

From Intent to Impact: Enabling Transdisciplinary Research for Responsible Scientific Stewardship

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Executive Summary: Global challenges are complex and must be tackled in a holistic manner. Understanding and addressing them requires collaboration across disciplines, often uniting the humanities and social and natural sciences, to ask better questions and identify practical and revolutionary solutions. Universities can be excellent vehicles for transformational change as they educate the next generation of civically-motivated thinkers to create meaningful action and impact. Too often systemic, artificial barriers exist within these institutions that prevent meaningful transdisciplinary collaboration from succeeding. We recommend that universities identify grand challenges and foster a culture of cross-department collaboration with appropriate internal and external resources to enable broader impacts. Together, funders and institutional policymakers play a critical strategic role in fostering civic scientists and transdisciplinary researchers to solve multifaceted global problems.

I. Introduction

From addressing climate change to curing devastating diseases, science has the potential to profoundly improve society and solve global challenges. Conventionally, when a problem is identified, scientific experts work toward solutions that are then applied to a target population. This approach, however, often misses important context, leading these experts to ask the wrong questions and design solutions that are not necessary or even desired within the communities they intend to help, eroding public confidence in science (Simoncelli 2023). When this happens, the underlying objective of funding to deliver impactful solutions that improve society is lost (OECD 2020). Many seemingly perfect scientific solutions on paper have failed because they do not adequately address or understand underlying influences at play (Lawrence et al. 2022).

Civically-minded researchers, by contrast, use participatory engagement to effectively integrate a

target population's experiential and contextual knowledge into the scientific process (Christopherson et al. 2018). Today, training programs and institutional support practices in science, technology, engineering, and mathematics (STEM) are not typically designed to cultivate civic science (Pineo et al. 2021). No single person or single disciplinary team can master all disciplines and be a perfect messenger or actor in all scenarios, yet a team of multi-disciplinary researchers collectively can possess the skills and creativity necessary to address a multifaceted problem (O'Donovan, Michalec, and Moon 2022). Importantly, this includes respectful collaboration with the humanities and social sciences, as public engagements are more deeply embedded within those fields (Patel et al. 2021).

Universities are educating the future workforce across a variety of fields and disciplines. They are also hubs of cutting-edge research and innovation. The proximity of diverse experts and thought leaders

is one of academia's greatest and most unique strengths and can enable collaboration across disciplines (Yang et al. 2023). These partnerships can also be leveraged by a university's unique position and ability to engage with local communities and industries. It is impossible to master all subjects through formal education, but collaboration is a skill that transcends subject matter and enables positive synergy (Jarmai and Vogel-Pöschl 2020). Additionally, exposing students to alternative methods and instilling mutual respect amongst peers can positively benefit a more creative and collaborative future workforce.

However, collaboration can be difficult. Researchers must bridge institutional silos and confront differing assumptions or conceptions on how to address challenges. Furthermore, longer project duration, difficulty publishing in high impact journals, falling between or across funding directives, communication issues within teams, and institutional pressures to implement research with a single focus are major hurdles for transdisciplinary research projects (Huang et al. 2023). Nevertheless, these barriers can be overcome with appropriate institutional policies and funding support.

II. Moving the needle

i. Support intra-institutional grand challenges

Individual institutions, particularly large research universities, may be well-positioned to identify "grand challenges" that their faculty, working together, can tackle over the long term. Senior university research leadership (e.g. vice presidents for research or equivalent) should propose such grand challenges and identify long term financial support given current faculty expertise, local industry interests, and community group interest and benefit. Such challenge calls should emphasize and require a transdisciplinary approach to problem solving and highlight specific areas in which each school and department can address the grand challenge. Transdisciplinary teams contextualize grand challenges at a societal scale, incorporating policy and other systems-level thinking to holistically approach a problem, transcending traditional disciplinary boundaries instead of drawing upon the conventional frameworks of single or multiple disciplines (Choi and Pak 2006). While clear goals are important, to achieve

transformational change, there must be institutional policies in place to foster a culture of civic science behind a grand challenge (Bammer 2020). Importantly, not all grand challenge efforts require the same level of financial resources. Each institution may have vastly different financial capabilities, and while one university may afford large infrastructure projects, others may support administrative assistance or policy change while still guiding impactful transdisciplinary research. Both internal and external funding sources can be designed to enable or require such transdisciplinary engagement (Bankston and Vernon 2023).

