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Title: Transformative mentorship and research training with undergraduate students underrepresented in the sciences

Abstract:

This proposal describes how an established, interdisciplinary VCU research institute and its research course (REAL Level 3), developed using inclusive pedagogy and focused on community-engaged research, could be easily scaled up to provide foundational research training for all VCU students. The Institute for Research on Behavioral and Emotional Health (IRBEH) provides mentoring, networking, and community-bridging opportunities for faculty and students working in the area of behavioral and emotional health, with special attention to serving underrepresented minority students (URM). The course takes advantage of IRBEH's "Spit for Science" (S4S) research project, a longitudinal study focused on college student substance use and emotional health. Students have the opportunity to engage in all aspects of the research project from subject recruitment to data analysis. They complete collaborative research projects, under the guidance of graduate student mentors, and then present their findings back to the community. For this proposal, and building on our experience mentoring undergraduate researchers and our established partnerships with faculty on both campuses and student programming, we seek to expand the S4S undergraduate research course to 500 students per semester; recruit a new S4S cohort to have recent, relevant data for student research projects; and create linkages to future research opportunities for students, including for URM students and as a pathway to graduate school.

Alignment with Institutional Priorities:

This proposal mirrors proposed strategies under VCU's Quest 2028 and the Strategic Research Priorities Plan (SRPP).

- Under the Quest Theme 2 (Student Success), Goal 2.1 (Transform Curriculum), we seek to expand mentored, transformative REAL opportunities for all students.
- Our commitment to mentoring the next generation of researchers aligns with Quest 2028's Theme 1 (Diversity Driving Excellence), Goal 1.3 (Thought Leadership) and with the SRPP's Initiative to Achieve a Just and Equitable Society (Goal 1.2) by seeking to increase the number of undergraduate students from diverse backgrounds producing scientific knowledge and participating in interdisciplinary research across VCU.
- The research culture of S4S, which is reflected in the associated undergraduate research course, focuses on inclusive, community-engaged research, wherein collaborative student groups engage in team science. These priorities for team science are reflected in Quest 2028 Theme 3 (Research and Innovation), Goal 3.2 (Collaborative Research Culture).

IRBEH and S4S have a proven track record of mentoring URM students and providing REAL opportunities to undergraduate students at VCU, and the proposed project will further expand our current capacity to do so. We currently mentor 40-50 undergraduate researchers each year

through our foundational research course and two NIH-funded R25 research training programs. In 2021, 9 undergraduates presented their research at VCU's annual UROP poster symposium (all projects examined how mental health or substance use varied across race/ethnicity), and 6 undergraduates presented posters at external conferences including the LGBT Health Workforce Conference, the Diversifying Clinical Psychology Networking Event, and the Annual Biomedical Research Conference for Minority Students (ABRCMS). Our undergraduates also engage in collaborative, interdisciplinary research alongside faculty members across both campuses. Each year, S4S receives ~20 new data sharing agreements to use the S4S Registry data. In 2020 and 2021, 26 projects used the S4S dataset to train undergraduate researchers and involve them in analyses on college student health; 24 projects worked with students and trainees from minoritized groups; and 6 projects used the S4S data for a course assignment or discussed S4S in an undergraduate course. Additionally, IRBEH and S4S faculty collaborators chair workgroups that meet throughout the year and provide smaller group supervision and mentorship for students that extends beyond the classroom. Workgroups are dynamic, formed around topical areas, driven both by strategic initiatives (top down from leadership) and by faculty and student interests (bottom up from members).

Student Learning/Success:

Data from VCU's Division of Strategic Enrollment Management indicates that the Class of 2026 has the largest percentage of URM students in our history (40%). Twenty percent of the incoming class are first-generation scholars who are also of financial need. As the number of underrepresented students at our university grows, we have a responsibility to ensure that all students, regardless of background, have the opportunity to engage in culturally-responsive experiential learning. As discussed below, our research course has been designed with a focus on inclusive pedagogy. A significant portion of our class alumni identify as underrepresented students. Furthermore, the nature of our research - interdisciplinary secondary data analyses - further improves feasibility and accessibility.

