



TPSEMath

Transforming Post-Secondary Education in Mathematics

PREPARING MATH MAJORS FOR CAREERS: PARTNERING WITH INDUSTRY

HEATHER MCKAY,
SUZANNE MICHAEL, AND
RENÉE EDWARDS



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Transforming Post-Secondary Education in Mathematics (TPSE Math) aims to effect constructive change in math education at U.S. community colleges, 4-year colleges and research universities by working closely with faculty leaders, university administrations, membership associations, and disciplinary societies. TPSE Math identifies innovative practices where they exist, advocates for innovation where they do not, and works with and through partners to implement and scale effective practices in the pursuit of mathematically rich and relevant education for all students, whatever their chosen field of study. TPSE Math is funded by a grant from the Carnegie Corporation of New York.



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INTRODUCTION

Transforming Post-Secondary Education in Mathematics (TPSE Math), a project funded by the Carnegie Corporation, the Alfred P. Sloan Foundation and the National Science Foundation, is dedicated to enhancing math education in two- and four-year colleges to prepare students with the “*mathematical knowledge and skills necessary for productive engagement in society and in the workplace*” (<https://www.tpsemath.org/>). In 2019, TPSE contracted with the Rutgers' Education and Employment Research Center (EERC) to study career readiness programs for math students and to identify and study promising practices in math departments across the country.

EERC, housed within the School of Management and Labor Relations, engages in multi-site, multi-method qualitative and quantitative evaluation, and conducts research to inform curricula and programs at the intersection of education and workforce development. With input from members of TPSE's Mathematics Advisory Group (MAG), EERC developed and administered an online survey to faculty, department chairs and senior administrators at 143 public and private two- and four-year colleges across the nation as well as five non-profit organizations (survey respondents N=219). The survey asked questions about career preparation, career pathways, advising, research and internship opportunities, alumni networks, interdisciplinary collaborations, and partnerships with employers.

In addition, the EERC team conducted 26 in-depth phone interviews with faculty, staff, and students at seven college¹ identified through the survey as having innovative programs. We also viewed a TPSE webinar with a presentation from the Dana Center at the University of Texas – Austin. The webinar and interviews provided a more detailed cross-institutional perspective on career readiness activities and programs.

This brief on industry is one of six briefs and an executive summary in the Preparing Math Majors for Careers series prepared by EERC that discusses the findings and recommendations that emerged from this qualitative research study.²

¹Babson College; Villanova University; Brigham Young University - Idaho; Harvey Mudd College; University of Nebraska – Lincoln; University of Arizona; and the University of Wisconsin

²All the briefs in this series are available from the EERC website at:

<https://smlr.rutgers.edu/content/transforming-post-secondary-education-mathematics-research>

PARTNERING WITH EMPLOYERS/INDUSTRY

Across the country, math departments are interested in creating partnerships with employers and industry to ensure that they are preparing students with the knowledge and skills needed to be successful in the 21st-century workplace. Partnerships facilitate the enhancement of curriculum and the development of internships and research projects in which students learn about and get ready for the labor market. The words of one faculty respondent illustrate that not all math departments are taking advantage of these partnerships, even where there is faculty buy-in for their development:

I would like to connect with industry more. We haven't gotten involved in that yet.

While connecting with industry and employers may seem easy to some, the data gathered from the TPSE-M survey and the EERC team's interviews with math faculty and college staff indicate that for many departments, this is a huge challenge. For some, this work is completely foreign to them:

The whole experience of working with the private sector feels really hard for a lot of faculty—they don't know what they don't know.

Knowing what students need in careers is more difficult to know. Finding employers that can help with developing these resources is very difficult.

In this brief we discuss some of the challenges of partnering with employers; identify ways to address these challenges; and present strategies institutions have used to connect with employers. We also provide specific recommendations for math departments interested in building partnerships with regional industries and employers.

