

Building Capacity for STEM Outreach: Development and Implementation of a University Graduate Certificate in Community-Engaged STEM

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Abstract

Community-engaged scholarship can improve the impacts of science, technology, engineering, and mathematics (STEM) fields on health care, access to technology, and environmental welfare. Nevertheless, few graduate programs in STEM fields provide training that connects research with engagement with the public. This article describes the development of a graduate certificate in community-engaged STEM. The program includes a graduate service-learning course that partners with an underfunded public high school to offer grade-appropriate lab activities. In addition, students are required to participate in a seminar series, spend significant time working with a community partner, and develop an independent community-based project. The certificate requirements allow trainees to align their community-engaged work with their scientific research projects. These mentored experiences in community-engaged scholarship for graduate students are designed to have multiplicative effects to support local communities, improve campus culture, enhance diversity in STEM fields, and yield more impactful research enterprises.

Keywords: broader impacts, competencies, service-learning, graduate education, community engagement



For several decades, higher education researchers have warned that colleges and universities need to become better aligned with the concerns of our society (Bok, 1990; Delve et al., 1990; Newman, 1985). Newman argued that higher education should support the quest to secure neighborhoods and cities from crime, drug use, and violence, and to protect our environment from waste and exploitation. He proposed that American universities should be preparing their graduates to “see themselves as able to help shape the world in which they must adapt” (p. 49). To accomplish these important educational goals, Boyer (1990, 1996) offered a new vision of faculty work that addresses the diverse and changing needs of society. Boyer proposed that the definition of scholarship should include not only basic research and interdisciplinary communication, but also rigorous public engagement.

This call to arms for American universities to include community-engaged scholarship as part of their educational and scholarly mission has been met with various levels of commitment. Efforts have included service-learning courses, outreach, participatory action research, and public scholarship (Morrison, 2020). Comparisons across universities have led researchers to identify best practices for authentic community-engaged scholarship (Furco, 2010). High-quality community partnerships involve mutually beneficial exchanges of ideas, expertise, and resources (Harkavy, 2023; Holland, 2005). Importantly, these best practices are associated with the most rigorous scholarship (O’Meara, 2005; Wade & Demb, 2009). Best practices are critical, given the risks and harms that can come with scholars not being appropriately prepared to interact with the public (Stofer et al., 2023), including the failure to take power dynamics into account,

inadequate assessment of the engagement outcomes, and superficial and transient connections with community groups. These poor practices can lead to a further loss of public trust in science.

As scholars develop these standards for community-engaged work, it becomes logical to develop a curriculum to convey this knowledge to the next generation of scholars as part of their responsibility to serve the greater good. Indeed, a few universities have recognized that community-engaged scholarship should be incorporated into graduate education and offer graduate certificate programs in community-engaged scholarship (Matthews et al., 2015). Such formalized training programs align with the interest of many graduate students who wish to prepare to address societal challenges (O'Meara, 2008). New models are emerging to incorporate community-engaged scholarship with research opportunities (Keeler et al., 2022). Although this is certainly a positive development, many graduate training programs remain discipline-focused, without attention to public engagement and collaborative problem-solving. If trainees lack access to mentorship and professional development related to community partnerships, they may struggle to effectively translate their disciplinary expertise to societal challenges (Campbell, 2005; Kratochvil et al., 2022; Weerts & Sandmann, 2008).

STEM Context

The motivation to create a university-wide graduate certificate in community-engaged STEM was driven by the confluence of several independent rationales, including the need for society to understand the contributions of STEM discoveries and innovation, the sense of professional obligation among researchers to help educate the public, the strong desire of trainees to participate in this type of community outreach, and the existence of strong community engagement infrastructure at the University of Pennsylvania (Penn). Here we provide a further discussion of each of these considerations and then describe the process of instantiating the certificate program.

Public Buy-in for Impact

In addition to gaining knowledge for knowledge's sake, STEM professionals may discover information that is useful only if society takes appropriate action. For example, citizens often need to understand the

relevant scientific and/or technical knowledge to undertake inconvenient or costly behavioral changes to protect their health and safety or the environment. As recent history has shown, scientifically based policies that defend the public against viral epidemics or substance abuse disorders can be derailed by a misinformed or distrusting society (Allen et al., 2022; Hall et al., 2022; Lupia et al., 2024). Conversely, through well-developed communication, the broader community can inform STEM professionals about the problems that deserve more intense research and discovery (Holzer et al., 2014). Taken together, STEM professionals need effective community-engaged scholarship to increase the relevance and impact of science and to better serve society's needs.

