Higher Education Research Council
Undergraduate Research Fellows
Boise State University
Final Report

Academic Year 2021-2022

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Introduction

The Institute for Inclusive & Transformative Scholarship oversaw the HERC Undergraduate Research Fellowship at Boise State University Fall 2021, and Spring 2022. HERC funds were used to support Boise State undergraduate students who had minimal research experience with a 10-week mentored research opportunity during the fall and spring semesters. Funds provided by the Higher Education Research Council supported a total of 17 students across 13 different STEM disciplines.

On behalf of the Institute for Inclusive & Transformative Scholarship, we thank the Higher Education Research Council for their generous support in helping build meaningful experiential learning experiences for Idaho students and supporting faculty research.

HERC Funding:

Stipends	**Amount**	**Details**
Fall Semester Research Stipends	$21,000	7 students at $ 3,000 each
Spring Semester Research Stipends	$30,000	10 students at $3,000 each
Total	**$51,000**	

The Higher Education Research Council provided $51,000 in funding to support STEM undergraduate research at Boise State University this year. Please see the table below of how stipends and travel awards were dispersed.

The titles and abstracts of the student projects are on the following pages.

Fall 2021 and Spring 2022 HERC Fellows
Research Projects

Fall 2021 Fellows

Benjamin Balzer - Molecular Biology

Title: Custom DNA Origami Scaffolds for Digital Nucleic Acid Memory
Abstract: Motivated by the continuous growth of data storage capacity the semiconductor memory materials are approaching their production limits. DNA has been selected as a valid alternative candidate due to its information density and long retention time. Here at the Nucleic Acid Memory Institute we developed digital Nucleic Acid Memory (dNAM), which uses DNA origami as a breadboard for data storage that provides a matrix of complementary strands that bind dye-labeled single stranded DNA (ssDNA). DNA origami is made from a ssDNA scaffold and short oligonucleotides (short ssDNA) that fold together into a predefined shape. The dNAM project currently relies on the M13 ssDNA scaffold which has a fixed length of 7.2 kilobase pairs (kb), limiting size and customization of the DNA origami. Ability to create larger scaffolds will expand the storage capacity and versatility of the DNA origami breadboard. In order to create larger scaffolds, we used a phagemid/helper phage system to produce ssDNA in bacteria and then export it from the cell. Using restriction enzymes cloning we produced a custom 11,054 base pair scaffold from previous ssDNA produced phagemids. Future project's perspectives are to increase yield of the scaffold production as long as its length and create a fully customizable sequence tool to expand the robustness and accuracy of dNAM.

Cameron Brown, Anthropology

Title: Dogs produce distinctive play pants: Confirming Simonet
Abstract: Identifying meaningful vocalizations in nonhuman animals can explain the evolution of human communications. However, non-speech like sounds, including laughter equivalents, are under-studied. The purpose of this pilot is two-fold: 1) we aimed to determine whether dogs perform a domain-specific pant during play, and 2) we sought to capture target vocalizations characterizable as a play pant, and compare them across three interactions: training, play, and rest. We defined the target vocalization as including frequencies between 0 to 4 kHz; lengths between 0.1 and 0.3 seconds; large, irregular oscillating waveforms and high amplitudes; and the absence of harmonic bands. Bonded human and dog partners participated in a session that included all three interactions. During these sessions, both partners wore wireless microphones that transmitted to a receiver and digital recorder, while a standalone digital camera captured video of the interactions. A total of 16 human-dog pairs participated. Using a one-way ANOVA, the results demonstrate that dogs do perform a domain-specific play pant, which was almost completely absent during training and rest. These findings suggest that a laugh like play pant is used by dogs during play, and that future research should explore other interspecific acoustic signals as communicatory.

