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Project-based multidisciplinary graduate program for community-centered design

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Project-based multidisciplinary graduate program for community-centered design

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Abstract

There have been multiple drivers for changes in STEM graduate education that have been reported by major national groups. (1) Evidence from prior research demonstrates that community engagement benefits all stakeholders, including educational institutions. Here we report on student outcomes, positive impact, and on barriers we encountered for three cohorts of an NSF-funded multidisciplinary graduate program (National Science Foundation Research Traineeship Program, NRT) at George Mason University with a strong component of community engagement and user-centered design. The objective of the NRT program is to shape a highly effective training of STEM graduate students in high priority interdisciplinary or convergent research areas through the use of comprehensive traineeship models that are innovative, evidence-based, and aligned with changing workforce and research needs.

Cohorts of 12, 14, and 18 graduate students were admitted to the program since academic years 2019-20. Their background ranged from psychology, neuroscience, computer science, computational data science, and social work to several engineering disciplines. During the summer faculty from several fields (Engineering, Computer Science, Mathematical Sciences, Social Work, Education, Psychology) offer workshops covering data science, design cycle, MVP (minimal viable product), stakeholder interviews, community partner introduction, qualitative interviews, focus groups, and Institutional Review Board application (IRB). During the academic year each cohort forms teams and decides on a subject they are passionate about. There is a requirement for a community partner and engagement to be in place early on in this process and throughout the academic year, when teams design and develop a solution to a problem presented by the partner.

Typically, engineering projects are conducted “about” or “for” an identified population, or with the aim to develop novel solutions to existing problems. The NSF community-engaged NRT at Mason is unique in that project teams collaboratively engage “with” community stakeholders and identified population members throughout all aspects of the process, from idea generation, design and implementation, to dissemination. As a result, they are able to work on projects that require a human-centered approach to problem solving. At the end of the year, our NRT teams and community partners showcase their projects at our annual retreat where participants from the community agencies representing several disciplines and settings attend. All stakeholders take part in the annual retreat, including future cohorts of students. The retreat offers opportunity for interactions in person (face-to-face) and networking between cohorts of students.

One objective of the program is to offer graduate students a multidisciplinary perspective that goes beyond their subject knowledge as acquired through their original graduate program. The program trains students to frame research questions by integrating knowledge from multiple perspectives, including disciplinary knowledge, community knowledge and lived experiences. For example, a computer scientist would not have access to previously incarcerated individuals during their PhD program, but in our program, they were immersed in a project that required them to interview people reentering society after leaving the jail system. This change in perspective is accomplished by three goals of the program: Goal 1: Prepare trainees to address societal challenges related to disability; goal 2: Enable new convergence research on brain-body interactions in disability; goal 3: Produce diverse cohorts of interdisciplinary STEM professionals with skills essential for research and innovation-related careers. As we have continued improving the program, we have observed the continuation of interest by community partners and the focusing of their requests, as they gain familiarity with the projects and with each cohort of trainees.

In this manuscript we describe the iterative process we have implemented and what we have so far accomplished in terms of convergence research [6] and community engagement.

Keywords

Graduate student education; multidisciplinary research; team science; user-centered design; community engagement.

Introduction

There is a significant need for the educational system at the graduate level to include integrative training across disciplines, and to offer skills so that students can meaningfully engage with target communities in an impactful way (2). The Center for Adaptive Systems of Brain-Body Interactions (CASBBI) at George Mason University has as long-term objective catalyze and apply convergence research targeting people with disabilities. A number of faculty involved in CASBBI designed a training program for graduate students. Funding provided by the National Science Foundation (NSF) Research Traineeship program (NRT) supports five years of training for five cohorts of students. We proposed a model of STEM graduate education that places community-engaged scholarship at the core of the traineeship experience. The integrative capstone experience is a yearlong design project, where multidisciplinary teams work together with community partners on problems at the intersection of health, society and technology. The overall goal has been a comprehensive development of NRT students to be versatile STEM professionals for a range of research and research-related careers within and outside academia. We have so far recruited three cohorts and completed the training for the first two. Figure 1 below shows the logic model implemented to support interdisciplinary training while achieving impactful convergent research.

