The**INNOVATOR**

In This Peer-Reviewed Issue

Message from the President

One of the NPSMA Board of Directors' main goals is to provide compelling member benefits. This inaugural curated edition of *The Innovator* was envisioned with you in mind. No one is more knowledgeable about PSM programs, students, partners, and outcomes than you, our NPSMA members. The 20-year milestone of the first PSM programs and 10-year milestone of NPSMA's establishment seemed the perfect time to give this community its own venue to share, curate, and archive your considerable knowledge and insight. What we learn from each other today will no doubt enable our continued leadership in industry-responsive graduate education for the next 20 years. On behalf of the PSM community, my sincere thanks to all involved in this signature effort of the NPSMA.

FEATURE ARTICLE

20 Years and Counting:
How has PSM training in "Transferable Skills" changed?

Heidi A. Harkins and Linda D. Strausbaugh

The first Professional Science Master's programs were created in the late 1990s in response to STEM workforce demands. Twenty years later, there are more than 350 programs at more than 160 academic institutions. An innovative aspect of the PSM concept was, and remains, the involvement of the employer community in the design and support of degree programs. Employers are especially helpful in identifying and helping to provide professional skills that guarantee success in the workplace. All PSM degrees are required to offer professional development elements in addition to graduate-level, advanced scientific disciplinary content. Designated early on as "PLUS" to reflect an add-on to scientific courses, the designation fails to capture the fact that professional skills are often integrated into disciplinary courses. This kind of educational component is known as "transferable skills" in current vernacular and we use this term in our article. In the early years of the PSM initiative, the emphasis on transferable skills was in the financial/accounting and business management areas. We wondered how the transferable skill sets embedded in the PSM might have changed over the past twenty years.

Author- generated, word cloud composite of skills deemed important and priorities from several surveys (2015): National Association of Colleges and Employers (NACE; hiring managers at 260 employers); Bloomberg (1,320 job recruiters at >600 corporations); Career Builder; Millennials Branding; Money (54 million employee profiles, 350 industries).

We aimed to discover answers to several related questions.

- What are the skills that are now in demand by employers? Has PSM transferable skills content stayed abreast of evolving demands?
- As the diversity of scientific fields encompassed by PSM programs has expanded, have new discipline-specific needs for transferable skills training emerged?
- How have changing technology and instructional methods at institutions of higher learning affected the delivery modes of transferable skills elements or courses?
- As the numbers of PSM degree programs in an institution and the total number of students enrolled in them have increased, how can programs meet the challenges of professional development training?

The PSM survey and skills in demand by employers.

Job readiness of new employees at all levels has become prominent in national workforce discussion. As one example, the annual Bloomberg Job Skills report identifies skill gaps based on both employer desirability and graduate possession of same [https://www.bloomberg.com/graphics/2016-job-skills-report/]. Specifically targeted to the skills desired of MBA graduates, this analysis is more aligned with Professional Science Master's degrees than those that focus exclusively on undergraduate degrees. Another reason that the Bloomberg report is an appropriate resource and reference point for our community is its inclusion of industry-specific priorities, most of which are relevant to PSM STEM fields. In Table 1 we created a summary of the most desired skills from information contained in the 2015 Bloomberg Job Skills report [http://www.bloomberg.com/graphics/2015-job-skills-report/].

Table 1. Skill sets valued by employers based on importance and rarity.

Skill set	Chemical	Energy	Financials	Healthcare	Pharma	Technology	Manufacturing
Communication Skills	✓	✓	✓	✓	✓	✓	✓
Leadership Skills	✓	✓		✓	✓	✓	✓
Strategic Thinking	✓	✓	✓	✓	✓	✓	✓
Creative Problem Solving					✓		✓
Teamwork	✓	✓	✓	✓	✓	✓	✓
Analytical Thinking	✓	✓	✓	✓	✓	✓	✓
Quantitative Skills		✓					
Motivation/Drive		✓	✓				✓
Adaptability					✓		

Green designates skills that are less common and more desired. Blue designates skill sets that are more common and more desired. Table created from information in the Bloomberg 2015 job skills report. [http://www.bloomberg.com/graphics/2015-job-skills-report/]

To understand how well PSM transferable skills content has stayed current with in-demand transferable skills, we conducted in 2016 a brief Qualtrix survey of the professional development training offered by existing PSM programs (https://unc.az1.qualtrics.com/jfe/form/SV_0lIOdpMggA0fqJv). Ninety-eight PSM programs and >370 courses identified as transferable skills courses were represented in 61 institution responses from program directors, affiliated faculty, administrators and "other." Invitations to participate in the survey were emailed to the PSM National Office and NPSMA distribution lists – the lists are limited to institutions that have previously associated with at least one of the two organizations. The institution participation rate of ~37% (61/163) performs well with expectations for voluntary internal surveys (30-40%; Fryrear, 2015). The actual response rate is likely higher than it appears since some institutions on the distribution lists may no longer have active PSM programs.

The initial phase in designing the survey was to create a menu of in-demand transferable skills. To accomplish this, we extracted information both from the national Bloomberg survey and from local employer input that is reflected in PSM curricula. We used lists available to us from diverse programs in Connecticut, New York and North Carolina to gain a snapshot of transferable skills training in current programs. The classes of transferable skill sets used in the survey are listed in Figure 1. As a first step in our evaluation of how the PSM is doing with respect to transferable skills, we considered in more depth the most desired general skills in Table 1: Communication Skills; Leadership and Strategic Thinking; Teamwork; and Analytical Thinking.
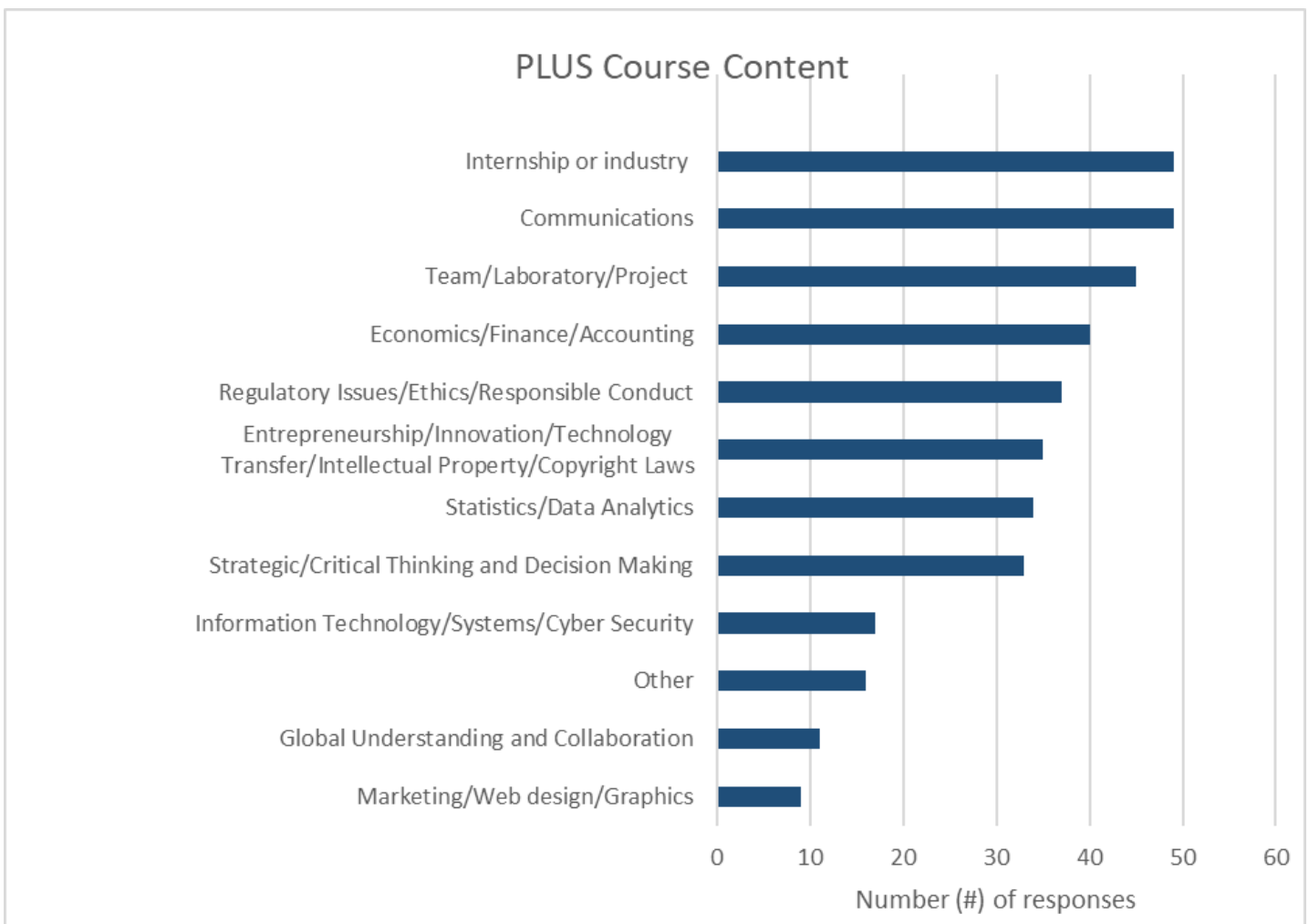

Figure 1. PSM Transferable skills course content as number of total content responses.

Communication Skills

We begin with communication skills for two reasons. First, communication skills illustrate well a potential understanding gap between employers and STEM educators. Second, communication skills impact directly many of the other most desired skills. Anecdotally, faculty and instructors are typically adept at helping students learn to communicate with fellow disciplinary experts, but may not be as effective in helping students learn to communicate with the non-specialist, although this is precisely what the work environment requires and has been a point of emphasis for the PSM. STEM employees need to think, communicate and act across all kinds of boundaries: different levels of technical expertise, job functions, disciplines, and cultures (Wilson, 2015). PSM graduates must be able to create, edit and effectively present content verbally and through writing.   They will encounter the need for strong communication skills both inside (e.g. with co-workers, management) and outside (e.g. investors, customers, clients, media) the workplace. Communication skills is the most frequently taught specific transferable skill (Figure 1) and eighty-five percent of respondents list it as taught in their programs that span all STEM disciplinary fields.

