# **BASIS** SCOTTSDALE

## **SENIOR PROJECTS** 2021–2022


Artwork by **Emily Hao** | page 10

# SENIOR PROJECTS & SENIOR RESEARCH PROJECTS

At this point in their senior year, BASIS Charter School students have completed a set of four BASIS Capstone classes to earn their BASIS Diploma with Honors.. In addition, many students are in the process of completing the prestigious College Board's AP Capstone Diploma™, a challenging, two-year sequence of AP Seminar™ and AP Research™, plus four other AP® Exams, all of which require extensive research, writing, and oral defense. The BASIS Diploma Senior Project marks the culmination of this hard work and perseverance.

Completed in the third trimester of their senior year, the Senior Project is unique, self-designed, and reflective of the students' varied academic interests and passions. Regardless of the discipline —business, art, humanities, science, engineering, social work, medicine, or law — each senior must develop and explore a research question. Creating an abstract that sets the tone of the research, participating seniors must submit a project proposal, and later, orally defend their methodologies.

Under the guidance of an external advisor who is a professional in their field, as well as a faculty advisor from their school, students dedicate 10–15 hours per week to the completion of their Senior Project. To document their journey, students post weekly blog entries about their experiences, successes, and challenges as they explore their guiding question. This journaling provides a unique viewpoint on the student activities and adds a reflective layer to their research process.

Throughout the development of the Senior Project, BASIS Charter Schools support their seniors every step of the way as they develop investigative skills and their own individual scholarly pursuits. The abstracts in this publication clearly illustrate each senior's ability to apply the knowledge, and intellectual curiosity they have acquired in the classroom to professional research methods and learning. At the successful conclusion of this project, students are eligible for a BASIS Diploma with High Honors, the most distinguished accolade offered by BASIS Charter Schools.

Each member of the BASIS Charter Schools network commends our seniors for their dedication, and motivation, not only for completing this Senior Project, but for their commitment to the BASIS Charter School Curriculum. Congratulations to them on this powerful achievement, and our best wishes as they move forward on their educational journey.

Carolyn McGarvey
Chief Executive Officer
BASIS.ed AZ+

Peter Bezanson
Chief Executive Officer
BASIS.ed Texas

BASIS® CHARTER SCHOOLS

# Scottsdale SENIOR PROJECTS

## AMIRA A.

### SEAM-STRESSED: A QUILT FROM AROUND THE WORLD

**ABSTRACT:** Embroidery is a common fiber art form across the world. Essentially, embroiderers use a needle and thread to decorate pieces of fabric with a stitched design. While the art of embroidery can be found throughout the world, the motifs, stitches, colors, and fabrics used can differ across regions. For example, some common motifs in China are dragons, peacocks, and phoenixes. However, in Scandinavia, it is more common to embroider flowers, fields, leaves, and birds. Embroidery can be performed on any kind of fabric, and it is usually found on articles of clothing, blankets, bags, and religious items. For this creative project, the objective was to create a hand-embroidered quilt. Quilts are made from quilting squares, which are sewn together to create one large quilting fabric. In this quilt, some of the quilting squares were personally hand-embroidered in different styles and motifs from across the world. The hand-embroidered squares and the normal squares were sewn together to produce the quilt top. Then, batting, or stuffing, was added as the middle layer of the quilt, and backing was added as the final bottom layer. Binding and quilting stitches were used to secure the three layers. The embroidered quilt demonstrates not only how embroidery styles differ across different regions, but also how embroidery styles share some common characteristics.

- **BASIS ADVISOR:** TJ Peacher • **ON-SITE MENTOR:** Carol Gordon
- **LOCATION:** Telaraña Fiber Guild

## NEHA B.

### MODELING ION TRANSPORT AND DENDRITE FORMATION IN ALL-SOLID-STATE LITHIUM-ION BATTERIES

**ABSTRACT:** Lithium-ion batteries are increasingly playing a crucial role in our daily lives with applications in electric cars, smartphones, and laptops. Lithium-ion batteries charge quickly, last long, and pack more power than traditional lead-acid batteries, but several issues limit their efficiency and safety, especially the formation of needle-like structures called dendrites that can cause short circuits. Through my research, I helped answer the following question – Can a patterned interface between different battery components suppress dendrite growth? To do this, I interned at a Stony Brook University lab studying all-solid-state Lithium-ion batteries, which are more energy-dense than traditional Lithium-ion batteries. I aimed to create a new model for Lithium-ion batteries that would not only improve safety but also productivity and affordability. Over this past summer, I conducted preliminary research into patterned electrode-electrolyte interfaces by simulating an indented surface pattern on the Li-metal anode. I found that adding a surface pattern to the anode does lower dendrite growth, so now through my Senior Project, I continued studying different surface patterns to determine which interface best suppresses dendrite formation. I found that smaller indents in the Lithium-metal anode are more effective at reducing dendrite formation, meaning that such an interface might allow for viable all-solid-state Lithium-ion batteries. In the future, I hope my research into more efficient and safer Lithium-ion batteries can help develop a new energy source that powers technological advancements while prioritizing sustainability.

- **BASIS ADVISOR:** Natasha Proctor • **ON-SITE MENTOR:** Dr. Dilip Gersappe
- **LOCATION:** Stony Brook University Gersappe Lab

## TANISHA B.

### USING BIOINFORMATICS TO FIND A SOLUTION TO SEIZURES

**ABSTRACT:** Seizures have been a medical issue that has plagued humanity for centuries and are one of the most feared medical situations to be in. Seizures can often result in long-lasting medical issues, which begs the question, how can we help stop seizures once they've already started? The only fixes on the market are medication that isn't effective all the time and basic nutrition advice. How can we target the brain and neural networks in order to prevent these from occurring? Over the course of this project, I hoped that this internship will allow me to help answer these questions. By working on a project to develop a medication that could stop seizures, I gained more experience in a lab and with making solutions to long-standing problems. Going into this internship without intensive lab experience is daunting, but through this experience, I learned more about my future major and how we can use biochemistry, anatomy, and engineering in order to develop a product that can help others. This project was conducted at Arizona State University, under the direction of Dr. Brett Vernon.