Claire Conner, Early Childhood Special Education

Title: Teaching Professional Communication Skills to Undergraduate Students
Abstract: Effective communication is necessary for every profession (Hargie, 2016). Understanding how to facilitate dialogue is especially important for educators (Wei, Murphey & Firetto, 2018). Discussions help students understand course content, and effective professional communication is key to creating shared meaning with students, parents, and colleagues (Michaels & O'Conner, 2015). This study was conducted in the fall of 2021 to identify what interventions, including direct instruction, feedback, and self-assessment,

support undergraduate education students in developing their professional discourse skills. The researcher first conducted a literature review regarding communication and discussion skills. She then created a module that taught an overview of these skills. Lastly, she created a rubric to measure students' acquisition of the skills. She presented the module and rubric to the class as an online assignment at the beginning of the semester. Class participants then recorded biweekly small group discussions. The researcher scored each individual student on the created rubric and met with students after each session to review the rubric and provide feedback on their performance. Students also completed a brief self-assessment form after each discussion. Utilizing the rubric, the researcher tracked student progress across six criteria over six small group discussions. The data show improvements in scores across all domains, with the largest proportional increase after the first two feedback sessions. The class participants completed an optional survey at the end of the semester that indicated students felt the four interventions: module, rubric, self-assessment, and individual feedback sessions, were either very or somewhat beneficial (with the expectation of two out of eighty responses). Out of all the interventions, students indicated that the individualized rubric is the best to incorporate into future courses. The researcher created a rubric and module template for faculty interested in incorporating professional discourse skills into their coursework, as the majority of these skills are generalizable across contexts.

Allison Kurtin, Political Science

Title: Civil Liberties in Latin American Prisons: The Effect of the Coronavirus Pandemic and Government Responses

Abstract: "This paper establishes a correlation that explains COVID-19 mitigation measures in Latin American prisons, utilizing data collected for each country, as well as two case studies. Some Latin American countries have been notorious for poor prison conditions and limited protection of civil liberties for persons deprived of their liberty. I expect that the countries with better conditions will implement more effective strategies to prevent the spread of COVID-19 in prisons. In this paper, I collect data that represents both countries' protection of civil liberties prior to the pandemic and the level at which that same country implements strategies to mitigate the spread of COVID-19. The data collected shows a weak positive correlation between these two factors, supporting the thesis that countries that protect prisoners' civil liberties will also attempt to protect them from COVID-19. Two case studies are also included in this paper to provide supporting evidence for the research topic. First, I provide a case study of Venezuela, a country notorious for poor civil liberties protections and prison conditions. I find that Venezuela also implemented very minimal COVID-19 mitigation measures. The second case study is on Chile, in which the government and democracy is a bit stronger than other Latin American countries. Based on the categories discussed in the data section of this paper, Chile scored the highest score possible for implementing COVID-19 prevention strategies in prisons. The data collected and analyzed and the two case studies work together to support the thesis of this paper that countries that effectively protected civil liberties of prisoners prior to the pandemic also effectively protected them during the pandemic. On the other hand, countries that poorly protected prisoners would not successfully implement strategies to combat the pandemic in prisons.

Kyle LaCoursiere, Geosciences

Title: How does inter-annual snowpack variability impact reservoir storage in the Magic Reservoir?

Abstract: Water users in the state of Idaho are dependent on reservoir storage for irrigation during the dry season. By knowing the reservoir storage early water users can decide on how much water to use and when to use it. We want to predict reservoir storage so that water users can then have early access to the upcoming

storage levels and can then decide the action needed in using the predicted reservoir storage. To predict reservoir storage, we used a linear regression automated model selection that highlighted the important variables of Spring temperatures, Winter temperature at Soldier R.S. SNOTEL site, and Snow Water Equivalence (SWE) at Camas Creek Divide SNOTEL site. The model found that these variables are the major drivers of predicting maximum reservoir storage at Magic Reservoir in Idaho. The implication of this finding is that spring temperatures play a larger role in prediction reservoir maximum storage than Snow Water Equivalence. This is impactful as spring temperatures are not thought of as a major driver in predicting reservoir maximum storage, when in accordance with the results shown from this study spring temperatures are a major driver in predicting reservoir maximum storage.