Professional Obligation

STEM professionals enjoy the unique privilege of focusing on their creative interests and areas of curiosity, and such privileges are generally funded by governmental and philanthropic agencies (Bridgman, 1947; Koepsell, 2010). In return, tax-paying citizens can reasonably expect that scientific advances will be shared with them in an understandable format. In this way, accessible STEM communication is critical for the public's trust in and understanding of science and technology and their willingness to continue supporting these enterprises (Lupia et al., 2024). Given the obligation that STEM professionals owe society, STEM training should include opportunities for trainees to develop the competencies needed to communicate with the public in a responsible and ethical manner.

Trainee Interest

An equally important consideration for creating a community-engaged STEM graduate certificate was the strong desire among the younger generation of STEM professionals for community-engaged scholarship training and opportunities. In a previous report, STEM graduate students emphasized how engagement fulfilled a sense of personal identity and commitment to serve (Reddick et al., 2018). Given the value of community-engaged work for STEM professionals, graduate students can benefit from learning the relevant best practices, which they can incorporate into their professional journey. At the same time, training the next generation of STEM scientists to value and participate in community-engaged scholarship is likely

to strengthen the impact of a university's STEM-related research activities.

Ongoing Activities and Capacity

Before the Community-Engaged STEM Certificate Program was established, many Penn faculty and students were already engaged in work that connects Penn's multidisciplinary STEM research endeavors with the local Philadelphia community. Several educational outreach programs had been created, such as the Educational Pipeline Program (Hamilton et al., 2007), DrosophILA (Laws et al., 2023), and Project BioEYES (Shuda et al., 2019). A variety of community-engaged scholarship initiatives have been led by graduate students. For example, students in the neuroscience graduate program have created an organization called Graduate-Led Initiatives and Activities (GLIA) that offers elementary school programs and high school tutoring. Similarly, students in the pharmacology graduate program have created an organization called Pharmacology Graduate Opportunities for Outreach and Development (Pharm4GOOD) to engage with the local community, particularly underrepresented populations. These established initiatives demonstrate the existing interest of STEM graduate students to regularly participate in engagement work. The new Graduate Certificate Program in Community-Engaged STEM aims to improve the quality of these initiatives while providing formalized academic acknowledgment for student participation in this work. Such academic credit will meaningfully support students who are interested in pursuing community-engaged work in their future careers.

In summary, the need for public engagement for impact, the sense of professional obligation, the strong interest of trainees, and the robust existing programs were major motivating factors that led to the development of the program described here. The concept for this certificate was developed by a Penn faculty member (L.M.F.-C.) and Penn graduate student (E.M.P.C.) as part of a funded fellowship, the Provost Graduate Academic Engagement Fellowship at the Netter Center. The proposal was enthusiastically supported by academic leaders in Penn's Perelman School of Medicine, School of Arts & Sciences, and Provost's Office, with the overall goal of providing interested students with a broad academic perspective for how community-engaged scholarship both enhances the quality of STEM research and

serves the broader community, as further described below.

Process of Creating a New Certificate

With the above motivations in mind, the Community-Engaged STEM Certificate Program was launched with a core group of faculty willing to support the initiative. Faculty across Penn's graduate and professional schools with sustained involvement in community-engaged scholarship were included in the planning stages. Professors from the Perelman School of Medicine, School of Arts & Sciences, Annenberg School of Communication, School of Dental Medicine, School of Nursing, School of Engineering & Applied Sciences, School of Veterinary Medicine, and the Vice Provost for Education endorsed and expressed commitment to the creation of a community-engaged STEM certificate program. To expedite its launch, the Perelman School of Medicine and the School of Arts & Sciences agreed to administratively cosponsor the certificate. A core group of nine Penn faculty members from these two schools readily agreed to serve on a Faculty Advisory Board to oversee the program and advise students. The Biomedical Graduate Studies Program provided critical administrative support to oversee the program's logistics, such as course rostering, room reservations, website maintenance, and transcript documentation. Plans are under way to expand the certificate's availability to graduate students in the Annenberg School of Communication, School of Dental Medicine, School of Nursing, School of Engineering & Applied Sciences, and the School of Veterinary Medicine. With the broad array of STEM specialties being represented, the certificate is designed to be flexible enough to suit the interests and expertise of students from these diverse programs.

