UNIVERSITY of VIRGINIA

4-VA at UVA

2022 FUNDING CYCLE REPORT

Welcome to 4-VA at UVA!

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University of Virginia

Whether facilitating new collaborations in research or supporting pilots of emerging technologies to support teaching and learning, 4-VA continues to be a driving force for innovation at the University of Virginia. The 2022 grant year represents a year of recalibration for 4-VA at UVA; the team expanded to include a new deputy campus coordinator and much of the pandemic-induced uncertainty of the two years prior receded. With a renewed focus on fostering collaborations, improving efficiencies, and identifying innovative solutions to educational challenges, 4-VA at UVA reaffirmed its commitment to the Collaborative Research Grants program and testing cutting-edge educational technology.

In 2022, 4-VA at UVA supported 29 UVA faculty members in their collaborations with faculty members at other Virginia public institutions of higher education, representing $499,000 in grant funding and opportunities for at least 29 students to engage in faculty-led research. In the pages that follow, you will have the opportunity to review assessment data that underscores the broad impact of the 4-VA at UVA Collaborative Research Grants program and read summaries of the groundbreaking research that was supported by the program in 2022.

In addition to facilitating research partnerships across Virginia institutions, 4-VA at UVA supported the pilot of a new technology, Gradescope, to support teaching and learning. This software facilitates an instructor's ability to provide detailed feedback to students and supports a more efficient approach to expanding learning assessment possibilities.

In 2022, 4-VA at UVA built upon an already strong foundation to expand opportunities for leveraging the strengths, resources, and expertise of member institutions. In addition to 4-VA at UVA grant recipients, much credit is due to the 4-VA at UVA team, UVA Provost's Office, and the 4-VA offices at our collaborating institutions for enabling this important work.

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COLLABORATIVE RESEARCH GRANTS

4-VA

Collaborative Research Grants offer faculty the opportunity to utilize seed funding to leverage expertise and resources around the Commonwealth. There are two funding mechanisms in the 4-VA at UVA Collaborative Research Grants program: primary funding is awarded to a UVA faculty member who is the lead Principal Investigator (PI) on a project and complementary funding is awarded to a UVA faculty member who is a Co-PI on a project funded by another 4-VA institution. With access to funding via a 4-VA Collaborative Research Grant, faculty teams can build evidence to show that their projects will make valuable, impactful contributions to their fields, thereby increasing their chances of winning larger external grants.

In the 2022 award year, the 4-VA at UVA Collaborative Research Grants program supported UVA faculty through 15 primary funding awards and 14 complementary funding awards, representing academic departments across the University and collaborations with four other 4-VA institutions.