Data from VCU's REAL Dashboard show opportunity for improvement. In Spring 2022, ~13,450 undergraduates (62%) had REAL experiences. However, of those, only ~4,000 students (30%) had an experience at Level 3 or 4. Our course is already listed as a Level 3 REAL experience and we would be able to significantly increase both opportunities to engage in experiential learning and to do so at a high level. If you analyze Spring 2022 REAL experiences across demographics, while 48% of those enrolled identified as a URM student, only 19% of URM students had Level 3 or 4 experiences. Similarly, only 18% and 20% of Spring 2022 REAL participants identified as first generation or Pell-eligible students. Thus, our target population is URM undergraduates. Our dedication to, and experience with, mentoring underrepresented undergraduate researchers make us well poised to offer inclusive, transformative experiences for the students. The curricular research experience also decreases at least one barrier to participation by offering course credit toward graduation at the same time.

Project Goals and Objectives:

The overarching goal of this proposal is to scale up the S4S undergraduate research course so that all students, particularly URM students, have access to a Level 3 REAL experience. Before discussing specific goals and objectives, we start by briefly summarizing the S4S research project and existing course, highlighting those aspects that make the course an ideal candidate for a university-wide course.

S4S research project.

Overview. S4S began in 2011 with the scientific goal of understanding how genes and the environment come together to influence college student substance use and emotional health. S4S has enrolled 7 cohorts of incoming freshmen, with longitudinal surveys completed upon

entry to college and follow-up surveys completed every spring thereafter. The S4S Registry has consistently achieved high participation rates of 67-68% across all freshman classes, which compares quite favorably to cooperation rates of 22-40% reported in other web-based college surveys. The sample is diverse, and sample demographics do not differ significantly from the overall university study population: 17% identify as Asian, 17% as African American, 6% as Hispanic, 51% as White, 6% as more than 1 race, and 3% report other/unknown. Participants are asked to provide a DNA sample via saliva. The S4S Registry is the largest registry of college student health behavior with genotypic and longitudinal phenotypic data in the world.

Data have been, and will be collected using the established S4S data collection pipeline. Through coordination with the registrar's office, all first-year students ages 18 and older receive an email invitation to their VCU account to participate in the project with a link to the online survey. Since the project's launch in 2011, 47 surveys have been completed by students. S4S assesses core constructs including demographics, social activities, work and finances, relationships, alcohol and substance use, mental health, sleep, family history and relations, stressful/traumatic experiences, social support, religiosity, high school and college behavior, peer behavior, personality, and current health.

The S4S Registry is further enriched by our ability to match survey data with other data maintained by VCU. Through partnerships with the Division of Strategic Enrollment Management and Student Success and the Office of Institutional Research and Decision Support at VCU, we have been able to obtain a wealth of academic data including cumulative and semester GPAs, academic standing, credits attempted and earned, and pre-matriculation SAT/ACT scores. We also have and will collaborate with Student Affairs to obtain records of university and recreational sports participation (e.g. card swipes as students enter campus gyms), information about student organization membership, and other data regarding student interaction with campus resources/programming. This provides a unique opportunity to study environmental factors as measured by objective data rather than self-report.

Student-faculty engaged research. Faculty and students (with a faculty sponsor) can petition the S4S Steering Committee for inclusion of measures of interest into the surveys. This has resulted in an impressive breadth of data (>12,300 VCU student participants with over 3500 variables plus genetic information) that is open to both faculty and student researchers. More than 200 faculty and students from 30 different VCU departments and 8 schools have used the data. S4S offers a multitude of ways for undergraduate students to gain research skills and to work collaboratively with faculty. VCU faculty use S4S as a dataset for course assignments and mentored undergraduate research projects that provide students with opportunities to co-author published papers, present at scientific conferences, and contribute to community events.

Community-engaged research. IRBEH was created as a community-engaged research institute, designed to build translational bridges between research and the community, in ways that benefit all. Accordingly, community engagement is a central part of S4S. We have partnered with leadership across the Monroe Park Campus (MPC) to share its findings back with the VCU community. For instance, we contributed to The Well's (now RecWell) "Stall Street Journals" to distribute educational information and prevention messages to VCU undergraduates. Prior to the pandemic, staff collaborated with local community organizations to offer DNA extraction workshops and offered a "Discovering Genetics Summer Camp" as part of the Mary and Frances Youth Center's summer program. S4S has also partnered with Rams in Recovery and 4 local school systems to implement evidence-based substance use programming. These activities demonstrate the community partnerships maintained by S4S and the significant role it plays in translating science into practice.

Team science. S4S has recently formalized a team science approach to analyses. The following workgroups, described in **Table 1**, are active in facilitating data sharing, mentoring of students, and promoting transdisciplinary research. Additionally, we have resource cores in Database Navigation, Statistical Analysis, and Genetics. Further, the workgroup/core leaders serve as representatives on the S4S Steering Committee.

