

# Postbaccalaureate Bridge Programs Diversify PhD Pathways

*Sophia D. Merow*

Let us first define our terms.<sup>1</sup> An academic *bridge* program typically aims to improve preparation for or ease transition to postsecondary education. A *postbaccalaureate* program is one completed after receipt of an undergraduate degree.

In recent years, postbaccalaureate bridge programs that provide pathways from a bachelor's to a PhD in the mathematical sciences have multiplied. The Joint Post-Baccalaureate Program in Mathematics, Physics, and Earth and Planetary Sciences at Washington University in St. Louis welcomed its first class to campus in the fall of 2015. The NSF Bridge-to-Math-Doctorate program at the University of Texas at Arlington was launched a year later. The University of Pennsylvania's math department admitted the first cohort to its Bridge to PhD in 2017, and Iowa State began offering a Postbaccalaureate Certificate in Mathematics in 2018. Both the California-based Bolstering the Advancement of Masters in Mathematics (BAMM!) program and the University of Virginia's Bridge to the Doctorate got under way during the pandemic-disordered 2020–21 academic year, and at the time of this writing (June 2021), Northwestern University's Causeway Postbaccalaureate Program is poised to kick off its opening summer.

So what's behind this proliferation? Recognition that, as BAMM!'s Oscar Vega (Fresno State)<sup>2</sup> puts it, “the mathematical sciences are lagging—badly—in terms of equity and representation, especially in the United States.”

*Sophia D. Merow is a freelance writer and editor. Her email address is sdmerow@gmail.com.*

<sup>1</sup>Well, sort of.

<sup>2</sup>While Vega was the director of BAMM! as this article was in progress, Cal Poly Pomona's John Rock has since assumed the role.

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Northwestern's Eric Zaslow quantifies the lag: the percentage of PhDs granted to underrepresented minority (URM) Americans—those who identify as Native American, African American, Hispanic, or Pacific Islander—at top-50 institutions hovers at around five percent, while these minorities comprise roughly 30 percent of the general population. “So,” Zaslow concludes, “graduate programs should be awarding PhDs to URM students at SIX TIMES their current rate.”

Program organizers see their efforts as both an initial step toward addressing the lack of diversity at all levels of mathematics and a contribution to the country's broader strivings toward increased equity. But they know that the road will be long and their work only a fraction of what is needed.

“This is a long-term problem,” asserts the project description in the grant proposal for Northwestern's Causeway program, “and it requires a long-term solution.”

## Variations on a Theme

Though broadly in agreement about supporting underserved students, increasing diversity, expanding opportunity, and fostering a sense of belonging among those who might not resemble the stereotypical mathematician, postbaccalaureate bridge programs in mathematics nonetheless vary along a number of dimensions.

**Target demographic.** Programs largely share the goal of increasing the number of PhDs awarded in the mathematical sciences to members of groups that are traditionally underrepresented. Within this demographic they cater to those who, whether because of life hurdles or financial barriers, limited course offerings or a late-blooming passion for mathematics, are insufficiently prepared for standard doctoral programs. Some—Smith College's Center for

Women in Mathematics Postbaccalaureate Program, for instance—target one specific segment of this population, while others have regional restrictions or a particular disciplinary slant. Due to the tuition structure of participating universities Fresno State, San Francisco State, and Cal Poly Pomona, BAMB! is unlikely to make financial sense for students who are not already California residents, reports Oscar Vega. Renato Feres notes that a student whose goal is to pursue graduate studies in one of the more strictly applied subfields of mathematics would likely not find Washington University's program a good fit. Programs with National Science Foundation funding are open only to US citizens or permanent residents.

**Program length.** Given target populations with nontrivial gaps in their preparation for PhD-level mathematics, the programs under consideration here are more than week- or summer-long "boot camps." On the shorter side, Smith College's program offers one or two semesters of intensive study at the advanced undergraduate level. At the other extreme, University of Michigan's Marjorie Lee Browne Master's Program in Applied and Interdisciplinary Math pairs two years (four academic terms) of course work with two summers of research.

**Cohort size.** These resource-intensive programs tend to be relatively small. Cohorts range from two to three students per year (e.g., Penn) to six to 10 (e.g., Iowa State). At the University of Texas at Arlington, about 10 percent of the department's graduate students are bridge program participants. "The students in the program should not feel isolated from the remaining doctoral students in the PhD program," says UTA's Tuncay Aktosun. "Yet, there should be enough students in the program so that they can interact as a cohort."

