RUTGERS EDUCATION AND EMPLOYMENT RESEARCH CENTER

CAREER PREPARATION IN MATH GRADUATE PROGRAMS

2021 Survey and Interview Project

Executive Summary

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Transforming Post-Secondary Education in Mathematics (TPSE Math) is an initiative dedicated to enhancing math education in two- and four-year colleges. Funded by the Carnegie Corporation, the Alfred P. Sloan Foundation, and the National Science Foundation, TPSE's central vision is to prepare students with the "*mathematical knowledge and skills necessary for productive engagement in society and in the workplace*."[1] To achieve this vision, TPSE's work seeks to learn more about the strategies math faculty and their departments use to help students identify career in math and to ensure math majors are career ready.

In 2021, TPSE contracted with Rutgers' Education and Employment Research Center (EERC) to study the recruitment and admission processes of both master's and doctoral programs in math, and how those programs support their graduate students. TPSE was also interested in EERC further investigating the career preparation and advising strategies that had emerged in EERC's prior TPSE-funded research on undergraduate math programs.[2] These strategies included career advising, curriculum and learning opportunities, mentoring, internships/externships, research opportunities, and faculty development.

METHODOLOGY

The current study used a mixed-methods approach. With TPSE input, EERC developed an online survey that combined open- and closed-ended questions about the above topics. This survey was distributed to mathematics department chairs and graduate coordinators across the country. We then searched the survey responses for innovative approaches and analyzed the data for themes and patterns. Using these themes, we then developed an interview protocol and conducted interviews with a sample of survey respondents from both master's- and doctoral-level programs. Our report combines the qualitative and quantitative data and analysis from both the survey results and interviews.

SAMPLE

The final sample for our study included public and private institutions located across 30 US states and two Canadian Provinces. Both Research I and Research II institutions are represented. Survey data is based on 17 terminal master's programs and 46 doctoral programs. Interview data was collected from Zoom calls with two department chairs from terminal master's programs and seven chairs or graduate studies directors from seven doctoral programs.

The study elicited a variety of useful and relevant insights about (and for) math graduate programs.

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[1] TPSE. (n.d.) *About*. https://www.tpsemath.org/about

[2] The six briefs in the series are: *Working with Alumni*; *Revising Curriculum*; *Advising Strategies and Practices*; *Professional Development for Faculty and Staff*; *Practices and Polices for Career Readiness*; and *Partnering with Industry*. The briefs are available at https://smlr.rutgers.edu/content/transforming-post-secondary-education-mathematics-research

FINDINGS

Recruitment strategies. Departmental and college websites were found to be the common mechanisms of recruitment for both terminal master's and doctoral programs. Master's programs also relied heavily on undergraduate advisers, while doctoral programs relied more on national conferences. The need to shift to remote recruiting during Covid pandemic created challenges for many programs, but those conditions may have increased equity in both colleges' access to students (by leveling the playing field between larger, more established programs and smaller, less-known programs) and students' access to colleges (by increasing conference access for minority and underrepresented students). As part of their recruitment processes, some programs have become more intentional about fostering more personal and individualized relationships with potential applicants, e.g., writing personal follow up letters.

Admissions factors. Respondents from the majority of master's and doctoral programs surveyed indicated they planned to drop the use of standardized exams in their admissions process. Both survey respondents and interviewees raised concerns about the efficacy of exam results and equity in their use. Instead, most master's and doctoral programs emphasized applicants' prior math experience in their decision-making about admissions. Doctoral programs also heavily weighed prior research experience.

Diversity, equity, and inclusion (DEI). Focus on DEI issues in academia has significantly grown in recent years. We found that programs at both levels of graduate study have begun to engage in one or more initiatives to increase diversity and inclusion in their programs: for example, by forging relationships with Hispanic serving institutions (HSIs) and historically black colleges and universities (HBCUs) or the provision of financial support for students from historically under-represented groups. However, many respondents cited a lack of departmental resources or incentives to actually transform the makeup of their student bodies, particularly at the master's level. At the same time, several programs observed that their ability to increase recruitment of historically underrepresented students was intimately connected to having diverse faculty members with ties to HBCU's and HSI's. Further, a few programs underscored the importance of recruiting groups of underrepresented students to establish a sense of community for such students which furthered recruitment efforts.