We'd be remiss if we didn't mention that email and social media are other areas of communication that need attention to prepare PSM graduates for the workplace. Students should know that some practices and greetings acceptable to communicate with friends do not translate to the workplace, even on an informal platform. In addition, students should be mindful of their social media profiles and deliberate in postings.   On the one hand, a presence on social media is desirable. A 2017 CareerBuilder study of employers found that 57% were less likely to interview candidates they couldn't find online. On the other hand, the study also confirmed that 70% have used social media to screen candidates (up from 11% just over a decade ago) and 54% reported that decisions not to hire had been made based on social media profiles.

Leadership and Strategic Thinking

We've decided to combine the skill sets of Leadership and Strategic Thinking for the purposes of our PSM discussion.   Often characterized as seeing the "big picture" and correctly deploying time, talent and money to reach a future goal, strategic planning is repeatedly identified as a top executive/leadership skill. How is this skill helpful to the entry-level PSM graduate who is not likely to be accepting an upper level position? As Nina Bowman noted in the Harvard Business Review, it's not just for executives. She goes as far as to say that strategic thinking is valued at all levels and is even an "unwritten part of all job descriptions."   All employees benefit from the ability to arrive at profes-sional and personal decisions through an understanding of the effective use of time and resources in the strategic context of longer term goals. In the PSM survey, fewer than half (48%) of respondents listed strategic/critical thinking and decision-making as content offered in their programs. We did not list the specific skill of leadership in the survey selections, but do have team/laboratory/project management as an option. Given the definition of management as the skill of controlling and making decisions about an organization, management courses might well offer a component of leadership training. Fifty-nine percent of respondents cited management as a transferable skill set offered by their programs. Forty-three percent list only management; the remaining 16% list both management and strategic thinking as transferable skills.

Analytical Skills

The third of the four general skills we're considering is Analytical Skills. While the specific kinds of in-demand analytical skills differ by employment sector, all have in common the collection and analysis of data and solving problems using them. Writing for The Balance, Alison Doyle identifies some of the elements in analytical thinking, and has useful suggestions on how to include them in resumes, cover letters and interviews. Doyle sees five components to effective analytical thinking: Communication, Creativity, Critical Thinking (ability to evaluate data and make decisions), Data Analysis, and Research (learning more about the problem you need to solve). In the PSM survey the transferable skill set closest to the common features of analytical skills is statistics/data analytics, identified as a transferable skill component in PSM curriculum by 48% of respondents. Further recognition of the emerging importance of this skill is that 38% of respondent institutions have PSM programs in Computer science/analytics/big data/statistics.

PSM experiential learning and teamwork

It would be difficult to overemphasize to PSM students the importance of knowing how to act collaboratively in a team.   As an employer who has hired PSM students for more than a decade told one of us, he has never had to fire anyone for lack of technical abilities, but most dismissals were due to an "inability to play well with others." Marty Brownstein, in the succinct "Dummies" series from Wiley publishing, has described the 10 important qualities for being an effective team player. The successful team member is: reliable; a constructive communicator; an active listener; an active participation; open and willing to share; cooperative and pitches in to help; flexible; committed; a problem-solver; and is respectful and supportive of others. Employers and supervisors are constantly assessing these important qualities.

Where in the PSM curriculum is a student likely to learn about teamwork? The most important defining feature of the PSM degree is the mandatory inclusion of formal experiential learning. Taking the forms of internships, group projects or other industry-related capstone experiences, the PSM student is immersed in the workplace. This required element of the PSM curriculum is a crucial part of learning about teamwork and professional conduct in the workplace environment. Internships or industry projects are the most cited element of transferable professional skills In PSM programs (Figure 1).

Have new areas of transferable skills emerged?

We were also interested in learning about the evolution of in-demand transferable skills, especially the possibility of discipline-specific ones. The survey asked directors to identify the field(s) of study that the PSM program addresses, selecting from the five PSM National Office categories. All five currently defined STEM areas were represented in survey responses (Figure 2, Panel A). We wanted to be sure that different disciplines were represented in our survey responses. We can approximate the relative distribution of PSM program fields nationally (Figure 2, Panel B.) based on information from the 2015 survey of programs by the PSM National Office (disciplinary categories were different from the new ones now in use).

Figure 2. Representation of STEM fields in the survey. Panel A. Relative participation (%) of survey respondents (n=93 programs representing 61 institutions) by self-identified STEM fields of study as currently defined by the PSM National Office. Panel B. Estimated relative representation (%) of all PSM programs nationally (n=333) by STEM field. PSM program fields in a 2015 survey (Komura, 2014) were assigned to the fields in panel A.
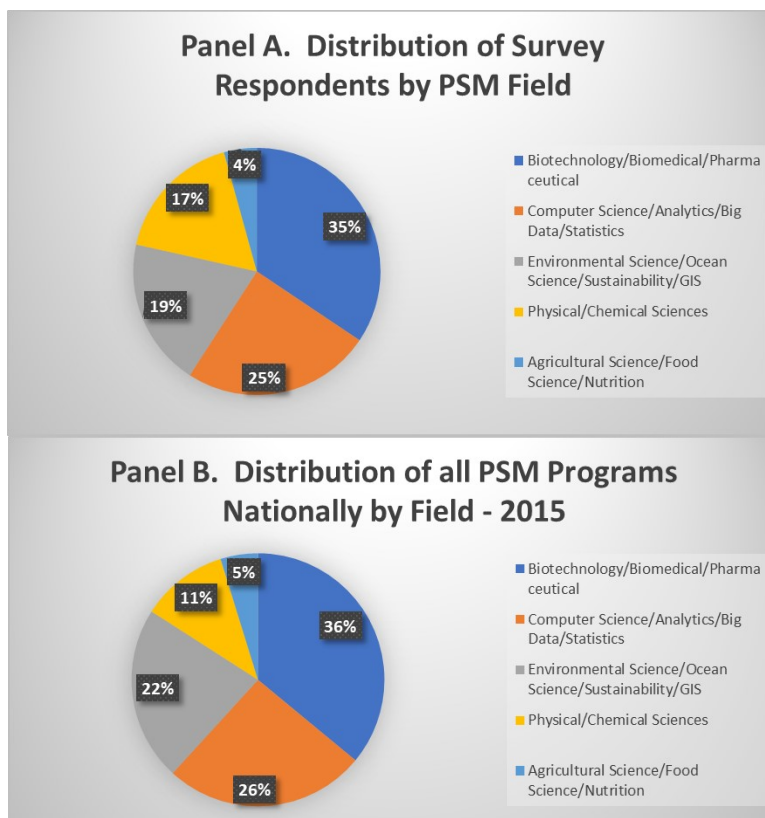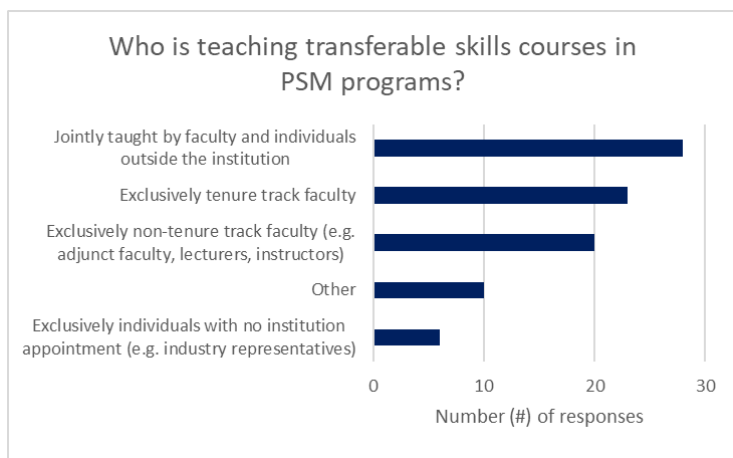
Comparing Panels A and B, we can see that the relative representation of fields in the survey and nationally are concordant. We can also use these sets of data to estimate the percentage participation in the survey by disciplinary fields: Biotechnology/Biomedical/Pharmaceutical, ~28%; Computer Science/Analytics/ Big Data /Statistics, ~28%; Environmental Science/Ocean Science/ Sustainability/GIS, ~26%; Physical/Chemical Sciences, ~46%; Agricultural Science/ Food Science/Nutrition, ~27%. These data indicate that the survey captures representative sampling of PSM STEM fields.

The "original" PSM emphasis on transferable skills in economics, finance and accounting continues to be prevalent. Fifty-seven percent of all respondents identify these as components of their professional development training. However, new types of transferable skills have emerged over the past two decades in response to changing landscapes in both employment and graduate education. One example of this is the discipline-driven emergence of regulatory issues, ethics and the responsible conduct of research as components of PSM professional development in 54% of all respondents. Training in regulatory issues and ethics tends to be concentrated in the STEM fields of biotechnology/biomedicine/ pharmaceuticals (72% of responses) and agricultural science/food science/nutrition (100% of responses), although regulatory training also occurs in all of the other STEM fields to a slightly lesser degree (responses in the other fields range from 43-50%).   Another example of the evolution of transferable skills offered through PSM programs is the recent incorporation of entrepreneurship, innovation, technology transfer, intellectual property and copyright laws as components across all STEM disciplines. Fifty-one percent of institution responses include these elements. In a third example, the emergence of web design and graphics as marketing and communication tools is beginning to be reflected as transferrable skills in PSM programs. Thirteen percent of responding institutions list marketing/web design/graphics as a transferable skills component, again across programs in all five STEM disciplines.

What are the pedagogics of transferable skill elements or courses?