The process of creating the certificate was accelerated by the strong support from various stakeholders within the professoriate and administration, although there were a few sticking points. It was challenging to design a single, cohesive program that would be accessible to graduate students across various Penn schools. Given that completion of the certificate may involve students taking courses in different schools within the university, a potential barrier was the difference in tuition rates across schools. This problem was overcome by schools with higher tuition rates agreeing not to

charge the higher rate to students from other schools for taking certificate courses. Another challenge pertains to the goal of having a shared seminar series to allow students across schools to develop a sense of community within the certificate. This goal was hampered by the intensive course and clinic schedules in certain professional doctoral programs, causing difficulty in finding a seminar time that was accessible to all students across various programs. To address this challenge, we decided to allow students from these schools to mainly attend community-relevant seminars within their own programs, with limited attendance to the certificate-sponsored seminar. In the main, stakeholders were willing to compromise and be flexible to create a certificate that would be accessible to as many students as possible.

It is worth noting that a variety of graduate certificates that pertain to STEM-related disciplines, such as medical physics and biomedical informatics, were already on offer at Penn. The new certificate is unique because it connects STEM specialties with the needs of society, offering students direct engagement with the local community. Trainees in this certificate may serve as ambassadors of STEM career pathways, improving educational opportunities and a sense of belongingness for members of the broader community. To our knowledge this is the first community-engaged scholarship certificate program designed to accompany doctoral training for students in STEM fields.

Details of the Program

The Required ABCS Graduate Course

A valuable catalyst for advancing community-engaged scholarship at Penn is the Netter Center for Community Partnerships. The Netter Center brings together people and assets from both the university and the wider community to collaboratively solve problems, such as poverty, health inequities, environmental sustainability, and disparities in education. One mechanism facilitated by the Netter Center is the academically based community service (ABCS) course, which integrates service with research, teaching, and learning. In this way, ABCS courses can combine academic expertise with the expertise of the community to create mutually beneficial, mutually transformative partnerships. This collaborative problem-solving pedagogical approach aims to improve the quality of both life and learning

in the community and add to the impactful scholarship of the university. Research on similar service-learning courses has demonstrated several positive outcomes for students, including improving students' sense of self-efficacy (Reeb et al., 2010), their understanding of social issues (Eyler et al., 1997), and their socioemotional well-being (Flanagan-Cato et al., 2023). Despite the many documented benefits of service-learning (Weigert, 1998), these courses are rarely part of a STEM graduate curriculum. With the possibilities of ABCS courses in mind, and the broad participation of STEM graduate students in extracurricular community activities, a key component of the new certificate is a graduate ABCS course that provides a foundational experience in community-engaged STEM.

The new graduate student ABCS course that was created as part of the Community-Engaged STEM Certificate Program is titled Research & Community: Biomedical Research in the Urban Curriculum. The course has two major goals. First, the course is an opportunity for STEM doctoral students to develop their science communication skills and share their enthusiasm for STEM with students at a nearby public school. Many Philadelphia public schools have inadequate resources to offer grade-appropriate lab activities, leaving students disadvantaged in their access to a STEM education. The graduate students in this course create and conduct engaging, hands-on science lessons to increase high school students' knowledge in science and interest in STEM-related careers. The second goal of the course is to improve awareness about the conditions of urban public schools, particularly in Philadelphia. The course includes critical readings and small group discussions about the historical role of science in underrepresented communities, the connection between students' biomedical research at Penn and the local Philadelphia community, and opportunities to increase science-oriented engagement throughout their doctoral training. In short, the course provides mentored experience in community-engaged STEM and a rigorous understanding of inequalities in STEM education.

This course was first offered during the Spring 2023 semester and continues to be offered annually. Seven graduate students from three different graduate programs (Bioengineering, Neuroscience, and Cellular and Molecular Biology) enrolled

in the inaugural semester of the course. At the end of the semester, graduate students reported feeling better equipped to communicate with community partners and were more interested in integrating community concerns into their future research programs and careers. Participating graduate students provided the following representative reflections of the course as part of their assignments:

This course has truly re-shaped my understanding of community-engaged science. I used to think that occasional volunteering and outreach could be sufficient to foster relationships within my community. I am now very sure that I want to pursue a career that focuses on community outreach. As a female scientist from an under-represented background, this course has inspired me to do more for my peers and the community around me. (Student 1)

After taking this class, I realize that incorporating community-engaged scholarship into my research on [tendon] reconstruction could lead to better patient outcomes. With community needs and concerns in mind, researchers can develop more effective interventions and better support patients during their recovery. We need more people trained to solve real-world problems, and this class has helped me to better understand how I can make a positive impact. (Student 2)

Overall, students left the course with greater knowledge about the importance of engagement work both within academia and in the community, practical skills for responsible engagement, and desire to continue this work. To date, three students from the course have enrolled in the certificate program. Thus, the course is providing a strong experiential and academic foundation for students interested in the certificate.

