Overview of Statistics as a Scientific Discipline and Practical Implications for the Evaluation of Faculty Excellence

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Executive Summary

Statistics is at the same time a dynamic, stand-alone science with its own core research agenda and an inherently collaborative discipline, developing in response to scientific needs. In this sense, statistics fundamentally differs from many other domain-specific disciplines in science. This difference poses unique challenges for defining the standards by which faculty excellence is evaluated across the teaching, research, and service components.

This document strives to provide a conceptual framework and practical guidelines to facilitate such evaluations. To that end, the intended audience includes all participants in the evaluation process—provosts and deans with faculty members in statistics positions; chairs and heads of statistics, biostatistics, and non-statistics departments; and the promotion and tenure evaluation committees in academic institutions. Furthermore, this document seeks to assist statistical scientists in the negotiation of faculty positions and the articulation of their collaborative role with the subject-matter sciences.

Highlights of interest to decision makers such as chairs, heads, deans, provosts, and members of promotion and tenure evaluation committees include the following:

- For faculty members with a focus in statistics, excellence in research scholarship can be a mixture of publications in subject-matter journals resulting from collaborative research and publications in statistics-centric journals.
- In publications arising from collaborative research, statistics faculty members should not be expected to be first author, senior author, or, obviously, single author.
- For faculty members with a focus in statistics, successful extramural funding in the role of co-principal investigator (or other key senior roles) is evidence of a meaningful role as an essential partner in the research endeavor.
- For faculty members with a focus in statistics, mentoring of graduate students and service on research supervisory committees is evidence of important research activity.

Also of interest to chairs and heads, it is critical that the departmental culture (including faculty, students, and staff) reinforces the breadth of active statistical research and emphasizes an appreciation for the fundamentally interdisciplinary nature of many types of statistical research.

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Highlights of interest to statistical scientists pursuing academic careers actively engaged in interdisciplinary collaboration with subject-matter scientists include the following:

- It is recommended that the letter of offer and position description include collaborative research specifically as an expectation and as a primary component of evaluation for rank promotion and tenure.

- It is important that terms be negotiated, articulated, and specified in writing in the letter of offer and position description. These terms may be discussed during yearly evaluations, as involvement in collaboration can change over a career. This is particularly relevant for faculty members who transition into increasing involvement in collaborative activities.

Statistics as a Scientific Discipline and Implications for Faculty Excellence

Introduction: Uniqueness of the Challenge

Statistics arose as a distinct scientific discipline in the late 1800s and early 1900s, at a time when many areas of science underwent increasing quantification and issues of data collection, analysis, and interpretation reached a critical threshold of complexity. In fact, the most distinguished scholars and thought leaders in statistics throughout history have always had a foot in core statistical contents and at least one scientific area of application, including genetics and genomics, agricultural sciences, biomedical sciences, health sciences, clinical sciences, engineering and quality control, economics, social sciences, and political sciences. As a result, statistics evolved to become, at the same time, an inherently collaborative discipline developing in response to scientific needs and a dynamic, stand-alone science with its own core research agenda. This important collaborative component makes statistics fundamentally different from many other disciplines in science.

In many scientific disciplines, research often focuses on a specialized area that generates external funding and for which first-author (or senior-author) peer-reviewed publications are the primary criteria for judging and rewarding excellence in scholarship. The scholarship landscape of statistics is broader. The criteria for excellence in scholarship certainly can include a specialized research program. However, the criteria also expand well beyond to much more collaborative interdisciplinary scenarios that, if truly relevant to the subject-matter sciences, are bound to be inherently interwoven with the very fabric of other scientific disciplines. In fact, if all statistics faculty members were narrow in their research focus, this would be considered a symptom of a serious problem. It would indicate that the inherent and crucial collaborative nature of statistics is not being maintained.

Expectations for Scholarship

Statistics is undeniably an enabling scientific discipline for so many other areas of science, while rapidly developing at its core and becoming increasingly complex across the board. As a consequence, a healthy statistics department (or department with faculty that specialize in statistical methodology and applications) must simultaneously nurture its core research agenda and develop an attitude that encourages and rewards substantial and meaningful collaboration. Therefore, excellence in scholarship for faculty members who actively engage in

interdisciplinary research can be a mix of publications in subject-matter journals resulting from collaborative research and publications in statistics-centric journals.

It should also be noted that the overall discipline of statistics is rapidly evolving and becoming increasingly complex. As a result, peer-reviewed articles about translational research, survey, and teaching directed to readers in "consumer of statistics" disciplines should be regarded as legitimate and essential scholarly activities by the department.