S4S undergraduate research course.

Overview. S4S was intentional in creating undergraduate research experiences from its inception. When the project launched in 2011, so too did the undergraduate research course. The course is a 3 credit, REAL Level 3 course

that takes advantage of S4S Registry data to create a shared experience for undergraduates to develop foundational research skills. It runs each fall and spring, and we routinely receive over 100 applications each semester for our 15 student slots. The course is currently listed through Psyc 494 and Biol 391, and students across all majors/school levels are eligible. Of the >300 undergraduates who have enrolled in our course, ~25% are URM students and ~35% are Pell Grant eligible.

Content. The course provides intensive, entry level training in research methodology and basic statistics. Students work in small groups, with the help of a graduate student mentor, to analyze S4S data. We have developed a set of 6 worksheets to help graduate student mentors guide students along in the research project: (1) develop the research question and hypothesis to be tested; (2) use the S4S codebook to locate variables of interest; (3) describe the sample and run descriptive statistics for variables; (4) choose a statistical test, run analyses, and visualize data; (5) summarize and synthesize results; and (6) identify strengths and limitations. Using a common dataset for all group projects allows students to learn from each other, troubleshoot together, and engage in a shared experience that strengthens cohort bonding. The S4S dataset also allows for students to work in a dataset created by their peers, on topics central to their university experience, and thus enhances engagement and motivation. At the end of each term, a public symposium is held and results presented. Throughout the course we also teach students to read and evaluate research articles, reflect on their experiences, and communicate with peers about scientific research. Classes include guest lectures (interdisciplinary faculty across VCU) where students review research papers and learn about topics related to the goals of the research. Research ethics are to be stressed in class discussions. **Table 2** (below) shows an example course schedule highlighting the main components of our course: research methods training, collaborative group projects, faculty lectures, ethics, and dissemination. The guest lecturing faculty shown below were chosen as potential examples as they are current collaborators.

Table 1. Spit for Science workgroups and descriptions

<i>Facilitating Positive Outcomes for LGBTQIA Students</i>	Our goals are to examine the role of protective factors in increasing positive outcomes for LGBTQIA students and the potential moderating influences of social support and belongingness on the relationships between stressors (i.e., social isolation, discrimination, and family-related stress), flourishing, and social, academic, and mental health outcomes.
<i>Minoritized Ethnic and Racial Students' Experiences Working Group</i>	Our working group is multidisciplinary, comprised of faculty, students, and external collaborators in psychology, social work, education, kinesiology, sports management, and behavioral genetics. We are conducting studies that examine social determinants of health (e.g., discrimination, social and systemic inequalities, COVID-19 pandemic) and cultural assets (e.g., racial-ethnic identity, civic engagement, etc.) on academic outcomes and minority mental health, including alcohol, tobacco, and other substance use.
<i>Positive Factors Working Group</i>	The positive factor's working group is exploring the role of various positive factors (e.g., resilience, well-being, flourishing, etc.) on mental and physical health outcomes. Our goals are to produce high-quality research in this area with the hope of moving science from a deficit-based approach to one also focused on strengths and positive factors that promote well-being.
<i>Substance Use, Disorder, and Recovery Working Group</i>	Our group seeks to examine substance use in college students during emerging adulthood, to include alcohol and illicit substances, across the spectrum of use to disorder to recovery. We aim to focus on group-based differences, prediction models, and longitudinal models of these outcomes.
<i>Traumatic Stress and Mental Health Outcomes Working Group</i>	Our working group examines the impact of exposure to stressors and traumatic events in relationship to psychiatric and substance use outcomes across college. We are also interested in examining sex/gender differences, potentially modifiable moderators, and interplay with genetic risk.

Learning objectives. By the end of the course, students are able to: accurately describe the scientific method and apply it to team research projects; define research ethics and communicate the basic tenets; identify and evaluate ethical dilemmas brought about by scientific progress, especially in the areas of complex traits and addiction; appreciate the role, impact, and interdisciplinary nature of substance use and mental health; identify the structure of a research article and the role of each section; develop skills to approach dense peer-reviewed articles by breaking them into parts and looking for broad themes and results; and combine strengths/knowledge of individual team members to produce a collaborative final project.