Other Certificate Requirements

The Graduate Certificate in Community-Engaged STEM complements a student's disciplinary training in four parts: coursework, a research seminar, mentored community-engaged scholarship experiences, and a capstone project. This curriculum is overseen by members of the Faculty Advisory

Board, who are committed to the quality of the program's requirements and mentoring students in the program. Designed to encourage community-engaged scholarship for all interested STEM graduate students at Penn, the program has built-in flexibility to accommodate the various requirements of students' main degrees. The coursework component includes two graduate-level ABCS courses and one asynchronous online course. The two required ABCS courses are the Research & Community course, described above, and an elective ABCS course. The elective course allows students to individualize their learning and tailor the certificate to their own research and academic interests. Elective course options include courses with a focus on education, public health, design, technology, and engineering. As ABCS courses, all elective options involve mentored interactions with the local community.

The asynchronous course, the Penn Experience, was created by Penn's School for Social Policy & Practice and the School of Dental Medicine with the objective of facilitating conversations about race, racism, and Penn's connection with the local neighborhood. The course uses various forms of literature and media to provide a strong foundation in the history of Penn's relationship with Philadelphia's neighborhoods, raising awareness of institutional racism and the consequences of Penn's real estate encroachment on the community. In addition, the course offers perspectives on best practices for greater engagement and inclusion in Penn's various academic, clinical, and social activities. By including this course in the certificate's requirements, the program can ensure that enrolled students can engage with the community with an appropriate sensitivity to possible tensions, as well as a strong sense of the expertise of community members.

The monthly research seminar is led by the certificate's Faculty Advisory Board. Each seminar highlights an example of an existing community-engaged project, including how it was developed and how it serves its community partners. The specific topics can vary from year to year, depending on the interests of the students involved in the certificate program. In addition to giving students an appreciation for the plethora of community-engaged scholarship opportunities, the seminar serves as a shared experience, building fellowship among the

certificate students. The seminars are also an opportunity for students to develop, hone, and share their ideas for community-engaged scholarship projects. The seminar presentations include instruction on best practices in community-engaged scholarship, social determinants of health, and education inequities.

Regarding mentored community-engaged scholarship, students must complete 40 hours of sustained, STEM-related engagement with members of the public. The goal of this requirement is to support students' development and competency in participating in long-lasting community partnerships to fulfill community needs. The requirement of 40 hours of involvement with a particular community partner is intended to promote a meaningful relationship with the community partner and be feasible to accomplish within a semester by committing approximately 3 hours per week. The certificate program website (<https://www.med.upenn.edu/cescp>) describes an array of ongoing engagement opportunities that are open to student participation. The engagement opportunities are overseen by members of the Faculty Advisory Board to ensure that students are cultivating and implementing responsible and ethical community-engaged scholarship practices. As the final requirement, students must create an independent capstone project based on their community-engaged experiences. The capstone project can take the form of a scholarly work, such as a research paper; a presentation at a professional conference; or STEM-based resources for the community. Each year, a special session of the seminar series is dedicated to students presenting their capstone projects.

Taken together, the coursework, seminar series, and community-engaged scholarship experiences allow students in the Community-Engaged STEM Certificate Program to be informed practitioners of community-engaged STEM projects. These activities also are designed to build a coterie of students and faculty who share a commitment to community-engaged scholarship, regardless of their STEM discipline. Importantly, students are encouraged to align their unique research expertise with a need in society. To ensure that the certificate is attainable for doctoral students, each component of the curriculum can be undertaken at any point during their main program of study. Although completion of

the certificate is possible within 2 years, there are no time limits within the duration of students' doctoral program.

Competencies Developed in the Certificate Requirements

The Graduate Certificate Program in Community-Engaged Scholarship at Michigan State University includes a useful framework of competencies to be developed in students aspiring to conduct community-engaged work (Doberneck et al., 2017). Following that example, the Graduate Certificate of Community-Engaged STEM is designed to provide training for each of these competencies. As shown in Table 1, each of the eight competencies is emphasized in at least one, but usually several, components of Penn's Community-Engaged STEM Certificate Program.

Measuring the Impact

The Inaugural Year

The certificate program went from conception to implementation in approximately 20 months, enrolling graduate students in the Perelman School of Medicine and School of Arts & Sciences in Fall 2023. The monthly seminar series began in September 2023 with an overview of the program's goals and requirements. Subsequent seminars featured presentations from members of the Faculty Advisory Board or the community liaisons, focusing on the broad array of community-engaged work happening at Penn. For example, the January seminar focused on various child advocacy programs. The February seminar then featured a discussion of programs that address the social determinants of health. Approximately 15 students participated in the seminar series during the first year, largely from the Biomedical Graduate Studies doctoral program. In addition, several students have completed the asynchronous Penn Experience course.