PREPARING FOR CHANGE

For math departments, changing focus from a purely academic pathway to one that prepares students for participation in the labor force can be difficult. While stepping into the unknown can be scary, respondents consistently indicated that shifting focus to careers and industry was important. For some, it was not the idea of change that concerned them as much as how to proceed and successfully make that change. Many

indicated that change became easier with more education and information, typically gained through professional development activities. (For more on this see the EERC brief: Preparing Math Majors for Careers: Professional Development for Faculty and Staff). They also found that opening up a departmental dialogue helped to create a culture where training for industry is valued. One respondent from Harvey Mudd College spoke in depth about this:

One thing every department should look at is many faculty members are trained to be pure mathematicians and have never thought about what it's like to work in industry. Fortunately, this is changing with new academic graduates, but not for those that graduated 20 years ago. There are lots of opportunities to normalize what it is like to be in an industrial position. Faculty need permission to talk about this in that they don't know how to get from point A to B. How to talk to students about getting a job when they never really did that themselves in industry, anyway. Get them into settings that they see what it's like to be in industry, and they will find that it looks a lot like what it's like to do mathematical research—what they already do and understand. A lot of that is departmental cultures. So, to change that culture, one thing departments can do is tell faculty that it's part of their job to identify an industry partner and talk to them, and help the faculty acquire the necessary skills. Then they are happy to do it.

DEVELOPING PARTNERSHIPS

In the sections below, we discuss the ways some departments have successfully partnered with industry and employees.

DESIGNATE A PERSON TO WORK WITH INDUSTRY

One strategy that came up repeatedly in our data was dedicating at least one person in the department to work on connecting with industry and employers. To do this well, departments had to decide that employer relationships were going to be a priority. A few departments noted that this was a departmental choice, but many

more talked about this being a directive from the chair. An important aspect of assigning this function to a faculty member or staff person is explicitly indicating that it is an important activity and thus rewarding it. One respondent spoke about this tactic:

One of our faculty members has taken on the responsibility of being a liaison with local employers/industry. He meets with these people regularly, and our students have greatly benefitted from these efforts. I highly recommend that each math department appoint (or ask for a volunteer [to fill]) such a position.

PROFESSIONAL ASSOCIATIONS

One respondent from a career services center recommended having faculty members become familiar with, or even join, professional industry associations. Not math associations for academics, but rather industry associations in fields that hire math majors. Such faculty connections can expand knowledge about the range of fields and professions faculty can discuss with students. She also noted that outreach to industry associations can be a useful assignment for students.

ADVISORY BOARDS

Convening an advisory board of industry representatives to work with faculty was mentioned fairly often. Most frequently, advisory boards are used to inform curriculum. However, regular contact with advisory board members can also facilitate internships and externships as well as research opportunities. Advisory board members can also identify real-world problems and work with students on them. Further, advisory board members can be invited to present workplace industry issues to departments' brown bag series and student clubs.

We have a national advisory board that has most of its members in industry and government labs. They help us connect our students to careers at their companies, and they help us adjust our curriculum to prepare students better for careers in industry.

CONNECTING WITH ALUMNI

Partnering with alumni was a particularly fruitful way for math departments to make connections to industry. (For more on this see the EERC brief: *Preparing Math Majors for Careers: Working with Alumni*). Math department alumni who work in a variety of fields can help faculty enhance their curriculum to suit current industry trends. They can facilitate the development of internships and externships, create scholarships, and even hire students. Many colleges have successfully drawn upon their alumni networks to speak at departmental and campus events or student roundtables, and even help with advising students. One respondent made the following recommendation:

Bring in alumni and others working in local and out-of-state businesses to talk about how their education has connected to their current employment.

Planning social or networking events with alumni is another way to connect. Babson College did this on their Boston campus. (For more on this see the EERC brief: *Preparing Math Majors for Careers: Working with Alumni*).

USE INSTITUTIONAL RESOURCES

Math departments can also access and connect to industry and employers through campus-based career centers, business development centers, and advising offices. Most of these centers have existing relationships with regional employers. Faculty can build on these relationships by tapping into knowledge the center staff has already gathered about the employers. They can also learn the most effective ways to identify and engage employers with their teaching and advising. (For more on this see the EERC brief: *Preparing Math Majors for Careers: Advising Strategies and Practices*). One respondent spoke about a positive experience working with a campus advising office

Our undergraduate advising office has brought employers into the department for information sessions at different times.