Table 2. Example course schedule

Aug 20	Reading scientific papers (Training)	Aug 22	Behavioral Genetics & S4S (Training)
Aug 27	Annotated bibliographies (Training)	Aug 29	Dr. Fuemmeler (Guest; Massey)
Sept 3	Literature searches (Training)	Sept 5	CITI review & plagiarism (Ethics)
Sept 10	Eugenics & discrimination (Ethics)	Sept 12	Dr. Vassileva (Guest; IDAS)
Sept 17	Dr. Breland (Guest; CSTP)	Sept 19	Dr. Wolstenholme (Guest; VCU ARC)
Sept 24	Dr. Svikis (Guest; IWH)	Sept 26	Plan community event (Dissemination)
Oct 1	Dr. Dewey (Guest; CVCDAR)	Oct 3	Dr. Maes (Guest; VIPBG)
Oct 8	Basics of SPSS* (Training)	Oct 10	Worksheets 1 & 2 (Projects)
Oct 15	Descriptive Statistics & SPSS (Training)	Oct 17	Worksheet 3 (Projects)
Oct 22	Open Science Framework (Ethics)	Oct 24	Inferential Statistics & SPSS (Training)
Oct 29	Worksheet 4 (Projects)	Oct 31	Worksheet 5 (Projects)
Nov 5	Worksheet 6 (Projects)	Nov 7	Effective Presentations (Training)
Nov 12	Work on presentations (Projects)	Nov 14	Work on presentations (Projects)
Nov 19	Practice presentations (Dissemination)	Nov 21	Symposium (Dissemination)
Nov 26	No class; fall break	Nov 28	No class; fall break
Dec 3	Community event (Dissemination)	Dec 5	Wrapping up and next steps

Genetics of addiction recitation. Undergraduates enrolled in the course have the option to register for our course through Biology, requiring them to complete an additional 90 min/wk recitation. (Historically, >90% of students have chosen this option.) Students work in class to develop, analyze and interpret a genetic analysis using S4S genotypic data. Students then write a scientific paper summarizing their project. They are taught the fundamentals of DNA and complex trait genetics, engage in interactive labs covering DNA extraction and calculation of allele frequencies, learn how to use a genetics analysis program, and then complete a small genetic association study.

Community engagement. The research course has been designated as a service-learning course since 2015. Students: (1) plan a community event wherein they talk to their peers (and the broader VCU community) about their research projects; (2) work with community partners on research projects of interest to those stakeholders; and/or (3) assist the S4S Registry with data collection. The course also emphasizes best practices in community-engaged research and scientific communication to non-academic audiences.

Inclusive pedagogy. We create all of our undergraduate research programming with an emphasis on inclusion and equity. The S4S course director has significant training in inclusive teaching practices and also directs two NIH-funded research training programs for undergraduates with the overarching goal of developing a pathway to increase diversity in behavioral and biobehavioral research. Our course incorporates best practice models of inclusive excellence including a syllabus diversity statement, highlighting health equity and social determinants of health in our course content and research project topics, and showcasing the work of diverse scientists in our course materials.

Specific proposal objectives.

1. *Scale up the undergraduate research course to 500 students per semester.* Our course structure is easily adaptable to more students, provided we have financial and infrastructural support. Students would be grouped into course sections of ~35 students each for a total of 15 sections. Within each section, students would be put into groups of 6 and choose from 3 possible research project topics. Stipends for graduate mentors (3 per class/45 overall) to

oversee research projects and for graduate teaching assistants (GTA) (5 course sections per GTA/ 3 overall) to oversee the course sections enable feasibility. We also foresee the need for an FTE staff or faculty member to serve in a project coordinator capacity, helping S4S program staff coordinate the course, scheduling, and administrative logistics.

2. *Additional S4S data collection.* In order to offer the undergraduate research course, it is imperative to strengthen its sustainability by supporting the parent research project. Without active data collection, students cannot get on-the-ground research experience in the community, nor will they have access to recent, relevant data. We will recruit one new S4S research study cohort starting in project year 2. New data collections will capture emerging topics in the area of behavioral and emotional health for student group research projects.
3. *Create pathways to future research opportunities.* Our undergraduate research course is a foundational research experience, opening doors for our students to participate in additional research experiences. IRBEH runs two NIH-funded research training programs for URM and has a list of >100 collaborators with whom students could be placed. Additionally, students could join and work collaboratively with faculty in S4S workgroups that are actively analyzing the data. Faculty partners also access the S4S Registry to recruit students into new spinoff studies. For example, undergraduate students are currently working on the ACES study, which is focused on understanding risk factors for posttraumatic stress disorder and alcohol use disorder for those exposed to trauma. They attend weekly lab meetings, sit in on interviews with participants, and help with in-person lab visits. We will formalize the linkages between the course and these activities in order to provide students with additional research experiences, including URM students and those seeking to attend graduate school.