During the first year of implementing the program, additional STEM-relevant engagement opportunities came to light, and we expanded the options available to students to fulfill the certificate's requirements. The certificate website includes a form for students to submit suggestions of new or ongoing engagement opportunities to continue to build this database. As our network of Penn faculty, staff, and students interested in this work grows, the website will serve as a repository and networking

Table 1. Competencies Developed in the Community-Engaged STEM Certificate Program

Competency	The Penn Experience virtual course	Foundational ABCS course	Monthly seminar	Mentored community engagement	Capstone project
Foundations: understanding of history and variations in CES	X	X	X		
Partnerships: initiating, sustaining, techniques for collaboration		X		X	
Criticality: reflection, ethics, engaging with diversity	X	X			X
Scholarship: research, teaching, service/practice		X	X		X
Perspectives: Asset-based, capacity building, systems approaches	X	X	X	X	
Evaluation/Assessment: peer review					X
Communication: public and academic audiences		X		X	X
Careers: Accomplishments, career span			X		X

site. Now that the Graduate Certificate in Community-Engaged STEM has been established in the School of Medicine and the School of Arts & Sciences, additional work is needed to tailor the program to other STEM-related schools at Penn.

Several layers of program evaluation have been established to ensure the success of students in the Community-Engaged STEM Certificate Program. In terms of student evaluation, the enrolled students are tracked for their progress as community-engaged scholars. Their engagement work is mentored by a member of the Faculty Advisory Committee. Faculty advisors complete a performance evaluation form for their mentees in the middle and at the end of a student's community-engaged scholarship project. The evaluation form tracks several metrics of the student's performance, including commitment, demonstration of best practices, prioritizing the needs of the community, and adapting based on experience. The advisor also gathers feedback from community partners. Based on this

documentation, students are given feedback and recommendations for improvement.

A second layer of evaluation assesses how the certificate program affects the students' career trajectories and future community-engaged scholarship activities. At 2-year intervals, we will contact former certificate students to catalogue their current employment position (research, teaching, etc.) and the extent to which they include community-engaged scholarship in their professional activities. This biannual time series may provide the basis for a study on how graduate-level community engagement training is associated with later career activities. We also hope that certificate alumni will provide a professional network to further advise the program.

In addition to evaluating students' progress in the certificate program and their subsequent career paths, the Community-Engaged STEM Certificate Program itself will undergo regular internal reviews. The program has created a Student Advisory

Board consisting of graduate students who are currently enrolled in the program. These students will serve on the Advisory Board for one year. The Student Advisory Board meets twice yearly to provide constructive feedback on the program, including whether the requirements are achievable and accessible to a wide population of students, the prevalence and availability of certificate faculty advisors, the relevance of seminar topics, and the availability of engagement opportunities that align with student career and research interests. In addition, the Faculty Advisory Board meets annually to determine and implement improvements to the program. Faculty meetings will include a consideration of the feedback from community partners, which will be gathered from all community partners that participate in the program.

No community advisory board has been created for the certificate program at this time. Rather, community advisory boards exist for the various programs that the graduate students may participate in, such as programs overseen by the Netter Center. Therefore, we will take advantage of the current community advisory boards to gather input regarding feedback, concerns, and suggestions about the certificate program. Although a formal study may be feasible in the future, no plans are under way to document the impact of the certificate program on community partners. A guiding principle of these review processes will be to continually improve relevant competencies in the students and continually ensure that the student–community partnerships within the program are best serving the needs of the community. We will also consider how and when to expand the program to other STEM-related schools within Penn. As an ultimate layer of evaluation, the program will also seek an external review after 5 years, requesting input from scholars involved in similar programs at peer universities.

The school partners have expressed broad appreciation for previous and ongoing academic supports that Penn students bring to schools; however, any expansion in programming is based on the potential benefits perceived by the schools' administration and staff. To the extent that graduate students increase Penn's capacity to support these local schools, there is room to increase Penn's footprint. Nevertheless, any increase in Penn student involvement often requires additional coordination, such as identifying

partner classrooms, aligning time slots, finding appropriate space, and supporting the curriculum. It is critical that such complications do not add to the workload of the public schools' teachers and staff. Awareness of these obstacles and the relevant problem-solving skills is an important learning experience for graduate students participating in the program.

Next Steps

This certificate program has been well received by graduate students and the university, and we expect participation to grow over time. By uniting students across the broad spectrum of STEM fields, the program has the potential to be an interdisciplinary thought incubator, innovating Penn's collaborations with the local community. As graduate students contribute to novel programming in community-engaged STEM, we encourage the participating graduate programs to consider incorporating a student's independent community-engaged scholarship innovations into their dissertation work. We are in the process of developing an annual Spring symposium to showcase certificate student engagement projects and promote further interest in engagement work.