We wanted to gain some insight into how PSM programs are educating students in transferable skill sets. What are the approaches to providing transferable skill sets? Who is teaching this material? What are the scheduling and delivery modes? Survey responses to these three questions revealed a flexible approach that often expands beyond traditional academic models. Programmatic approaches described in survey responses covered a range of scheduling and delivery options, each of which enables students to achieve proficiency in transferable skills. At one extreme was a set of courses required of all PSM students at an institution, regardless of STEM discipline for a specific degree program or track. In several cases, the set of courses focused on business practices and were offered in partnership with the institution's business school, sometimes resulting in the awarding of a certificate. At the other extreme, some institutions provided a menu of transferable skills courses that could be customized by students based on STEM fields and desired career trajectories. At other institutions, approaches to PSM transferable skill sets represented a hybrid approach with some courses required and others elective. Figure 3 depicts the types of instructors who teach transferable skills in PSM programs. Only slightly more than 20% of responses indicate that transferable skills courses are taught exclusively by tenure-track faculty. About 65% of the responses suggest that courses are taught exclusively or jointly with persons outside the tenure track, some of whom do not have institutional appointments at all.

Figure 3. Types of educators who are teaching transferable skill components and courses in PSM programs.
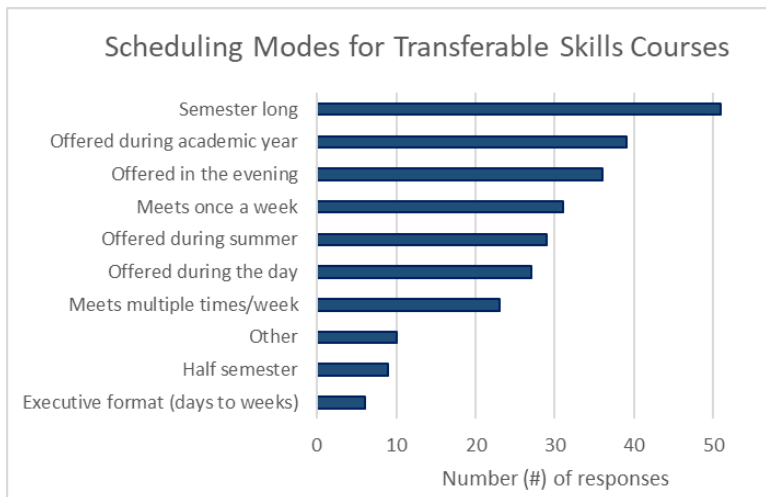
Scheduling Modes for Transferable Skills Courses

Figure 4. Flexible scheduling modes characterize the teaching of PSM transferable skills

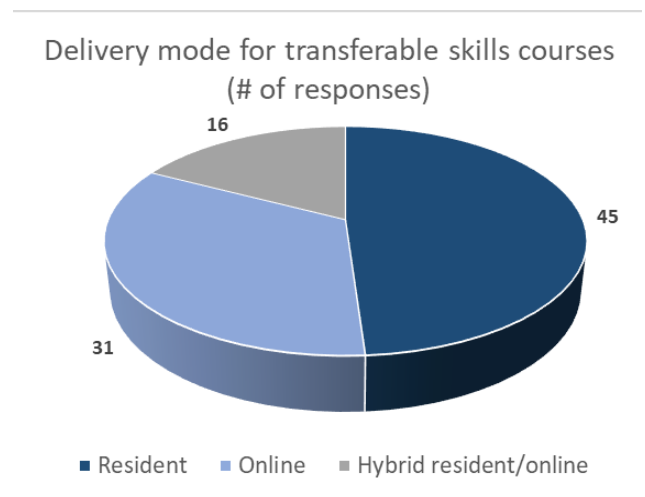## Delivery mode for transferable skills courses (# of responses)

Figure 5. Transferable skills courses are delivered in multiple formats.

Almost as many courses are offered in the summer as during the academic year. Courses are more often offered at night than during the day. Professional development training is about equally partitioned between single meetings per week and multiple meetings per week. In PSM transferable skills programming, 50% of the respondents denote courses that are offered fully on line (33%) or in hybrid online/resident (17%) formats (Figure 5).

Many students in PSM programs work full or part-time. From our experiences in the PSM community, we know that programs often draw on persons who have full-time or part-time positions in the employment sector to participate in teaching skills for workplace success. For these learners and their instructors who are not full-time faculty, flexible scheduling and delivery supports their participation and drives the innovative pedagogy of PSM transferable skills education.

How can PSM programs meet the future challenges to transferable skills education?

As PSM programs grow at an institution, both in number of programs and number of students, it is often desirable to scale and create campus partnerships to share expertise, costs and responsibilities for professional development training. The PSM movement has long been the conceptual and practical leader in the identification and delivery of transferable skills in graduate education. This is an expertise that the PSM community must share more widely. One option for some programs has been to share responsibility with the institution's graduate school. As described herein, examples of a few of the in-demand skills are: communication skills for reaching the non-specialist; leadership and team/project/laboratory management; strategic/critical thinking and decision-making; and data analytics/analytical thinking.   What graduate student or post-doctoral trainee would not find these skills of benefit, regardless of career trajectory? How many of us who became professors or program directors would not have found these skills of value in successfully establishing and directing research teams and projects? Some PSM programs (e.g. those at Keck Graduate Institute, University of North Carolina-Chapel Hill, and others) have found success in offering a certificate to doctoral and postdoctoral trainees based on PSM transferable skills courses and components.

One of the challenges in providing transferable professional development training is adding it to new or existing degree programs without sacrificing disciplinary content. One innovative approach is to move from credit-hour or time-based models to student competency-based education models. Many of the transferable skill sets valued by employers might be amenable to flexible on-line or in person modular formats – some of these types of non-traditional delivery modes for transferable skills training already exist in the PSM world as is evident from Figures 4 and 5. This tactic requires a fundamental shift in the way departments and colleges approach programming. Academic units need to facilitate approvals for team-taught courses that include teaching by instructors who are not formal faculty

members, as well as support and recognize efforts of full-time faculty members who organize and participate in such team-taught courses. Innovative approaches to awarding credits in competency-based and experiential learning would be very useful for transferable skills. Atypical scheduling blocks need to be accommodated by the institution's office of the registrar. An important aspect of on-line transferable skills courses or modules is an ability to easily share, especially between institutions where issues of costs and credit transfers can present insurmountable barriers.

So, how are we doing and what does the future hold?

Transferable skills taught across the PSM world are very much in synchrony with current employer demands. The Future of Jobs report from the World Economic Forum, based on input from 371 leading global employers that represent more than 13 million employees, reaffirms the ongoing importance of the "PLUS" approach of the PSM pioneers:

On average, by 2020, more than a third of the desired core skill sets of most occupations will be comprised of skills that are not yet considered crucial to the job today, according to our respondents. Overall, social skills— such as persuasion, emotional intelligence and teaching others—will be in higher demand across industries than narrow technical skills, such as programming or equipment operation and control. In essence, technical skills will need to be supplemented with strong social and collaboration skills. (Executive Summary, The Future of Jobs and Skills Report, p3).

The Report reminds us that both technical and transferable skills are not stationary. Many, if not most, PSM degree programs are adaptable by design and more readily responsive to changing needs.   The Report calls for a long-term focus to rethink higher education systems that can be disadvantaged by highly siloed education and the "applied" versus "basic/pure" dichotomy; the PSM concept has tackled both of these issues.   The Report encourages businesses to work closely with education providers to imagine the curriculum of the future. In this aspect, the PSM with its mandated engagement of employers is ideally positioned to play a role in bridging the gap between the employment and education sectors. PSM leadership could provide a much-needed benefit by finding ways to make more widely and well-known the knowledge base and successful practices of the community.

Transferable skills are not, nor should they be, static. PSM program directors need to periodically reassess in-demand transferable skills and adjust accordingly. First, while it is relatively straightforward to catalog transferable skills offerings, it is not as clear-cut how effective our training actually is. Input from both PSM employers and graduates with workplace experience should be sought to help gauge the real-life value of the professional development training that has been provided and to improve upon it. Second, existing training elements need to be revisited periodically to ensure ongoing concordance with workplace demands. In our earlier example, the refocusing of communications skills to emphasize interaction with a heterogeneous audience and to keep abreast of new communication platforms illustrates the evolution of content.

As new technologies emerge, they can also give rise to entirely new kinds of transferable skills. It has not been that long ago that education in computer sciences and bioinformatics were largely confined to new degree programs, including PSMs. In relatively short order, employees in every STEM field were expected to have practical knowledge in the use of computers and discipline-specific applications. This required the development of curricular elements that were career-focused, compact (compared to corresponding degree requirements), and widely transferable, much akin to the early "PLUS" training in business practices. Based on surveys, it appears that practical knowledge in the collection and analysis of big data is emerging as one of these new kinds of transferable skills. Practical knowledge of big data has become desirable in virtually every PSM field. Students need an abbreviated and applications-based training that can cross disciplines. It would be useful to identify and share successful approaches to this new transferable skill in the PSM world.

From its inception, the PSM concept was visionary and deeply engaged in partnerships with business and industry, long before it became a priority for other degree programs. PSM programs have been delivering transferable skills to our students for two decades. We not only have much to share, but the flexibility that characterizes the PSM degree positions it well to respond to the ever-changing landscape of both disciplinary and transferable skills that are in demand.

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OPINION

Yes, you are responsible for PSM PR
Sheila Tobias and Ray J. Hoobler

PSM program directors are responsible for most activities related to the success of their PSM degree program. These include the academic activities of recruitment, admissions, retention, graduation of students; program management tasks: budgeting, forecasting, recruiting and hiring instructors, course scheduling; community engagement with local businesses and non-profits; alumni engagement and outcome tracking; and promoting the program on their campus. External promotion is often overlooked or just ignored because of lack of knowledge or resources.

The efforts needed to manage the above list is a full-time job, and we assume the average program (with 20 to 25 students) is managed only part-time with administrators, faculty, and support staff. But efforts to "grow, build, and sustain" will require that program directors develop effective marketing campaigns—a process new and unfamiliar to most.

This was not always the case. In the first decade of expansion, it was imperative to define the "science master's" in a new context, lest students, faculty and the employers we were aiming to attract be allowed to consider the master's in its older context, particularly in the physical sciences, as a failed Ph.D.

