As a result, I have analyzed, combined, and replicated the methodologies of three researchers on how to create this material. This means that it used 1.4 liters for 1 pound. Cotton, on the other hand, uses 8.1 liters for 1 lb. On a much larger scale, in order to create 8 million tonnes, or 16 trillion pounds of cotton material, 129,600,000,000,000 liters of water is needed. In comparison, for 16 trillion pounds of the alginate bio-textile, 22,400,000,000,000 liters of water is utilized. There is a significant difference between the amount of water used in the textiles, and the one created using alginate. The experimental one is much less sustainable in terms of water.

Chris Djurasovic: Hypertrophic Cardiomyopathy Electrocardiogram Readings in Athletes

This research project explores the reliability of electrocardiogram testing in identifying hypertrophic cardiomyopathy within athletes under the age of 35 through an analysis of cardiology and electrophysiology fellows examinations of the test results accuracy. Through this exploration, it is possible to determine whether or not the test's false positive rates are low enough to implement ecgs as a standard test practice within American athletes. The tests studied include normal ecgs, as well as cases of hypertrophic cardiomyopathy that have been confirmed through MRI testing. The interpreters will not know which previously confirmed cases are positive and will be asked to use the ecgs to identify which cases they believe have HCM. This data will be used in a quantitative analysis to determine whether or not the false positive and negative rates fall within an acceptable range. The results showed a 90% success rate in the correct identification of HCM within the set of ecgs, a rate that shows to be just outside of the goal of a 9% error. This shows that further testing should be done in order to confirm this rate and determine whether it is worth the cost of applying it as a standard practice.

Jocelyn Liao: A Green Roof Module with Integrated Plant Microbial Fuel Cell (P-MFC) for Stormwater Mitigation
Climate change brings frequent and intense storms, which challenge aging stormwater infrastructures. Green roofs are considered "green infrastructures," which are being increasingly used in urban areas as a sustainable stormwater solution. A plant microbial fuel cell (P-MFC) is a novel technology that uses bacteria living around the root of plants to generate electricity. This study explores the integration of P-MFC with a Sedum plant based green roof module for the dual benefit of stormwater runoff reduction and renewable energy generation. A water storage layer and capillary irrigation are proposed to improve MFC efficiency. The capillary wick can also function as a salt bridge to further enhance power generation. Three prototypes were fabricated to test the hypotheses. Preliminary experiments demonstrated that capillary irrigation and the salt bridge configuration increase P-MFC's power density and decrease the internal resistance significantly. The research demonstrated that green roof modules with integrated P-MFCs can be a renewable energy generator, promoting adoption of green roofs as sustainable solutions for climate resilience by reducing storm flood, capturing CO2 in the atmosphere, and producing green electricity simultaneously.

Payton Rater: Physician Burnout and Shift Schedules

There is a major issue with burnout among physicians, as physician burnout is occurring rapidly in all specialties. In a study comparing physicians to the general population it found emergency medicine had one of the highest rates of burnout (Shanafelt TD, Boone S, Tan L, et al, 2012). There has been a lot of research measuring physician burnout in all different capacities such as through different specialties and different factors affecting physicians, but the problem is there is no fighting solution to physician burnout. There is only information out there measuring physician burnout in a variety of ways. Analyzing the shift schedules will allow for a conclusion to be drawn and a new way to look at physician burnout. In this study, a qualitative online survey was sent out to emergency medicine physicians at the Auroras in the greater Milwaukee area in order to evaluate their level of burnout which is analyzed in the dimensions of emotional exhaustion, depersonalization, and personal accomplishment. The survey aims to identify if there is a correlation between physician burnout and shift schedules, and thus being able to identify a problem that is able to have an active solution to physician burnout. By using the data collected that found the percentile scores for the three MBI-HSS (MP) scales compared to a general population of 11,000+ people across diverse occupations, it was concluded the average percentile was greater in the full time night shift physicians than in the full time day shift physicians. Despite the limitations of a small sample size and the selection bias of people who had more personal experiences with their shift schedules, the research indicates night shift physicians are more likely to be burnt out. With these results hopefully when physician burnout is being assessed in the future it encourages directors to look at the scheduling of their physicians to have a good balance between the two shifts.