Primary funding

$429,000
Total

$28,600
Average

Complementary funding

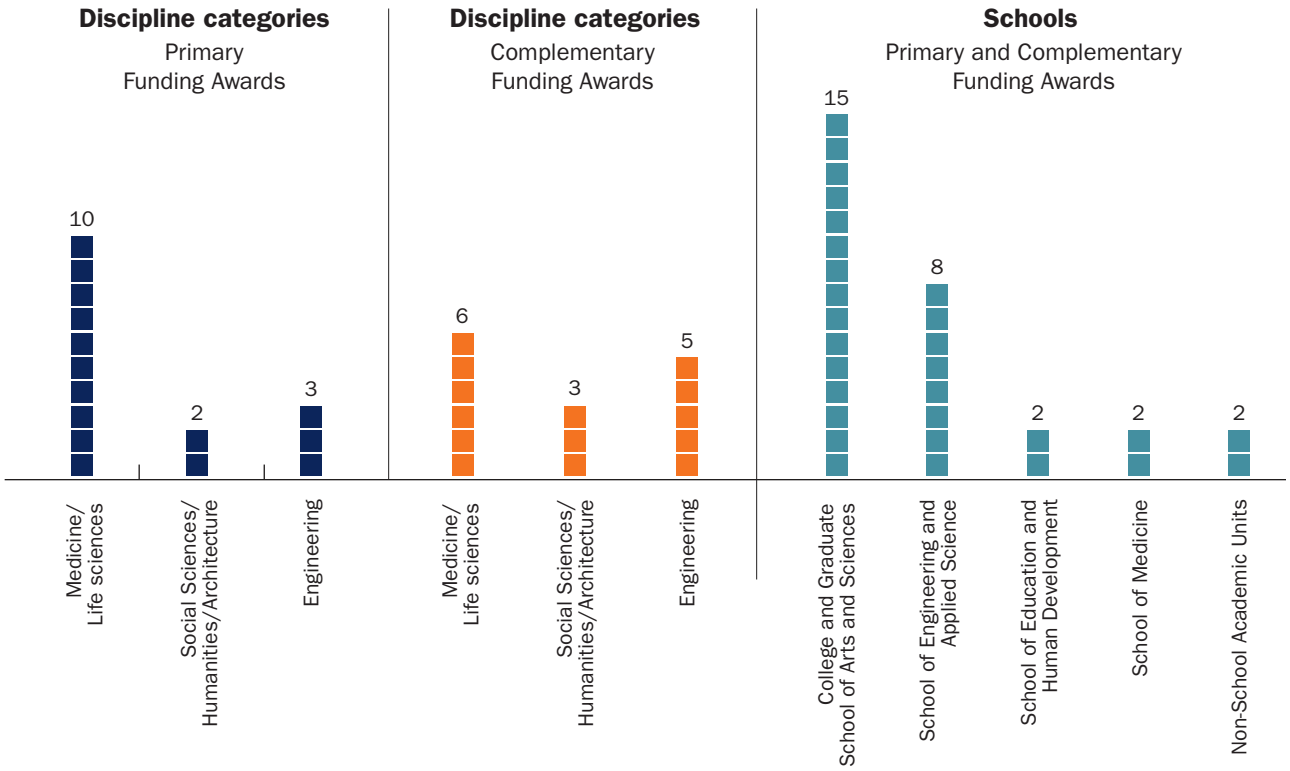
$70,000
Total

$5,000
Average

4-VA at UVA 2022 investment in collaborative research

$499,000
Total

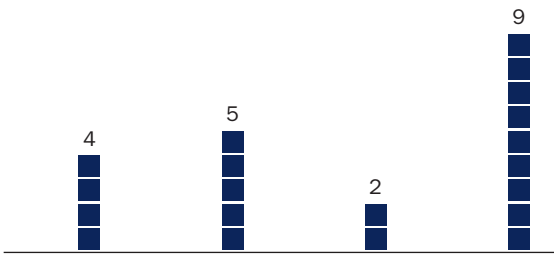
The 2022 Collaborative Research Grant award year was inclusive of faculty across the University.



Collaboration

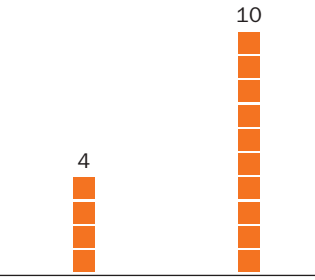
The 4-VA at UVA program encourages UVA faculty members to collaborate across the Commonwealth.

Primary Funding Award Collaborations by Institution



Note: several primary funding awards included collaborators at multiple institutions

Complementary Funding Award Collaborations by Institution



From a sample of 15 CRG Studies:
10 indicated that their non-UVA Co-PI was a new professional connection with whom they had not previously worked

Impact

4-VA Collaborative Research Grants are intended to enable faculty teams to test ideas in pursuit of subsequent external funding opportunities. To better understand the program's impact on this goal, a survey was administered to all 2022 4-VA at UVA CRG primary funding award recipients (n=15). Although the survey was administered barely a year after their initial 4-VA CRG award, the data suggest that 2022 CRG primary funding recipients are actively engaged in disseminating their findings and pursuing external funding awards, and much of this work remains ongoing.

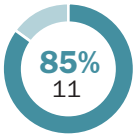
Of survey respondents, three have applied for external funding and seven more are in the process of applying. As of publication of this report, $3.7M in external funding has been received as a result of the initial investment from 4-VA at UVA. Additionally, respondents were asked to report their successes in disseminating the findings from the studies supported by 4-VA at UVA, specifically whether UVA PIs pursued journal publications and conference presentations. Two respondents have written journal articles that have already been accepted for publication with six additional respondents currently drafting articles for review; three respondents have been accepted to present their findings at scholarly conferences. Five primary award recipients (42%) leveraged their 4-VA CRG project to begin a new, related study.

Student engagement is an important element of the Collaborative Research Grant program, and when asked about student participation in their projects, 4-VA at UVA CRG primary award recipients indicated a strong commitment to providing hands-on learning experiences in research training.

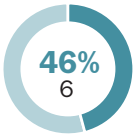
Projects reporting student involvement

Number of students participating: **14 Undergraduates; 15 Graduates**

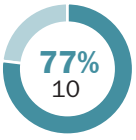
Data Collection



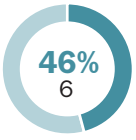
Data Entry



Data Analysis



Manuscript Drafting



Beyond gaining valuable hands-on training in research methods, students are finding ways to translate their CRG experience to the classroom. Survey respondents indicated that their 4-VA at UVA CRGs have supported undergraduate papers and presentations (7), poster presentations (3), and doctoral dissertations (5).

COLLABORATIVE RESEARCH GRANT *SUCCESS STORIES*

Resource Use at a Critical Life Stage: Pollen Collection by Queen Bumblebees

2022 4-VA AT UVA COLLABORATIVE RESEARCH GRANT RECIPIENT

Study volunteers used nets to capture queen bumblebees. The research team then collected and analyzed pollen from these samples for DNA barcoding.

Dr. David Carr, Research Associate Professor of Environmental Sciences, and Director Blandy Experimental Farm

Across news channels and social media, reports about the demise of bumblebees are plentiful. Dr. David Carr, University of Virginia associate professor and Director of the Blandy Experimental Farm, is a believer that in addition to their buzzing around our headlines and gardens, bumblebees can teach us about the impact of the habitat loss and other landscape challenges. To better understand bumblebee behaviors, environments, and ecological contributions, Carr applied for a 4-VA at UVA Collaborative Research Grant, in partnership with Dr. Haw Chuan Lim at George Mason University, for a study titled "Resource Use at a Critical Life Stage: Pollen Collection by Queen Bumblebees." In this study, Carr's primary goal was to develop a better understanding of the resources necessary to promote a healthy bumblebee population.

To understand the impact of Dr. Carr's research, it is helpful to make a distinction between the honeybee and the bumblebee. According to Dr. Carr, "While a honeybee queen lives for a few years and the hive survives over time, a bumblebee hive starts from scratch every year." This difference is important because a honeybee hive can prepare for winter by sending out worker bees to collect pollen and nectar, allowing the whole colony to endure resource-depleted seasons. On the other hand, a queen bumblebee does not have loyal bees to prepare for the harshness of winter and must fend for herself after coming out of hibernation.