The PSM challenged conventional wisdom about curriculum (science 'plus'), the value of internships, and cross-disciplinary expertise. In the 1990s, IBM was perhaps the only company developing "the T-shaped professional." We, the PSM movement, had to get noticed! That's when "marketing" loomed large enough in our funders' view to warrant a $30,000/year public relations budget. During this time, funds were earmarked by the Sloan Foundation to pay a professional public relations firm to promote the PSM concept. Their efforts led to articles in The Chronicle of Higher Education, Science (twice), C&EN (Chemistry and Engineering News (twice) and The Society for MicroBiology. At a time when the daily newspapers were still a primary source of information, we published in USA Today, The Wall St. Journal, The Detroit News, The Baltimore Sun and The Providence Journal, the last two published articles were locally penned Op-Ed columns on the subject of the "new degree." Today, marketing is no less important, but programs have to compete locally and nationally for attention.

Types of Stories and Story Ideas

Op-Ed pieces.
Encourage your directors of programs, faculty and business advisers to write Op-Ed pieces in newspapers about your PSM. As experts in their fields, they will be considered well qualified to write opinion pieces that people will read. And their op-ed piece may stimulate letters to the editor, requests for more stories and an ongoing dialogue in your locality.

Feature-like press releases.
"Features" are not exactly news stories but based on an engaging personality who directs, saw the need for, or is part of the program. (People like to read about other people.) Feature editors or reporters who write about science, education, business, innovation, and health are good contacts for feature-like press releases or "profiles."

NPSMA MARKETING RESOURCES

PSM Program Growth Curve

20th Anniversary Press Release Template

Marketing Flyer for Employers

Marketing Flyer for Students

Marketing Flyer for Policy Makers

Stories with a news peg.

A "news peg" is what makes the story timely or newsworthy now. Announcements of awarded grants, graduates landing a highly visible job, additions to your business advisory board or expansion of your programs all constitute news pegs. You can also include press conferences, panels, and future events. A note on public announcements, ask what their lead time is, as many require ten days' notice.

An update on the national PSM movement.

Check with the NPSMA and PSM Office for updates. Use the growth in the number of programs (see updated Growth Curve) as a call for local attention to your program. Rarely does a new degree attract the kind of expansion that the PSM has done in just two decades. That story has never been told nationally, primarily because the investment in PR waned after 2004.

Blog posts.

These articles are more distilled than in any other venue. The assumption is that people aren't going to read anything very long on the web, so the reporter will value an idea that can be presented fast and succinctly backed up with a rationale as to why it's important to know this. Charts, pictures, graphics, links – all kinds of visuals are particularly useful in a visual medium, so try to have suggestions if you have them available or help the reporter find them.

Pre-contact Preparation

Before you call or send an unsolicited press release or inquiry, read several copies of the publication you are considering. If the organization is online, review their website. Your purpose is to make your press release or article relevant to their audience.

Seek magazines, local and state, especially any that feature programs about and for state-wide business leaders, and state and local government professionals.

University and college newspapers are an excellent place to place a story, as students and faculty read them or access them online.

Become the expert on your program. You are the expert in this field and need to present yourself accordingly.

NewsLink.org is a good online resource for:

- Lists of newspapers, periodicals, print and online by state and city/location
- Journalism organizations
- New-media newsletters
- Starting points for journalists

Content Suggestions and Tips

Facts—be certain of your facts and be able to back them up. If things change after your press release, just say so when contacted by the reporter. Indicate that the story is for immediate release unless you have a reason to hold a story until a particular date or event.

Don't overload your release with too much information. Save that information as background to give a   reporter when he/she calls you. Be careful not to dilute your "lead."

Always put your contact information and the date at the top of your press release.

Story—reasons the story you are about to tell is newsworthy:

- Date, Nature, and Launch of your program
- Number of enrolled students (current and aggregated)
- List of employers hiring this year's class
- Increase in number of tracks
- Participation of faculty in regional/national meetings
- Awards to the program or about individual students, graduates' promotions, successes of students or graduates which can be delivered to graduates' hometown media outlets

Follow up—after you send out your press release or story idea, follow up with a call or email to confirm the media outlet received it. If you have worked to establish personal contact with the writer, editor, or producer, follow-up will be easier.

Conclusion

It's not entirely true, as performers are wont to say, "It doesn't matter what the press says about you, so long as they spell your name right," but there are real tangible benefits of PSM programs building effective public relations campaigns to graduates seeking jobs in the private or public sectors and for graduates not having to explain at the outset what their degree—whatever its specific title—represents in the way of expertise, exposure, and specific skill sets. As part of her final report to the Sloan Foundation in 2015, one of the co-authors (Tobias) included a survey of a large sample of PSM graduates' LinkedIn™ posts, only to discover that few featured their "plus" courses, or even their internships. In part, she speculated, their omissions had to do with PSM graduates having followed dutifully the recommended LinkedIn™ format or having tailored their self-descriptions to specific employers' job postings. But it also suggests that program directors may not have emphasized sufficiently to their graduates how to present the unique features of their PSM degree, both on their resumes and in their job interviews. If that is the case, we are falling short in effectively promoting the unique benefits of our programs to our students. On a positive note, the NPSMA is releasing marketing "templates" that will assist its members in promoting their programs both internally and externally.

More and farther-reaching publicity for the PSM, now in the 20th year since the model was first described in The Chronicle of Higher Education, would take out remaining pockets of unfamiliarity among students, parents, employers, and STEM faculty as to what the PSM is all about. Since, in the current funding environment, that effort falls to individual program leaders and supporters, it behooves us all to accept our responsibility for PSM PR.

If required by your institution, you should work with your university's communications or public relations team. Most university marketing and communications groups post their resources and regulations online. They will be happy to work with you and help you reach the right audience. We hope the above information will guide your efforts, as an individual or part of a team, to promote your program.

Sheila Tobias of Tucson, Arizona, has made an art and a science of being an outsider to science and mathematics, where hers is a household name for the books Overcoming Math Anxiety; They're not Dumb, They're Different; Breaking the Science Barrier; and Rethinking Science as a Career. She is currently working on "Engineering-enhanced Liberal Education."   [Sheila Tobias <sheilat@sheilatobias.com>]

Ray Hoobler, University of Utah, joined the PMST program as Director in January 2016 and is responsible for strategic management of the program as well as admissions, recruiting, and marketing. He currently teaches the program's course: Strategy and Marketing for Scientists. [Ray J Hoobler <ray.hoobler@utah.edu>]

IN PRACTICE

What is the ROI on Graduate Education for PSM Programs?

Ray J. Hoobler

"What's the ROI (return on investment)?" "How much does the program cost?" These are common questions I get, and they capture a significant concern for many potential students when discussing graduate education. Dollars are but one of many factors that contribute to a successful graduate career. With regards to ROI, I have always assumed it was positive but never crunched the numbers. Also, I don't want to brush the question aside with the oversimplified response "it depends," so I took some time to look at how other graduate programs address the question and formulated a response for the Professional Science Master's degree.

The short answer is: yes, graduate education can increase one's earning potential and have a positive ROI. For this article, I use a 10-year time frame showing the ROI and net salary gains will be positive. I'll also look at how pursuing a graduate degree part-time can further reduce the opportunity cost.

Business schools offering traditional MBA programs are a reasonable starting place to address this question as one expects an MBA program to increase earnings potential. For this exercise, I examined two business schools, The University of Chicago Booth School of Business, and The University of Utah Eccles School of Business, using information provided on the website business-schools.startclass.com (Business Schools, 2015). The StartClass website compiled data directly from the websites of each business school through 2015. I chose the Booth School of Business, as a former colleague of mine attended this school, allowing me the opportunity to ask him questions about that particular program. I work as the Director of the Professional Master of Science and Technology program at the University of Utah; the PSM program is not affiliated with the Eccles School of Business (but obviously has an interest in comparing the ROI of our PSM to our school's MBA). Using the methodology established for MBA programs, I've looked at the 10-year ROI and 10-year Gain for the University of Utah Professional Science Master's program; using this method, other programs can do a similar analysis.

In 2015, The Booth School of Business was ranked 4th by US News, 2nd by Bloomberg, 1st by the Economist, 9th by the Financial Times and 6th by Forbes. The MBA program cost is almost $128,000 for residents and non-residents. In 2015, The University of Utah Eccles School of Business was ranked 70th by US News and 59th by Bloomberg. The MBA program cost was approximately $51,000 and $73,000 for residents and non-residents, respectively.

According to Business School Websites, the average resident cost across all MBA programs was nearly $27,000 for residents and $41,000 for non-residents, which makes both examples more expensive than an average MBA program. An analysis of national MBA program cost was not performed.

Here, the 10-year ROI and 10-year Gain are used as described by Business School Websites:

$$ROI = \frac{\sum_{year=1}^{10}(Salary)_{post} - \sum_{year=1}^{10}(Salary)_{pre}}{Total\ Program\ Cost} \times 100$$

$$10\ year\ Gain = \sum_{year=1}^{10}(Salary)_{Post} - \sum_{year=1}^{10}(Salary)_{Pre} - Total\ Program\ Cost$$

Where the Total Program Cost includes tuition, fees, etc., as well as lost wages (opportunity cost). The 10-year Gain takes the 10-year salary difference and subtracts the total cost. Note that an ROI < 100% corresponds to a negative 10-year Gain. To maintain consistency with the source, these numbers are not adjusted for inflation. Post-Graduate salaries are reported as the average for the school and wages are assumed to grow at a rate of 5%. For the University of Utah Professional Master of Science and Technology Program, post-graduate salaries were estimated using information from glassdoor.com, the University of Utah Career Services website, and the American Chemical Society Salary Calculator, and are meant to be representative of the Salt Lake City metro area. These estimates reflect a fixed 10-year period. One could argue that the post-graduate salary should only cover 8 years to account for two years of study; however, I have used the 10-year values to be consistent with Business School Websites' model. Only resident program cost was examined, as nearly all our students are charged resident tuition.

What do the numbers look like?

Overall, the numbers support the value of graduate education when looking at a 10-year ROI and 10-year Gain. The exceptions to this are for individuals who are already high earners and not able to translate a graduate degree into a salary higher than the reported mean. The opportunity cost for full-time study can be high, being equal to or exceeding the program cost. While MBA programs have reported average post-graduate salaries, the 10-year ROI and 10-year Gain can only be calculated with knowledge of the pre-graduate salary. In Tables 1 and 2, I have provided three scenarios using a range of pre-graduate salaries for the Booth and Eccles MBA programs. A similar set of scenarios is shown in Table 3 for the University of Utah's PMST program.