Potential Partners and Collaborators:

Because we use team science and a community-engaged research approach, our proposed project will engage with student programming and units across campuses in multiple ways. We will work with S4S workgroup chairs who are faculty in the College of Humanities and Sciences, School of Social Work, and School of Medicine. We have previously partnered with Rams in Recovery and The Well (now RecWell), as described above. Additionally, in our undergraduate course, student groups have used the S4S dataset to conduct research projects in partnership with RecWell and Residential Life and Housing, including to examine the benefits of participating in recreational sports and the substance use patterns of students living on and off campus. We will build on these partnerships for the proposed project, and we will continue to partner with the Office of Undergraduate Research and Creative Inquiry in order to offer future research opportunities for undergraduates. We also anticipate working with units on the MPC to integrate the S4S module into their curricula and/or to develop additional registration options for interdisciplinary students. S4S has previously worked with faculty in Social Work and Biostatistics to integrate the S4S Registry data into their courses.

Outcomes:

1. Scale up the S4S undergraduate research course to 500 undergraduates/semester.
 - a. Increase the number of URM, first generation, and Pell-eligible students with Level 3 or 4 REAL experiences. We will aim to have underrepresented students overrepresented in our course sections (250 underrepresented students per semester). Using Spring 2022 numbers as a guideline, this would result in up to a 21%, 28%, and 22% increase in URM, first generation, and Pell-eligible students, respectively, engaging in a Level 3 or higher REAL experience per semester.
 - b. Collaborate with curriculum committees in MPC units to offer the S4S course. Success is defined as doubling (n=4) registration options for students.
2. Complete additional S4S data collection.

- a. Expand the S4S Registry by recruiting a new study cohort. We will aim to recruit N=2500 participants in year 2 to complete an online baseline survey and to provide a DNA sample. We then will administer a follow up survey each subsequent spring semester (baseline + 4 follow-up surveys for 5 total surveys).
 - b. Provide timely and relevant data from the 5 new surveys for ~90 applied student learning projects/semester. Projects will be developed in collaboration with S4S workgroups and community partners that have real-world implications.
3. Create pathways to future research opportunities for undergraduate students.
- a. Make student poster presentations part of post-course activities. We will set a goal of all student groups presenting their posters at the Undergraduate Research Poser (UROP) showcase.
 - b. Match students with existing IRBEH research projects (S4S workgroups, S4S spinoff studies, and our existing NIH-funded training programs) and curate a list of other campus research opportunities. We will aim for 10% of student enrollees to complete additional research experiences at VCU.

Timeline:

Year	Activities
Y1	Work with partners to develop survey and identify community partnerships to guide course student project topics
	100 students in course by spring semester
	Seek feedback from student enrollees
Y2	Collaborate with Office of Undergraduate Research and Creative Inquiry to curate a list of additional research experiences available to students
	Using feedback from Year 1 course participants, adapt course as needed
	250 students in course each semester
	Baseline data collection to start
	Outreach to MPC unit curriculum committees about integration of research course into degree requirements
Y3 – Y5	Begin formally working with course alumni to match them to additional research experiences
	500 students in course each semester
	Students begin to use new data for course projects
	Follow up data collection
	Continue matching course alumni with additional research experiences

Budget/Resources, 5-year total = \$1.8 million

Years 1 & 2: TOTAL \$722,000 for 2 years

- **Course cost - \$277,000:** \$110,000 (Graduate student mentors for ~600 students across 2 years); \$117,000 (3 GTAs across 2 years); \$50,000 (Project Coordinator salary starting Y2)
- **Data collection cost - \$445,000:** \$131,000 (Baseline survey data collection for ~2500 student participants); \$76,000 (Saliva sample collection at 97% participation, DNA component is one-time event; not needed in subsequent years' funding); \$194,000 (Genotyping of saliva samples, a one-time expense); \$44,000 (S4S Registry staff services)

Years 3 - 5: TOTAL \$1.06 million for 3 years

- **Course cost - \$834,000:** \$333,000 (90 graduate student mentors/year, for 3 years); \$351,000 (3 GTAs/year, for 3 years); \$150,000 (Project Coordinator for 3 years)
- **Data collection cost - \$223,000:** \$131,000 (Follow up survey data collection at 77% participation); \$92,000 (S4S Registry staff services)