When considering the plants, flowers,

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Kelsey Schoenemann, a UVA doctoral candidate in Environmental Science, used field experience and data from this 4-VA project as a foundation for her dissertation. Looking to the future, she plans on pursuing a career that focuses on environmental justice and local policy development, with an emphasis on native biodiversity. She said she is thankful for the 4-VA funding, as this project has allowed her to expand her professional network and gain skills that complement her professional goals. Schoenemann identified the highlight of her 4-VA work as getting to interact with the broader community and engaging in conservation conversations with a diverse group of volunteers.

and trees that bumblebees use to gather nectar and pollen, Carr notes that "we don't know which ones are most important and which ones [bumblebees] bring pollen back from because they don't bring pollen back from every location." To address this knowledge gap, Drs. Carr and Lim, aided by Ph.D. candidate Kelsey Schoenemann, studied bumblebee queens from six different species at twenty-five sites across the Commonwealth of Virginia.

To maximize their sampling, Ms. Schoenemann recruited volunteers from the Virginia Master Naturalists to identify queens, collect them with nets, sample pollen, and take photos. Schoenemann conducted trainings prior to the queens' annual emergence and then dispatched her cadre of volunteers to collect samples at three different phases of the season. By separating the sample collections into three stages, the researchers were able to assess changes in bumblebee nutrient collection over time. Data collection is ongoing, and the team is hopeful to begin analysis soon (as of this article, Dr. Carr estimates the team has collected data on over 500 queens).

Looking to the future of his research, Dr. Carr outlined three major next steps. First, he said that he wants to involve more graduate students in the EXPAND program at UVA so they can have diverse learning experiences. For instance, Dr. Lim trained Ms. Schoenemann to DNA barcode over 200 samples during the project. A second step will be to use the findings from this study to develop a better understanding of how various environments impact bumblebee populations and life cycles. A final third step would be to conduct an economic analysis of the decline of bumblebee populations, given that some food crops can only be pollinated by bumblebees (e.g. tomatoes).

A bumblebee queen with pollen sample. Specimens from six different bumblebee species were collected by volunteers across the Commonwealth.

When asked about the impact that the 4-VA at UVA Collaborative Research Grant had on his work, Dr. Carr credited the program as a catalyst for reaching out to other Virginia universities, learn about people's expertise, and engage new colleagues in scholarly discussions.

Dr. Carr and Dr. Lim's research highlights the Collaborative Research Grant's impact across the Commonwealth by engaging community members and focusing scientific research on real-world problems. The team's efforts to better understand the impact of habitat loss and ecosystem changes on bumblebees provide an important foundation to continued study of the healthy, vibrant environments that will allow bumblebees to thrive. Their work reduces the distance between the academy and the backyard garden, creating opportunities to make meaningful contributions to bumblebee conservation.

Microfluidic Platform to Manipulate and Assess Neuronal Electrical Activity

2022 4-VA AT UVA COLLABORATIVE RESEARCH GRANT RECIPIENT

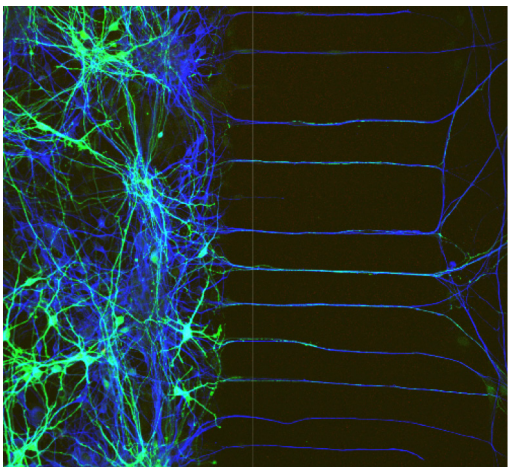
Dr. Christopher Deppmann, Associate Professor of Biology, Associate Professor of Biomedical Engineering

One of the hallmarks of 4-VA's Collaborative Research Grants (CRG) program is the formation of new scholarly connections between faculty members across the Commonwealth. Partnering with Dr. Christopher Hughes at James Madison University, Dr. Christopher Deppmann, UVA Professor of Biology, leveraged support from 4-VA at UVA to explore how neurons - the nerve cells of the central nervous system - connect and communicate.

Providing a foundation for his work, Deppmann highlights how neurons are unique cells that have distinct structures and features. Neurons communicate by receiving information at specialized receptors called dendrites, passing the signal through the body and axon of the cell, and then sending the message across a synapse, using neurotransmitters, to a new neuron.

Deppmann contextualizes his research as a "reductionist approach to understanding information processing." Broadly speaking, the researchers are translating the language of brain behavior, one neuron at a time, building their individual vocabulary until they can create more complex networks. Specifically, Deppmann describes his work as "…create[ing] a microchip made of neurons… [which] allows us to understand where the different parts of the neuron are and how they connect to other neurons." While any neuron system can be constructed and manipulated, Deppmann focuses on the fight-or-flight system and is working on more efficient ways to measure the release of the neurotransmitter norepinephrine.

Speaking about his work, Deppmann



Neurons suspended in microfluidic devices. Deppmann uses images like these to better understand, map, and manipulate neuronal activity.

expresses gratitude for the investment of 4-VA at UVA CRG funds, "Collaboration is where innovation happens as different disciplines come together and do something they could not have done on their own." Through his 4-VA CRG award, Deppmann was able to support undergraduate student travel to JMU to gain firsthand experience working in clean room facilities and producing microfluidic platforms.

Deppmann's study is a collaborative experience built on a thirteen-year relationship that is grounded in "imagination and science fiction brainstorming sessions." Within that relationship, Deppmann provides biology expertise while Hughes provides a deep knowledge of material characteristics and manufacturing. Additionally, Deppmann is quick to credit Brian Augustine (High Point University) as an important theoretical contributor during brainstorming sessions.