Table 1. 10-year ROI and 10-year Gain for three scenarios applied to the University of Chicago Booth School of Business.

Pre-Graduate Salary	$60,000	$80,000	$100,000
Program Cost	$127,960	$127,960	$127,960
Program Length (years)	2	2	2
Opportunity Cost	$120,000	$160,000	$200,000
Total Cost	**$247,960**	**$287,960**	**$327,960**
Post-Graduate Salary	$120,000	$120,000	$120,000
10-year Pre-Graduate Salary	$754,674	$1,006,231	$1,257,789
10-year Post-Graduate Salary	$1,509,347	$1,509,347	$1,509,347
10-year Salary Difference	$754,674	$503,116	$251,558
10-year ROI	**304%**	**175%**	**77%**
10-year Gain	**$506,714**	**$215,156**	**$(76,402)**

Table 2. 10-year ROI and 10-year Gain for three scenarios applied to the University of Utah Eccles School of Business.

Pre-Graduate Salary	$40,000	$60,000	$80,000
Program Cost	$50,957	$50,957	$50,957
Program Length (years)	2	2	2
Opportunity Cost	$80,000	$120,000	$160,000
Total Cost	**130,957**	**170,957**	**210,957**
Post-Graduate Salary	$91,123	$91,123	$91,123
10-year Pre-Graduate Salary	$503,116	$754,674	$1,006,231
10-year Post-Graduate Salary	$1,146,135	$1,146,135	$1,146,135
10-year Salary Difference	$643,020	$391,462	$139,904
10-year ROI	**491%**	**229%**	**66%**
10-year Gain	**$512,063**	**$220,505**	**$(71,053)**

Table 3. 10-year ROI and 10-year Gain for three scenarios applied to the University of Utah Professional Master of Science and Technology program (full-time).

Pre-Graduate Salary	$30,000	$40,000	$50,000
Program Cost	$15,442	$15,442	$15,442
Program Length (years)	2	2	2
Opportunity Cost	$60,000	$80,000	$100,000
Total Cost	**$75,442**	**$95,442**	**$115,442**
Post-Graduate Salary	$55,000	$55,000	$55,000
10-year Pre-Graduate Salary	$377,337	$503,116	$628,895
10-year Post-Graduate Salary	$691,784	$691,784	$691,784
10-year Salary Difference	$314,447	$188,668	$62,889
10-year ROI	**417%**	**198%**	**54%**
10-year Gain	**$239,005**	**$93,226**	**$(52,553)**

As would be expected, part-time study offers a valuable opportunity to eliminate (or substantially reduce) the opportunity cost associated with graduate study shown below:

Table 4. 10-year ROI and 10-year Gain for three scenarios applied to the University of Utah Professional Master of Science and Technology program (part-time).

Pre-Graduate Salary	$30,000	$40,000	$50,000
Program Cost	$15,442	$15,442	$15,442
Program Length (years)	3	3	3
Opportunity Cost	$0	$0	$0
Total Cost	**$16,592**	**$16,592**	**$16,592**
Post-Graduate Salary	$55,000	$55,000	$55,000
10-year Pre-Graduate Salary	$377,337	$503,116	$628,895
10-year Post-Graduate Salary	$691,784	$691,784	$691,784
10-year Salary Difference	$314,447	$188,668	$62,889
10-year ROI	**1,895%**	**1,137%**	**379%**
10-year Gain	**$297,855**	**$172,076**	**$46,297**

There are obvious drawbacks to part-time study. The need to balance work, school, and—most likely—family is challenging and requires individuals who excel in time management. The likelihood of substantially increasing one's salary would be another risk, as the path to move vertically in an organization may not be possible. That said, if a company has a 50% reimbursement program for continuing education and the resulting post-graduate salary is only 6% above the pre-graduate salary, the 10-year ROI, and 10-year Gain are still possible:

Table 5. 10-year ROI and 10-year Gain for three scenarios at the University of Utah Professional Master of Science and Technology (part-time with 50% tuition reimbursement and 6% in post-graduate salary).

Pre-Graduate Salary	$30,000	$40,000	$50,000
Program Cost	$7,721	$7,721	$7,721
Salary Growth Rate	5%	5%	5%
Program Length (years)	3	3	3
Opportunity Cost	$-	$-	$-
Total Cost	**$8,871**	**$8,871**	**$8,871**
Post-Graduate Salary	$31,800	$42,400	$53,000
10-year Pre-Graduate Salary	$377,337	$503,116	$628,895
10-year Post-Graduate Salary	$399,977	$533,303	$666,628
10-year Salary Difference	$22,640	$30,187	$37,734
10-year ROI	**255%**	**340%**	**425%**
10-year Gain	**$13,769**	**$21,316**	**$28,863**

PSM Salary Analysis

In the article *Does a Professional Science Degree Pay Off?* (Carpenter, 2012), Siri Carpenter reviewed data from the Council of Graduate Schools *Outcomes for PSM Alumni: 2010/11* report (Bell & Allum, 2011). At that time, "just over half started at between $30,000 and $59,999 per year" with the middle quantile at approximately $40,000 to $59,999 per year. In the 2014 report, the distribution shifted higher and the middle quantile is approximately $50,000 to $79,000 per year (Komura, 2014) with a clear maximum at $50,000 to $59,000 per year. A comparison of the survey results is shown in Figure 1 (Allum, Outcomes for PSM Alumni: 2011/12, 2012), (Allum, Outcomes for PSM Alumni: 2012/13, 2013). It is encouraging to see survey participation increasing.

Figure 1. Salary distribution of PSM graduates working full-time. Survey data from 2011, 2012, 2013, and 2014 outcome reports.
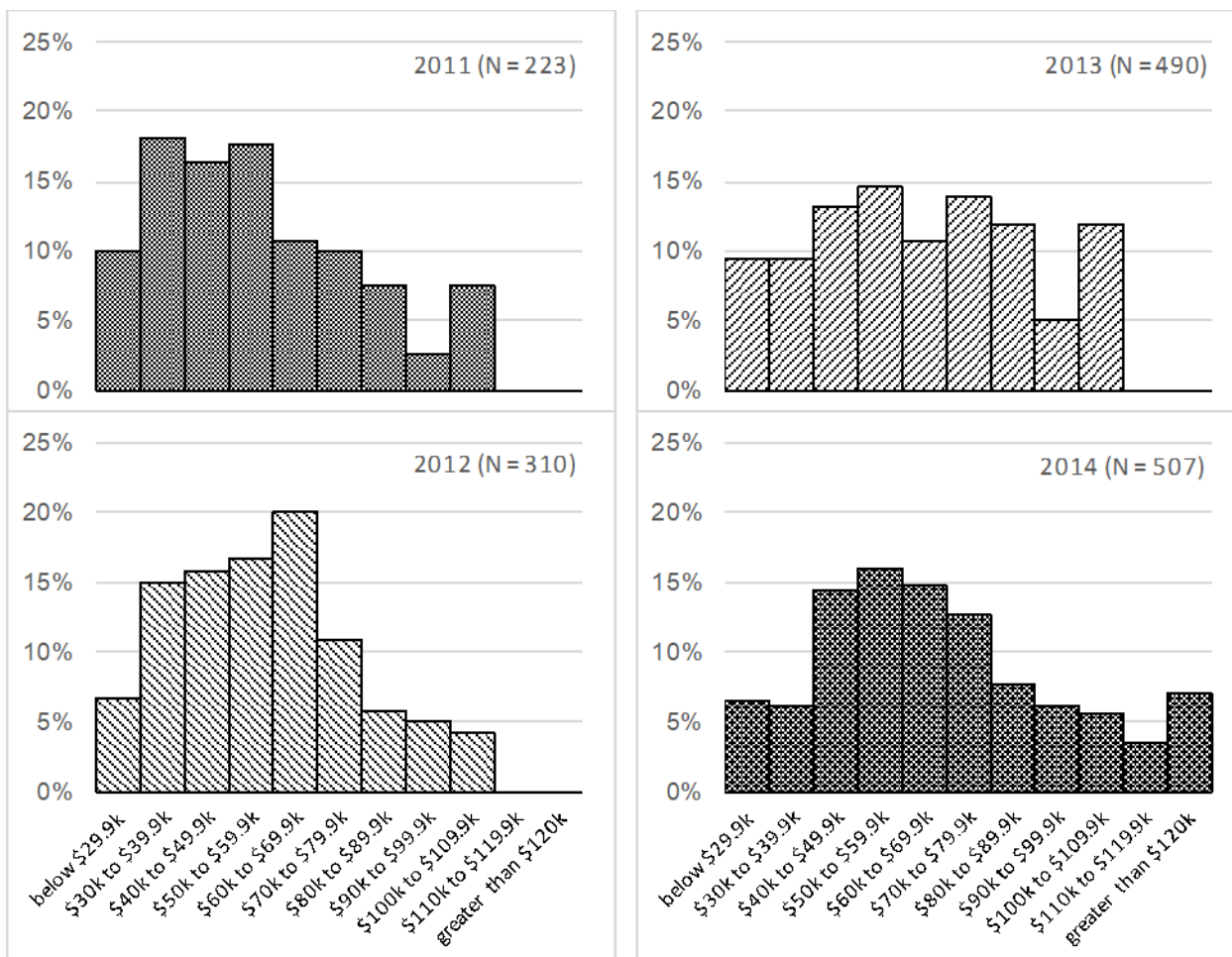
What is the recommendation?

Without question, having a graduate degree can improve your earning potential. Many science and technology positions are only open to those with a graduate degree, and it is common to see "M.S. required, Ph.D. preferred." While a traditional master program usually requires full-time study, PSM programs offer individuals the opportunity to obtain a graduate degree in 2-3 years, often allow part-time study, and can open up opportunities for advancement. The overall value of the degree, regardless of discipline, will depend on the individual and a graduate degree is no guarantee for increased earnings or promotion; however, they can provide the knowledge and skills needed to compete for critical roles in today's advanced science and technology companies.