Broader Goals

Graduate programming in community-engaged STEM relates to two urgent issues in STEM fields: the social obligation to proactively include the public in our scholarly endeavors and the need to improve representation in STEM fields. Regarding public access, the STEM community is mainly incentivized by grants and publications, and these systems are not always designed to hold STEM professionals accountable for their direct contribution to the stakeholders in their communities. Nevertheless, the culture of STEM professions has increasingly embraced the value of broadening participation, which includes better engagement with the public to decide what research questions matter and to disseminate the knowledge generated through research. Universities can exercise leadership by establishing new incentives for democratizing science, which in turn would likely produce better science. We propose that the creation of educational programs, such as the certificate described here, can represent a bold investment, signaling the scholarly value that a university places on community-engaged STEM. Such

academic leadership can have multiplier effects, including nudging STEM professionals to increase their community involvement; inspiring trainees to develop best practices of community work in their careers; and improving the education, health, and economic outcomes of their local communities. We will monitor whether such programming has these desired effects by documenting faculty participation in community-facing programs; graduate student participation in the training; and available local educational, health, and economic indicators.

Regarding the need to improve representation in STEM fields, Vannevar Bush (1945) famously noted that science would be at its highest quality if “ability, not the circumstances of family fortune, is made to determine who shall receive higher education in science” (p. 1427). In the more than 80 years since that statement, STEM fields remain insufficiently diverse. Well-known barriers for underrepresented students to enter STEM fields include insufficient pre-college preparation, campus climate, debt disparities, and a lack of faculty diversity. A university initiative to promote graduate education in community-engaged STEM is not a magic bullet to resolve these hurdles. However, it may mitigate these issues to some extent with upstream effects on improved STEM literacy in local communities, improved sense of belongingness on campuses by demonstrating a commitment to diverse communities, and the appeal of academic positions in STEM fields to people of diverse backgrounds by aligning STEM endeavors with an interest in their groups’ well-being. Although this work is not immediately planned, possible metrics to assess these outcomes could include local school standardized testing, the number of underrepresented graduate students joining STEM programs, and successful recruitment and retention of faculty from underrepresented groups in STEM fields. In this way, university leadership’s support of community-engaged STEM scholarship may help the university attain a more robust STEM research enterprise. Indeed, community-engaged scholarship can both reflect and improve intellectual merit, and thus the university commitment to community-engaged STEM education can be a vehicle to meet multiple goals.

We recognize that other higher education institutions will differ in the motivations and constraints that may affect their

ability to develop an educational program for graduate students to gain professional experience in community engagement. The creation of Penn’s certificate program was facilitated by preexisting community relationships, the complementarity of the local educational needs and Penn graduate students’ teaching capacity, and the university administration’s commitment to community partnerships. Conversely, universities without sufficient preexisting community engagement programs available to graduate students or lacking a community-engagement culture on campus may face challenges in developing a curriculum for such a program. Similarly, dissertation mentors may discourage students from spending time on something not strictly part of their dissertation. In addition, researchers and administrators who do not engage in community-engaged projects may not recognize the importance of training for community engagement. In some cases, graduate deans may be resistant to creating new credentials. Therefore, we propose that useful steps toward building a program of this type would likely include strengthening the infrastructure to connect graduate students with meaningful community partnerships, defining a broad community need that aligns with available graduate student skills, and gaining the support of relevant university curriculum leaders.

Conclusions

Research universities have worked to better integrate their work with community concerns to retain social relevance. Penn’s certificate program may offer a useful framework for a next step in formalizing a university’s commitment to community-engaged STEM within graduate education. In our experience, the concept of this certificate has broad appeal with various university constituents, allowing it to be created and implemented within a short time. The certificate curriculum required the creation of a few new components, namely the seminar series and a required course, but some courses and many community-engaged scholarship opportunities already existed. Therefore, it seems likely that some research universities may be well positioned to craft a similar educational opportunity for STEM graduate students. Through such programs, we can look forward to a new generation of STEM researchers who are well equipped to add value to their work by meaningfully engaging with their local communities.