Superconductivity in High Entropy Alloys

2022 4-VA AT UVA COLLABORATIVE RESEARCH GRANT RECIPIENT

Dr. Despina Louca,
Maxine S. and Jesse W. Beams Professor of Physics
Department Chair

When Dr. Despina Louca considers the world around her, she wants to make things better using her expertise in physics. For example, when she is driving across a steel bridge, she cannot help but brainstorm ways to make that bridge stronger, lighter, and more durable. This tendency to consider how physics impacts the world around her led Louca to study high entropy alloys (HEAs). With support from a 4-VA at UVA Collaborative Research Grant (CRG), Louca began investigating the unique structure of HEAs and how their disordered crystalline structures promote superconductivity.

As a primer for Louca's research, she describes how aluminum is a lightweight metal useful for applications in aviation and space exploration, which in its pure form aluminum, has a low melting temperature that compromises its structural integrity. However, when combined with other elements to create an alloy, aluminum retains its lightweight properties while integrating the alloyed metals' strengths (such as a higher melting temperature). When these alloys form, the crystalline structure transitions from an orderly arrangement to one of disorder.

To better understand the structure of HEAs, Louca partnered with Dr. Christina Rost at James Madison University to produce HEAs and subject them to a process called neutron scattering. Briefly, neutron scattering is a process of firing streams of neutrons at atoms and interpreting how they reflect off the atoms' nuclei. According to Louca, researchers achieve "unprecedented resolutions and information about where atoms are inside of crystals" via neutron scattering. Through their work, Louca and Rost have developed a stronger and deeper understanding of the structure of HEAs, which informs the field's ability to produce more efficient materials and manufacturing processes.

In discussing the partnership resulting from the 4-VA grant, Louca highlights how JMU provides expertise in material development and synthesis while Louca interprets the neutron scattering data and associated impacts on thermodynamic properties. Additionally, in seeking out HEA samples, Louca began collaborating with a research team in Japan. One of the many results of this collaboration was that the Japanese researchers sent an undergraduate student to Charlottesville, VA to work with Louca for a study abroad experience. Furthermore, a former Ph.D. student who worked on the CRG project continues to collaborate with Louca after accepting a position at the University of Rochester. Through the 4-VA CRG program, Louca has established her lab as an HEA nexus point of collaboration that continues to grow.

Reflecting on the impact of her 4-VA experience, Louca credits the program with allowing her "to gather preliminary data to support my larger external grant applications." She is currently targeting a National Science Foundation grant that supports HEA research; the data gathered through 4-VA will prove instrumental in putting together a competitive proposal. With support from the 4-VA at UVA Collaborative Research Grant program, Louca continues to grow a network of expert researchers and advance the development of materials that have real world applications and impacts.

Randomness by Algebraic Structures

2022 4-VA AT UVA COLLABORATIVE RESEARCH GRANT RECIPIENT

Dr. Leonid Petrov, Associate Professor, Department of Mathematics

Researchers apply for 4-VA Collaborative Research Grants (CRGs) for a variety of reasons, often to support data collection, material synthesis, or field work. However, Dr. Leonid Petrov, collaborating with Dr. Daniel Orr (Virginia Tech), utilized a 4-VA CRG funding for a unique reason: to host a specialized mathematicians conference to discuss randomness and Lie-theoretic structures at the University of Virginia. Petrov characterizes the goals of the conference as bringing together experts with backgrounds in theoretical and applied math and finding the intersection of these two fields; he is excited about the opportunity "to unify students, post-docs, and speakers from several universities across the United States." This creative application of CRG funding underscores UVA's role as a major contributor in the world of theoretical mathematics.

Explaining the focus of the conference, Petrov shares how theoretical mathematical constructs can be translated to application to study real world problems. For instance, to illustrate the impact of Lie-theoretic structures, Petrov imagines a one-lane road of traffic entering a construction zone and describes how his research "predicts how much things are going to slow down, what collisions are likely, and how different traffic patterns will interact with the unpredictability of the construction zone."

Considering the interaction between theoretical and applied mathematics, another example is understanding the behaviors of particles and identifying large-scale patterns through limit theorems. According to Petrov, some conference participants are building quantum spin chains that facilitate a researcher's ability to organize atoms, develop theories about their behaviors, and test theories in real time. By bringing these researchers together with experts in other areas of math, Petrov hopes to stimulate conversation and collaboration across the country.

Petrov is excited about the opportunity to showcase UVA Grounds to a national audience. Beyond the theories and experiments, he values the impact of bringing people to UVA's Grounds: "They see the facilities and faculty of UVA and discover this is a place to send graduate students and post-docs to further their training." Through an ambitious and imaginative application of 4-VA funding, Petrov models the collaborative mindset that underpins the mission of the 4-VA consortium.

Randomness and Lie Theoretic Structures is scheduled for March 4-5, 2024, with speakers from the University of Minnesota, North Carolina State University, Massachusetts Institute of Technology, Texas A&M, New York University- Courant, University of Virginia, Rutgers, and Virginia Tech. Registration and schedule information can be accessed at https://math.virginia.edu/random-lie-2024.