To be successful, there should be dedicated university staff to highlight opportunities for research translation, mediate conflicts should they arise, and promote community engagement toward forward-thinking scientific discoveries and solutions. This can include employing university leadership that take societally focused research seriously, interdisciplinary coordinators to facilitate dialogue across departments, and grant administrators with experience across several multidisciplinary organizations with different reporting and administrative structures. Students and faculty should be rewarded for engaging and collaborating with researchers outside their departments through a variety of incentivization mechanisms, such as monetary support, professional recognition, and amplification of work through hosted seminars and external events (Jessani et al. 2020). Finally, it is crucial that these efforts maintain sustained financial support (>10 years) to establish lasting culture change and connection with the broader community.

Utilizing scientific and technological innovation to solve grand challenges and improve civic life is not new and institutions can learn and build upon past successes and challenges (Pimentel, Cho, and Bothello 2023). For example, the Global Change Institute (GCI) at the University of Queensland curates knowledge and ideas from across disciplines into challenge-based research networks that identify innovative, creative, and holistic solutions. Selected researchers are awarded a modest grant, but also receive administrative support through organized stakeholder workshops, media and communication support, and toolkits to measure and report research impact data (Global Change Institute, n.d.). Some

institutions may also support civic scientists by building centers and spaces that promote collaboration and cluster hire across disciplines specifically toward the grand challenge (Lipuma et al. 2023). While larger, more well-funded institutes can afford this, such financial requirements remain a persistent barrier to many institutions. Nevertheless, generating educational curricula and accrediting training programs that span academic disciplines and departments can guide solutions-focused learning in a much more affordable manner (Faupel-Badger et al. 2022). For example, the City College of New York Master's in Translational Medicine (CCNY MTM) program highlights how programmatic design and administrative commitment can support civic science without significant financial commitment. It trains students from diverse academic backgrounds to leverage the CCNY's connection to its local community, identify unmet needs, and design practical solutions to grand challenges that impact human health. The MTM program includes faculty from several departments to train students on responsible research and bioethics, effective problem identification, and business practices to bring technological innovation to the public (Steinhardt 2023).

While these and other similar programs have had positive impacts in students' lives and bolstering a transdisciplinary workforce, a persistent challenge for transdisciplinary programs and institutes is the lack of publicly available impact data. One reason for this could be the difficulty in forecasting and establishing an appropriate time horizon to evaluate the outputs of a program or grand challenge's success. So, it may be too soon for groups like GCI or MTM to comprehensively analyze the impacts of their programs. While one can track the growth of community partnerships and interactions in the short term, the benefits of those connections may take years to be realized, often after a project has ended (Archibald et al. 2023). Unfortunately, without reporting quantitative metrics of success, transdisciplinary programs could lose funding and never be able to capture and report on the positive impacts of their programs. Therefore, although causal links between funding and civic outcome may be difficult to prove, positive externalities such as strengthened local ties, improved collaboration, or trainee connections with mentors across various disciplines are themselves successes and should be

tracked and reported publicly as alternative metrics of success (Batchelor et al. 2021).

ii. Fund civic science teams

Research funders (federal, philanthropic, and others) should organize initiatives explicitly targeting transdisciplinary civic science teams, requiring that projects have multiple lead investigators from more than one discipline to be awarded funding in an effort to promote equal collaboration and shared responsibilities across the disciplines of each co-lead. Submitted proposals should include how the investigators will engage with a target population (if they have not already done so) and how they plan to solicit and incorporate feedback throughout the research and innovation process (Christopherson et al. 2021). In addition to scientific merit, applications should be evaluated on how prepared research teams are to manage the societal impacts of their work, including considering whether lead investigators are trained in civic science or have a demonstrated history of public engagement (Chausson and Martin 2022). Additionally, funding programs should allocate specific resources to allow institutions to set up policies and infrastructure to promote civic science and collaboration. While some organizations emphasize broader impacts in award decisions, civic science programs and funding calls should be intentionally structured to facilitate community-driven research and foster a longer-term throughline toward sustained research impact. Ultimately, this could benefit the scientific enterprise broadly by creating new pathways for experimental design and research evaluation.