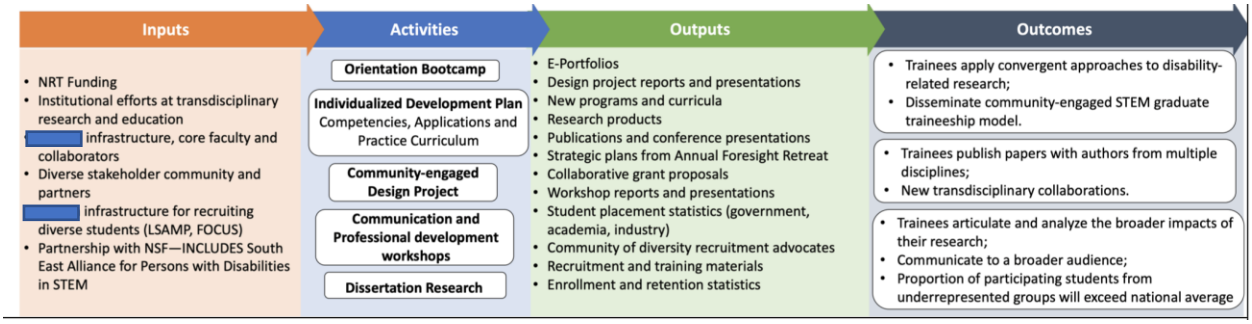

Figure 1. Logic model with NRT activities to achieve innovative community-engaged graduate STEM education supporting interdisciplinary and broad training of a diverse workforce while achieving impactful convergent research.

Design and operation

Research on community engagement shows that it is a mechanism to leverage scientific results into actionable science (3,4). Our team has implemented CER (community-engaged research) with the explicit goal of developing and iteratively refining a traineeship model that prepares trainees to address societal challenges beyond their own scientific focus. This is one example of convergence research, where a compelling societal need drives the research and brings together disciplines that weren't initially focusing on that need (5). In order to achieve convergent research in a symbiotic manner we designed a program that can be adapted depending on the specific community stakeholder and needs to be addressed. (6)

We seek to enhance trainees': (1) convergent research skills (e.g. team science, problem identification, hypothesis construction, research design, data analytics); (2) interdisciplinary knowledge (e.g. engineering, data science, and social science approaches); (3) engagement with community stakeholders (e.g. participatory design with diverse stakeholders to develop ecologically valid solutions); (4) professional skills (e.g. ability to communicate socioeconomic and policy implications of research; leadership, teamwork, and management); and (5) communicating to a diverse audience (e.g. written, translational, and presentation).

We have so far trained over 43 students in three cohorts and have adapted the specifics of the traineeship twice: once after feedback from cohort 1 and once after cohort 2. While the program included faculty and stakeholder interviews in a wide range of skills, here we focus on the student gains on convergent skills, as well as community engagement skills.

Assessments and Results

Evaluation of the program was performed by Institute, with pre and post assessments developed by a team of faculty and evaluation researchers. The same pre/post instruments were used for all cohorts of students. The convergence skills outcome was pooled from several survey questions. Examples of the survey instrument in terms of convergence skills are shown in figure 3 below. The first cohort showed gains in convergence skills (learning skills and technical skills) and provided feedback on how to better deliver content throughout the summer and academic year. The team adapted the content to better fit the profile of the second cohort while still responding to the feedback. Two major inputs were to include peer-mentors and to be explicit about

expectations in terms of interacting with community stakeholders. During the second cohort we have implemented changes to address these two issues. Evaluations for 13 out of the 14 graduate students in the second cohort are shown in figure 4, with statistically significant gains in both convergence skills measured.