- **BASIS ADVISOR:** Amber Ellico • **ON-SITE MENTOR:** Amrita Pal/Brett Vernon
- **LOCATION:** Institute of Science and Technology at Arizona State University

## KATELYN C.

### BRIGHTER FUTURES: STUDYING YOUTH WORKFORCE PROGRAMS FOR THE NEXT GENERATION

**ABSTRACT:** Youth internship programs have been shown to significantly increase readiness for the workforce, engagement with civics and academic outcomes. However, Scottsdale, unlike Phoenix, Glendale, or Chandler, currently does not have a robust internship program sponsored by the city government that is open to high schoolers. For my senior project, I aimed to change that. My research primarily consisted of assessing the best methods to coordinate the program's development across departments like Human Resources, gain the support of stakeholders like local high schools, and obtain necessary funding from the City Council.

- **BASIS ADVISOR:** Christopher Klugman • **ON-SITE MENTOR:** Stephanie Zamora
- **LOCATION:** Scottsdale City Government

## VAISHNAVI C.

### EQUINE ASSISTED THERAPY: VARIOUS ASPECTS OF EQUESTRIANISM

**ABSTRACT:** Equine therapy is a method of treatment that uses the bond between people and horses to enhance physical or emotional healing. Designed for people of all ages, this type of therapy has been shown to treat a wide range of mental and physical health issues, which produce varying benefits like confidence and emotional awareness. The question I considered was: Is there a difference in the beneficial effects between individuals with physical disabilities and individuals with mental disorders? Though the importance of equine therapy has been documented throughout history, across cultures and in recent research, little is written about how the bond between humans and their hooved companions works to bring out the best in every person. Working alongside certified therapeutic instructors at the Camelot Therapeutic Horsemanship center, this project briefly surveyed the practices in equine therapy, reviewed research on their health and mental health benefits depending on each individual's disability and examined the relational significance across different treatment methods. From my observations, I have learned that each individual participating in equine therapy has a specific therapeutic approach designed for them by their instructors/therapist, so there are some notable differences between individuals with physical abilities and those with mental health issues. In most cases, therapeutic riding is used by people with physical disabilities to improve well-being and develop muscle tone, coordination, and confidence, while people with psychological problems use equine assisted psychotherapy to foster inward reflection, confidence building, and emotional grounding.

- **BASIS ADVISOR:** Ryan Carey • **ON-SITE MENTOR:** Hannah Brisso
- **LOCATION:** Camelot Therapeutic Horsemanship

## NATALIE C.

### REGENERATIVE MEDICINE IN EQUINE HEALTH

**ABSTRACT:** Regenerative treatments have been a proposed theory for decades within animal health. What if stem cells or components of the blood could treat soft tissue injuries? For horses, injuries in the limbs can limit their qualities of life significantly. Without the ability to painlessly walk and work, horses suffer severely if not treated. Stem cells, Platelet Rich Plasma (PRP), and Interleukin-1 Receptor Antagonist Protein (IRAP) are the three main methods of equine regenerative medicine. Stem cells are sourced from fat, cultured in a lab, and injected directly into the injuries. PRP uses active platelets within the blood plasma to activate growth factors. IRAP sources white blood cells from blood serum to stimulate cartilage growth in injuries. For my research project, I interned at Cave Creek Equine Sports Medicine & Surgery and observed the administration of these regenerative treatments in person and documented the procedures with pictures on my blog. I accompanied this data with excerpts of scientific studies, some of which were conducted by my mentor. By observing all three treatments at the clinic, I could compare the effectiveness and form an opinion on the pros and cons of each treatment. Because of the many sports injuries that horses face during training, especially when they involve tendons and ligaments, bringing these treatments to light could change the way that current and future veterinarians tackle these pressing injuries.

- **BASIS ADVISOR:** Sarah Martinez • **ON-SITE MENTOR:** Dr. Martin Vidal
- **LOCATION:** Cave Creek Equine Sports Medicine & Surgery

## THOMAS C.

### THE APPLICATIONS OF MEDICINE AND PHYSICS IN RADIATION THERAPY

**ABSTRACT:** Radiation therapy, using high-energy x-rays or other particles to destroy cancer cells, is one of the primary methods of eliminating cancerous cells. Many new forms of radiation therapy are researched and developed each year, including volumetric modulated radiation therapy (VMAT), intensity-modulated radiation therapy (IMRT), and brachytherapy. However, despite new research being published annually, there are still many known variables to these treatments. Additionally, despite the advancement of imaging techniques designed to track the location of tumors, some variability still exists, causing radiation therapies to fail. Under the supervision of Mr. Harrington, a medical physicist at the Mayo Clinic, I hoped to study how the different radiation therapies differed in success rates, potential errors, and risk for nearby organs. I initially researched the responsibilities of medical physicists and the largest sources of error in radiation therapy. As I progressed through my project, I studied the individual components of machines that deliver IMRT and how the distribution of radiation doses is displayed and recorded. Halfway through my project, I shadowed my mentor at the Mayo Clinic and was able to study the different machines and tools in person. During the final few weeks of my project, I researched brachytherapy in-depth and compared its potential errors and success rates to IMRT and VMAT.

• **BASIS ADVISOR:** Sarah Martinez • **ON-SITE MENTOR:** Danny Harrington • **LOCATION:** Mayo Clinic

## LAVANYAA G.

### PRESSING THE PERIOD POVERTY CRISIS

**ABSTRACT:** Public Health works to preserve the general well-being of the population. While many do not consider Menstrual Health a Public Health crisis, the reality is that the preservation of Menstrual Health is essential to maintaining good health. Consequently, we have tampons, pads, sanitary napkins, and other products, however, not every girl has access to these products. The Period Poverty Crisis regards these girls who cannot afford menstrual products or simply do not have access to them. Due to the stigma behind menstrual health, this issue is becoming more and more severe over time, and without any publicity, there is no way to combat this issue. I want to change this. Go With the Flow, a partnered organization with the National Organization for Women's Phoenix Chapter, targets the crisis by bridging the gap between education and menstrual health in select public schools in Arizona. By providing products to students, raising awareness of the issue, and collecting donations from the community, Go With the Flow creates an educational environment under which every girl can flourish. In my work as an intern for this organization, I aimed to consider what factors broaden the gap and what more we can do, as individuals and as a community, to solve this Public Health Crisis once and for all.