Anna Shuey, Biology

Title: Effects of doxorubicin on autophagy in fibroblasts

Abstract: "NOTE: This is a work in progress. We have changed some aspects with further research and wanted to add some data that has just been collected as part of the ongoing project since the HERC fellowship was awarded. I plan to present at the summer ICUR event on behalf of HERC. I hope this will work for this purpose and a finalized version will be presented later in the summer at ICUR. Doxorubicin is a highly effective chemotherapeutic used to treat many adult and pediatric cancers, such as solid tumors, leukemia, lymphomas and breast cancer. However, its use is limited due to a dose dependent cardiotoxicity, which can lead to lethal cardiomyopathy. It is generally accepted that the principle mechanism is oxidative stress induction through the production of reactive oxygen species (ROS) and free radicals in the myocardium. The increased level of oxidative stress can subsequently induce apoptosis and cell death in cardiomyocytes. Efforts to reduce/prevent doxorubicin toxicity using antioxidants have largely failed in pre-clinical and clinical trials, indicating that oxidative stress may only partially explain the cardiotoxicity. Thus, novel mechanisms responsible for doxorubicin cardiotoxicity and intervention measures targeting these novel mechanisms need to be explored in order to expand the use of this effective anticancer drug. Fibroblasts are the largest cell population in the heart and play a critical role in normal cardiac function. Cardiac fibroblasts are the main cell type responsible for the synthesis, deposition, and degradation of cardiac extracellular matrix (ECM). Cardiac ECM not only provides structural support for cardiac cells, but also plays important roles in electrical signaling, secretion of growth factors and cytokines, and potentiating blood vessel formation. In contrast to extensive research efforts on toxic effects of doxorubicin in cardiomyocytes, data on the effects and mechanisms of doxorubicin on cardiac fibroblasts and ECM homeostasis are limited. Autophagy is molecular machinery for "self-eating" in cells. It is a highly conserved process of self-degradation of cellular components in response to extra or intracellular stress and signals such as starvation, growth factor deprivation, and pathogen infection. Autophagy are involved in many disease conditions. The goal of this study is to examine the effects of doxorubicin on autophagy in cardiac fibroblasts. The results of this study further our understanding of mechanisms of doxorubicin-induced cardiotoxicity, which may lead to novel intervention measures that target these key signaling events, and ultimately improve therapeutic options for cancer treatment. Through use of cell culture, western blotting, and PCR techniques, we have been able to gain new knowledge into the effect of doxorubicin on autophagy by the monitored expression of known autophagy biomarkers P62 and LC3B. Preliminary western blot data has shown that both P62 and LC3B expression are reduced in the NIH 3T3 cell line, which indicates increased level of autophagy. A similar trend was not obvious in primary cardiac fibroblasts, suggesting fibroblasts from different origins may respond to doxorubicin treatment differently. Our preliminary results suggest that doxorubicin has an effect on

autophagy within fibroblast cells, although perhaps to differing degrees for different cell lines, and this could be a potential mechanism to explore in preventing doxorubicin-induced cardiotoxicity with further study.

Claire Vaage, Environmental Sciences

Title: Delineating riparian vegetation using remotely sensed data: a variable width model from the Boise foothills