Conduct a search on relevant background literature	
Identify a research problem	
Construct a falsifiable hypothesis	
Develop testable and realistic research questions	Apply and integrate knowledge from different disciplines
Create a research plan with all appropriate components, including objective and specific aims, study design and rationale, approach, evaluation plan, timeline, and contingency plans	Define a problem using multiple perspectives based on disciplinary knowledge, lived experiences, and/or community knowledge
Articulate the significance of a research project and its impact in different scientific fields and to society, including intellectual merits and broader impacts	Apply different methodological approaches to address an open-ended problem
Analyze data using tools such as Excel spreadsheets	Apply knowledge gained to develop solutions to new problems
Use statistical software, such as R, SAS, Stata, or SPSS	Collaborate on a diverse, multidisciplinary team to effectively address a challenge
Use programming languages, such as C/C++, Python, MATLAB	Foster a positive and cohesive multidisciplinary team environment
Understand data science concepts, such as principal component analysis, clustering, classification, supervised learning	Assess and critically reflect on your performance in addressing a challenge
	Assess and critically reflect on your performance in addressing a challenge

Figure 3. Survey items for convergence technical skills (left side list) and convergence learning skills (right side). Trainees rated their level of ability in each skill area by selecting one of five options: “no experience”, “beginner”, “competent”, “proficient”, “expert”. Example pooled outcomes are shown in figures 4 and 5.

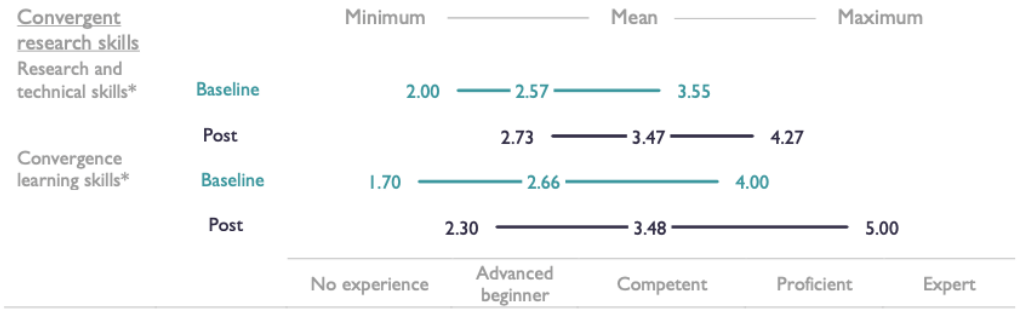

Figure 4. Pre and post scores for n=13 respondents (second cohort) in convergent research and learning skills.

Some of the individual skills showed dramatic improvement in both cohorts. For example, the item “listen to community stakeholders to understand their perspectives and needs” had an average of “beginner” ability before our program, and in the post assessment the average response was between “competent” and “proficient”, with some trainees answering “expert” and none of them considering themselves “no experience”.

Four of the 10 post survey respondents (cohort 1) and 6 of the 13 respondents (cohort 2) indicated how the program directly influenced their current or future research, with a change in perspective being the main outcome. Below we show a representative subset of their responses.

“I really want to transform my research to be more community based and I definitely want to connect with stakeholders in order to develop my research questions rather than come up with them independently.”

“I would really like to start incorporating a community component to my future research projects. Or more broadly, it helps to take a step back and actually think about the population we are trying to help. It can be easy to get stuck in scientist mode without thinking of the wider implications of our research on society.”

“(…) I would love to bring a community aspect to my research in the future. This is not research related, but in my clinical work, I am also finding myself asking more feedback from patients and getting their opinions on ways to improve our systems. Before every consultation, I've found myself asking patients what they expect to get out of our work together. In a sense, my patients are stakeholders in clinical care.”

“For my future research I hope I could continue this project and see it through so that more than just people in the DC Jail would benefit from it. I also think it will encourage me to be more open and willing to see more than just long-term "huge" solutions and recognize the small steps that can be taken to make an impact.”

“I have used the knowledge, from procedural integration to communication and team science, to forge a novel collaboration, connect with potential Committee members, and present my research at both local meetings and national conferences alike.”