It is important to recognize that traditional metrics of success like publications or patents may not be the best measurements of impact of funded civic science work. These metrics nevertheless persist likely because they can be easily quantified and compared to more traditional scientific research, which in turn justify funding appropriation for similarly structured programs. However, there are additional metrics that funders should look to to assess the impact of awarded work, such as public engagement in funded research through inclusive workshops, progress reports of how target populations have positively shaped research development, and highlighted examples of diverse career paths which graduates pursue as indicators of

success, particularly in the short term (Hansson and Polk 2018). Quantifying these alternative metrics and weighting them appropriately is an area of active research that should continue to inform how civic science is assessed (Duda et al. 2023). Once quantifiable, these metrics could restructure how impact is evaluated when comparing programs across a funding organization and integrate into portfolio analysis tools. Updated quantitative and qualitative measures should factor heavily into demonstrating program or project success and continued funding. Expanding beyond traditional metrics of research success could affect how funders and universities alike evaluate researcher impact, potentially impacting tenure and other institutional incentives.

III. Building collective strength

Together, institutional and funding programs and policies can create a feedback loop that civic scientists should harness to generate positive societal impact. However, a common pitfall occurs after a project's funding ends or institutional priorities shift, leaving research teams stranded and target populations feeling abandoned (Patrick et al. 2023). This could prevent a funding program or grand challenge from achieving its full impact and damage the trust built between researchers and their local communities. Instead, independent coalitions of civic scientists should share their experiences and capitalize on the momentum to grow the transformational impact of their work, irrespective of funding source or host institution. The Center for Advancing Research Impact in Society (ARIS) has exemplified the positive outcomes that a network of scientists and engagement practitioners can create by sharing resources, growing partnerships, and mobilizing knowledge to enhance the societal impact of science. ARIS hosts annual summits, sponsors awards and fellowships, and provides professional development opportunities, trainings, and toolkits to its more than 1,500 members (Renoe et al. 2023).

Open and respectful communication is key, both within projects and in publicly sharing project findings. Constructive dialogue should be practiced and continuously improved upon as a pillar of civic science. The foundations of successful communication require learning and appreciating

norms and biases within disciplines and communities with strategies in place to address conflict before it arises (Aarons et al. 2020). Additionally, science associations like the American Association for the Advancement of Science (AAAS) and other multi-disciplinary professional societies can be effective at building networks of diverse researchers to share resources, discover new opportunities, and establish best practices for community engagement and cooperation (Robasky et al. 2020). These transdisciplinary groups should build meaningful, long-term relationships with community-based organizers to identify local needs and establish effective routes to disseminate new discoveries by joining business development meetings and co-hosting events in local cultural spaces and museums. They should also organize seminars, workshops, and symposia that promote transdisciplinary collaboration and establish awards that recognize civic engagement through research. These networks will be critical as the civic science landscape grows and evolves to ensure that successes and failures are shared and learned from and not be dependent on single funding sources or institutions to continue building trust and promoting relationships between science and broader society.

IV. Conclusion

Addressing societal challenges is a shared responsibility that requires new approaches, new technologies, and changes to traditional norms. Funders, academic institutions, and research networks all shape the design and implementation of initiatives that promote civic science, and their roles are connected. Universities are training the next generation of civically minded leaders and, with proper support and institutional prioritization, can make a tangible impact toward addressing societal challenges. Dedicating resources to building networks of leaders with humanities, social sciences, and STEM backgrounds is crucial to making lasting change, improving equity, and solving global problems.

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