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References

- Allen, J. D., Fu, Q., Shrestha, S., Nguyen, K. H., Stopka, T. J., Cuevas, A., & Corlin, L. (2022). Medical mistrust, discrimination, and COVID-19 vaccine behaviors among a national sample U.S. adults. *SSM—Population Health*, 20, Article 101278. <https://doi.org/10.1016/j.ssmph.2022.101278>
- Backer, D. I., & Rodriguez, A. D. (2025). Movements at the fiscal/monetary crossroads: Financing a Green New Deal for schools in Philadelphia. *Journal of Urban Affairs*, 47(1), 87–101.
- Bok, D. (1990). *Universities and the future of America*. Duke University Press.
- Boyer, E. L. (1990). Scholarship reconsidered: Priorities of the professoriate. Carnegie Foundation for the Advancement of Teaching.
- Boyer, E. L. (1996). The scholarship of engagement. *Journal of Public Service and Outreach*, 1(1), 11–20. <https://openjournals.libs.uga.edu/jheoe/article/view/666>
- Bridgman, P. W. (1947). Scientists and social responsibility. *The Scientific Monthly*, 65(2), 148–154. <https://www.jstor.org/stable/19013>
- Bush, V. (1945). *Science, the endless frontier: A report to the President on a program for postwar scientific research*. National Science Foundation.
- Campbell, K. B. (2005). Theorizing the authentic: Identity, engagement, and public space. *Administration & Society*, 36(6), 688–705. <https://doi.org/10.1177/0095399704270582>
- Canner, J. E., McEligot, A. J., Pérez, M. E., Qian, L., & Zhang, X. (2017). Enhancing diversity in biomedical data science. *Ethnicity & Disease*, 27(2), 107–116. <https://ethndis.org/archive/files/ethndis-27-107.pdf>
- Delve, C. I., Mintz, S. D., & Stewart, G. M. (1990). Promoting values development through community service: A design. *New Directions for Student Services*, 1990, 7–29. <https://doi.org/10.1002/ss.37119905003>
- Doberneck, D. M., Bargerstock, B. A., McNall, M., Van Egeren, L., & Zientek, R. (2017). Community engagement competencies for graduate and professional students: Michigan State University's approach to professional development. *Michigan Journal of Community Service Learning*, 24(1), 122–142. <https://doi.org/10.3998/mjcs-loa.3239521.0024.111>
- Eyler, J., Giles, D. E., Jr., & Braxton, J. (1997). The impact of service-learning on college students. *Michigan Journal of Community Service Learning*, 4(1), 5–15. <http://hdl.handle.net/2027/spo.3239521.0004.101>
- Flanagan-Cato, L. M., Plate, R. C., Steele, C., & Jenkins, A. C. (2023). Effects of community-engaged neuroscience course on mood and intergroup anxiety. *Journal of Undergraduate Neuroscience Education*, 21, A159–A165. <https://doi.org/10.59390/HXTQ3326>
- Furco, A. (2010). The community as a resource for learning: An analysis of academic service-learning in primary and secondary education. In H. Dumont, D. Istance, & F. Benavides (Eds.), *The nature of learning: Using research to inspire practice* (pp. 227–249). Centre for Educational Research and Innovation, OECD Publishing. <https://doi.org/10.1787/9789264086487-12-en>
- Hall, O. T., Bhadra-Heintz, N. M., Teater, J., Samiec, J., Moreno, J., Dixon-Shambley, K., Rood, K. M., Fiellin, D. A., & Jordan, A. (2022). Group-based medical mistrust and care expectations among Black patients seeking addiction treatment. *Drug and Alcohol Dependence Reports*, 2, Article 100026. <https://doi.org/10.1016/j.dadr.2022.100026>
- Hamilton, R. H., Hamilton, K., Jackson, B., & Dahodwala, N. (2007). Teaching: Residents in the hospital, mentors in the community: The Educational Pipeline Program at Penn. *Neurology*, 68(19), E25–E28. <https://doi.org/10.1212/01.wnl.0000261007.54772.fd>
- Harkavy, I. (2023). Dewey, implementation, and creating a democratic civic university. *The Pluralist*, 18(1), 49–75. <https://doi.org/10.5406/19446489.18.1.06>
- Harkavy, I., Hartley, M., Hodges, R. A., & Weeks, J. (2015). The history and development of a partnership approach to improve schools, communities and universities. In *Developing community schools, community learning centers, extended-service schools and*