Citations supported by this grant:

Aggarwal, A., Nicoletti, M., Petrov, L. Colored interacting particle systems on the ring: Stationary measures from Yang–Baxter equation (2023) · arXiv:2309.11865 [math.PR] https://arxiv.org/abs/2309.11865

Evaluation of the hydro-chemical and biological implications of a watershed liming in Shenandoah National Park (SHEN): organic carbon and mercury mobilization /bioaccumulation

2022 4-VA AT UVA COLLABORATIVE RESEARCH GRANT RECIPIENT

Dr. Ami Riscassi, Senior Research Scientist, Department of Environmental Sciences

When Dr. Ami Riscassi applied for a 4-VA at UVA Collaborative Research Grant (CRG), she had planned a study that would complement work being funded by the National Park Service (NPS); as the NPS began to plan a watershed restoration project in Shenandoah National Park, Riscassi saw an opportunity to collect data that would provide a more detailed understanding of the effects of watershed liming. Her work, however, quickly grew beyond the initial 4-VA proposal and provided a research infrastructure that facilitated the continuation of an additional NPS project that was previously set to expire.

Partnering with Dr. Todd Scanlon (UVA), Dr. Christine May (James Madison University) and Dr. Sally Entrekin (Virginia Tech), Riscassi led a team that looked at how watershed liming (adding lime compounds to reduce acidity of water sources) changes the chemistry of streams and affects macroinvertebrates and local fish. Riscassi described her project as "holding [scientists] accountable to whether what we are doing to help the fish actually does [help]. Increasing pH is good for fish but might have unintended consequences such as mobilizing carbon and toxic mercury that can bioaccumulate." While the project is a comprehensive study of mercury levels in water, macroinvertebrates, and fish pre- and post-restoration, delays in the NPS liming timeline have delayed the 4-VA project and the team is currently still collecting pre-restoration baseline data.

To collect data, the team is focusing on real-time in-situ and weekly sampling methods. Eventually, the collected data will be compared to non-limed water sources to better understand the chemical effects of the NPS restoration project. Riscassi speaks of the power of 4-VA funding, recounting how the NPS does not typically do watershed restoration, so they had limited budgets for outcome studies.

Riscassi identified two major impacts of 4-VA grant funding. First, Rachel Lombardo (a UVA fourth-year undergraduate student) was tasked with deploying a water quality sonde measurement device in the targeted stream. Rachel was given complete authority over the deployment, and learned how to calibrate, setup, and use the device. Riscassi excitedly spoke about how this project led to "a fourth year teaching a senior research scientist how to use technical equipment!" A second impact of the 4-VA grant was on the NPS; because Riscassi had developed a structure to gather data on mercury levels, an NPS

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Rachel Lombardo, has worked with Drs. Scanlon and Riscassi for two years. Her motivation to join the team grew out of her career interests in environmental medical research and how pollutants affect human health. Lombardo highlighted how looking at water contamination and restoration will provide a strong foundation for her future, including applying to doctoral programs in environmental toxicology. As a result of her involvement in a 4-VA at UVA funded grant, Lombardo gained critical hands-on experiences such as participating in data presentations, a presentation at the American Chemistry Society, and a Distinguished Major Project in Spring 2024.

ASHIM D'SILVA | UNSPLASH

A stream in Shenandoah National park. Riscassi described her project as "holding [scientists] accountable to whether what we are doing to help the fish actually does [help]. Increasing pH is good for fish but might have unintended consequences such as mobilizing carbon and toxic mercury that can bioaccumulate."

study on the impact of mercury levels on dragonfly larva was given additional funding to continue.

Looking to the future, Riscassi is hopeful that her team's efforts will have scholarly and policy impacts on watershed conservation: "we had the funding to do the basic research, but 4-VA allowed us to answer questions that had never been asked before; a higher level of inquiry." Riscassi believes that a deeper understanding of the environmental impacts of watershed liming will lead to improved restoration efforts across the National Parks Service, building a healthier and stronger ecosystem. Through her 4-VA CRG award, Riscassi is not only contributing to healthier river ecosystems, but is creating a diverse collaborative ecosystem across Virginia universities.

Graph-based Cyber Attack Detection and Mitigation in Power Grids

2022 4-VA AT UVA COLLABORATIVE RESEARCH GRANT RECIPIENT

Dr. Jundong Li,
Assistant Professor, Electrical and Computer Engineering
Assistant Professor, Computer Science
Assistant Professor, Data Science

Through a collaboration with George Mason University (GMU), UVA Assistant Professor Dr. Jundong Li is working to increase the security of power grids across the United States. Leveraging civil engineering, computer science, and system optimization strategies, Li's team seeks to develop a stronger understanding of power grid traffic and vulnerabilities, with a goal of recommending system improvements.

When asked about the inspiration for his 4-VA at UVA Collaborative Research Grant (CRG) proposal, Li said "the safety of the power grid in the U.S. and globally is important. Studies show that power grids are susceptible to adversarial attacks from the local to international level." Collaborating with Dr. Jie Xu of GMU, the team is developing a computer science model that tracks power grid data, identifies normal traffic patterns, and pinpoints areas of vulnerability.

Describing exactly how the researchers conduct their work, Li shared "the power grid is laid out in a large graph format where everything is connected. We mark where power stations are located on the graph and study the traffic in and out of that intersection." Utilizing large datasets over time, the team plots and predicts the traffic intensity and frequency. Using this complex model of predictors, they hope to identify abnormalities in traffic patterns that could be indicative of an attack on that power station. Once their model pinpoints differences in the normal data patterns, governing agencies can take action to mitigate the vulnerability.

The researchers' backgrounds represent a true collaborative effort; Li is an expert in computer science and Xu focuses on the structure of power grids through an industrial and civil engineering lens. Their partnership is particularly strong as it allows a real-world problem to be addressed using large datasets and applied knowledge. Ultimately, Li identifies their work as being beneficial to energy companies and local governments by "robustifying the grid and having a better understanding of what connections are most vulnerable to attacks."