Nevertheless, we did not hear about any systemic approach to DEI (e.g., faculty hiring, student recruitment and support, advising, or curriculum changes).

Advising strategies. Few math graduate programs represented in our study conducted any advising around career planning or employment outside of the academy. Most PhD students had to wait until they were at the candidacy level to receive such, albeit limited, career advising. Although all colleges have campus-based mental health services, many departments, especially doctoral programs, use adviser sessions, for well-being checks to identify and address student stress.

Only 25 percent of master-level programs offer peer mentor/support, however, the few that exist involve some innovative strategies including a chain advising structure. Almost half of

doctoral programs offer peer mentor/support. One program indicated they specifically added advising support to address pandemic-related challenges.

Social networking/math related associations: Of note, 80 percent of respondents from doctoral programs and 60 percent of respondents from master's programs reported that *"there was a very close and interactive group"* among their students. Factors contributing to this included scheduled and ad hoc social activities. In addition, at the doctoral level, programs had established graduate seminars, provided collaborative research activities opportunities, and in one case, assigned multiple graduate students to the same office.

Further, at two fifths of doctoral campuses, students also had the opportunity to participate in math club/associations, including chapters of national organizations, e.g., the American Mathematical Society, the Association for Women in Mathematics. These groups sponsored social/recreational events, workshops/panel sessions about current student research activities, and, at times, sessions about career/employment information.

Faculty knowledge of non-academic career pathways. Survey respondents at both levels of graduate study indicated that faculty in their program are knowledgeable about careers outside of academia. However, interview informants clarified that this knowledge was typically based on the individual faculty member's specialization or prior experience in industry. More theoretical faculty are typically not as knowledgeable about these areas as those in applied math fields. In addition, many programs noted a generational divide in terms of both faculty knowledge about industry and their willingness to encourage students to pursue careers outside of academia, with younger faculty more knowledgeable and enthusiastic in these areas.

Non-academic career preparation. Curricular changes emerged as the primary way programs prepared students for non-academic careers at both the master's and doctoral level. Many programs required applied courses such as statistics or computer programming. Some programs also integrated more real-world problems into existing courses. Other common career preparation activities included career panels, internships, and establishing connections with local industry. In addition, some programs have even established industry advisory committees in their department and allow industry representatives to serve on doctoral committees. However, these activities were not widespread across the programs studied. Moreover, funding support for career exploration and advising activities remains an area of need in both master's and doctoral programs.

Career and occupational pathways encouraged by most faculty. In most cases, faculty continued to emphasize academic teaching and research jobs over careers in industry and government. This took place despite the growing trends of "adjunctification" throughout much of the academy; the decrease in job security in many postdoctoral and faculty positions; and a general decrease in student interest in academic careers as they progress through graduate programs. Master's programs seem to be more encouraging of non-academic careers than doctoral programs, a difference between these two graduate levels that should be explored further.

Professional development focused on non-academic pathways. Survey respondents at both the master's and doctoral levels indicated little professional development was offered in their program that focused on preparing students for careers outside the academy. However, many interviewees cited a need for such discussion and training. Some informants shared that they were trying to develop or expand such training and working to build stronger relationships with industry/government. At the same time, informants stated that professional development initiatives could only be successful if they were paired with larger cultural shifts in math graduate programs. In their view, while younger faculty often understood the need to expand preparation for non-academic career pathways, older math faculty were more likely to hold an attachment to an academic pathway, remaining unaffected by the reality that their students may not want to (or simply may not have the option to) pursue that career track.

RECOMMENDATIONS

Based on our survey and interview data, EERC has identified a number of recommendations for TPSE and math graduate programs. Many of these recommendations mirror the findings of our earlier TPSE study on undergraduate math programs.[3] They broadly include increased professional development opportunities for math graduate faculty around non-academic career preparation; building stronger relationships between math graduate programs and industry; and increased funding support for advising and non-academic career initiatives.

[3] See 2020 EERC study briefs at https://smlr.rutgers.edu/content/transforming-post-secondary-education-mathematics-research