**Credential?** Nonstandard by nature, postbaccalaureate bridge programs chart different paths through existing educational structures. Penn's bridge offers a master's, Iowa State's a certificate. While Michigan's Trachette Jackson describes her university's program as a reimagination of the master's (intended "to provide protected time to focus on strengthening foundational mathematical skills and exploring research options"), Northwestern's literature emphasizes that the Causeway program is *not* a master's. "We do not want to require that students take graduate-level courses before they are properly prepared," explains the Causeway project description. "Our concern is that a master's program would not be able to focus on foundations and that students can be ill-served by leapfrogging essential steps."

**Feeder?** Programs differ in the extent to which they feed into specific doctoral programs. While Causeway explicitly aims to serve a national need rather than to increase diversity at one particular school, Penn's bridge program was designed to prepare admitted students for the department's own PhD program. Students who successfully complete the

University of Texas at Arlington's bridge program have the option to proceed to UTA's doctoral program, but they are encouraged to consider other universities' offerings as well. Aktosun reports that 94 percent of UTA's bridge students have smoothly transitioned to regular doctoral programs or first to a master's and then to a doctoral program in the mathematical sciences; 60 percent of these continued their studies at UTA.

**Funding sources.** Funding comes from some combination of grants, institutional support, and private and corporate donations. Funding sources for the University of Pennsylvania's bridge program include the mathematics department, the School of Arts and Sciences, and the National Science Foundation. Initially funded by an NSF grant, Michigan's program is now possible thanks to financial backing from the university's Rackham Graduate School and the College of Literature, Science, and the Arts. Iowa State is able to admit and fund students who are not US citizens or permanent residents because the program receives no federal dollars; it relies on support from the math department, the College of Liberal Arts and Sciences, and donations (including from equipment manufacturer John Deere).

**Program components.** Program organizers agree that mentoring is critical, but implementations vary. Students in UVA's and University of Michigan's bridge programs have both faculty and graduate student mentors. In Washington University's program, each student has one mentor monitoring academic progress and another attentive to nonacademic issues. Causeway's two-way mentoring system situates participants not only as mentees of Northwestern graduate students and faculty but also as mentors to local high school students. BAMB! supplements existing master's programs with two years of mentoring and community-building activities. "That mentoring is at the center of the whole program makes BAMB! unique," says Fresno State's Vega.

Research experience is another key component of many programs. It is difficult to increase diversity among mathematical sciences PhDs as long as research becomes a focus of graduate education only at the doctoral level, University of Michigan's Jackson explains, since there is evidence that underrepresented minorities are more likely than other students to pursue master's degrees before committing to doctoral education. "Having more options to engage students in research master's programs that provide full funding and strong preparation for doctoral programs can have impact where other efforts to diversify doctoral programs have been relatively unsuccessful," she says. Students in Michigan's bridge program receive a research fellowship for one

term plus two summers of additional research support.<sup>3</sup> Causeway students begin the 12-month program with a summer research experience and have the opportunity to present their findings at subsequent research seminars. As the Causeway project description notes, “It is important for students to experience the rigors and travails of research before committing years of their lives to the effort.”

### Challenges

Postbaccalaureate bridge programs neither finance nor run themselves, and funding and administration top the list of challenges would-be program organizers face.

“Funding is a chicken-and-egg kind of thing,” observes Northwestern’s Zaslow. “Having institutional buy-in may be attractive in securing a grant, but securing a grant may be necessary for institutional buy-in.” Causeway’s solution to the thorny problem of financial sustainability involves a consortium structure intended to both build a base of stakeholders and create a model for funding beyond the initial period of NSF support. Partner institutions and organizations will provide both key program resources (by becoming recruiting partners, for example) and financial support (in the form of membership fees).

Even after funding is secured, organizers can expect lots of questions from deans and provosts, presidents and trustees—especially if a proposed postbaccalaureate program is a university’s first. Programs like Michigan’s and UVA’s have benefitted from being one among an assortment of postbaccalaureate programs on campus. Michigan’s Marjorie Lee Browne Master’s Program in Applied and Interdisciplinary Math was one of three bridge programs introduced in 2011; the university now has seven, in disciplines from engineering to business to classics. The UVA math department had toyed with the idea of a bridge program, but it wasn’t until the Graduate School of Arts & Sciences launched a broader Bridge to the Doctorate initiative that they got one off the ground. “I’m not sure we could have done it ourselves,” admits UVA’s David Sherman. And even with strong institutional support, the workload associated with these by nature hands-on programs is high, delegation and division of labor a necessity. “It would be overwhelming for two or three people to try to do something like this,” says Sherman. “It really needs to be a larger group than that.”

