TPSEMath

Transforming Post-Secondary Education in Mathematics

PREPARING MATH MAJORS FOR CAREERS: PROFESSIONAL DEVELOPMENT FOR FACULTY AND STAFF

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Transforming Post-Secondary Education in Mathematics (TPSE Math) aims to effect constructive change i 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 w ere 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 nonprofit organizations (survey respondents N=219). The survey asked questions about career preparation, career pathways, advising, research and internship/externship[1] opportunities, alumni networks, interdisciplinary collaborations, and partnerships with employers at the respondents' home institutions.

In addition, the EERC team conducted 26 in-depth phone interviews with faculty, staff, and students at seven college [2] identified through the su vey 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 professional development is one of six briefs and an executive summary prepared by EERC that discuss the findings and recommendations that emerged from this qualitative research stud .[3]

[1]EERC is mindful that there are differences between internships and externships, as well as many overlaps in respect to student earning. However, this study did not distinguish between them. We thus use the combined term "internship/externship" when discussing this career readiness activity.
[2]Babson College; Villanova University; Brigham Young University - Idaho; Harvey Mudd College; University of Nebraska – Lincoln; University of Arizona; and the University of Wisconsin.
[3]All the briefs in this series are available from the EERC website at:
https://smlr.rutgers.edu/content/transforming-post-secondary-education-mathematics-research

THE CHALLENGE OF PROFESSIONAL DEVELOPMENT

An observation frequently made by TPSE respondents and interviewees was faculty's often *"limited real-world experience,"* which affected their ability to address career readiness in the classroom and during student advising (For more on this see the EERC brief: *Preparing Math Majors for Careers: Practices and Polices for Career Readiness*). One respondent wrote, *"most faculty are academics by interest and training, and so [are] not necessarily intimately familiar with non-academic workplace requirements."* Another stated,

> *The greatest challenge is that most of the faculty were trained as pure mathematicians and do not have the industry connections that would be most useful for our students.*

Lacking knowledge, experience, or connections with industry, many faculty members felt ill-prepared to help students make the critical connections between what they were learning and how it might be used in workplace settings. In fact, one respondent noted, what many schools called *"applied math"* was not the math that students were going to be using in industry and science, except for the few that went into physics or traditional engineering. Another respondent observed, *"modern applied math is more about data and information, and no one was teaching that, but our students obviously need it, and math is moving in that direction."*

Some faculty members acknowledged having a limited understanding of the math skills students would need for employment.

> *It was embarrassing that some of the most exciting and important applied math was better understood by students outside the math department than by math majors. We could not, in good faith, continue to insist that learning about Euclidean domains was more important for students than learning about numerical methods of linear algebra, FFT, wavelets, optimization, probability, optimal control, reinforcement learning, and other fundamental topics of modern applied math.*

With the apparent exception of faculty teaching actuarial sciences, and some teaching statistics, the use of real-world problems and mathematical modeling exercises seemed to be limited. The response of one faculty member serves as a reminder, however, that there is still value in teaching math that is *"not easily or directly connected to career readiness or real-world problems."* Despite the absence of any workplace connection, she tries to help her students *"build general critical thinking skills."*

In terms of advising, many faculty respondents indicated that they lacked knowledge about the jobs that might be available for students who major in math or even what types of jobs their graduates were getting. (For more on this see the EERC brief: *Preparing Math Majors for Careers: Working with Alumni*). As a result, faculty often felt they were being less helpful to their students despite a desire to foster their students' success. At the same time, many faculty reported having limited time to go beyond their subject area or to make the industry connections that would enhance their capacity to help their students inside and outside of class. (For more on this see the EERC brief: *Preparing Math Majors for Careers: Partnering with Industry*). Some respondents further noted that work aimed at bolstering students' career readiness and exploration of career pathways received limited department support, with faculty being neither *"recognized [n]or rewarded"* for such effo ts (For more on this see the EERC brief: *Preparing Math Majors for Careers: Practices and Polices for Career Readiness*).

These challenges are significant, but perhaps most concerning were the faculty who indicated that some of thei colleagues do not believe it is *"their responsibility"* to engage with real-world problems or even to make linkages between what they teach and their students' futures. These faculty believed, *"their responsibility towards the undergraduates consists of teaching the course they are assigned with as little personal contact as possible."*

The good news is that, despite the above challenges and disturbing perspectives, a number of colleges and math departments across the country recognize the importance of career readiness and are beginning to find ways t include it in their programs. In the next section we identify some of the strategies these colleges and departments are using to expand their capacities with regard to career readiness and career pathways.

PROFESSIONAL DEVELOPMENT OPPORTUNITIES

Professional development emerged as the most common strategy to grow faculty's knowledge and skills around career readiness. Several respondents even indicated that professional development was a standard aspect of faculty experience, considering it *"part of a faculty member's job description"* or a central factor in *"retention, tenure, and promotion."* For instance, at Brigham Young University - Idaho, (BYU-I) faculty are required to teach 36 credit hours a year which includes 6 credit hours for professional development. One BYU-I respondent commented that professional development enables their department to remain current, so faculty are able to both effectively prepar students entering the workforce and also help students already employed by industry. They went onto say, *"without it [professional development], the courses would be terrible."* Additionally, the faculty try to work on courses in teaching teams. Sometimes one faculty member will use their professional development time to work on an aspect of a shared course. For example, one faculty member recently used their professional development time to add application activities to the introductory statistics classes. They then shared these materials so the entire department could benefit from the project. Collaboration and sharing improves courses more rapidly than if single instructor worked on revisions on their own.