Continuing the theme of collaboration, Li is quick to praise the 4-VA CRG program for facilitating his ability to fund the work of graduate students during the summer term. Through literature reviews and model development, Li's students are gaining critical exposure to the research process while developing a broader professional network.

Li's CRG work is ongoing, with data collection and analysis continuing to refine the predictive models. Looking to the future, Li is hopeful that the 4-VA investment will yield outcomes that support grant proposals to the U.S. Department of Energy and National Science Foundation. With government leaders' ongoing concerns about threats to power grids, Li's research represents a critical intersection between scholarship and practical solutions.

Political Equality, Self-Interest, and Election Timing: The American Public's Preferences on When to Hold School Board Elections

2022 4-VA AT UVA COLLABORATIVE RESEARCH GRANT RECIPIENT

Dr. Beth Schueler, Assistant Professor Education and Public Policy, School of Education and Human Development

Dr. Beth Schueler's 4-VA Collaborative Research Grant (CRG) supported research represents an inquiry to better understand the motivations, preferences, and consequences of local election scheduling. In partnership with Dr. David Houston at George Mason University, Schueler looked at school board election timing and how voters' attitudes towards on- and off-cycle elections impact election outcomes.

Speaking about her team's research focus, Schueler reported "We have some evidence that voter turnout in school board elections is very low (in the single digits to low teens). There is compelling evidence that turnout rate is associated with when the elections occur." According to Schueler, low voter turnout for school board races has a direct relationship with how elections are impacted by special interest groups and the broader community. For instance, off-cycle election (a contest that occurs outside national campaigns) results tend to be more heavily skewed by special interest group influence and may not meaningfully represent a community's views. Conversely, when school board elections are held on-cycle with state and national elections, community participation tends to increase. By exploring attitudes regarding election timing, Schueler hopes to provide campaigns and municipalities with data-informed guidelines on how to maximize voter turnout and community representation in elections.

To better understand voter attitudes towards the timing of school board elections, Schueler is conducting a national survey, where she plans to disaggregate the views of teacher (union and non-union) and non-teacher registered voters. The survey instrument is designed to give the research team a better understanding of how special interest groups (e.g., teachers unions) and general voters perceive the importance of election timing across a range of variables. By randomly presenting respondents with reasons to have on-cycle or off-cycle school board elections, the researchers can measure the persuasiveness of different arguments and outcomes.

Discussing the collaboration with Houston, Schueler revealed that they had known each other since graduate work at Harvard University and that their professional journeys brought them both to the Commonwealth. Speaking to the impact of 4-VA funding, Schueler stated "to 4-VA's credit, I had an idea about this project but I don't think I would have reached out to [Houston] without the funding from the program. The CRG definitely sparked the collaboration." She credits Houston with bringing to the project national polling experience and expertise on political polarization. Schueler is proud that 4-VA CRG funding helped elevate a niche field within political science that focuses on the machinations of education policy.

Looking at the impact of her research, Schueler is quick to underscore how democracy happens at the local level and hopes that her work can motivate election officials and political parties to take steps to achieve balanced, representative elections at every level of government. Looking beyond her current 4-VA CRG-funded study, Schueler aspires to survey the attitudes of elected officials on school board election timing and compare those against the general voter pool. With local office as an entry point for many aspiring politicians, having a better understanding of the attitudes, motivations, and investment of voters is critical to securing representative democracy.

Longitudinal Structural Equation Modeling for Incomplete Proportion Data in Obesity Research

2022 4-VA AT UVA COLLABORATIVE RESEARCH GRANT RECIPIENT

Dr. Xin Cynthia Tong, Associate Professor of Psychology, College and Graduate School of Arts & Sciences

In the medical sciences, two major indices of health and body composition are the Body Mass Index (BMI) and Percentage Body Fat (PBF). Historically, these two formulas were used to assess a person's health and risk for comorbid medical challenges; both use a single-moment snapshot of a person's weight, height, and body measurements to assess someone's health and associated risk factors. Within this medical shorthand, researchers have established various equations and models for the relationship between BMI and PBF; however, this approach contrasts with an assessment of changing body composition over time and how those changes may put people at risk for future health problems. Therefore, Dr. Xin Cynthia Tong, Associate Professor of Psychology at UVA, believes the current understanding between BMI and PBF may be incomplete. With support from a 4-VA at UVA CRG, Tong investigated the utility of BMI and PBF over time, rather than at discrete cross-sectional data points.

To address this gap in body composition forecasting, Tong and her VCU collaborator, Dr. Dipankar Bandyopadhyay, utilized the Fels Longitudinal Study dataset, a medical dataset at Boonshoft School of Medicine that has been collecting data since 1929. The researchers conducted statistical analyses to better understand the relationship between BMI and PBF across a lifespan, with particular technical challenges such as the effect of missing data and fitting longitudinal structural equation models with individually varying time points. Furthermore, their models accounted for how various health factors (e.g., blood pressure, waist measurements) are related to body composition estimates and health outcomes.

Their findings suggest that PBF demonstrates a linear change over time, while BMI follows a quadratic growth pattern. Tong has disseminated the findings from her CRG study across a range of professional outlets, including authoring an article in the Journal of Data Science, presenting at the Society of Multivariate and Experimental Psychology (SMEP) conference and the International Society for Data Science and Analytics conference, and speaking on Bayesian longitudinal data modeling at VCU. Regarding next steps Tong said, "we are working on a tutorial paper for providers to better analyze such intensive longitudinal data and understand BMI and PBF," which is intended to improve clinical recommendations and patient outcomes. Finally, the findings from this 4-VA CRG project have encouraged Tong and Bandyopadhyay to begin an application for an NIH R21 grant to continue their work.