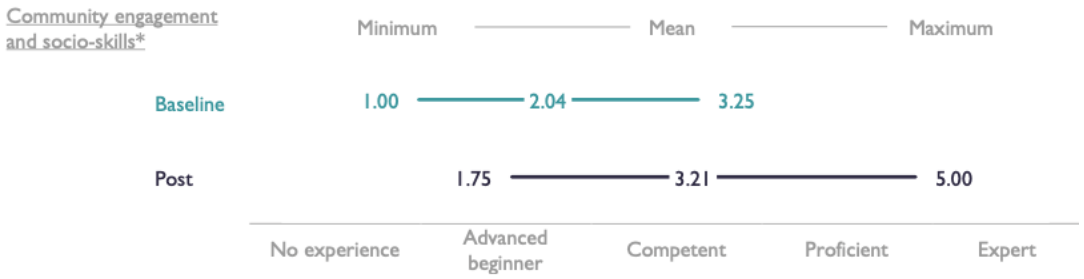

Figure 5. Pre and post scores for n=13 respondents (second cohort) on community engagement and socio-skills surveys; pooled responses from several survey questions.

A similar set of survey questions related to community engagement. The second cohort (figure 5) showed gains that mirrored the results for the first cohort (pre-mean 2.66, post-mean 3.85). Like for convergence skills, the main outcome of the community engagement goal was the change in perspective in both cohorts, with a heightened awareness of how to build a long-term relationship with community partners, and gains in tools and methods to properly conduct stakeholder interviews and long-term community-engaged research.

One innovative approach we have utilized to train students to authentically incorporate the voices of various stakeholder communities as well as disseminate their research to a broad audience is the concept of a "Digital Story". Each trainee team in cohorts 2 onwards were required to develop a digital story in the first semester of their project. The format of the story could be a video, an interactive website or multimedia document. Each of the four teams in Cohort 2 utilized a different format for their digital story that enabled trainees to define the problem in a compelling manner by integrating knowledge from multiple sources including lived experiences and community knowledge (e.g., photos, quotes, video clips, interviews, patient journeys), and present and organize data and arguments in new interactive, ways. For example, one team created a video documenting the difficulties faced by a graduate student seeking mental health services that was based on actual interviews. Another team developed an interactive website that allowed a viewer to understand obstacles faced by wheelchair users as they navigated around campus. The digital story format also enabled the trainees to engage the community through storytelling. For example, one of the digital stories on mental health parity was broadly disseminated by the community partner to various stakeholders and policymakers in local government to raise awareness of the gaps in accessing mental health services. These stories were refined iteratively refined through peer reviews among trainees, feedback from faculty as well as feedback from community stakeholders. We are continuing to refine and improve on the use of the digital story in our current cohort.

Our team will continue to redesign the program to improve on subsets of skills where trainees pointed deficiencies. For example, during the first two cohorts (during covid) there were no face-to-face interactions, and there were no in person workshops (for example, on wearable devices). Hands-on engineering skills were absent and trainees commented on those. We intend to address these shortcomings in future offerings of the program. For example, perhaps there could be a traditional workshop component for basic skill learning, but then a 'community lab' component for that same training (e.g, wearables) where community stakeholders are invited in or we go to them to do a short demo and solicit interactive feedback. The program will continue to have a strong commitment to both technical and professional training of the students.

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Holly Matto

Holly is an Associate Professor in the College of Public Health, Department of Social Work at GMU in Fairfax, VA since 2011. Prior to that, Holly was at GMU's School of Social Work for ten years where she taught theories of human behavior, direct practice, and research methods in the master's and doctoral programs. She has over 20 years of research and practice experience in the field of addiction science and has conducted treatment intervention studies with diverse clinical populations. Over the past several years, she has been working with interdisciplinary colleagues to develop interventions that help patients monitor their biobehavioral state and deliver personalized patient-specific self-regulation strategies. Specifically, her work examines how change in visual sensory input can be used to regulate autonomic nervous system activity.

Siddhartha Sikdar

Siddhartha is currently a Professor in the Department of Bioengineering at University. He is the Director of the CASBBI. His research group within CASBBI conducts translational research using imaging to investigate brain-body interactions in a number of clinical conditions of major public health significance, such as chronic pain, stroke, spinal cord injury, and amputation. His current research is funded by the NSF, NIH, DoD and the VA. He is a member of IEEE and AIUM.