Sonia Zacharias: Computer Aided Drug Design of HIV Latency Reversing Agents

Antiretroviral Therapy (ART) has allowed HIV infected patients to manage symptoms enough to live relatively healthy lives, yet a definitive cure eradicating all parts of HIV remains undiscovered. Current therapy is only able to decrease the viral load but does not eradicate the latent reservoir of infected CD4 T cells that contain HIV-1 DNA in its genome. One approach to completely eradicate HIV is the "shock and kill" approach by latency reversing agents (LRAs) like class I Histone Deacetylase (HDAC) inhibitors. The problem with currently available HDAC inhibitors is that they are not isoform selective which reduces the potency and effectiveness, in addition to raising toxicity concerns. In this study, the computational software Schrodinger is utilized to design allosteric selective HDAC3 inhibitors. Molecular Docking was utilized to obtain predicted binding poses and binding affinity of small molecules to the HDAC3. As well as structural optimization was conducted using ligand designer to aid in design efforts. In comparison to the natural substrate Inositol Phosphate ligand, the results demonstrated that we were able to design HDAC3 inhibitors with an improved binding affinity of -7.857 kcal/mol to the co-repressor site of HDAC3. The newly designed molecules exhibit drug-like properties, logP of -1.6, MW 344.3, HBA 8, all abiding by Lipinski Rules. With the assistance of computational tools we were able to design potentially improved analogs of our hit molecule that can be synthesized and experimentally validated.

Alexa Bremmer- The Role of Probiotics in the Management of Crohn's Disease
As the prevalence of Crohn's disease increases worldwide, considerable attention is dedicated to developing more effective therapeutics to prevent and ultimately cure Crohn's Disease. Considering the microbiome's influence on the pathogenesis of the disease, probiotics have emerged as a possible therapeutic with more efficacy than established treatments. According to the American Gastroenterological Association's (AGA) clinical practice guidelines on the role of probiotics in the management of Crohn's disease no recommendation can be provided due to a current knowledge gap. In order to provide insight into this gap, a quantitative survey was distributed to gastroenterologists in Southeastern Wisconsin to evaluate their current position and usage of probiotics in the treatment of Crohn's Disease. A meta-analysis was performed probiotic-based therapy in the context of relevant clinical trials to examine their efficacy in remission maintenance. 64 % of surveyed gastroenterologists believed that probiotics alone could treat Crohn's; however, 63% responded that probiotics could supplement conventional therapies. While there was no statistical evidence that commercial probiotics-based interventions effectively treat Crohn's, conclusions from the study reveal that microbiota-based therapies have a complementary role in Crohn's therapeutic armamentarium.

Mira Dahms: Implementing Food Drop-off Tables in the Wilson Elementary School Cafeteria in Order to Reduce Food Waste
A key contributor to the emissions produced around the world include food that is thrown away. When food is thrown away, it not only produces emissions, but it also wastes food that could be given to those in need of it. A large portion of food waste is thrown away in school cafeterias, most often among younger students. This study focuses on the Wilson Elementary school cafeteria in Mequon, Wisconsin, where a food drop-off table was implemented for five days over a two-week period during the first grade lunch period. The food drop-off table allowed the first grade students to place packaged, uneaten and unopened foods on these tables at the end of the lunch period before they throw their food away, and the waste was measured quantitatively, by its weight, to determine how the use of the drop-off tables reduces the amount of waste thrown away. It was found that through the use of the drop-off table, the food waste discarded over the five days decreased by approximately 45%. The food placed on the drop-off tables was not given back to the students because of health and safety concerns. The results will hopefully contribute to the literature base of experimental research and data which encourages schools and researchers who want to reduce food waste to implement drop-off tables in school districts.

Jake Emold - Partial Sensory Deprivation's Effect on Adolescents (not present)
My research is designed to develop a DIY alternative to a frequently used therapeutic practice. Stress is very persistent among teens; any method that could encourage adolescents to utilize coping mechanisms is a net success. This study aimed to allow teens to better manage their stress level by giving them a distraction free environment to think freely. These tests took place with the cooperation of teens at Homestead High School in the middle of their school day. I borrowed heavily from key tenants of darkness therapy and all measurements recorded were directly in line with the precedent set from previous Sensory Deprivation studies. Heart Rate data was used throughout the study as Heart Rate Variation and Heart Rate 20-interval means were used to compare and contrast data cross-sectionally.