Reflecting on the impact of the 4-VA CRG program, Tong said "it allows me to work on real projects and explore new statistical techniques." Furthermore, she credits the grant with growing her professional connections within the quantitative psychology field. She recounted how researchers at SMEP approached her wondering how she got this project off the ground. Tong readily told them "4-VA allowed me to take this idea from a side project to a focused project." Through collaborative research, Tong's team has contributed to a more nuanced understanding of how to interpret PBF and BMI over time, illustrating the transformative power of the 4-VA Collaborative Research Grants program.

Nanocrystal-Ionic Liquid Superstructures for Capture and Conversion of CO2 to Value-added Chemicals

2022 4-VA AT UVA COLLABORATIVE RESEARCH GRANT RECIPIENT

Dr. Huiyuan Zhu,
Associate Professor of Chemistry, College and Graduate School of Arts & Sciences

Dr. Huiyuan Zhu's research encapsulates the 4-VA spirit of promoting research across Virginia institutions of higher education. As a faculty member at Virginia Tech, Zhu partnered with Dr. Sen Zhang, associate professor of chemistry and Commonwealth of Virginia eminent researcher at UVA, on a 4-VA CRG in 2020. Through that collaborative relationship, Zhu discovered that UVA offered expanded access to technical methods and equipment as well as faculty connections for fertile discussions, and in August 2022, Zhu left Virginia Tech to join the UVA Department of Chemistry where she is now an associate professor.

When speaking about her 4-VA Collaborative Research Grant (CRG), Dr. Zhu stated that her "research is focused on catalysis with broad implications for clean energy and environmental sustainability." More specifically, Zhu's research involves "using readily available resources, such as atmospheric molecules like CO2, N2, and H2O, as feedstock to produce fuels and value-added chemicals through electrochemical processes." With support from a 2022 4-VA CRG, Zhu focused on CO2 specifically. Her approach involved extracting CO2 from the atmosphere, accomplished through the use of mesostructured nanocrystal-ionic liquid assemblies. Subsequently, the captured CO2 is bonded to nanocrystal catalysts composed of stable metal alloys, like copper bismuth. The final step employs renewable electricity for converting CO2 into valuable fuels. Notably, the small size of the nanocrystals employed in the process significantly enhances the overall efficiency of this conversion. Looking to the future, Zhu hopes to explore methods of scaling this process in a way that is both energy efficient and results in a clean energy product with a uniform molecular structure.

When asked how the 4-VA Collaborative Research Grant enabled her research, Zhu endorsed the idea that "4-VA is a seed fund that rewards high-risk research…this is a really new project with some great ideas about combining CO2 capture and conversion at the same time." The 4-VA CRG also enabled Zhu to procure preliminary materials and gather initial data. Furthermore, the area of simultaneous capture and conversion represented a new research direction for her that was bolstered by the collaboration through 4-VA. She reported that the research network supported by the CRG allowed her to leverage faculty expertise across institutions.

The preliminary findings from Zhu's CRG study demonstrated sufficient promise that the team, which includes Zhang, applied for and received a $3.7 million grant from U.S. Department of Energy. This grant enables them to expand their research beyond CO2 conversion and delve into the production of clean hydrogen using water.

COMPLEMENTARY FUNDING

4-VA supports the development and strengthening of cross-institutional relationships through collaborative research grants. In addition to the primary funding provided by a Principal Investigator's (PI's) institution, complementary funding may also be available for collaborating faculty (Co-PI). The following is a report of 2022 complementary funding awards, which represent cases where UVA faculty members served as collaborators on 4-VA grants funded by other 4-VA institutions.

Fourteen complementary funding grants were awarded to UVA faculty members in 2022, totaling $70,000.

VIRGINIA TECH

ADVANCING HEALTHCARE SOLUTIONS THROUGH ENGINEERING, DESIGN, AND BUSINESS

Primary Investigator: Christopher Arena; **Department:** Biomedical Engineering and Mechanics
UVA Faculty: Mark Okusa; **Department:** Nephrology

OVERCOMING TRANSPORTATION BARRIERS TO BIOFILM IN MEDICAL DIVIDE - ASSOCIATED INFECTIONS

Primary Investigator: Bahreth Behkam; **Department:** Mechanical Engineering
UVA Faculty: Andreas Gahlmann; **Department:** Chemistry

TOWARDS AN AI-POWERED ACTIVE PHISHING PROTECTION SCHEME

Primary Investigator: Peng Gao; **Department:** Computer Science
UVA Faculty: Yixin Sun; **Department**: Computer Science

SMARTER AND HEALTHIER BUILDINGS: AI-POWERED SMART INTERFACES FOR INDOOR ENVIRONMENTAL QUALITY TOWARDS OCCUPANTS' HEALTH AND WELL-BEING

Primary Investigator: Farrokh Jazizadeh; **Department:** Civil and Environmental Engineering
UVA Faculty: Arsalan Heydarian; **Department:** Engineering Systems and Environment

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ROBUST AND ADAPTIVE DEEP REINFORCEMENT LEARNING

Primary Investigator: Ming Jin; **Department:** Electrical and Computer Engineering
UVA Faculty: Gang Tao; **Department:** Electrical and Computer Engineering

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ION TRANSPORT IN POROUS CARBON FIBERS AND ITS APPLICATION IN ELECTROCHEMICAL CATALYSIS

Primary Investigator: Guoliang Liu; **Department:** Chemistry
UVA Faculty: Sen Zhang; **Department:** Chemistry