• **BASIS ADVISOR:** Ryan Carey • **ON-SITE MENTOR:** Dianne Post/Zoe Ebling
• **LOCATION:** Central Phoenix Inez Casiano NOW

## ELLA H.

### GLOBAL COLLABORATION AND BUSINESS IN TEXAS

**ABSTRACT:** In an increasingly connected world, Texas– the top international export state and the second highest import state in the US– motivates international collaboration by offering a competitive tax climate, a skilled workforce, and a variety of expert technology industries. Despite the pandemic, Texas entered 2021 as the ninth largest economy by GDP among world nations and entered 2022 with more jobs than before the pandemic. As companies including Tesla, Amazon, CBRE Group, HP, Samsung, and Oracle expand their Texas operations, the state's economy strengthens. Texas's economic and global success is in part due to the Texas Association of Business, which lobbies for pro-business public policies in Texas. To better understand how public policy fuels innovation and international collaboration, I interned at the Texas Association of Business based in Austin, Texas, assisting the Policy and Advocacy team with research regarding Technology and Infrastructure, Economic Development Incentives, Health Care, Education and Workforce, and Energy and Transportation, as well as with global work relating to trading partners such as Mexico and Israel. Drawing international talent and training K-college students build the workforce, making them key pieces of the business conversation. For that reason, I connected with school choice advocates from Texas and Arizona, sharing my charter school and Senior Project experiences. I ultimately hope that this project helps students understand the far-reaching impacts of policy, inspiring them to be informed citizens. Furthermore, Texas can serve as a policy making case study for other states aiming to expand their roles in international business.

- **BASIS ADVISOR:** Dana Johnson• **ON-SITE MENTOR:** Stephanie Matthews
- **LOCATION:** Texas Association of Business

## EMILY H.

### OVERLOOKED YET UNFORGETTABLE: THE ART OF DESIGNING

**ABSTRACT:** What is design exactly, and why is it so important? At the heart of design, it's human communication. Design is everywhere, and we interact with and gain important information from designs daily, whether it's through the user experience of a computer screen, a book's illustration cover, or through the billboards when driving. Design is often overlooked as an integral discipline, and this project explored what exactly makes design effective for school communities as well as the wider consumer sphere. By interning at the BASIS.ed Central Office in Creative Services, I experienced what it's like to be a designer within the professional industry, developed my skills in art and design and applied what I learned to my own creative projects. There, I worked on a variety of professional design projects, from photography to print, digital, and web publications. In my own creative projects, I hope to take my design knowledge from my internship to create my own designs, illustrations and animations. Ultimately, this project addressed the professional as well as my own design processes from start to finish, and by the end of the project, I explored a variety of mediums and learned how to create unforgettable designs.

- **BASIS ADVISOR:** Cheryl Berech • **ON-SITE MENTOR:** Andrea Devereux/David Coven
- **LOCATION:** BASIS.ed Creative Services

## AIDAN H.

### ON THE DEVELOPMENT PIPELINE OF MODERN VIDEO GAMES

**ABSTRACT:** How do computer games work? How does someone make them work? These are the questions you don't often hear asked, although many people know the immense effort that goes into creating a video game. Their saturation in the modern world has us taking their complexity for granted. In understanding the development process of video games, we can better understand the computer programs which uphold our digital world. Working remotely at home, my goal was to study the development pipeline of a video game to eventually build my own. Rather than just studying the development process from afar, however, a hands-on experience with designing and ultimately building a videogame yields a much better grasp of video game design. Available online is a plethora of computer video game development resources. Developing a 3D, first-person, open-world, sandbox game allowed the focus of the project to be on the underlying engine, the heart of the game, rather than on the specific game mechanics, graphics, or models, which can come later and are purely creative design choices. The under-the-hood processes and events share commonalities with many other areas of computer science and computer networking; it follows that they were the primary focus of my project.

• **BASIS ADVISOR:** Natasha Proctor • **ON-SITE MENTOR:** John Chen • **LOCATION:** Virtual

## JAYASANTHOSH PHANI K.

### COMBATING STRESS WITH KARATE

**ABSTRACT:** My Senior Project focused on the effect of karate on stress in everyday life. Stress is a huge problem that many people face in the world around us, including students, friends, and family. There are many methods to coping with stress, but I found the practice of karate or martial arts to be particularly interesting. Studying the effect karate has on stress is important because knowing what makes martial arts effective against stress can psychologically help us see the steps of how one can relieve it themselves. My research was conducted at Scottsdale Martial Arts Center (SMAC), which is where I have been training for the past 6 years of my life. SMAC is a great place to do my research because I am familiar with the protocol and work being done and there are plenty of people that can lead me in the right direction of how martial arts relieves stress. I found the answer by reading books on psychology relating to major changes in cortisol levels for example and doing a self-reflection on how doing karate repelled the anxiety I feel in myself. My main goal was to figure out what specific aspects of karate calm the human brain down to the point of relief and see the effectiveness of it against other alternatives.