CONNECTING WITH LOCAL AND REGIONAL INDUSTRY

Utah Valley University's math department maintains relationships with local and regional industry and government employers through alumni and faculty contacts. They regularly bring in speakers to math club events, department colloquia, and college-wide lectures. Recent speaker series have focused on the importance of math in the rapidly growing field of data science and in the regional biotech sector.

ENGAGE WITH LOCAL AND REGIONAL RESOURCES

While some departments and colleges such as Spelman (see *Connecting with Local and Regional Industry* inset) have been successful in working with large multinational companies, others have had more success working with local and regional employers. Local employers are often more accessible to students with respect to internships and research projects. Asked about who they work with, a respondent from Brigham Young University, Idaho, said, “Local business is a definite yes.” Another respondent noted that, “the research park on campus includes many different employers who offer opportunities for current students on campus.”

COMMUNITY-BASED ORGANIZATIONS

An idea that emerged from a handful of respondents was engaging with the community nonprofit and government sectors instead of or in addition to companies. Respondents talked about the many benefits of working with such organizations, including both opening students’ eyes to a new array of opportunities to use their math skills and helping resource-strapped organizations improve communities.

Several of our classes use community-based learning, having partnerships with local nonprofits, where students serve as consultants during their class.

INDUSTRY-SPONSORED PROGRAMS

Ford Motor Company partners with Spelman College on a program called Ford First Gen. Ford funds provide a cohort of 50 first-generation first-year students with personal and professional support services in order to improve graduation rates and enhance student success. The first year cohort is paired with 10 peer mentors who are rising juniors and also first-generation students. Peer mentors spend at least 10 hours a week with their mentees. Ford First Gen students participate in bi-weekly seminars focused on career development, artistic engagement, healthy relationships, envisioning your future, and more. They also engage with industry professionals in and outside of the Metro-Atlanta area on monthly excursions; meet with Spelman faculty across academic disciplines; and have Ford-sponsored summer internship opportunities that foster experiential learning and critical thinking.

MAINTAINING AND FOSTERING PARTNERSHIPS

While forming industry partnerships can be challenging, many said that maintaining them can be even more difficult. A few respondents spoke of the importance of making faculty–employer relationships mutually beneficial. Faculty should learn from employers and employers should learn from faculty. Faculty need to understand what math skills industry needs, while employers need to understand what math majors can bring to them - how the skills students acquire as math majors can be applied to industry.

The process of coeducation between employers and faculty, however, can be difficult and time consuming. Those who have had success suggested that it is a continuous process, but the first step is starting the conversation. This can take a variety of forms. Inviting employers to speak in classes or at roundtables is one strategy. Another is hosting a group of employers as part of a job fair where students can ask them questions about industry jobs. The collaborative work that is involved in setting up internships and externships is yet another way to facilitate mutual learning. The development of individual or class research projects is still another strategy. Each of these strategies also present opportunities for employers to identify promising students for future hires:

In addition, we invite our industry partners to regularly talk to the students, and [they] make connections [for hiring] that way.

For employed alumni, the benefits of re-engaging with their former math departments may involve far more than recruiting new talent. For these alumni, the connection can provide the means to give back to their alma mater.

Of interest was that most respondents indicated that their department was basically using a single strategy to connect with industry partners—a class, a speaker series, an internship program. They found their sole approach helpful, but many were beginning to discuss being more strategic and systematic and exploring the use of a variety of methods.

We certainly talk with employers routinely when they are guest speakers, however we have not been truly strategic/intentional in this work. We should do better.

In fact, respondents from departments that reported the most successful industry partnerships described how they had shifted the culture of their departments. They had “normalized” the inclusion of industry in departmental activities. A respondent at Harvey Mudd provided an example:

Integrating all of this into the department—departments have mission statements, learning objectives, etc. The bottom-level integration is what validates the work. Departments can maybe give mini grants when a faculty member goes on sabbatical. Say “Hey, we know you have a reduced salary, but here’s \$1,000: Let’s find an industry rep, and your deliverable is a report and classroom activity that relates to the college at a local level. Integrate a real-world problem in the coursework by collecting those activities and putting them in the classroom.”