EXPLORING STUDENTS PERCEPTIONS OF ENGINEERING USING ARTS-INFORMED METHODS: A MULTI-CASE STUDY

Primary Investigator: Homero Murzi; **Department:** Engineering Education
UVA Faculty: Diana Duran; **Department:** Engineering Systems and Environment

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NANOCRYSTAL-IONIC LIQUID SUPERSTRUCTURES FOR CAPTURE AND CONVERSION OF CO2 TO VALUE-ADDED CHEMICALS

Primary Investigator: Huiyuan Zhu; **Department:** Chemistry
UVA Faculty: Sen Zhang; **Department:** Chemistry

DESIGN OF A LIPID-BASED READOUT SYSTEM FOR RAPID DIAGNOSTIC OF INDIVIDUALS WITH TRAUMATIC BRAIN INJURY

Primary Investigator: Daniel Capelluto; **Department:** Biological Sciences
UVA Faculty: Jeffrey Ellena; **Department:** Chemistry

ILLUMINATING COMPLEX SOLAR PHOTOVOLTAIC PROJECT PERMITTING PATHWAYS

Primary Investigator: Ron Myers; **Department:** Fish and Wildlife Conservation
UVA Faculty: William Shobe; **Department:** Center for Economics & Policy Studies

GEORGE MASON UNIVERSITY

ENERGIZING SCHOLARSHIP OF TEACHING AND LEARNING (SOTL) PRODUCTION IN VIRGINIA THROUGH THE DEVELOPMENT OF A REGIONAL COMMUNITY OF PRACTICE FOR SOTL FACULTY DEVELOPERS

Primary Investigator: Laura Lukes; **Department:** Institute for Digital Innovation
UVA Faculty: Lindsay Wheeler; **Department:** CTE

MUSIC OF ENSLAVED VIRGINIANS: HISTORY, PERFORMANCE, PLACE

Primary Investigator: Emily Green; **Department:** Music
UVA Faculty: Bonnie Gordon; **Department:** Music

METAL SULFIDE-BASED NANOMATERIALS FOR HIGH-PERFORMANCE MULTIVALENT METAL BATTERIES

Primary Investigator: Chao Luo; **Department:** Chemistry
UVA Faculty: Sen Zhang; **Department:** Chemistry

INNOVATING POINT CLOUD PROCESSING FOR NETWORKED SYSTEMS

Primary Investigator: Bo Han; **Department:** Computer Science
UVA Faculty: Felix Lin; **Department:** Computer Science

Gradescope

As part of 4-VA's commitment to promoting the adoption of emerging tools for teaching and learning, 4-VA at UVA awarded funding to UVA's Center for Teaching Excellence (CTE) to purchase a license to the software Gradescope. Gradescope is currently available to faculty and staff through the UVA Learning Tech portal, which is managed by the CTE. Gradescope offers a more efficient way for faculty to manage the administrative tasks of student evaluation, freeing up time for teaching, mentorship, research, and service opportunities.

Before 4-VA support, Gradescope was used by nine UVA departments; however, since the 4-VA funded license made the program available across Grounds, adoption of the software grew and ongoing funds have since been budgeted to continue its availability. Broadly speaking, Gradescope is an AI-trained platform that helps instructors build adaptive grading rubrics for assignments. Furthermore, it can handle a range of evaluation modalities, including multi-step problem sets, fill-in-the-blank, multiple choice, short answer, and essays. This AI-assisted grading process empowers instructors to measure concepts comprehension at a deeper level in larger classes that have traditionally been limited to multiple choice style evaluations.

To be clear, Gradescope does not automatically grade open-ended assignments autonomously. Rather, it organizes evaluation content in a way that makes it easier for instructors to process and assess; instead of grading entire assignments serially, Gradescope groups questions across an entire class. Therefore, instructors are presented with all answers for an individual problem with answers grouped according to the scoring rubric. For instance, if a fill-in-the-blank answer is "The Declaration of Independence," Gradescope will identify and group all the correct answers together and all the incorrect or unclear answers separately. Instructors are then able to validate the correct answers on a single screen, assess the incorrect or unclear answers, and provide consistent, individualized feedback and scoring through an instructor-generated rubric. If an instructor determines a question was unclear after seeing consistent incorrect responses, they can change the scoring rubric and have it automatically applied to all relevant responses. Finally, Gradescope integrates with Canvas, allowing grades to be transferred across systems and further reduces administrative burdens.

80%

Percentage of faculty who feel gradescope is easy to use/set-up, features, pedagogical impact, and accessibility

Access Gradescope here: https://learningtech.virginia.edu/tools/gradescope

Gradescope also supports quantitatively grounded assessments by generating statistical reports for each assignment that provide an overview of class means, medians, modes, and standard deviations for the entire assignment and for individual questions. At the individual question level, reports show instructors frequencies of feedback types (e.g. process gaps, confusion with different concepts, early calculation error) across all students on a particular assignment. This level of feedback helps instructors to identify poorly worded problems or gaps in content delivery. Reports also provide automated insights about student behaviors (e.g., whether a student has looked at their feedback scores).

To date, Gradescope has been successfully deployed across Grounds, with average faculty rating of ease of use/set-up, features, pedagogical impact, and accessibility at 80%. Gradescope assists instructors' ability to manage administrative tasks, so they have more time to spend with students. 4-VA at UVA's commitment to promoting the adoption of emerging tools for teaching and learning has enabled the provision of a resource that decreases administrative burdens and facilities faculty-student engagement.

THIS REPORT WAS PRODUCED BY THE 4-VA AT UVA TEAM:

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