• **BASIS ADVISOR:** Mason Waaler • **ON-SITE MENTOR:** Ray Hughes • **LOCATION:** Scottsdale Martial Arts Center

## SYLVAN L.

### A COMPUTER A WEEK KEEPS THE DOCTOR IN REACH: A PEDIATRIC TELEMEDICINE NARRATIVE ANTHOLOGY

**ABSTRACT:** Narrative Medicine is a rising field that uses medical storytelling to promote healing and empathy in the healthcare setting. As telemedicine rises, with the intent to increase medical efficiency by reducing time spent in clinics, with it, the question arises whether narrative medicine and telemedicine can coexist. When communication at both patient and physician's fingertips is faster than ever due to technology, it can become less viable to take the time to utilize narrative practices. Time is a resource that is rapidly becoming more and more important. How will this shift towards rapid care influence healthcare settings? Patients' care is often based on non-verbal communication. It may be especially critical to examine the increase in telemedicine, where a physician's abilities to detect body language cues are inhibited compared to in-person visits. Physicians must adapt a new skill set entirely. This project examined local current perceptions about telemedicine. I interviewed a convenience sample of 4 patients who have experienced telemedicine in the past 3 years due to the pandemic. My structured interview questions attempted to elicit whether patients felt heard and whether they were able to receive the optimal care desired. By listening to their narratives this project gained a better understanding of the balance of narratology and telemedicine in a clinic setting. My data showed that narrative practice and telemedicine can co-exist and at times, they could even improve the patient experience. My data also showed patients are shown to be comfortable with telemedicine, especially over extended uses.

• **BASIS ADVISOR:** Bonne De Blas • **ON-SITE MENTOR:** Robin Pearlstein, EdS MSN PMHN-BC • **LOCATION:** Virtual

## SIERRA M.

### THE HISTORICAL IMPACT OF PLAINS INDIAN SIGN LANGUAGE ON THE DEVELOPMENT OF AMERICAN SIGN LANGUAGE

**ABSTRACT:** The Whites have had the power given them by the Great Spirit to read and write and convey information in this way. He gave us the power to talk with our hands and arms, and… when we meet with Indians who have a different spoken language from ours, "we can talk to them in signs." - Chief Iron Hawk, Sioux Nation. Before the development of American Sign Language, sign languages were used by both deaf and hearing tribe members of indigenous American groups. Such languages have been documented in a region spanning from the Arctic to modern-day Peru. In particular, Plains Indian Sign Language was used as a lingua franca among the tribes of the Great Plains. PISL was referenced by Thomas Galludet, the co-founder of the United States' first school for the deaf, and documentation of the language's lexicon was widely distributed among educators of the deaf during the nineteenth century. As ASL became more formalized and the American government began to take more territory from Native Americans, deaf tribal members were sent to deaf schools where they were taught ASL and prohibited from using their native language. Due to cultural destruction on the part of the U.S, about 100 PISL speakers exist today. My research compared both ASL and PISL in order to examine the impact of PISL on the development of ASL and determine if ASL is one of the many ways that Native American culture has contributed to broader American culture.

• **BASIS ADVISOR:** Shannon James Kolodin • **ON-SITE MENTOR:** Dr. Tyler Peterson
• **LOCATION:** Arizona State University

## SIDDHARTH M.

### STOCK MARKET ARBITRAGE: USING DERIVATIVES AND ALGORITHMIC TRADING TO DEVELOP LOW-RISK INVESTMENT MODELS

**ABSTRACT:** Whether someone is deciding between sleeping in and attending their morning class or between living with a roommate and a studio apartment, the relationship between risk and reward plays some role in every decision we make. This relationship is the centerpiece of the investment industry. From private equity and venture capital to mutual funds and index funds, the goal of investment vehicles is to grow money in a way that aligns with the investor's needs and balances the risk-return tradeoff. After all, any investment carries a certain amount of risk. Or does it? In a perfectly efficient world, arbitrage opportunities in the financial market would never exist, but our financial system is nowhere near perfect. For my creative project, I have explored the investment opportunities that lie in these inefficiencies. I developed a derivative market screener that finds short-term low-risk arbitrage opportunities, using assets in both the stock and derivative markets to "beat the market." Specifically, I explored how options (European and American) can be incorporated into investment strategies in order to increase the risk-adjusted return of an investment. I have documented my journey of testing different models and investment theses like the put-call parity as I learned about quantitative trading and hedging. Ultimately, my goal has been to develop a short-term computer-assisted trading model that provides a higher risk-adjusted return than the Standards & Poor's 500 through searching option chains for arbitrage opportunities.

• **BASIS ADVISOR:** Dana Johnson • **ON-SITE MENTOR:** Darion Phan • **LOCATION:** Virtual

## ANANTH N.

### AIRWAY CC16 IN ASTHMA PATIENTS: A STUDY IN BRONCHOALVEOLAR LAVAGE FLUID

**ABSTRACT:** Asthma is an inflammatory process that causes difficulty in breathing due to airflow limitation and excess mucus production. It affects millions of people in the U.S. alone and there's no cure as of now. The inflammation associated with asthma is regulated by a group of proteins called pro-inflammatory cytokines. I aimed to explore these proteins in relation to another protein called Club Cell Secretory Protein 16 (CC16), which has anti-inflammatory properties. The research was conducted at the University of Arizona in Dr. Monica Kraft's lab which had the proper equipment for collecting bronchoalveolar lavage fluid (BAL fluid) and contained all the proteins of interest. We examined the BAL fluid through two different assays which provided us the concentrations of the proteins. The concentrations were then statistically analyzed through programs such as Excel and JMP to find significant connections between the concentrations of cytokines and CC16. In the end, we investigated the associations between CC16 and several different cytokines within normal and asthmatic participants in order to potentially find relations to the clinical phenotype of asthmatic subjects, which would expand pulmonary research.

