



TPSEMath

Transforming Post-Secondary Education in Mathematics

PREPARING MATH MAJORS FOR CAREERS: EXECUTIVE SUMMARY

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RUTGERS

School of Management
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EDUCATION AND EMPLOYMENT
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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.



Rutgers' Education and Employment Research Center (EERC) is housed within the School of Management and Labor Relations. EERC conducts research and evaluation on programs and policies at the intersection of education and employment. Our work strives to improve policy and practice so that institutions may provide educational programs and pathways that ensure individuals obtain the education needed for success in the workplace, and employers have a skilled workforce to meet their human resource needs. For more information on our mission and current research, visit smlr.rutgers.edu/eerc.

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INTRODUCTION

Transforming Post-Secondary Education in Mathematics (TPSE Math) is dedicated to enhancing math education in two- and four- year colleges, *“to ensure that students and society are enriched by the power and beauty of mathematics.”*¹ Funded by the Carnegie Corporation, the Alfred P. Sloan Foundation, and the National Science Foundation, TPSE’s central vision is to prepare students with *“mathematical knowledge and skills necessary for productive engagement in society and in the workplace.”*² To achieve this vision, TPSE has been interested in learning more about the strategies math faculty and departments, and the institutions in which they are situated, use to help students identify career pathways in math and ensure math majors are career ready. In 2019, TPSE contracted with the Rutgers' Education and Employment Research Center (EERC) to study the career readiness strategies and programs being used by math departments around the country. The goal was to help TPSE identify promising career readiness practices to be promoted, implemented, and scaled across the nation.

This Executive Summary presents the key findings from EERCs study and serves as an introduction to a series of six briefs released under the heading Preparing Math Majors for Careers. The six briefs are: “Working with Alumni”; “Revising Curriculum”; “Advising Strategies and Practices”; “Professional Development for Faculty and Staff”; “Practice and Policies for Career Readiness”; and “Partnering with Industry.” These briefs are available at <https://smlr.rutgers.edu/content/transforming-post-secondary-education-mathematics-research>.

This executive summary is divided into four major sections—Methodology, Major Findings, Selected Recommendations, and Conclusion—that are followed by an Appendix.

¹TPSE, n.d. Retrieved July 8, 2020 from <https://www.tpsemath.org/>

²Ibid

METHODOLOGY

To begin its study, the EERC team held a number of conference calls with members of TPSE’s board of directors to discuss their goals for the study, specific questions they wanted to look into, and general areas of interest. Board members also identified leaders in the field—colleges and departments that had already developed innovative strategies or programs to enhance students’ career readiness.

ONLINE SURVEY

Based on these discussions, EERC developed an online survey for faculty, department chairs, and senior administrators. The survey, which included both closed and open-ended questions, asked respondents about how the math department at their home institution handled career preparation, career pathways, advising, research and internship opportunities, alumni networks, interdisciplinary collaborations, and partnerships with employers. The survey was disseminated to members of the TPSE Mathematics Advisory Group (MAG) and the TPSE affiliate list; combined, these groups represented a total of 946 possible respondents. Of these, 219 completed surveys, yielding a response rate of 23 percent. The pool of completed surveys represented 148 institutions and organizations, of which 143 were public or private two- or four-year colleges. These colleges were located across 37 states and included Research I and Research II institutions. Table 1 presents the distribution of returned surveys by type of institution or organization as well as by the number of respondents from each type. (See Appendix A for a breakdown of responses by state.) The vast majority (85%) of surveys came from four-year colleges, accounting for 87 percent of respondents.

TABLE 1. TPSE-M SURVEY RESPONDENTS BY TYPE OF INSTITUTION

Type of Institution/Organization	Number of Institutions	Percent of All Institutions/ Industry-Nonprofits	Number of Respondents	Percentage of All Respondents
Two-Year Community College	15	10	18	8
Four-Year College / University	128	85	191	87
Industry / Nonprofit	5	3	7	3
Unknown	3	2	3	1
TOTAL	151	100	219	99*

*Does not equal 100% due to rounding.

Table 2 presents the distribution of respondents by the highest position they held at their institution. Faculty accounted for the largest proportion of respondents: 53 percent. Seventeen (17) percent of respondents were department chairs, and 11 percent were deans, provosts or held other senior college positions.

TABLE 2. TPSE-M RESPONDENTS BY HIGHEST POSITION CURRENTLY HELD

	Number	Percentage of Total
Dean, Administrator, Director, or Provost	24	11
Department Chair or Department Head	37	17
Faculty Member	117	53
Lecturer or Instructor	8	4
Emeritus or Retired	8	4
Other /Unknown	25	11
TOTAL	219	100

Survey answers were analyzed to identify themes and/or patterns within and across questions. The themes and patterns that emerged from our analysis are summarized below and discussed in greater detail across the full set of EERC briefs in this series.