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IN PRACTICE

Developing Career Self Efficacy through Biotechnology Industry Practicum Projects

Meaghan Nappo and Paul T. Hamilton

North Carolina State University's Master of Microbial Biotechnology (MMB) program, founded in 2003, offers students a unique blend of science and business education integrated with real-world bioscience industry exposure. Making the MMB unique to other Professional Science Master's degrees is its curriculum and advantageous location. NCSU is located about 15 miles from Research Triangle Park, the regional heart of North Carolina's biotechnology industry, which is comprised of over 650 bioscience companies. The close proximity allows students to easily create face-to-face connections with biotechnology companies and industry professionals. The MMB curriculum is designed to expose students to the biotechnology industry through practicum projects, networking, guest speakers, and internships.

Each year, the MMB program admits about 15 students to the two-year Professional Science Master's program. This year, after the first week of classes, a newly admitted MMB student expressed with concern, "I only have two years. I have two years until I need to decide on a career path." The two-year MMB program can feel brief and overwhelming, especially when job placement after graduation is looming over students' heads throughout its entirety. Students come prepared to do what it takes - coursework, lab work, internships, and networking - to ensure they are able to secure a job upon graduation, but their concerns are valid and speak to the importance of the core mission of the NCSU MMB program, "to thoroughly prepare students to become successful professionals in the bioscience industry." The combined in-class and out-of-class elements of the 40-credit-hour curriculum are specifically designed to provide MMB students with career insight and exposure so that, upon graduation, they will be competitive in the job market and receive fulfilling job placement. In fact, 98% of MMB graduates surveyed in 2015 reported job satisfaction. Overall, respondents indicated satisfaction with their job meaningfulness, security, salary, autonomy, and opportunities for advancement.

There is only so much experience a student can gain in the classroom; soft skills and confidence do not always translate from the classroom to being on the job. To address this possible gap, one of the MMB's program goals is:

"To offer experiential learning opportunities, both in the classroom and through field-based industry exposure, that prepare students to develop key skills necessary to secure jobs and experience success in their respective careers."

This goal is primarily achieved through a student's successful completion of "MB 585: Industrial Case Studies in Microbial Biotechnology" during their first three semesters in the MMB program. Using experiential learning as a model, practicum projects provide students with comprehensive industry exposure, which contributes to establishing career self-efficacy. According to McCarthy and McCarthy, experiential learning allows students to explore various career options, network, and collaborate with both academic and professional mentors. MB 585 helps students explore their career options while in school through guest speakers, written assignments, soft skill development, and a team-based practicum project. In a typical semester, a student's grade is based on individual assignments (literature review, current events write-up, and presentations), their practicum project (written deliverable graded by both the company and instructors), and peer evaluation from each team member.

A majority of MMB students majored in biological sciences, biotechnology, or microbiology as undergraduates, but many have minimal industry experience, if any at all. To supplement the students' limited exposure, professionals are invited to present their industry and career insight throughout each semester. Guests with job titles like Director of Program Design, Vice President of Process Development, or Vice President of Human Resources discuss their career

paths, company structures, and topics such as venture capitalism, intellectual property, human resources, business development, and R&D in an intimate setting that encourages an open dialog. These conversations create the groundwork for each student's semester-long working relationship with their assigned biotechnology company.

These presentations also expose students to the experiences of professionals who hold different roles within various sectors of the biotechnology industry. Many begin the program unsure of their career trajectory but gain a breadth of knowledge in MB 585 by engaging face-to-face with over 25 different people from the biotechnology industry. Students completing the course have provided feedback such as, *"I personally look up to Mr. [Anonymous]. I plan to work in the same line as his, business development. He talked about his personal experience and that gave me an idea of what it takes to get where he is now"* and *"Hearing from various speakers teaches us about and keeps us updated on current technologies in the companies in RTP after taking the course."* Students often speak with the presenters after class and meet at a later date for a more in-depth conversation. Even after graduating from the MMB program, alumni remember how the guest speakers contributed to their graduate school experience and often volunteer their own time and expertise for in-class presentations.

Lastly, these presentations are designed to help students understand the personnel and business structures of large and small companies and to be able to better visualize their roles during the practicum project. One important aim of these presentations is to instill in the students a level of comfort and confidence when interacting with their assigned company so they can gain as much as possible from the experience.

Two graded assignments, a literature review and current event write-up, allow students to explore the complexities of the biotechnology industry and gain a better understanding of their practicum project. Students submit a literature review that pertains to a particular biotechnology sector, typically one that is relevant to the semester's practicum project. Students better understand the developments in industry by assessing and clarifying the most current and relevant information available. They report on topics such as synthetic epigenetics, algal biofuels, or comparisons of biological and synthetic fungicides. For many students, this assignment allows them to visualize how the theories and lab techniques learned during their undergraduate careers are actually used and applied in the biotechnology industry. Students also submit two assignments summarizing current topics in biotechnology. Similar to the literature review, this assignment provides a better understanding of the current state of biotechnology and where the field is headed in the future. Together, these assignments provide career self-efficacy and foundational knowledge that prepare students to walk into established biotechnology companies already poised to make valuable contributions. They know which questions to ask and, most importantly, how to complete the tasks at hand.

The MB 585 curriculum provides students with opportunities to develop skills that undergraduate and traditional thesis-based graduate programs do not always emphasize. In the article "Mixed Signals: Do College Graduates have the Soft Skills that Employers Want?" Stewart *et al.* point out that recent studies show a widening gap between employer expectations and college graduates' actual "soft skills" (or lack thereof). For Chattoraj and Shabnam, such skills enable people to successfully engage in a wide variety of activities and situations they may encounter in their professional careers, will prepare them to face the many challenges of the corporate world, and are traits businesses increasingly seek in employees. A few of these skills emphasized by the MB 585 curriculum include communication, leadership, and teamwork. Each semester, students present their findings on the abovementioned assignments and receive feedback on their written and oral communication skills, which better prepares them to discuss ideas and research in their professional lives. The students work on the practicum project, which can range from market analysis, to technology assessment, to process improvement, and then present their findings to the company and the university community. Students work in teams to complete the projects, a format that is intentionally designed to help each student understand the kind of leader and collaborator he or she is. At the end of each semester, students reflect on their own experiences as part of the team and also receive anonymous feedback from their team mates.

The written assignments and practicum project lay the groundwork for the soft skill development needed for career success. Each semester, students spend a majority of their time working on the practicum project. At the beginning of each semester, students are provided with company project descriptions and asked to rank each one according to personal preference. Students are divided into teams of four to six people and each team is assigned a company. The aim of these assignments is to have each student work on a project that excites them, which will

improve the quality of their own experiences as well as the final product. With a student team lead guiding the group, students work with their assigned local biotechnology company for about 12 weeks on a project developed by the company. These companies represent various segments of the biotechnology industry (i.e., pharma, medical devices, agricultural biotechnology, and industrial biotechnology) and range in size from small to large. In the past, students have worked with small startups with fewer than 10 employees as well as large multi-national companies, such as Biogen, Becton Dickinson, Syngenta and BASF, and are in direct contact with CEOs, directors, project managers, and researchers.

For many students, these projects are the first time they are directly working with industry professionals. For others, it is the first time they are a part of a collaborative project on a team consisting of both students and working professionals. This exposure develops students' career self-efficacy by allowing them to better understand the biotechnology industry, network with industry professionals, gain on-the-job training, practice teamwork, and strengthen written and oral communication skills. At its core, the goal of each semester's practicum project is to expose students to business practices and develop soft skills to help them make sound career decisions.

While project topics change from semester to semester, all have a common component: Students establish goals based on a company's needs and provide a final report and presentation summarizing their semester's work. Importantly, students are working with a company's real concern or idea, using its facility and data, and interacting with its personnel. The professional experiences students gain during their three semesters in practicum are uniquely valuable, as they provide far more than that which can be taught through textbook-based learning, discussion, and analysis of industry scenarios in the classroom.

Students are purposefully assigned to different teams and companies each semester. Working with a new group each semester allows students to better understand their contributions to the group and grow as leaders and team members. MMB students are encouraged to reflect on the role they each play in the group and the implications these roles might have for their career paths. The team project gives students the chance to recognize potential weaknesses; for example, one student noted, *"Managing the group was a challenge. My organization skills could also improve."* At the same time, students assess their strengths and how these traits can contribute to a work environment. Another student reflected, *"I believe I did a solid job of keeping the group focused and moving towards our incremental goals. I've learned that I'm very result-driven, and I'm successful when I break a project into parts. [I] got better at assessing scientific literature and drawing conclusions."* Through these experiences, students will ideally recognize their strengths and weaknesses prior to starting their professional careers and strengthen their career self-efficacy.

Corporate culture can change from company to company and affect an employee's overall job fulfilment. The MMB practicum projects expose students to organizations of all sizes, ranging from start-up companies to those that are well-established. This diversity is intentional, allowing students to gain insight into the type of company that might be the best fit for them. Additionally, rotating to different industry sectors gives students a better understanding of the wide-range of opportunities.

Students meet with company representatives as frequently as once a week for project updates. The students meet with the companies primarily to discuss the project's progress and confirm students are developing a final product that satisfies the company. The meetings also give students the chance to practice time-management, oral communication, and collaborating in a professional setting. It is the students' responsibility to coordinate the meetings, which often involve the opportunity to present their progress in front of a group. Past participants indicated that these meetings taught them many important strategies for presenting in a corporate setting; for example, students may come to realize they only need one or two succinct summary slides for an entire meeting and that additional information can be provided before or after the meeting. These experiences undoubtedly give students confidence not only when starting their job search, but also once they are on the job after graduation.

Beyond the exposure to industry companies and employees, the practicum projects provide students with the opportunity to be a part of cutting-edge biotechnology research. As mentioned above, many MMB students have limited to no industry experience upon starting the program. They complete projects on regulatory, market, or technology assessment, as well as product feasibility (see Table 1). By the end of the program, they have worked on

at least three different projects with three different companies and have final project results to reference in interviews. MMB students go from feeling uncertain about their place in the biotechnology industry to having actual experiences from which to draw when considering their place in it.