• **BASIS ADVISOR:** Sarah Martinez • **ON-SITE MENTOR:** Dr. Monica Kraft • **LOCATION:** The University of Arizona

## WESLEY P.

### TACKLING HEALTH EQUITY: A NETWORK-WIDE COLLABORATIVE TO ADDRESS SOCIAL DETERMINANTS OF HEALTH FOR UNDERSERVED PATIENTS IN ARIZONA

**ABSTRACT:** The U.S. spends more on health care than any other industrialized country but has extremely lackluster access to care and inequitable care. Social Determinants of Health (SDOH) are the conditions in which people are born, live, work, play, and age, and these circumstances influence a wide range of quality-of-life factors. This work aims to develop a thoughtful strategy and operational framework in order to identify and address social health needs, target underserved, high-need populations and connect them with the proper resources. This project aims to develop an electronic screening and data collection framework to address SDOH. The SDOH Collaborative was developed with the goal of using food insecurity to build the data framework for assessing and addressing SDOH factors that impact our patient's health outcomes. The first phase included screening for food insecurity using the Hunger Vital Sign questionnaire embedded into Electronic Health Record (EHR). We worked with our Data Analytics team to build the reporting infrastructure. Using the Plan-Do-Study-Action (PDSA) methodology, we streamlined workflows for the collection and analysis of data. This research is expected to yield actionable data indicating where targeted aid for SDOH resources can be distributed and provided. This project attempts to reduce health disparities and improve the health of the local community. It is a stepping-stone that will empower healthcare and social workers to locate areas with the most need and provide the proper resources. Our next steps are developing Clinical Decision Support tools and integrating the assessment digitally to reduce clinician fatigue. We also plan on developing a digital pathway for patients who have SDOH and linking them to their underlying chronic diseases, in line with our population health strategy.

- **BASIS ADVISOR:** Ryan Yanashima • **ON-SITE MENTOR:** Dr. Alison Essary
- **LOCATION:** Honor Health Thompson Peak Medical Center

## EMMA P.

### EXPLORING NATUROPATHIC MEDICINE THROUGH PHYTOCHEMISTRY AND MOLECULAR BIOLOGY

**ABSTRACT:** Many communities around the world depend on traditional, plant-based medicines, and when it comes to finding innovative treatments for diseases, pharmacognosy research, the study of medicinal drugs obtained from plants, holds promise. Over the course of my project at the Ric Scalzo Institute for Botanical Research, I sought to answer the overarching questions: what is the relationship between Traditional medicine and Western medicine and how do plants become effective treatments against diseases? By researching and analyzing several plants that have been historically used in botanical treatments across various cultures, I was able to learn about how naturopathic approaches and treatments can fill in gaps left by Western medicine while Western medicine techniques can provide evidence-based information on traditional, botanical therapies. My responsibilities in the lab were centered around chemical isolation work that aims to characterize the phytochemistry of medicinal plants to learn more about the key chemicals that cause the plants' therapeutic effects. I also shadowed bioassay experiments that tested and quantified the therapeutic effects of potential naturopathic-based treatments. This project allowed me to collect data on the biochemical makeup and usefulness of Ashwagandha as a treatment for mental alertness, of Artemisia annua as a treatment for COVID-19, and of Banisteriopsis caapi as a treatment for PTSD among other ongoing experiments. Furthermore, my time at Ric Scalzo gave me a better understanding of drug development and experimental design as well as the hands-on skills and methods used in biology research and pharmacognosy.

- **BASIS ADVISOR:** Ryan Yanashima • **LOCATION:** Ric Scalzo Institute for Botanical Research
- **ON-SITE MENTOR:** Dr. Yalda Shokoohinia / Dr. Jeffery Langland / Dr. Keely Puchalsk

## RILEY R.

### UNDERSTANDING THE NARRATIVES OF HOW THE COVID-19 PANDEMIC HAS AFFECTED CHILDREN WITH DISABILITIES

**ABSTRACT:** The COVID-19 pandemic has disproportionately affected the development of young children with physical and/or developmental disabilities, limiting in-person therapy services and exacerbating the pre-pandemic barriers these children already face in accessing effective healthcare. However, the accessibility gap children with disabilities face starts even with accessing toys, which are critical for children to engage with the world around them. Many toys (called switch-adapted toys) made specifically for severely disabled children are extremely expensive: a single toy can cost anywhere from $50–$200. My senior project aimed to address two questions. The first question concerns parents' narratives as to how COVID-19 has affected the development of their children with physical and/or developmental disabilities. I interviewed parents of children with disabilities at the Paradise Valley School District's James P. Lee Early Childhood Learning Center. The second question is how/to what extent switch-adapted toys may help the development of children with disabilities. As many of the severely physically disabled children do not have access to these toys, I created them by electrically adapting regular "off-the-shelf" battery-operated toys and rerouting the circuit to a larger button switch. Over the course of my project, I observed whether or not the switch-adapted toys may have made any improvement in the children's development. Through my project, I aimed to better understand how the pandemic has affected young children with disabilities and to provide an outlet for parents of these children to share their stories on how the pandemic has affected their children.

• **BASIS ADVISOR:** Bonne De Blas • **ON-SITE MENTOR:** Stacy Thomas
• **LOCATION:** James P. Lee Early Childhood Learning Center at Paradise Valley School District

## GINA R.

### THE IMPACT OF COVID-19 ON DENTAL PRACTICES

**ABSTRACT:** The operations of many different industries have been affected by the COVID-19 pandemic, and dentistry is no exception. Private dental practices have needed to adapt to changes that include a necessity for more extensive personal protective equipment, national health guidelines mandated by the American Dental Association, and differing attitudes in patients, ranging from apathy to anxiety. Additionally, due to changes in employment or other finances, many people lost coverage from dental insurance. With these many changes in mind, I wanted to research how the COVID-19 pandemic affected the dental industry, specifically in terms of inpatient adherence to routine dental exams and treatment. Because little-to-no prior research focuses on the individual patient's role in dentistry following the COVID-19 pandemic, I was interested in analyzing trends in how patients newly approach dentistry in the world of a global pandemic. At a private practice, I worked as an administrative assistant, learning the business aspects of a dental office. I digitized patient forms and filed information into the online software used at the office, as well as confirmed the validity of patient dental insurance prior to each appointment. From a patient database, I recorded changes in adherence to regular appointment times, examining variables like age and sex. My research sought to draw conclusions about how dental practices and patients might have been affected by the emergence ofCOVID-19; by isolating patient concerns about dentistry, I developed possible solutions to streamline the administration and recovery of general dental practices following the pandemic.