IN-DEPTH PHONE INTERVIEWS

To gain a more detailed cross-institutional perspective on career readiness practices, EERC conducted a total of 26 phone interviews with faculty members, chairs, administrators, staff, and several students from seven institutions³ that emerged in the survey as having innovative programs; and/or had been identified by a member of the Mat Advisory Group. We also viewed a TPSE webinar with a presentation from the Dana Center at the University of Texas – Austin. Notes were taken during and after interviews, and the webinar, then analyzed for themes and patterns. In this report and in our briefs, we highlight some of the school-specific innovative strategies and programs discussed during those interviews.

³Babson College; Villanova University; Brigham Young University - Idaho; Harvey Mudd College; University of Nebraska – Lincoln; University of Arizona; and the University of Wisconsin.

MAJOR FINDINGS

CAREER READINESS PRACTICES

Math departments across the nation are thinking about effective ways to prepare students for employment. Faculty respondents cited a variety of reasons for including career preparation activities in their work. Some do it as a response to calls for changes to the liberal arts curricula. Others are thinking about the need to compete with peer institutions for the best students. The majority of respondents, however, said their interest in career preparation activities stemmed from a desire to set their students up for success. Faculty sought both to better understand and to demonstrate how undergraduate mathematics preparation could be used in different jobs and industries. They also wanted to show students how the skills developed in the major could lead to interesting career pathways. In thinking about the application of math to careers, many faculty spoke about the need to consider paths beyond the typical routes like graduate school, teaching, and actuarial work and instead, to think about math as a pathway and a tool with applications in many fields. Colleges and departments are doing this work using a variety of practices, such as by incorporating real-world problem solving into the curriculum and/or by offering internships, career preparation classes, competitions, research experiences, and other activities. (For more on this see the EERC brief: *Preparing Math Majors for Careers: Practices and Policies for Career Readiness*).

REVISING CURRICULUM

Embedding career readiness content into math curriculum and courses helps students understand the utility of math across multiple majors and the many ways math can be applied in real-world situations. It helps them navigate difficult career decisions and better prepares them for careers in mathematics by educating them about the options and opportunities available to them. The integration of career readiness activities with mathematics content was one of the most common strategies math departments used to prepare their students for the future, but their approaches varied widely. Respondents cited several examples of strategies used to unite career readiness activities with math curriculum, including: required or elective career-oriented courses fully focused on educating students about and preparing them for mathematics careers; real-world problem-solving, modeling exercises, and/or career-focused modules integrated into mathematics courses; classroom visits by employers, alumni, upperclassmen, or internship coordinators; and resume-building exercises offered in classes or career centers. (For more on this see the EERC brief: *Preparing Math Majors for Careers: Revising Curriculum*)

ADVISING STRATEGIES AND PRACTICES

Respondents frequently indicated that students are often “unaware of career opportunities in math.” One way to solve that problem are through a strong advising program that begins with outreach to all students in their freshman year. Overall, respondents stated that advising at their college was intended to help students successfully complete their studies, prepare for careers, transfer to a four year college and/or progress into graduate programs. Numerous respondents cited their desire to increase students’ marketability and strengthen their competitiveness in the labor market. At the institutions surveyed, advising occurs commonly in two settings: within departments by faculty, and by professional advisors in career centers. Both forms of advising have benefits and drawbacks in terms of preparing students for careers. For example, both require professional development to expand the knowledge advisors and faculty have about career pathways in math, and how the skills math majors have can be used in different industries and careers. (For more on this see the EERC brief: *Preparing Math Majors for Careers: Advising Strategies and Practices*).

PROFESSIONAL DEVELOPMENT FOR FACULTY AND STAFF

Respondents and interviewees referred to math faculty having “limited real-world experience,” which affected their ability to address career readiness in the classroom and during student advising. The good news is that a number of colleges and math departments across the country recognize the importance of career readiness and are beginning to find ways to prepare faculty to include it in their work with students. Some strategies math departments are using include workshops and seminars; travel grants for professional conferences; and granting faculty release time to dedicate to establishing partnerships with industry. (For more on this see the EERC brief: *Preparing Math Majors for Careers: Professional Development for Faculty and Staff*).