Abstract: Riparian vegetation is critically important for dryland ecosystem functions including maintaining water temperatures for resident fish populations, enhancing carbon sequestration, stabilizing stream banks and flow, and supplying and retaining nutrients within water systems. Development of management and conservation strategies for these vital areas is dependent on mapping the extent of the characteristic riparian vegetation. The primary step in modeling hydrological ecosystem dynamics includes defining the riparian buffer through fixed-width or variable-width approaches. Fixed-width buffers do not accurately capture smaller, unique riparian areas because they only account for the watercourse, ignoring inputs such as stream order or geomorphology. A variable-width buffer reflects spatial variability in riparian vegetation by accounting for landscape complexities, such as fine-scale variation in topography that complicate proper estimations of riparian zones. Using a 1-m spatial resolution digital elevation model (DEM) derived from aerial lidar, we mapped the stream network of the southwestern section and lower elevations of the Dry Creek Experimental Watershed in Idaho, USA. This watershed encompasses a topographically complex/diverse ecosystem gradient, from sagebrush steppe to evergreen forest. Then, we generated random points along the predicted stream network to digitize (n = 1,500) and ground truth (n = 150) riparian vegetation. We developed a regression model to predict riparian vegetation width using the collected digitized and ground truth measurements, and additional covariates (i.e., slope, aspect, elevation, vegetation). Our results provide a way to accurately map riparian buffers in sagebrush steppe ecosystems through a novel variable-width approach and allow for additional research on the geomorphological, hydrological, and ecological characteristics of riparian areas within drylands.

Shuai (Sharon) Yang, Computer Science

Title: Profiling Hate Speech Spreaders on Twitter

Abstract: Hate speech is defined as any public communication that depreciates a person or a group by expressing hate or encouraging violence. From the identification of the profiles of hate propagators, it is possible to avoid the spread of hate speech and keep social networks healthier. In this study, I focused on Twitter. Simply analyzing words in tweets is a good starting point to identify hate speech and people who spread hate speech. However, we believe there is value in considering other expressions that are commonly seen in tweets. The purpose of this study was to explore a variety of expressions and unveil a set of common patterns that could lead to identifying user profiles that promote hate speech on social media (Twitter).

Spring 2022 Fellows

Cooper Conway, Political Science

Title: Per-Pupil Spending and Population Numbers Effects on ISAT Proficiency A Multiple Regression Analysis

Abstract: The stagnation of student performance in America has been linked to many factors. The primary explanations for the stagnation usually vary between the amount of per-pupil spending in America's K-12 system and outside factors such as culture and family (Coleman et al.,1966; Hanuschek, 1984). Newer research has used isolated increases in per-pupil spending at the local, state, and national levels to analyze the effects spending has on student outcomes (Baron, 2019; Carolyn, et al, 2020). The researcher in this study took a different approach using existing data pulled from the Idaho State Department of Education and the Reason Foundation to run a multiple regression analysis in IBM's Statistical Package for the Social Sciences (SPSS). The output from the multiple regression explained the relationship

between per-pupil spending and population numbers on math proficiency rates among economically disadvantaged eighth-graders on the Idaho Standards Achievement Test (ISAT). The researcher's findings indicate a negative relationship between per-pupil spending and the amount of economically disadvantaged eighth-graders on ISAT Math proficiency rates among economically disadvantaged eighth-graders. However, the percentage of economically disadvantaged eighth-graders in each district has a moderately strong negative relationship with math proficiency rates leading the researcher to believe outside factors such as family and cultural values may have a stronger relationship regarding economically disadvantaged student outcomes in Idaho.

Hannah Hedelius, Psychology

Title: Idaho Humane Society Workshop
Abstract: The Idaho Humane Society previously had a workshop for middle school students, however it was short in time and lacked essential topics including Fear Free handling and animal body language. Educating students on these topics is important for the care and safety of both animals and humans. We created a 2-hour Junior Vet Tech workshop and presented the curriculum using PowerPoint, animal observations, technique demonstrations, and available practice time. This increased both the interest in learning more about animals but also interest in volunteering at the Idaho Humane Society.

Alejandra Hernandez, Health Sciences

Title: The Importance of Community for a Study Examining Pesticide Exposure and Risk Perceptions Among Latinx Farmworkers
Abstract: Latinx farm workers make up over 80% of the United States farmworkers, and research has shown they have high levels of exposure to pesticides. Studies have also shown females are at risk for higher levels of pesticide exposure. The purpose of the overall study is to examine pesticide exposure and risk perceptions among male and female Latinx farmworkers. Here, I describe the importance of community when working with structurally marginalized populations like Latinx farm workers. The purpose of presenting this component is to give researchers an understanding of why creating trust and getting the respect of the communities that are being researched is so important. In addition, this will give researchers ideas as to how their research project can be more collaborative and include the community that is participating in the study. In this case, we have forged partnerships with multiple trusted community partners and organizations in order to recruit study participants, address potential power dynamics inherent in many research studies, and ensure this research provides a benefit to participants. Following the conclusion of the study, we will partner with Boise State's Project SCIENTIA to create multi-media science communication products to translate the study findings and recommendations to participants and groups supporting farmworkers.