WORKSHOPS AND SEMINARS

Some colleges offer professional development workshops, especially to faculty who have expressed *"a desire and interest"* in such opportunities. For example, one respondent wrote that their department offers, *". . . workshops for faculty to learn how to use modeling in teaching differential equations ([aimed at] practitioners) and to write and contribute resources for others to use ([aimed at] developers)."*

A faculty member at another college, assisted by an experienced graduate student, developed a professional development seminar course. Faculty have been *"strongly encouraged and recruited to participate in that seminar each semester."*

TRAVEL GRANTS FOR PROFESSIONAL CONFERENCES

A number of respondents mentioned receiving financial support to attend professional conferences. This support often covered the costs of conference registration and travel and were funded through departmental, college, or external grants.

FACULTY RELEASE TIME

While not a common practice, a few colleges fund faculty release time for the sole purpose of *"developing career-readiness activities in courses and math club and other extracurricular events."*

FACULTY HIRING

As faculty retire or departments are given new lines to meet expanding student demand, they should keep current industry in mind as they consider who they are recruiting and hiring and how new faculty will complement current faculty expertise. New faculty who have industry experiences and connections can build a department's capacity to address career readiness and career pathways beyond academia. As one respondent noted, *"new hires [who] are up to speed and ready to go and have the experience—fantastic."*

PARTNERSHIPS WITH INDUSTRY

Some schools and departments encourage faculty *"to participate in industry consulting."* For example, Babson College has *"a large executive education program where some of our faculty work directly with employers."* Consulting and other partnerships provide opportunities for faculty to learn about the skills and knowledge industry needs, develop student research and internship/externship activities, and identify real-world problems to work on in their classes. (For more on this see the EERC brief: Preparing Math Majors for Careers: *Partnering with Industry*).

OTHER STRATEGIES

Other strategies to help expand departmental and faculty knowledge of career readiness and career pathways include library-created math toolkits; bringing in outside speakers to discuss specific indust y applications of math subjects; and making use of the resources and expertise available at the college's Office of eaching and Learning or similar office or cent .

RECOMMENDATIONS

Departments that fail to invest in the growth of their faculty limit what they can offer students in a rapidly chan ing world. In the section below, we summarize professional development strategies colleges and departments might consider to enhance and expand their ability to help students prepare for the future.

College and departmental support. Faculty need to be encouraged and incentivized to build their ability to use real-world problems in their courses and to demonstrate how course content can be applied to research and work situations. Faculty release time, including time for professional workshops, needs to be viewed as a legitimate faculty activity and recognized within the promotion-and-tenure process. Financial incentives through mini-grants can help foster faculty–industry partnerships as well as the development of materials and exercises that link math to the world of work.

Interdepartmental workshops and collaborations. Campus-based workshop conducted jointly with complementary departments (e.g., computer science, business, engineering) can offer faculty new perspectives and help them develop a repertoire of strategies and content that facilitates the integration of real-world applications into math curricula. Interdepartmental teaching and research collaborations can also enhance the ability of faculty to make connections between different disciplines, thereby opening up new career pathways for math students to consider

Working with Alumni. Inviting alumni to join faculty meetings to discuss their work is yet another way to connect the academy and the workplace. (For more on this see the EERC brief: *Preparing Math Majors for Careers: Working with Alumni*). Such conversations can inform faculty about both the various applications of their teaching and the different career pathways current students might pursue.

Hiring Professional Advisers. Departments can benefit from the expertise and experience of the professional advisers who staff their campus career service offices. (For more on this see the EERC brief: Preparing Math Majors for Careers: *Advising Strategies and Practices*). Service center staff might provide an individual consultation or lead interdepartmental workshops focused on topics such as student advising and the preparation of portfolios and resumes.

Faculty Recruitment. Departments that seek to strengthen their students' career readiness should seek out *"the right faculty—with the passion and natural interest in preparing students for careers—to lead [that] effort."* Employing someone from industry can strengthen the department's connections to the world of work and open up new research and internship/externship opportunities for both faculty and students.

Disseminating and Using Developed Materials. Faculty expressed interest in sharing the career readiness materials and activities they have developed and in using materials others have created. Respondents cited open-access and Creative Commons-licensed websites with online tools as helpful resources to develop course curriculum and modeling exercises, as well as to enhance student advising. Resources cited by faculty include Brigham Young University's Foundation of Applied Mathematics, the Society of Actuaries' SIMIODE, and the National Science Foundation.

CONCLUSION

A misconception among some math department staff and faculty is that inte rating 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 suppo t, 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 strate ies that have proven successful and that, with a minimum of resources, can be replicated and scaled to fit diverse institutions, e.g., offering electi career exploration/preparation courses, adding assignments that involve real-world problems, integrating course content on different career pathways, using online modules, inviting guest speakers, enga ing with local employers, identifying research opportunities, offering internships/externships, and enga ing alumni in departmental activities. In addition, at colleges where there is an established career center, it 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 effo ts, especially around the development of industry partners, leverage expertise, and facilitate student referrals.

Some of the strategies identified in E RC'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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