WORKING WITH ALUMNI

Building alumni networks and hosting alumni events can be a daunting task, and many department representatives reported they either did not conduct systematic outreach to alumni or did not reach out to them at all. However, respondents who reported that their departments do make these connections described alumni as an invaluable resource. In fact, an active alumni network was cited across EERC’s interviews and TPSE-M survey responses as a huge, often untapped, resource for both current math students and departments. Alumni help students understand how to apply what they are learning in their math courses and provide information about different career pathway and specific jobs that use math skills. They provide helpful feedback to departments about majors and coursework. In addition, they serve as conduits to industry and employers. Further, alumni may become donors supporting scholarships and departmental activities. (For more on this see the EERC brief: *Preparing Math Majors for Careers: Working with Alumni*).

PARTNERING WITH 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. A key component of this work is identifying and working towards mutually beneficial relationships. Respondents frequently acknowledged the benefits of industry partnerships but seemed unsure how to develop and maintain such networks. Departments which have industry networks have used a variety of strategies. These include: designating a single person to work with industry, involving faculty in professional industry associations, developing advisory boards, and connecting with alumni workers. (For more on this see the EERC brief: *Preparing Math Majors for Careers: Professional Development for Faculty and Staff*).

SELECTED RECOMMENDATIONS

Below we briefly examine selected recommendations from the Preparing Math Majors for Careers series of topical briefs. Please see each brief for more detailed discussions of these and other recommendations.

POLICIES AND PRACTICES FOR CAREER READINESS

Create a culture around career readiness. The key is department-wide support. Build a culture that values career preparation without compromising the academic mission. This includes recognizing career preparation as valuable work.

Use real-world problem solving. Students learn better and are more invested in learning when their work is connected to the real world.

Teach students to advocate for themselves. Find ways to give students information to help them understand the applicability of their skills and how they can be used in the workplace. Help students learn to express this information verbally and in writing.

Encourage students to engage in research, participate in internships, and professional attend conferences. Early exposure to the multiple ways that math can be applied can stimulate interest and commitment to math as a major and/or career option. Such activities also enhance resumes and better position students for both graduate school and employment.

REVISING CURRICULUM

Consider the structure of your department. Some departments can make big changes because faculty are not structured in a hierarchical manner, which encourages collaboration. Other departments do not have publishing requirements for faculty, which frees up faculty time. Some departments offer incentives for faculty to make industry connections or bring in real-world problems for students to solve. Considering the resources available in your department can help inform what types of curricular changes your department should tackle.

ADVISING STRATEGIES AND PRACTICES

Realize it is likely that students are not informed of all the careers available to them as mathematics majors. Most staff or faculty who participated in a survey or interview indicated that most students, including math students at their institutions, were unaware of the full range of career options available to them. Departmental changes were viewed as more successful when students were given multiple ways to explore their career options. The more options available (or by having one or more required), the more student awareness seemed to increase.

Early and continuous advising. Career pathway advising that begins in the freshman year is an important investment for both math students and departments.

Building equity and creating a supportive learning community. Several interviewees emphasized the importance of more actively reaching out to historically underrepresented populations about the opportunities in and through a major or minor in math; and building a supportive community in which students help and learn from one another.

Joint faculty appointments between departments and schools. Given math's overlap with field such as computer science, engineering, and business, joint faculty appointments between departments can expand faculty's knowledge of modeling topics for their classrooms as well as for research, internship, and employment opportunities for math students.

Increased communication and collaborations between math departments and career service centers. Career center staff need help to better understand what math students are "*learning in their courses*" and how they might use those skills in a range of industries and job titles.

PROFESSIONAL DEVELOPMENT FOR FACULTY AND STAFF

Offer college and departmental support. Many respondents indicated that they were interested in participating in professional development workshops or other opportunities to expand their knowledge of career pathways for math majors and strengthen their ability to demonstrate how course content can be applied to research and work situations. But they also indicated that professional development activities require departmental support. Faculty need to be encouraged and incentivized. Time spent in professional workshops, developing faculty–industry partnerships, and creating materials and exercises that link math to the world of work needs to be viewed as legitimate faculty activity—eligible for faculty release time, funding, and recognized within the promotion-and-tenure process.

Offer interdepartmental workshops and collaborations. Campus-based workshops conducted jointly with complementary departments (e.g., computer science, business, engineering) can offer faculty new perspectives and help them to develop a repertoire of strategies and content that facilitates the integration of real-world applications into math curriculum. 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.

Recruit new faculty from industry. 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 create new research and internship opportunities for both faculty and students.

WORKING WITH ALUMNI

Draw upon faculty connections and networks. As students move through their education—taking classes, participating in research opportunities, and creating capstone-type presentations and portfolios—faculty members develop relationships with them. Encourage faculty members to maintain these relationships, keep current contact information, and personally invite former students to attend alumni events and participate in fundraising campaigns.