Andy Lee, Physics

Title: Projection Effect of Galaxy Clusters
Abstract: Dark matter halos are used as cosmological probes of the universe. From the halo mass function, we can obtain energy density parameters. However, in the observation of halos there are projection effects that make it difficult to count the number of galaxies in a halo. These projection effects include uncertainty about the radius of each halo and the line of sight distance. The line of sight distance is measured from the halo center. Distances are determined with redshift. We can use simulation data so we know everything about a halo and then compare different methods of counting galaxies. For simplicity, we used a fixed line of sight distance and assumed we knew the halo center. We compared galaxy counts from catalogs using different line of sight distances, with and without percolation, and fixed vs iterative radii. Percolation is counting a galaxy towards the more massive halo when the galaxy is within the radius of multiple halos to prevent halo radii from blowing up. The catalog without percolation has more galaxies at low masses but has little effect at high halo masses. We have found that the projection effects are dominated by galaxies within 15 Mpc/h.

Fall 2021 and Spring 2022 HERC Fellows
Research Projects

Marissa Maldonado, Mathematics Education

Title: Analysis of Undergraduate Mathematics Coursework for Curriculum Design
Abstract: Andragogy is the study of adult education and is an area of research that is neglected within university environments. There is a lack of curriculum/documentation analysis relative to increasingly modern formats of upper-division mathematics courses by use of technology and real-world applications. In finding proper modes of transportation for abstract mathematical concepts, teachers can make more informed approaches to teaching and developing curriculums at a university level. A case study will be conducted that compares the final group projects of a mathematical modeling course in alignment with assignment instructions, available documentation, and recorded lectures. This case study will give insight into how epistemology can be implemented into advanced, abstract mathematics courses for adult learners.

Cooper McGrath, Biology

Title: aBRCAdabra! Cytokines Make DNA Repair Disappear in Breast Cancer
Abstract: Approximately 1 in 8 women will be diagnosed with breast cancer in their lifetime. For a localized breast cancer, the five-year prognosis is 99%, but for metastatic breast cancer the five-year prognosis has remained an abysmal 27%. Proteins called cytokines have been found in abundance in breast cancer tissue and have been shown to increase the metastatic potential of breast cancer cells. Cytokines accomplish this by means of altered gene expression through their signaling cascades, but the role of cytokines in regulating the expression of genes associated with DNA repair is understudied. BRCA1, BRCA2, and BARD1, are tumor suppressor genes, that function in DNA repair of double stranded breaks. Regulation of these genes through cytokine signaling may lead to decreased DNA repair in the breast cancer cells, an increase in epithelial to mesenchymal transition (EMT), and a worse prognosis for cancer patients. Quantitative reverse transcriptase-polymerase chain reaction (qRT-PCR), and western blot analysis, was used to measure BRCA1, BRCA2, and BARD1, expression after treating breast cancer cells with cytokines, in vitro. Establishing a connection is important, as it could lead to physicians designing therapeutic plans that target BRCA deficiencies for patients with high levels of these specific cytokines, in turn leading to a better outcome for patients.

