

Recommendations for Master's degree programs in statistics and biostatistics

A. John Bailer^{1,6}, Roger Hoerl², David Madigan³, Jill Montaquila⁴, Tommy Wright⁵

¹Miami University, Oxford, OH USA

²Union College, Niskayuna, NY USA

³Columbia University, New York, NY USA

⁴Westat, Rockville, MD USA

⁵US Census Bureau, Washington, DC USA

⁶Corresponding author: A. John Bailer, e-mail: baileraj@miamiOH.edu

Abstract

A workgroup of the American Statistical Association recently completed a report that provided recommendations for Master's degree programs in statistics and biostatistics that are responsive to the needs of stakeholders who employ such graduates. A summary of a survey of recent Master's graduates and a separate survey of employers of Master's graduates will be presented. The following topics will be addressed: background and description of the study process; recent graduates' responses; employers' responses; and learning outcomes suggested by this process. These outcomes included: 1) a solid foundation in statistical theory and methods; 2) programming skills; 3) communication skills; 4) collaboration, teamwork, and leadership development; 5) experience with encountering non-routine, real problems throughout their graduate education; 6) internships, co-ops or other significant immersive work experiences; and 7) periodic surveys of recent graduates and employers to evaluate the success of programs.

Keywords: Programming, Communication, Non-routine problems, Internships

1. Introduction

Bob Rodriguez, while serving as President-elect of the American Statistical Association, formed a working group to address the following charge:

Develop guidelines, framed as learning outcomes, for Master's degree programs in statistics and biostatistics that are responsive to the needs of stakeholders who employ such graduates. These guidelines will reflect discussions with a variety of stakeholders in business and government to determine the needs of their Master's degree-level statistical workforces. These guidelines will assist Master's degree programs in statistics and biostatistics to align their curricula with desired outcomes.

A committee started work in March of 2011 and its report was released in November of 2012. A summary of this report was published in the Feb. 2013 AMSTAT News (<http://magazine.amstat.org/blog/2013/02/01/mastersworkgrou/>; accessed: 11 may 13) and the complete report can be found online (<http://magazine.amstat.org/wp-content/uploads/2013an/masterworkgroup.pdf>; accessed: 11 may 13). This paper provides a recap of this report.

2. Data collection

This committee constructed two questionnaires: one for surveys of recent Master's graduates and a separate, but related, survey for employers of recent graduates. These survey forms (Appendices 1 and 2, respectively, in the aforementioned reports)

were evaluated by the American Statistical Association (ASA) Survey Committee in November 2011. A list of recent Master's degree graduates was compiled after soliciting suggestions from the ASA Caucus of Academic Representatives and from other schools not covered by the Caucus. Names of 366 recent graduates were provided by 21 different schools. The numbers of graduates provided ranged from 1 to 110 (median=12, Q1=7, Q3=17). Workgroup members were each assigned a set of schools from which they were to take a sample of 2 recent graduates. Workgroup members then attempted to contact recent graduates to schedule a phone interview. Interviews were completed for 29 recent graduates (out of 115+ contacted) from 13 different schools. Phone surveys of recent graduates were conducted in the first half of 2012.

A list of employers of Master's degree graduates was compiled after soliciting suggestions from the ASA Board of Directors, Caucus of Academic Representatives and other contacts. An email was sent to 68 employers of Master's graduates. A follow up email reminder was sent two weeks later. A reply was received from 19 (28%) of these employers. Two of the employers opted to respond with a general email that did not explicitly address the specific questions. Email surveys of employers were conducted in September and October of 2012.

3. Results

3.1 Recent Graduates

The responses to the interview questions were grouped into common topic categories and summarized (see Table 1). When asked about the knowledge/skills learned in graduate school that helped them GET their first job, the graduates provided responses that fell into two broad groups. The first group included programming, general statistical / mathematical background or specific statistical methods knowledge. The second group included communication skills, other statistical experience or teaching assistantship experience. Many of the graduates were in the first job they took after graduation.

Table 1: Responses from these recent graduates – cells entries correspond to frequency of responses out of the n=29 graduates surveyed.

Question	Categories of responses					
	Program- ming	Stat/ bkgd/ math	Specific stat methods	Communi- cation	Exp.(e.g. project mgmt., consulting)	Thinking/ problem solving
Knowledge/ skills to GET first job	12	10	10	3	3	
Knowledge/ skills to WISHED had more of	9 + 3		7	3	3	2
Swap in more	7		6			
Experiences outside of formal coursework	2 (skills)				12 (work) + 10 (intern) + 6 GA/RA	

When asked about the knowledge/skills helped them PERFORM their first job, the graduates provided responses that fell into three broad groups. The first group emphasized programming/ computing tools, the second emphasized possessing a broad range of skills in statistical models and methods and the third addressed real world skills (communication, project reporting, working with clients and balancing competing demands and deadlines).

When asked about the knowledge/skills they WISHED they had learned in graduate school, the graduates’ top responses were additional programming skills, more experience with a particular statistical method and experience with real data.

Most students did not identify a course that they would “swap out” of their graduate curriculum in order to free up time for another desired course. Work experience and internship experience were both identified by more than a third of the respondents as being highly valued.