Use social media. Social media such as LinkedIn can be used to find local alumni. LinkedIn and other social media outlets, such as Facebook, can also be used to maintain alumni networks and send departmental invitations.

Host events. Once an alumni network has been established, host events such as alumni lunches, panel presentations, lecture series, and networking socials. These events can be leveraged to keep in touch with alumni, introduce them to current students, highlight the variety of career path options available to current students, and introduce alumni to potential future employees. An alumni network can also be drawn upon to organize social events where alumni can network with one another; these can be good opportunities to recruit them for undergraduate-focused future events.

PARTNERING WITH INDUSTRY

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 takes a tremendous amount of faculty time and departmental resources. The results of the TPSE-M survey and data collected from EERC's interviews demonstrate the existence of multiple strategies that departments and faculty can employ to enhance career readiness content without using extensive resources. While a systemic and integrated program is ideal, EERC's analysis suggests that even minor changes can have a big impact.

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 in the 21st century.

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APPENDIX

Alabama

University of Alabama

Arizona

Chandler–Gilbert Community College
Coconino Community College
University of Arizona

California

California Institute of Technology
California State University, Dominguez Hills
California State University, Fullerton
Coastline College
Glendale Community College
Harvey Mudd College
Occidental College
Pomona College
San Diego State University
San Francisco State University
Stanford University
University of California, Davis
University of California, Los Angeles
University of Southern California

Colorado

Colorado State University
Fort Lewis College
University of Colorado, Boulder
University of Northern Colorado

Connecticut

Trinity College
University of Connecticut
Yale University

Florida

Daytona State College
Eckerd College

Embry–Riddle Aeronautical University
Jacksonville University
University of Florida
Valencia College

Georgia

Emory University
Morehouse College
Spelman College
University of Georgia

Hawaii

University of Hawai'i, West Oahu
University of Hawai'i

Idaho

Brigham Young University, Idaho

Illinois

Dominican University
Governors State University
Millikin University
Northwestern University
University of Chicago
University of Illinois
University of Illinois, Chicago
University of Illinois, Urbana–Champaign

Indiana

Indiana University
Purdue University

Iowa

Coe College
Grinnell College
Iowa State University
Loras College
University of Iowa
University of Northern Iowa

Kansas

Emporia State University

Kentucky

University of Kentucky

Maine

University of Maine

Maryland

Anne Arundel Community College
Coppin State University
Goucher College
Johns Hopkins University, Maryland
Morgan State University
St. Mary's College of Maryland
Towson University
University of Maryland
University of Maryland, Baltimore County

Massachusetts

Amherst College
Babson College
Bard College at Simon's Rock
Bentley University
Boston College
Bridgewater State University
Framingham State University
Gordon College
Massachusetts Institute of Technology
Simmons University Massachusetts
Smith College
Wellesley College
Westfield State University
Wheaton College
Williams College
Worcester Polytechnic Institute

APPENDIX

Michigan

Baker College
Delta College
Ferris State University
University of Michigan

Minnesota

Augsburg University
Concordia University, St. Paul
Macalester College
St. Olaf College

Missouri

Metropolitan Community College
Washington University in St. Louis

Nebraska

University of Nebraska, Lincoln

New Hampshire

University of New Hampshire

New Jersey

Rutgers, The State University of New Jersey

New York

Baruch College
Cornell University
Medgar Evers College
Onondaga Community College
Queens College
Queensborough Community College
St. John's University
St. Lawrence University

North Carolina

Catawba Valley Community College
Davidson College
Duke University

Fayetteville State University
North Carolina A & T State University
North Carolina State University
University of North Carolina, Chapel Hill
Wake Technical Community College

Ohio

Cleveland State University
Ohio State University
Terra State Community College
University of Cincinnati

Oklahoma

Oklahoma Baptist University
Southern Nazarene University
University of Oklahoma

Pennsylvania

Franklin & Marshall College
Harrisburg Area Community College
Slippery Rock University
Villanova University

Rhode Island

Brown University

South Carolina

Coastal Carolina University
University of South Carolina

Tennessee

Belmont University
Pellissippi State Community College
University of Tennessee

Texas

Austin College
Austin Community College
Tarrant County College
Texas A & M University
University of Texas, Austin

Utah

Brigham Young University
Utah Valley University
University of Utah
Virginia
Hampton University
University of Richmond

Washington

Central Washington University
University of Washington
Whitman College

Washington, DC

American University

Wisconsin

University of Wisconsin, Madison

Industry / Nonprofit

Association of Public & Land-Grant
Universities
BioFire Diagnostics
Mathematical Association of America
National Center for Higher Education
Management Systems
SIMIODE: Systemic Initiative
for Modeling Investigations and
Opportunities with Differentia
Equations



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