Ace Pedraza, Biology

Title: How does prey type affect pitcher plant, Sarracenia purpurea, microbial community function?
Abstract: Microbial communities are formed by groups of microorganisms, which impact the earth's ecosystems. The way these organisms interact and function significantly affects how nutrients and energy move through our ecosystems. Discovering, analyzing, and defining the functions carried out by microbial communities can help reveal how ecosystems shift with changing conditions. However, it's a challenge to analyze and track microbial community interactions or functions within large ecosystems. Focusing and analyzing the microbial communities in small ecosystems first, will help to study larger ecosystems. This study uses the small-scale ecosystem of the carnivorous pitcher plant, Sarracenia purpurea, to investigate microbial community functions in the plant's digestive fluid. The microbial organisms found in the pitcher's digestive fluid help with the decomposition of captured insect prey. This study worked on answering the question: how does prey type affect pitcher plant, Sarracenia purpurea, microbial community function? Four different insect prey types and an inoculant of bacterial communities originally isolated from three wild pitchers were used to simulate a pitcher plant ecosystem in glass tubes. Analyses of enzymatic tests and substrate utilization revealed how different insect prey affect microbial community functioning. The results show a significant difference in the microbial community function for the different insect prey. Different insect prey affects the pitcher plant's microbial community function in chitinase, protease, and substrate utilization across 31 distinct compounds. Future studies will expand on other areas of microbial community function that affect how insect prey is digested in pitcher plants.

Matthew Robinette, Mechanical Engineering

Title: Impact of age and surface on lower limb muscle activity during walk and pivot tasks

Abstract: Muscular strength decreases with age leading to changes in lower limb muscle activity, such as increased agonist and antagonist co-contraction, during gait task older adults (over 65 years). External perturbations, including cognitive distraction and slick surface, challenge the central nervous system, resulting in muscle activity alterations to safely walk.1,2 Yet, it is unclear whether older adults exhibit greater alterations in muscle activity than young adults during gait task with challenging perturbations.

Ellie Schlake, Electrical Engineering

Title: Laser Sintering of Flexible Electronics
Abstract: Printed electronics allow for flexible and durable devices called flexible hybrid electronics (FHE). The flexible capabilities of FHE make them suitable for conformable biosensors, allowing movement and comfortability, real-time and non-invasive sensing. Direct-deposition printing of inks or colloidal suspensions is the primary process in FHE fabrication to produce various device features on flexible substrates. Unfortunately, printing technologies do not provide a consolidated thin film of the desired material; but only deliver the ink in nanoparticles or nonconductive clusters. Printing processes must be assisted with a high-temperature and time-consuming post-processing treatment to obtain desired material properties. Laser sintering is an alternative post-processing method to sinter nanoparticles. Laser sintering is sensitive to laser parameters such as power, intensity, wavelength, scanning speed, pulse duration, and sample parameters such as absorption cross-section, film composition, film thickness, substrate, and substrate temperature. By varying these parameters, attempted sintering of gold (Au), platinum (Pt), and silver (Ag) were done using a laser. The results demonstrate the effectiveness of laser sintering to achieve desired electrical properties of printed metallic films. We anticipate laser sintering as a method for metallic inks with excellent electrical properties and are susceptible to oxidation, expanding FHE applications.

Gwen White, Material Science and Engineering

Title: Patching Force Fields of Organic Materials through Open Scientific Software Development
Abstract: Solar cells made from organic photovoltaic (OPV) materials have the potential to provide sustainable solar power generation due to their low manufacturing cost and processability. Molecular dynamics (MD) simulations allows for the pre-screening of OPVs. Doing so requires the description of interaction potentials between simulation elements. of the thermodynamic self-assembly of new OPV compounds more efficiently than wet lab experiment, by modeling molecules with interactions specified by a "force field". The first step of simulating a new compound in MD is deciding how to apply forcefield parameters based on the chemical structure of the molecule, and if the chemical environment is not defined in the forcefield, then new parameters must be created. Here we develop and use computational tools for identifying bond, angle, and dihedral constraints that are missing from a forcefield, and perform quantum chemical calculations to parameterize these missing components. We set up the QUBEKit software stack on the Borah high performance computing (HPC) cluster, utilize SMILES strings to specify minimal molecular snippets, and parameterize models of Y6 and BTO, which have recently demonstrated power conversion efficiency over 17%.