3.2 Employers

Organizations reflected in our employer surveys include university-based collaborative study centers/academic medical research settings (5 of 19), federal government (3 of 19), contract research organizations (2 of 19), survey organizations (2 of 19), and financial/banking (2 of 19). The remaining organizations were represented by 1 of 19 respondents: clinical trials consulting, pharmaceutical, public policy non-profit, consumer products, clinical research organization, or manufacturing. Some employers responded based on experience in hiring for two different industry types. Table 2 displays a summary of their responses.

Table 2: Responses from employers– cells entries correspond to frequency of responses out of the n=19 employers surveyed.

Question	Program- ming	Stat/ bkgd/ math	Adv. stat method	Com muni- cation	Exp. (e.g. project mgmt., consult)	teamwork, leadership	Attitude	Thinking / problem solving
Top two candidates	11	10	4	14	3+2	5	8	7
What made hires successful	10	10		12	2	10	14	6
Deficits in recent hires	9	5	5	6		3	3	4
Knowledge / skills required and critical	10	16	5	12	3	5	4	3
Knowledge / skills desired	13		10	5	2	3	3	4
Add one thing to programs	4		2	5+4	4+4			3

Employers responded that communication skills (14 of 19 respondents), programming skills (11 of 19 respondents) and statistical background (10 of 19 employers) differentiated the top candidates when interviewing for open positions. Attitude, problem solving and teamwork follow in terms of importance to employers.

Successful past hires were characterized by attitude and personality (14 of 19 employers), communication skills (12 of 19) and statistical knowledge (10 of 19). In contrast, deficits in past hires were the complement of successful hires: programming deficits (mentioned by 9 of 19 employers), communication problems (6 of 19), and statistical knowledge gaps (5 of 19). The programming deficit related to the need to go beyond basic invocations of statistical software.

Required and critical skills mentioned by employers included: statistical knowledge (16 of 19), communication (12 of 19) and programming (10 of 19). Other required skills each mentioned by 3 to 5 of 19 employers were collaboration, teamwork and leadership, attitude, problem solving and thinking skills, relevant coursework and project work. Desired skills most mentioned by employers included: programming (13 of 19) and advanced methods coursework (10 of 19).

When asked what employers would like to see added to graduate programs, communication skills (written – 5 of 19, verbal – 4 of 19) were the top suggestions. Project participation and work on real, significant data analyses (both mentioned by 4 of 19) were next. This reflected a desire for students to have exposure to non-textbook, non-routine problems. Programming that captured more extensive data management,

good programming practice and advanced SAS skills were also mentioned by 4 of 19 employers.

4. Recommendations

4.1: Graduates should have a solid foundation in statistical theory and methods.

Graduates viewed this as needed to both get their first job and to perform their first job, and employers viewed this as a foundation required for learning new methods. This is an affirmation of the core that is taught at Master's programs.

4.2: Programming skills are critical and should be infused throughout the graduate student experience.

These skills were viewed by graduates as necessary to get and perform their first job. Graduates expressed a wish to have better programming skills and this could be addressed by infusing more programming exercises and experiences into Master's programs. This was noted by employers as a skill that differentiated top candidates for jobs from others, made hires successful, and reflected a required, critical and desired skill. SAS was mentioned more frequently than other environments. General programming skills beyond applying templates was a key feature that should be developed.

4.3: Communication skills are critical and should be developed and practiced throughout graduate programs.

These skills were noted by graduates as necessary for performing their first jobs. These skills differentiated between top candidates, and were viewed by employers as part of what makes hires successful. These skills were required and critical skills that were also a deficit in recent unsuccessful hires.

4.4: Collaboration, teamwork, and leadership development should be part of graduate education.

Being able to function in a team environment was observed in the most successful hires.

4.5: Students should encounter non-routine, real problems throughout their graduate education.

Being able to think carefully through such problems and to develop an analysis strategy was highly valued among employers. Programs should be purposeful in creating activities that would nurture and develop such skills.

4.6: Internships, co-ops or other significant immersive work experiences should be integrated into graduate education.

Experiences that might involve consulting, project management and teamwork experiences were recognized as very important by both graduates and employers. Partnerships between statistics/biostatistics graduate programs and local employers to develop internships or between statistics/biostatistics programs and other units on-campus should be explored. These experiences would help accomplish and reinforce previous recommendations, particularly Recommendations 4.2-4.5.

4.7: Programs should be encouraged to periodically survey recent graduates and employers of their recent graduates as a means of evaluating the success of their programs and to examine if other programmatic changes are warranted.

This report is a 2012 snapshot of the impressions of recent graduates and their employers. Employer needs will likely evolve over time, and while good statistical thinking will always be valuable, electives and other experiences in the graduate program will need to evolve over time. A regular review, say every 3-4 years, would help programs keep connected to workforce needs and their graduates. Departments are encouraged to maintain and update contact information for recent graduates to facilitate this survey.

5. Limitations

The recommendations given above reflect the results of interviewing recent graduates and employers of such graduates. Respondents to these surveys were not selected as probability samples from their respective populations, and no inferential claims about the population of recent graduates of Master's programs in statistics or the population of employers of such graduates are being made. An attempt was made to select graduates from a large number of schools with varying types of programs and from a collection of employers that spanned many different types of organizations. As a consequence, it is hoped that these responses will provide some sense of the breadth of skills and knowledge that are desired for Master's graduates.