• **BASIS ADVISOR:** TJ Peacher • **ON-SITE MENTOR:** Ruby Villasenor • **LOCATION:** Lakeview Dentistry

## SOHAM S.

### ABSTRACT-BASED SCREENING FOR CLINICAL SYSTEMATIC REVIEWS AS QUESTION ANSWERING USING NLP

**ABSTRACT:** Clinical systematic reviews (SR) are tools to synthesize the totality of evidence for clinical practice. The process for conducting a clinical SR is typically done in three steps:(1) search bibliographic datasets, (2) screening of obtained articles based on their title and abstract, and (3) full-text review of included articles. These steps not only require a large amount of time and a considerable workforce with expertise but also are error-prone and inefficient. Even now, the rate of publication of research in the biomedical field has been exponentially increasing, further making it difficult to organize new findings. Thus, synthesizing the totality of evidence within a specific domain becomes both time and resource-intensive. Hence, automation of these steps is required. Title-Abstract screening is one of the most time-consuming steps in the production of SRs. Many recent natural language processing (NLP) models have been proposed which received remarkable performance on natural language understanding tasks. However, when applied to the SR task, several limitations arise. To overcome them, we wish to reformulate systematic review as a question-answering (QA) problem. In my Senior Project, I presented the empirical study of the proposed QA approach on datasets developed from more than six different clinical SRs. By the culmination of my Senior Project, I gained insight on these questions: Can existing NLP and Deep Learning methods be efficient in the automation of clinical SR? More specifically, is the NLP QA methodology effective in carrying out automation compared to existing approaches for automating SR?

• **BASIS ADVISOR:** Steven Madler • **ON-SITE MENTOR:** Dr. Chitta Baral• **LOCATION:** Arizona State University

## DHRUV S.

### BEHIND THE CURTAINS OF VIDEO GAMES

**ABSTRACT:** Video games are usually reduced to a form of entertainment. While this description was true for the original video games that were developed in the 70's and 80's, today's games are much more. The games of the 70's and 80's, like Tetris, were basic and linear; however, today's games implement advanced systems like dynamic weather, intelligent background characters, realistic driving, and character customization to make the game world engaging and dynamic. These systems bring video games from a form of entertainment to an outlet of experiencing living, breathing worlds with next-level realism - much like a simulation. For my project, I explored the development of such games and aimed to understand how to create the complex systems used in current games. To do so, I used the development software Unity to build my own unique game with systems like combat, procedural terrain generation, weather systems, and multiplayer to name a few. Rather than a strict research project, this project is more of a journey aimed at exploring a field I find interesting. Through blog posts, I shared this experience and the insight I acquired when creating video games.

• **BASIS ADVISOR:** Mason Waaler • **ON-SITE MENTOR:** Hyunglae Lee • **LOCATION:** Virtual

## ANINDYA S.

### PLANTI: CREATING AN APP THAT REDUCES STRESS USING A VIRTUAL ASSISTANT

**ABSTRACT:** We carry history in our pockets. Since the dawn of the 21st century, humanity has become reliant—for better or for worse—on perhaps one of the most impactful innovations in modern history: the smartphone. With hundreds of apps being published on the iOS App Store and the Google Play Store every day, the mobile application has become one of the largest startup markets of the 21st century. However, while most applications focus on market trends such as Artificial Intelligence or FinTech, few focus on people and social wellbeing. As people become increasingly reliant on technology, it is necessary to focus on this important sector. In this project, I created and designed a mobile application called Pland while simultaneously learning about market research and clinical psychology. The application consists of two main components: a morning routine and an evening routine which aim to prevent overbearing stress by reducing decision-making. Over the course of the project, I learned from skilled mentors in psychology and design to efficiently add features to my app that not only aim to reduce stress but also look visually appealing. Furthermore, I learned about the two-pronged process of programming an app and used it to develop a database and User Interface. Lastly, I published the application on an interface known as Expo as a first step to receiving user feedback. Overall, I created and published an application by combining my interest in programming and psychology.

• **BASIS ADVISOR:** Steven Madler • **ON-SITE MENTOR:** Anushka Kumar • **LOCATION:** Virtual

## MADHURA S.

### STAY IN SCHOOL, KIDS: COMBATTING SCHOOL PUSHOUT

**ABSTRACT:** For millions of students across the country, staying in school is a lot harder than just attending. The school-to-prison pipeline is currently one of the most significant problems in education; it describes the phenomena where students are pushed out of the schooling system through limited counseling resources, discrimination, profiling, and harsh disciplinary policies. This problem is exacerbated by the high volume of schools that prioritize instituting police officers, known as School Resource Officers (SROs) on campuses, over mental and wellness professionals like counselors or psychiatrists. Unfortunately, the presence of SROs on campuses has been shown to increase carceral punishments and violence. School pushout largely targets students of color from low-income backgrounds, creating a cyclical problem where students from communities with limited resources and high crime rates are funneled into juvenile detention centers or even prisons, contributing to the larger problem of mass incarceration. Through my work at the ACLU, I was a campaign intern for Demand2Learn, an education equity initiative seeking to reduce the number of SROs on Arizona's high school campuses, lobby for reform at the school board level, and limit the scope of disciplinary policies. Specifically, I engaged in discourse about literature surrounding pedagogy and incarceration, interviewing students and families that have experienced school pushout, and contributed to policymaking that will reform education in Arizona.