- multi-service schools: International exemplars for practice, policy and research (pp. 303–321). Cham: Springer International Publishing.
- Holland, B. A. (2005). Scholarship and mission in the 21st century university: The role of engagement. In *Proceedings of the Australian Universities Quality Forum: Engaging communities* (pp. 11–17). Australian Universities Quality Agency.
- Holzer, J. K., Ellis, L., & Merritt, M. W. (2014). Why we need community-engaged scholarship in medical research. *Journal of Investigative Medicine*, 62(6), 851–855. <https://doi.org/10.1097/JIM.0000000000000097>
- Hong, L., & Page, S. E. (2004). Groups of diverse problem solvers can outperform groups of high-ability problem solvers. *PNAS*, 101(46), 16385–16389. <https://doi.org/10.1073/pnas.0403723101>
- Keeler, B. L., Derickson, K. D., King, H. J., Leneman, K. B., Moskowitz, A. F., Mrutu, A., Nguyen, B., & Walker, R. H. (2022). Community-engaged scholarship for graduate students: Insights from the CREATE Scholars program. *Journal of Higher Education Outreach and Engagement*, 26(2), 125–138. <https://openjournals.libs.uga.edu/jheoe/article/view/2708>
- Koepsell, D. (2010). On genies and bottles: Scientists' moral responsibility and dangerous technology R&D. *Science and Engineering Ethics*, 16(1), 119–133. <https://doi.org/10.1007/s11948-009-9158-x>
- Kratochvil, T. J., Keeler, H. J., & Davies, H. D. (2022). Asset-based community “response”: A model promoting effective student–community engagement in disaster scenarios. *Progress in Community Health Partnerships: Research, Education, and Action*, 16(2, Suppl.), 59–68. <https://doi.org/10.1353/cpr.2022.0039>
- Laws, K. M., Natale, E., Waddell, E. A., Shuda, J. R., & Bashaw, G. J. (2023). DrosoPHILA: A partnership between scientists and teachers that begins in the lab and continues into city schools. *eNeuro*, 10(2). <https://doi.org/10.1523/ENEURO.0263-22.2022>
- Lupia, A., Allison, D. B., Jamieson, K. H., Heimberg, J., Skipper, M., & Wolf, S. M. (2024). Trends in US public confidence in science and opportunities for progress. *PNAS*, 121(11), Article e2319488121. <https://doi.org/10.1073/pnas.2319488121>
- Matthews, P. H., Karls, A. C., Doberneck, D. M., & Springer, N. C. (2015). Portfolio and certification programs in community-engaged scholarship as professional development for graduate students: Lessons learned from two land-grant universities. *Journal of Higher Education Outreach and Engagement*, 19(1), 157–183. <https://openjournals.libs.uga.edu/jheoe/article/view/1189>
- Morrison, E. A. (2020). Exploring community-engaged scholarship: Insights and questions for HRD. *Advances in Developing Human Resources*, 22(1), 41–56. <https://doi.org/10.1177/1523422319886301>
- Newman, F. (1985). *Higher education and the American resurgence*. Princeton University Press.
- O'Meara, K. A. (2005). Effects of encouraging multiple forms of scholarship nationwide and across institutional types. In K. A. O'Meara & R. E. Rice (Eds.), *Faculty priorities reconsidered: Encouraging multiple forms of scholarship* (pp. 255–289). Jossey-Bass.
- O'Meara, K. A. (2008). Graduate education and community-engaged scholarship. *New Directions for Teaching and Learning*, 2008, 27–42. <https://doi.org/10.1002/tl.306>
- Reddick, R. J., Struve, L. E., Mayo, J. R., Miller, R. A., & Wang, J. L. (2018). “We don't leave engineering on the page”: Civic engagement experiences of engineering graduate students. *Journal of Higher Education Outreach and Engagement*, 22(2), 127–155. <https://openjournals.libs.uga.edu/jheoe/article/view/1389>
- Reeb, R. N., Folger, S. F., Langsner, S., Ryan, C., & Crouse, J. (2010). Self-efficacy in service-learning community action research: Theory, research, and practice. *American Journal of Community Psychology*, 46(3–4), 459–471. <https://doi.org/10.1007/s10464-010-9342-9>
- Shuda, J. R., Butler, V. G., Vary, R., Noushad, N. F., & Farber, S. A. (2019). A 3-year model for building a sustainable science outreach and teacher collaborative. *Journal of STEM Outreach*, 2(1), 1–15. <https://doi.org/10.15695/jstem/v2i1.12>

- Stofer, K. A., Hanson, D., & Hecht, K. (2023). Scientists need professional development to practice meaningful public engagement. *Journal of Responsible Innovation*, 10(1). <https://doi.org/10.1080/23299460.2022.2127672>
- Wade, A., & Demb, A. (2009). A conceptual model to explore faculty community engagement. *Michigan Journal of Community Service Learning*, 15(2), 5–16. <http://hdl.handle.net/2027/spo.3239521.0015.201>
- Weerts, D. J., & Sandmann, L. R. (2008). Building a two-way street: Challenges and opportunities for community-engaged scholarship at research universities. *Review of Higher Education*, 32(1), 73–106. <https://doi.org/10.1353/rhe.0.0027>
- Weigert, K. M. (1998). Academic service learning: Its meaning and relevance. *New Directions for Teaching and Learning*, 1998(73), 3–10. <https://doi.org/10.1002/tl.7301>