Harry Kroft: Birdcall Bioacoustics: Snow's Effect on Chickadee Call Propogation

This paper examines the effects of snow coverage on the propagation of Chickadee calls and attempts to determine whether Black-capped chickadee calls are structurally adapted to snow coverage. This study furthers our understanding of the Acoustic Adaptation Hypothesis (AAH) among songbirds by determining the effects of a single environmental variable, as many current studies of AAH have been inconclusive. This study quantitatively compares the attenuation of the long-distance function Black-Capped Chickadee notes, a non-migratory species active in northern North America during the winter months, with those of Carolina Chickadees found in the southeastern United States. Lab-recorded calls of both species were played back in a coniferous forest stand and re-recorded at various distances to measure the attenuation of the signals. This procedure was repeated for several levels of snow coverage. Due to an unfortunate lack of snowfall during the 2022 - 2023 winter season, the results are currently inconclusive.

David Krol: Gubernatorial Prediction Model

My research aims to create a gubernatorial prediction model that can be utilized in swing states. This model will differ from those that preceded it by eliminating the margin of error. To eliminate the margin of error, it was critical to make a system that reflects all areas of an election including aspects such as unemployment and incumbency. To achieve this, I utilized design-based research with statistical analysis. This procedure led me to create a system comprised of five vital election components. All of these components are quantifiable and readily available to any voter; making it far easier to complete as oppose to a qualitative model. As a result, I tested this system on three states Wisconsin, Michigan, and Pennsylvania. Within these three states, the previous 6 elections were tested, of which 15/18 were accurately predicted. At the moment, no statistical analysis has been performed as it does not meet the criteria for an approximately normal distribution.

Livia Lathen: Utilizing Marine Cyanobacteria for Fuel Production

Fossil fuel and other similar industrial processes account for approximately 78% of global emissions. Biofuels serve as a promising alternative to harmful fossil fuels due to their potential to serve as remedy for ozone depletion and rising global temperatures. Algal biodiesels, specifically, are prominent prospects for long term large-scale use due to their ability to produce far more fuel than corn or soybean alternatives. Cyanobacteria (a photosynthetic bacteria that mimics the look of algae) has been researched as a possible source for biodiesel production. Cyanobacteria, *Synechococcus elongatus* sp. strain PCC 7942 was successfully engineered to produce ethanol through the addition of a pyruvate decarboxylase and an alcohol dehydrogenase. Strain PCC 7942 is a freshwater strain of the bacteria. Although Cyanobacteria seems to be a favorable alternative to the usage of fossil fuels, large scale production would require massive amounts of water. There is concern that the water needed to produce Cyanobacteria would compete with drinking water, thus creating a major issue. In an effort to solve this issue research was performed to examine a saltwater strain of Cyanobacteria (*Synechocystis* sp. PCC 7338) as a biodiesel source. Ultimately it was determined that the saltwater strain of Cyanobacteria can produce a biodiesel; however,further research is needed to determine the safety and functionality of this resource.

Quinten McLaughlin: The Creation and Evaluation of an AI to Automate the Creation of Floor Plans in Architectural Design (not present)

Floor plan design is the most important, time-consuming, and expensive phase of the architectural design process, involving labor-intensive research, calculations, and trial-and-error to create a building most suitable to the client's criteria. AI has the potential to automate the creation process, which would dramatically reduce time and cost by several orders of magnitude. However, most of the AIs created for architects are small-scale proof-of-concepts, and are not usable by the industry. This study aims to first evaluate the previous methods of creating AIs to generate floor plans, create an AI based off of the structure of type of AI determined to be most suitable for the task, then evaluate the functionality of the new AI by challenging architects to differentiate between AI floor plans and human-made floor plans through a quantitative survey of 450 architects. Analysis of previous papers on creating AIs to generate floor plans indicated that a three-part Generative Adversarial Network (GAN) was the most suitable type of AI for its generalized functionality and versatility. After creating and training the AI, the survey results showed that architects were only successful in identifying the AI-generated floor plans 15% of the time. This is a resounding success, with answers indicating that the AI floor plans were not only indistinguishable in aesthetics, but also better in terms of functionality.