• **BASIS ADVISOR:** TJ Peacher • **ON-SITE MENTOR:** Cynthia Diaz • **LOCATION:** ACLU Arizona

## BHAVYASRI S.

### COLORISM AND COSMETICS: AN ANALYSIS OF THE IMPACT OF MEDIA/CELEBRITIES ON THE SKIN-BLEACHING PHENOMENON AMONG SOUTH AFRICAN YOUTH

**ABSTRACT:** Western beauty standards pressure females to conform to the notion of having a youthful glow, fair skin, and a thin and toned body: a concept stemming from the "white superiority" complex implemented during colonial times. A crucial issue within non-Western countries is that many try to overcome their cultural and individual features to be accepted. What has recently come to light is the rising number of men who are also participating in this process of skin-lightening. Out of all the documentaries I've watched, one of them dove into the impact of skin-whitening done by celebrities on the youth of a certain neighborhood in South Africa. Recalling suggestions my faculty advisor had regarding the influence of media, I focused on this topic with South Africa since it is a region I am familiar with it. Despite the products being banned from South Africa, you can still find them within the market in large quantities, and specialized clinics have opened with monthly treatments. Through this project, I have offered an answer to the question "Should the media be accountable for the rise in skin-whitening?" At Mesa Community College, I worked on conducting a cross-cultural analysis from the perspective of a cultural anthropologist through discussions with my mentor and readings found through their library. Independently, I analyzed various case studies and interviewed campaign leaders and various reporters. Through this project, I aimed to raise awareness around the world regarding the danger of such products.

• **BASIS ADVISOR:** Becca Real • **ON-SITE MENTOR:** Casiana Pascariu • **LOCATION:** Mesa Community College

## NATHAN T.

### THE THEORY BEHIND RECURRING REVENUE IN SPORTS: HOW TO ATTRACT AND RETAIN MEMBERS

**ABSTRACT:** Amidst high volatility and general uncertainty about the future of the economy, many companies turn to recurring revenue models in hopes of stabilizing their financials. Most often, recurring revenue comes in the form of subscriptions to various products or services, with companies such as Netflix and Spotify pioneering new models. In sports, recurring revenue appears in the form of monthly or yearly memberships that clients purchase to access a facility or program. However, with sports facilities having been closed for nearly a year and a half due to the pandemic, attracting new members and retaining old members is a glaring issue. At Legacy Sports' newest facility, a 320-acre multipurpose sports complex in Mesa, I worked with pickleball director Ryan Trefry to analyze the most efficient forms of membership attraction and retention. Pickleball, the fastest growing sport in the country, has become the prime case study for recurring revenue as more and more facilities convert their existing tennis courts into new pickleball courts. As a player myself, the influence of events like lessons, clinics, and tournaments on a player's willingness to purchase a membership is undeniable. Consequently, while interning at Legacy and working with various other facilities around the state, I determined why these events were effective in attracting new members, how different events had varying effectiveness in attracting and retaining members, and what monetary incentives memberships provided both clients and companies.

• **BASIS ADVISOR:** Dana Johnson • **ON-SITE MENTOR:** Ryan Trefry • **LOCATION:** Legacy Sports

## SUNIL V.

### THE SMITH NORMAL FORMS OF MATRICES

**ABSTRACT:** Algebra influences life everywhere in the world. When you're ordering food at a cafe, that can be modeled using abstract algebra. When you're sending an electronic message, abstract algebra is what ensures its security. When companies store data, they use matrices to encode user info and store it, and this concept is also Abstract Algebra. When using relativity to model space-time causal relationships, abstract algebra is the underlying concept. Such an important field to our society, but there are so many ideas left to discover. The best part is that we only need a pencil and paper to advance math, so I could effectively conduct my research virtually, from home. My research involves Algebraic Geometry and Abstract Algebra as a whole. Algebraic Geometry, the topic of this research, is involved in statistics, robotics, phylogenetics, game theory, modeling, and much more. Imagine if we have data in an n×n grid. We can simplify this data to only have numbers along the diagonal of the grid. Eventually, these numbers stop, so there are k≤n numbers on the diagonal, and all other data entries in the matrix are 0. This is called the Smith Normal Form of a matrix (SNF for short). Let A be this grid, formally called a matrix. By using Python to study computational examples, I drew conclusions to answer the following questions: Question 1: What is the relationship between SNF(A) and SNF (A2)? Question 2: Can SNF(Am) be deduced from SNF(A) for any m>0?

• **BASIS ADVISOR:** Steven Madler • **ON-SITE MENTOR:** Bryden Cais
• **LOCATION:** University of Arizona - Department of Mathematics (Virtual)

## NEHA V.

### INITIATING MUD-PUDDLING BEHAVIOR IN TROPICAL BUTTERFLIES

**ABSTRACT:** Although butterflies specialize in nectar consumption, they also seek dissolved nutrients in moist ground consisting of mud, dung, and carrion. This behavior—commonly referred to as "mud-puddling" or "puddling"—enables butterflies to uptake salts, amino acids, and essential nutrients that their diets are otherwise poor in. Oftentimes, the nutrients obtained through puddling are transferred from male to female butterflies during mating to serve as nuptial gifts. However, within the butterfly exhibit at Butterfly Wonderland, there are currently no sources of mud for butterflies to puddle at, and prior attempts to initiate this behavior have been unsuccessful. During my research project, I worked to initiate mud-puddling behavior in the butterflies housed in Butterfly Wonderland. I focused on three key questions: what kind of mud are butterflies most attracted to? What species of butterflies tend to puddle? And what other factors lead butterflies to puddle? Through my research, I hope to provide a healthier living environment for the butterflies within the exhibit, and ultimately contribute to larger-scale butterfly conservation efforts.

• **BASIS ADVISOR:** Juhee Park • **ON-SITE MENTOR:** Adriane Grimaldi • **LOCATION:** Butterfly Wonderland

## HAROLD W.

### CAN AI DETECT HUMOR? EVALUATING EXPANDED APPLICATIONS OF NLPS FOR EDUCATIONAL USE

**ABSTRACT:** Can Artificial Intelligence (AI) detect humor? Evaluating expanded uses of Natural Language Processing (NLP) AI in education. Online learning is hard. Despite the novel importance of online resources to aid in the learning process due to the COVID pandemic, there is still significant progress to be made in adapting technology to the needs of students. My project centered around the use of Natural Language Processing (NLP) in personalizing the educational experience. NLP describes machine learning programs that can understand and analyze human conversation and writing, and the Science of Learning and Education Lab at ASU uses NLP to identify patterns in student writing. In the past, NLP has been used to mimic human grading, identify trends in student creativity and even detect student burnout. I explored how humor in academic writing can be detected by AI, and how this can highlight a trend in student performance. However, there are numerous other variables that emerge in a student's writing that can reflect the student's wider performance. In the end, I aimed to develop a more accurate model to understand student attrition during online learning. I also aimed to find resources that can help teachers improve the learning experience in a virtual environment. NLP's ability to grade texts isn't exactly on-par with human feedback, but through my research, we will continue to assess whether NLP can adequately substitute mentor feedback, especially in large classes such as Massive Open Online Courses. The ability of NLP to analyze the quantity of data of online learning allows it to provide accurate reports to both teachers and students.