Table 1.   *Practicum Projects Spring Semester 2015- Spring Semester 2017*

Company	Date	Project Title/Topic	Location
BioResource International	Spring 2015	Antibiotic Growth Promoters: A Global Assessment	RTP, NC
Galaxy Diagnostics	Spring 2015	Go-To-Market Strategies: The Ability to Culture Fastidious Bacteria	RTP, NC
Metabolon	Spring 2015	Biomarkers in Clinical Trials for Drug Development	RTP, NC
Becton Dickinson	Fall 2015	Detection and Measurement of Intratumor Heterogeneity and the Tumor Microenvironment	RTP, NC
Becton Dickinson	Fall 2015	Anti-Inflammatory Devices	RTP, NC
ILS-Genomics	Fall 2015	Assessment of Future Investments in Next Generation Sequencing Technology	RTP, NC
North Carolina Biotech Center	Fall 2015	Strategic Review of the Contract Research Organization Industry in North Carolina	RTP, NC
Quintiles	Fall 2015	Understanding the "Cost-to-Serve" in Quintiles Partnership Models	RTP, NC
bioMason	Spring 2016	Marketing Opportunities for bioMason's Downstream Products	Raleigh, NC
BioResource International	Spring 2016	Best Practices for Marketing Poultry and Swine Feed Additive Enzymes	RTP, NC
KeraFast	Spring 2016	Strategic Provider Expansion Plan	Raleigh, NC
AgBiome	Fall 2016	Fungicide Analysis of the US Specialty Crop Market	RTP, NC
BASF	Fall 2016	Global assessment of Antifouling Solutions and Making Antimicrobial Peptides Cost Competitive to Traditional Biocides	RTP, NC
Novozymes	Fall 2016	Microbial Control in Biofuel Fermentations	Franklinton, NC
Novozymes	Fall 2016	Gas Fermentation for CO2 Utilization	Franklinton, NC
Novozymes	Fall 2016	Survey of Direct Fed Microbials in Animal Feed	RTP, NC
Syngenta	Fall 2016	Realizing the Vision of the Bio Factory	RTP, NC
Advanced Animal Diagnostic	Spring 2017	Research and Market Analysis for a Blood Leukocyte Differential in Swine Production	RTP, NC
Affinergy	Spring 2017	Review of Potential Candidates for Therapeutic Drug Monitoring	RTP, NC
Locus Biosciences	Spring 2017	Investigation of Causative Disease Agents in the Microbiome	RTP, NC

MB 585 provides instruction beyond the traditional classroom environment, as it exposes students to "real world" work experience using the experiential learning model. In an effort to foster self-efficacy, which, according to Bandura, is influenced most by personal experience, the guest speakers, writing assignments, soft skill development, and most importantly, practicum project help students to better understand the biotechnology industry and how they can impact it in a tangible and meaningful way.

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FEATURE ARTICLE

Trends and Outcomes in Professional Science Master's Programs
Kiriko Komura and Jim Sterling

Overview

The PSM initiative is a vigorous endeavor that continues to grow by increasing numbers of programs, students, and corporate partnerships across a wide range of disciplines and graduate institutions. There are currently 355 PSM programs worldwide, including approximately 80 that have joined over the past 3 years. Approximately 20 programs have been discontinued due to a variety of reasons that include low enrollment, merger or elimination of concentrations, and change of degrees to other degree types or categories.

In this article, we present a summary of PSM program characteristics that were collected from the institutions to provide a description of PSM program trends. Additionally, students' outcomes, based on surveys collected from alumni through their respective institutions from 2011-12 through 2015-16, are reported. First, the program classifications by fields of study and Carnegie Classifications are discussed. Second, the trends seen in student survey results are reported on the topics of (1) student reasons for PSM enrollment, (2) student satisfaction with various PSM attributes, and (3) student salary over the first 3 years post-graduation.
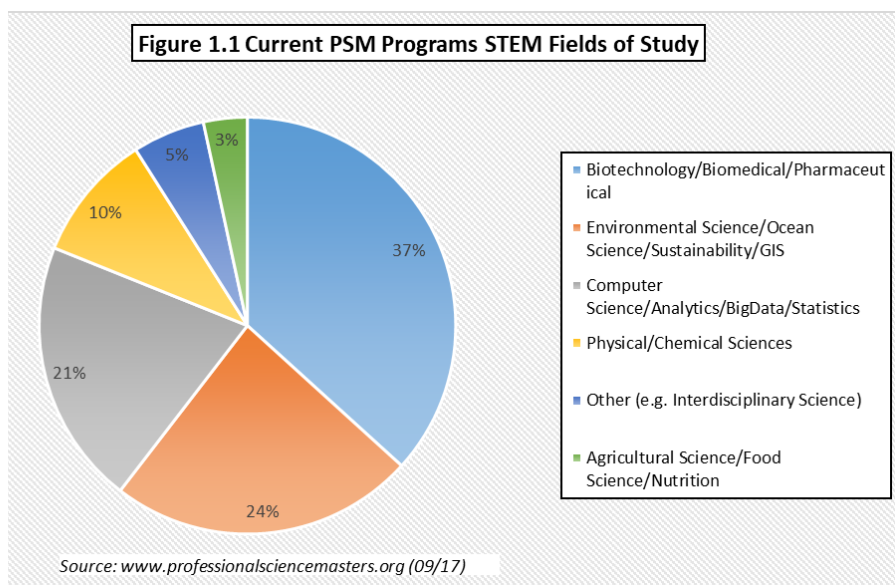
The results revealed an impressive transition of graduates from students to gainful employment with respectable salaries and a high level of satisfaction with their PSM degree. Finally, the PSM continues to be among the leaders in participation of women and minorities in master's degrees in the STEM disciplines.

PSM Program Information

The number of Professional Science Master's (PSM) programs continues to grow. In 2013, the PSM community celebrated the milestone of the 300th program being affiliated. Since then, approximately 80 programs have been newly affiliated, with the majority being developed during the 3-year period between 2014 and September 2017. Throughout the 20 years of the PSM development, many innovative programs in a wide variety of disciplines have been developed. The Council of Graduate Schools defined approximately 20 different program categories, and these were grouped into the 5 fields of study shown on the program finder on the PSM website that now classifies more than 350 unique PSM programs.

As shown in Figure 1.1, the most popular field is currently Biotechnology/ Biomedical/ Pharmaceutical Sciences (37%), followed by Environmental Science/ Ocean Science/ Sustainability/ GIS (24%) and Computer Science /Analytics /Big Data /Statistics (20.6%). This popularity is consistent even with newly developing PSM programs (PSM National Office 2017).

Simultaneously, several PSM programs have been discontinued due to various reasons, including institutional or departmental administrative changes, restructuring of program/curricula, or enrollment issues. Of the approximately 20 programs that have been discontinued, there appears to be a higher likelihood of program discontinuation in the fields of Physical/Chemical Sciences with 8 programs of this type recently closing. PSM guidelines seem to be difficult to implement in these fields, particularly with

Figure 1.1 Current PSM Programs STEM Fields of Study

- Biotechnology/Biomedical/Pharmaceutical
- Environmental Science/Ocean Science/Sustainability/GIS
- Computer Science/Analytics/BigData/Statistics
- Physical/Chemical Sciences
- Other (e.g. Interdisciplinary Science)
- Agricultural Science/Food Science/Nutrition

Source: www.professionalsciencemasters.org (09/17)

the emphasis on non-thesis/professional skills and experiential components - commonly known as STEM plus courses. However, some new Physical/Chemical Sciences have been recently developed, resulting in the total fraction remaining at 10% of the total number of PSM affiliated programs.

As expected with the increase in total PSMs, more students were awarded PSM degrees. In 2012, nearly 1,800 PSM degrees were awarded by 240 PSM programs (CGS, 2013). Additionally, about 2000 students were enrolled for the first time in PSM programs in Fall 2013 (CGS, 2013). The annual Survey of Enrollment and Degrees (PSM National Office, 2015) revealed that the PSM continued to have strong representation of women for STEM disciplines for degrees awarded in the academic year 2013-2014 (Male 50%, Female 48%, Unknown 1.7%). The trend demonstrates improved distribution of enrollment by gender than other degree programs, as the Survey of Graduate Enrollment and Degrees (CGS, 2016) reported that although more women earned master's degrees (58%) from the U.S. institutions, they had markedly lower representation in the fields of business, math/computer science, engineering, and physical/science. PSM curriculum has both business and STEM components, and retention of women in those fields of study are stable. This also aids in demonstrating that the PSM curriculum supports those who seek programs in STEM that is aimed at practical professional/societal impact, such as entrepreneurship and real-world problem solving.
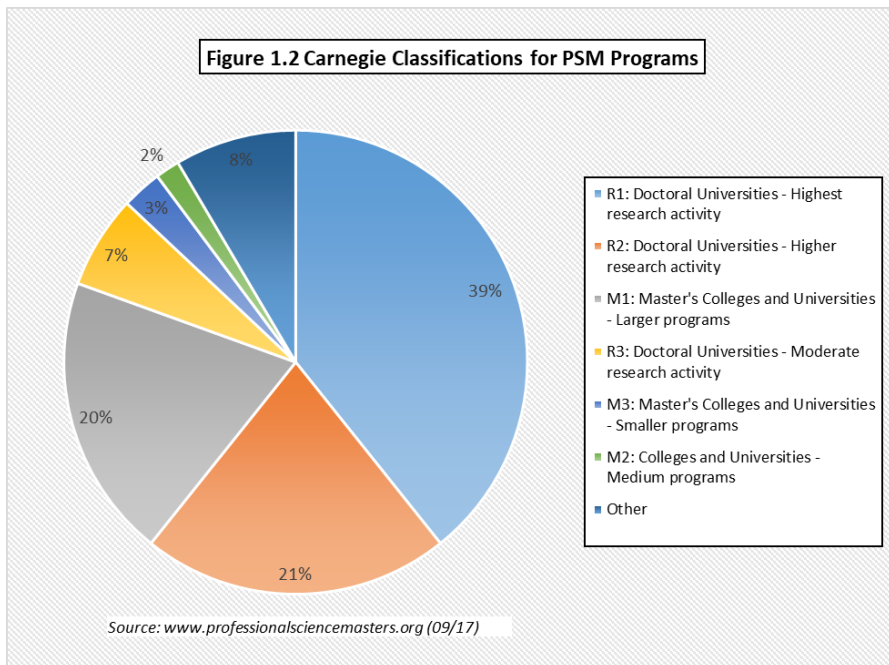
PSM degrees have now been offered by more than 350 programs at more than 160 institutions since 1997, and the vast majority of these are located in the United States, but they are also growing internationally. The PSM initiative is expanding globally. There are several PSMs now offered outside of the US, particularly in Australia and England. Additionally, South Korea has a new initiative that is expected to lead to a set of new PSMs over the next couple of years. Other program development currently includes institutions in the South East Asian and Central/Latin American regions. New program applications for affiliation of PSM programs are also increasing. A survey by the PSM National Office (2015) estimated 9,666 students applied to more than 300 PSM programs. Further enrollment and degrees data will be presented in a forthcoming report on the Enrollment and Degrees in Professional Science Master's (PSM) programs, Part II: 2016.