After funding and administration, the next most-cited challenge is recruitment. “Almost by definition our students are ones who are not in well-connected places,” says UVA’s Sherman. Organizers have implemented a variety of strategies to identify and attract promising candidates. They design websites and mount outreach efforts at conferences such as Field of Dreams and SACNAS; they draw

on networks of affiliated institutions, rely on colleagues to keep their eyes open for students who might be a good fit. “Advertise to organizations and faculty, rather than students, when first starting out,” advises Iowa State’s Michael Young. University of Texas at Arlington’s years-long relationship with members of the Gulf States Math Alliance has so effectively facilitated its recruitment of candidates from HBCUs and other minority-serving institutions that no nationwide awareness-raising campaign is necessary. “We seem to be getting enough applications,” reports UTA’s Aktosun. “Our own goal is not to recruit the strongest candidates to our program,” he adds, “but to recruit those who would benefit the most.” Causeway hopes to enlist its students as ambassadors eventually; by participating in meet-and-greets, hosting prospective students, and helping to curate the program’s social media presence, the thinking goes, students will develop a sense of ownership.

Challenges remain, of course, even once a program has been established and a cohort of students admitted. Fostering community has proven tricky, for example, given the small cohort size. “We make an effort to integrate the postbac students socially with our first-year graduate students,” says Washington University’s Feres. “However, this is not an ideal solution.” “Strong communities require a critical mass of people and getting things off the ground can be particularly challenging,” says Penn’s Philip Gressman. Organizers must also be able and willing to adjust expectations and tweak requirements as programs evolve and reality asserts itself. “The adjustment to a rigorous academic environment like ours is not always easy,” explains Feres. Bridge program participants may not, UVA’s Sherman points out, slot smoothly alongside their advanced undergraduate or beginning graduate classmates.

### What You Can Do

As indicated above, program organizers welcome referrals from colleagues. If you know a promising candidate for a postbaccalaureate bridge-to-PhD program, encourage them to apply to one. Offer to write a letter of recommendation.<sup>4</sup> With permission, give your student’s contact information to a program representative so they can reach out. “We are happy to set up a Zoom or phone call with the interested student to discuss their plans and whether our program is a good fit for them,” says Washington University’s Feres.

Recruitment challenges aside, program organizers believe that suitable students are out there—and that there are more than enough of them to go around. The need for bridges, in other words, outstrips the supply. “The more programs like BAMB! or other post-bac programs we can

<sup>3</sup>Marjorie Lee Browne Scholars are fully funded for the duration of the program; for three of the four academic terms, this funding takes the form of graduate student instructorships.

<sup>4</sup>“Lay out both sides of the match,” University of Pennsylvania’s Gressman advises. “What specific skills, strengths, or experience will this student bring with them to the program, and how does the recommender anticipate that the program will meet that student’s unique needs?”

get, the better,” says Fresno State’s Vega. “The more variety, the better.”

To facilitate proliferation, the architects of existing programs are beginning to compare notes, pool resources, and strategize about how to scale their efforts. BAMM! organizers plan to leverage lessons learned to expand the program to other similar institutions, perhaps via a program template colleagues could modify to meet their unique needs. In October 2020, Iowa State’s Bernard Lidický and Michael Young and Northwestern’s Eric Zaslow organized an American Institute of Mathematics workshop with the “dual goals of creating/sharing best practices among postbaccalaureate and bridge programs, and connecting stakeholders of such programs to one another so that conversation and coordination could continue beyond the timeframe of the meeting.” Among the plans for increased interaction and cross-pollination discussed: bringing students from across programs together as a way of creating a “super-cohort.” Though workshop participants hope that such gatherings can be repeated periodically, there are as yet no formal mechanisms for connecting those interested in postbaccalaureate bridge programs in the mathematical sciences; for now, the best way to join the conversation is to contact a program organizer.

Funding any individual’s pursuit of a PhD is a calculated risk. By improving candidates’ preparation, postbaccalaureate path-to-doctorate bridge programs hope to make it easier for graduate admissions committees to take chances on a more diverse cohort of could-be PhDs. If you participate in the evaluation of doctoral applicants in your department, advocate for an appropriately broad understanding of what preparedness and potential look like. “It is important for the long-term success of the post-bac/bridge concept,” says Penn’s Philip Gressman, “to normalize the idea that there are many different and equally valid ways to arrive at the PhD.”



Sophia D. Merow

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