- **BASIS ADVISOR:** Becca Real • **ON-SITE MENTOR:** Dr. Tracy Arner
- **LOCATION:** Science of Learning and Educational Technology Lab at Arizona State University

## HANNA Z.

### TEACHING AND LEARNING AN ADVANCED CURRICULUM

**ABSTRACT:** Childhood education tackles the unique goal of developing wisdom in the mind of a child while also teaching essential skills like Arithmetic and English. The question is: How does one transmit knowledge without infringing on the freedom that the development of wisdom requires? The traditional and constructivist classroom models were developed by developmentalists seeking an answer to this question. The traditional model, based on objectivism, advocates for a rigid classroom without much student input, focused on simply imparting knowledge upon students. Meanwhile, the constructivist model pushes for the exact opposite, a nearly structure-less class led by students, focused on developing their creative intelligence. While each model is extreme, a successful classroom can be created when elements of each are used simultaneously. BASIS Scottsdale Primary, the site of my project, promises both an advanced curriculum and social-emotional development. I evaluated the methods used to teach and their effects based on the constructivist and traditional classroom models. Based on my research, I aimed to better understand the balance between both teaching models as well as their specific observable advantages and disadvantages in a non-extreme classroom setting.

- **BASIS ADVISOR:** David Glosser • **ON-SITE MENTOR:** Brittany Walker • **LOCATION:** BASIS Scottsdale Primary East

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# Scottsdale SENIOR RESEARCH PROJECT

## ISHITA M.

### PARAMETRIZATION OF A MESOSCALE SIMULATION MODEL FOR PROTEIN SOLUTIONS

**ABSTRACT:** From acting as enzymes to protecting against foreign particles to providing structural support, living organisms comprise thousands of proteins collaborating to enable life. Proteins experience direct and indirect interactions with other protein and water molecules which dictates their conformation, stability, aggregation, and ultimately function. The indirect interactions are determined by the dense spatial arrangement of proteins, which make up 40%of cells. However, many in vitro experiments are feasible only for dilute protein solutions, which disregards indirect interactions. In silico computational simulations are attractive alternatives which can see the simultaneous, direct observation of all molecules in a system. Although, explicitly defining each and every molecule is computationally expensive. Instead, implicitly defining solvent particles as one continuous medium is more feasible. Now, how this solvent is implicitly defined is vital in developing an overall reliable protein-protein interaction model. This leads to my research question, "How can solvent-mediated interactions be parametrized to construct a reliable, mesoscale simulation model for protein solutions?" In this project, multi-conformation Monte Carlo simulations were used to simulate interactions between proteins in solution.
A two-phase thermodynamic model was used to define solvent-mediated interactions. A new protein-protein interaction potential was used that combines multiple terms to describe electrostatic, van-der-Waals, and water-mediated interactions. Radial pair correlation functions, structure factors, and second virial coefficients of the osmotic pressure were computed from simulations of lysozyme solutions and compared to experimental data. A scaling parameter in the protein-protein interaction potential was then varied to optimize the agreement between simulations and experiments.

• **BASIS ADVISOR:** Shannon James Kolodin • **ON-SITE MENTOR:** Dr. Matthias Heyden • **LOCATION:** Virtual

## OM P.

### BACTERIA, DON'T HIDE: 4-AMINOBENZALDEHYDE AND ITS FEASIBILITY AS A NOVEL MAINSTREAM ANTIBIOTIC

**ABSTRACT:** Antibiotic resistance is one of the greatest threats to humanity, threatening 2.8 million lives annually in the United States alone, and hundreds of strains of bacteria have emerged that are resistant to at least one antibiotic. My previous research determined a highly-effective natural antibiotic, analyzed the functionality of the components of the natural extract, and applied the information to the development of a novel, naturally-inspired antibiotic compound that is largely nontoxic to mammalian cells. The result of this process was the proposal of 4-Aminobenzaldehyde as a novel antibiotic medication. However, as with any drug development process, newly-discovered compounds require lab trials to prove their developmental claims. Therefore, this project sought to answer the question, "Can 4-Aminobenzaldehyde feasibly be used as a novel, mainstream antibiotic?" To answer this question, my project focused on testing 4-Aminobenzaldehyde to determine its ability to prevent bacterial growth, efficacy in killing bacterial cells, and level of toxicity to mammalian cells. I conducted several laboratory tests, including Kirby-Bauer assays, whereby agar petri dishes are inoculated with bacteria and discs of antibiotics to determine if an antibiotic can prevent bacterial growth, and Minimum Inhibitory Concentration (MIC) tests, whereby a serial dilution of antibiotic solution is inoculated with bacterial culture to determine the minimum concentration of antibiotic required to prevent bacterial growth. With this data in hand, I was able to safely conclude the feasibility of 4-Aminobenzaldehyde as a potential mainstream antibiotic.

• **BASIS ADVISOR:** Shannon James Kolodin • **ON-SITE MENTOR:** Sadhana Ravishankar, Ph.D/Santosh Hanmod, M.D
• **LOCATION:** The School of Animal & Comparative Biomedical Sciences at the University of Arizona; Banner Desert Medical Center

The teachers, administrators, staff, and executive leadership of the BASIS Charter Schools network **commend all of our seniors for their perseverance** in their research, and for their hard work throughout their BASIS Charter School journey. We give **our most heartfelt congratulations** to them for their achievements thus far, and these projects are only the beginning!

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