Figure 1.2 presents information on PSM programs distributed by Carnegie Classification for different types of institutions of higher education. As shown in the figure, 67% of current PSM programs are offered by doctoral granting institutions, and the majority of programs were placed in the *very high* or *higher* research activity categories of institutions. These results are consistent with the data that the highest numbers of doctoral and master's degrees' in science and engineering were produced from those doctoral-granting institutions (NSF, 2016). Though, PSM degrees are often non-thesis and non-research based degrees, high research activity institutions are leading the offering of PSM degrees. Master's Colleges and Universities (Larger programs) follow as the third category of institutions. *Other* (8%) institutions include international and special-focus institutions. In the past two years, several special-focus institutions, including medical schools and centers, have added newly-affiliated PSM programs.

PSM Student Outcomes.

Data collected through surveys of alumni regarding employment (PSM National Office, 2016) revealed that the PSM experience was very effective for their professional development and achieving career goals. This survey was distributed to recent graduates (within the past 5 years) who earned the PSM degree, graduating during the academic years 2011/12, 2012/13, 2013/14, 2014/15, 2015/16. The

Figure 1.2 Carnegie Classifications for PSM Programs

- R1: Doctoral Universities - Highest research activity — 39%
- R2: Doctoral Universities - Higher research activity — 21%
- M1: Master's Colleges and Universities - Larger programs — 20%
- R3: Doctoral Universities - Moderate research activity — 7%
- M3: Master's Colleges and Universities - Smaller programs — 3%
- M2: Colleges and Universities - Medium programs — 2%
- Other — 8%

Source: www.professionalsciencemasters.org (09/17)

following discusses some interesting findings from the collected data.

One of the questions in the survey inquires as to the students' primary reasons to attend their PSM programs. Responses included the following 8 choices:

- To acquire specific skills and knowledge
- To increase opportunities for promotion, advancement, and/or pay
- To learn more about something in which I am particularly interested
- To facilitate a job/career change
- It was the best option available at the time
- To use as a stepping stone for further education (e.g., Ph.D., M.D.)
- To meet requirements of a prospective employer
- To meet requirements of my current employer

Analysis of the data reveals that the top three reasons for enrolling in the programs remained consistent over the previous 5-year period:

1. To acquire specific skills and knowledge
2. To learn more about something in which I am particularly interested
3. To increase opportunities for promotion, advancement, and/or pay

Another question examines the main benefits of having earned a PSM's degree. Perhaps not surprising, the respondents ranked the benefits of earning PSM degrees similarly to the reasons of enrolling in their PSM programs indicating overall alignment with expectations and perceived outcomes:

1. I have acquired new skills and knowledge
2. I learned more about something in which I am particularly interested
3. It increased opportunities for promotion, advancement, and/or pay

The PSM guidelines (CGS, 2011) state that STEM plus components must address professional skills education: "a professional skills component must be developed in consultation with leaders from the targeted industry, business, government, or non-profit organizations". When asked about students' satisfaction with attributes of the PSM programs regarding this point, the most prevalent responses were:

1. Post-graduation employment prospects
2. The quality of non-scientific professional training (e.g. business, law, communication)
3. Internship(s) and real world practical experiences

Over the 5-year period studied, PSM graduates demonstrated satisfaction with the PSM-plus curriculum. Additionally, they reported that they were highly satisfied with and benefited from the quality of their scientific and/or mathematical training. As a Master's STEM program, the nature and features of PSM guidelines continue to support students' outcomes. This result is consistent with the satisfaction of 93% of respondents who confirmed that their current work is closely related to the subject area of their Master's degrees.

The outcomes of the 2015/16 PSM Alumni survey administered by the PSM National Office included a new question related to the annual salaries of students before enrollment and after graduation from a PSM Program, i.e. how their annual base salary changed for their principal job when they began their PSM programs vs. after the program was completed. As shown in Figure 2.1, within about 5 years after graduation from a PSM Program, the students' annual base salary increased by a minimum of 4% and up to 16%.

Figure 2.1 Pre-Post Change Over Time (%)
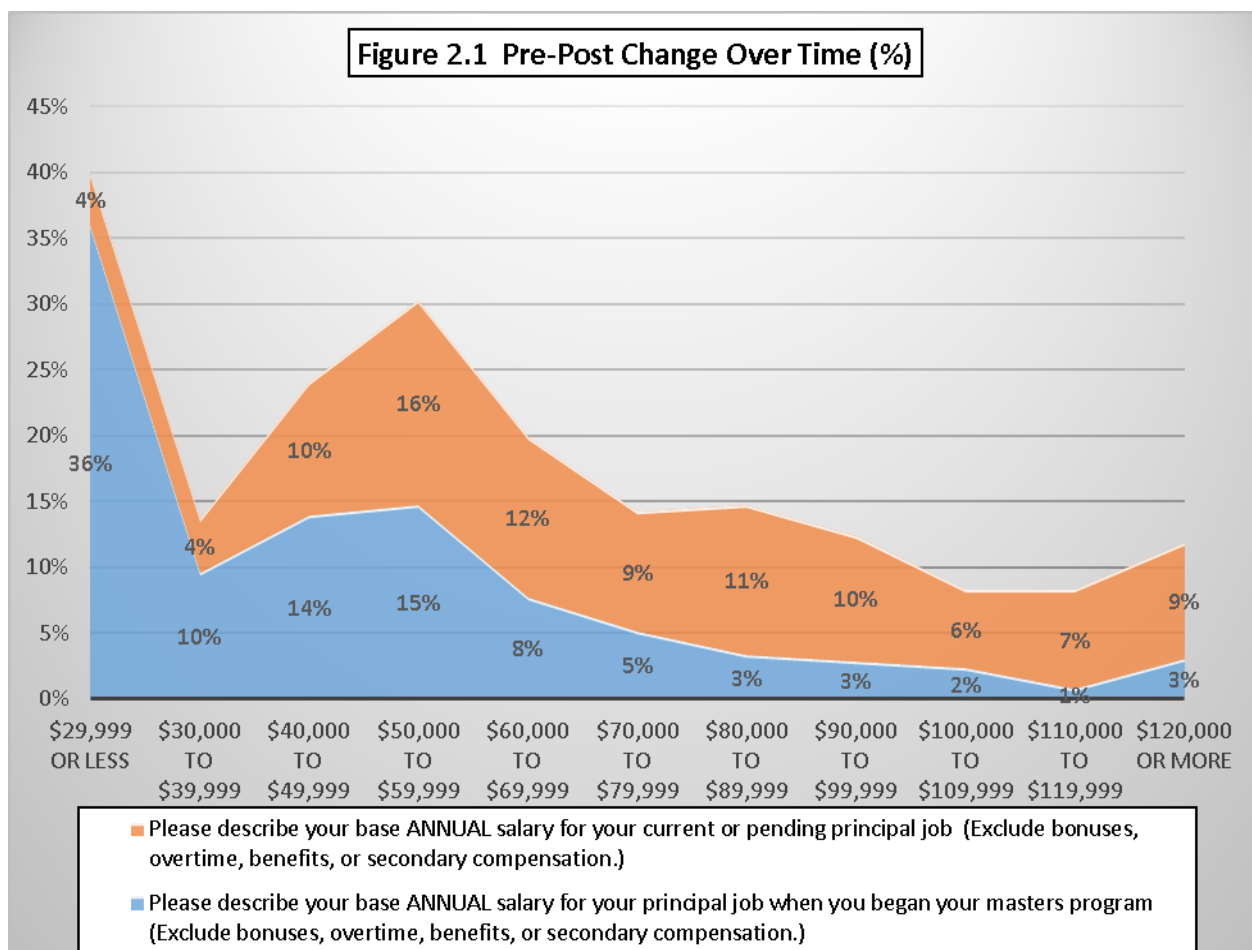
Source: Outcomes for PSM Alumni: www.professionalsciencemasters.org

Summary and Call for PSM Expansion

This article identified characteristics of current PSM programs and trends related to graduates of PSM programs and the authors hope that this article assisted the reader to better understand how the features of PSM guidelines and curricula can support students' career paths and professional development in STEM fields.

The PSM initiative continues to grow and has shown that it can continue to grow in the absence of funding from the Alfred P. Sloan Foundation, which so generously funded a host of PSM programs and initiatives for about 15 years. The PSM National Office will continue to ensure rigorous quality control processes through peer-review of affiliation applications and data integrity through data collection and analysis. We welcome inquiries regarding the data presented herein, which are also available on the website www.professionalsciencemasters.org. The latest report discussing student outcomes and enrollment degrees is also available on this website.

Finally, the collaboration of the NPSMA and the PSM National Office ensures very good member services through conferences and publications. We solicit the PSM community to support this important ongoing initiative by sharing information with those in the academic community who may be able to join the PSM initiative by adding programs or by connecting to prospective students and employers of PSM graduates.

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