When asked how they might start a new program, this same respondent said,

Let’s say I’ve been dropped into a liberal arts college in, say, Ohio, where I don’t know anyone. What would I do? I might start trying to identify companies that are hiring within 100 miles and find alumni there. I can do this all through LinkedIn. The contacts are out there, it just takes the effort. And effort takes incentives. So that is where departments come in. Figure out the incentive model. Set modest goals. Do an alumni pizza lunch. Bring alumni to the career fair, reach out to students. Get them into a course that aims at math majors and have them talk to students about developing their resumes. Have them do mock interviews. Students eat it up. It empowers them.

These comments highlight the idea that work to connect to industry needs to be supported at the department level and incentivized. Another respondent spoke about the importance of rewarding faculty for their industry outreach:

They are invested in it [industry partnerships] because it’s part of their job, and they are rewarded for doing their jobs. What departments need are structures to reward this. If not rewarded in some way, it won’t happen.

CHALLENGES

As discussed above, making inroads to work with industry and employers is challenging for faculty and institutions. In some cases, it involves jumping into possibly uncomfortable or unknown territory. For faculty, education and professional development can be an important tool in surmounting these challenges. Departmental support and culture change are also essential to employer and industry outreach translating into a successful long-term networking endeavor and not just ending after a single activity.

RECOMMENDATIONS

While working with industry can be daunting, some math departments around the country are making inroads. These efforts are happening at different scales and scope. Some are single initiatives—a class, a lecture series, a internship program—while others involve more in-depth culture changes, where reward structures for faculty to engage in this work exist and, in some cases, where industry partnerships have become the norm and just part of the job. Respondents at both stages suggested that getting started was the way to go forward; it can be scary, but it is better to do something.

Find ways to educate faculty and support their work with industry. Professional development efforts and rewards structures can be useful in promoting this work. They can also help to dispel some of the fear that may stop some faculty members from wanting to undertake or participate in this work

Be creative with your strategies and tactics. Math departments are using a range of methods to connect and partner with industry. Be creative and use all the resources available to you.

CONCLUSION

A misconception among some math department staff and faculty is that integrating career readiness and career pathway content requires a tremendous amount of faculty time and departmental resources. The results of the TPSE-M survey and the data collected from EERC's interviews demonstrate the existence of multiple strategies that departments and faculty can employ to add or enhance career readiness content to their programming without using extensive resources. Rather than a major commitment of time and financial support, these strategies require a shift of focus, some creativity, and a commitment to help students prepare for the future. While a systemic and integrated program is ideal, EERC's analysis suggests that minor changes can have a big impact.

Each of the six briefs in this series prepared by the EERC showcase different strategies that have proven successful and that, with a minimum of resources, can be replicated and scaled to fit diverse institutions, e.g., offering elective career exploration/preparation courses, adding assignments that involve real-world problems, integrating course content on different career pathways, using online modules, inviting guest speakers, engaging with local employers, identifying research opportunities, offering internships, and engaging alumni in departmental activities. In addition, at colleges where there is an established career center, it is important that the math department and individual faculty make use of its resources including center staffs connections with industry employers. Active department-center collaborations can also reduce duplication of efforts, especially around the development of industry partners, leverage expertise, and facilitate student referrals.

Some of the strategies identified in EERC's briefs are more resource dependent, including departmental curriculum reviews and restructuring or adding new degree programs (e.g., applied mathematics, data science). Given the dynamics of the Covid19 pandemic, including decreased college funding, shifts in student enrollment, and changes in how students perceive majors and career pathways, it is important for each college to fully assess which career readiness strategies are most relevant and feasible. However, regardless of how it is done, incorporating career knowledge and skills into higher education pathways is key to preparing students for careers in mathematics.

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Janice H. Levin Building
94 Rockefeller Road
Piscataway, New Jersey 08854
smlr.rutgers.edu/eerc