It should be recognized that statistics faculty members would most likely not be first author, senior author, or, obviously, single author on publications arising from collaborative research. For this reason, judging excellence of a given publication by "percent contribution" is an exercise in asking the wrong question. The relevant question should be: "Could the research have been published without the contribution of the collaborating statistician?" Or, possibly more important, "Would the quality of the research have been substantially compromised without the statistician's contribution?"

From a funding perspective, a statistics faculty member who actively engages in interdisciplinary research should not be expected to have substantial grant funding as a principal investigator (PI). Clearly, seeking grant funding as a PI for explicit core statistical research necessarily comes at the expense of time allocation for meaningful collaboration with researchers in allied disciplines. Instead, statistics faculty members conducting interdisciplinary research should pursue collaborative grant funding as key personnel (e.g., co-principal investigator, co-investigator, etc.), that is exercising their role as research partners with a funding allocation that acknowledges the contributions and needs of statistics in interdisciplinary research.

Essential Clarifications

At this point, a comment about the often-misunderstood words statistical consulting and collaboration. *Consulting* is an isolated activity geared toward solving a technical statistical issue. By contrast, *collaboration* is a partnership to solve a scientific problem.

Arguably, the most effective contribution statistics makes to the quality of scientific research in any discipline occurs before any data are collected—in the planning phase of research. Further, to be fully effective, the partnership between statistical scientists and subject-matter researchers should be maintained for the duration of the project, from planning through data collection, data analysis, interpretation, and manuscript writing and toward peer-review publication.

Seeking help from a statistician about analysis after the data have been collected can sometimes fall under the umbrella of collaboration in its least-effective form. However, this type of *post-hoc* collaboration can often be the beginning point of a long-term collaborative relationship. In this sense, even helping a researcher properly implement a routine analysis (an activity that is much more involved than most researchers realize) can be viewed as a stepping-stone component of the interdisciplinary culture of statistics, and thus, as a legitimate scholarly activity.

Overall Perspective

Working collaboratively with a subject-matter scientist throughout a research project, implementing and interpreting an analysis that requires PhD-level expertise in statistics, or adapting methodology to a novel context (which often requires a great deal of creativity and ingenuity) should all be regarded as legitimate scholarly activities. These activities are central to

the interdisciplinary collaborative nature of statistics. In fact, a research-active department of statistics (or department with statistics faculty) at a university should be especially strong and reinforcing of its collaborative interdisciplinary research activity. It is also important to note that, if collaborative statistical research is not encouraged, it can be detrimental to study design and analysis in the subject-matter science departments throughout the university. Therefore, it is imperative that statistics faculty working collaboratively with scientific partners be encouraged and rewarded for such endeavors.

Practical Guidelines for Evaluation of Interdisciplinary Statistics Faculty

These guidelines are recommended to be explicitly outlined in the position description and letter of offer upon hiring of a statistics faculty member expected to engage in interdisciplinary collaborative research. These terms may be discussed during yearly evaluations, as involvement in collaboration can change over time. This is particularly relevant for faculty members who transition into increasing involvement in collaborative activities. Such upfront and continuous outlining of expectations can and should allow interdisciplinary collaborative research activities to be important evaluation criteria for promotion and tenure.

Teaching Duties

Teaching duties can be a mix of classroom teaching, advising of graduate students, and statistical consulting as determined by the department chair and departmental needs. Specifics of these duties are discussed below.

1. **Classroom Teaching:** Teaching may involve courses designed for statistics students and/or non-statistics students, based on departmental needs. These courses could involve teaching statistics graduate students theory and methodology relevant to the practice of statistics and how to be contributing members of multidisciplinary teams. They could also involve teaching non-statistics graduate students how to be intelligent users, and critical evaluators, of statistical methods. Specifics will obviously vary substantially.
2. **Advising of Students**: Specifics will vary, but the important premise is that faculty members with an emphasis in statistics should actively work with graduate students in their own department, graduate students in other departments and disciplines, or both. Working with graduate students outside a statistics department will typically take the form of being a member of the student's supervisory committee in conjunction with a collaborative research colleague. Note that assisting with, and supervising, undergraduate student research can be important components of teaching duties.
3. **Statistical Consulting**: As defined earlier, consulting is an isolated activity geared toward solving a technical statistical issue, and it should be regarded as teaching by other means (i.e., non-classroom teaching) with an arguable service component. This type of teaching must also be regarded as a legitimate means to an end. First, consulting is an essential part of the development of professional skills for statisticians in training, as they develop communication and relationship-building skills. Ultimately, consulting serves as a means by which statisticians in training can gain confidence and a sense of self-worth and standing as a research partner. Consulting is also an essential step for the development of collaborative

scientists, as a venue to recognize the importance of collaborative relationships for adding value to their research projects.

The latter two types of teaching can sometimes be hard to quantify (i.e., no associated teaching evaluations), yet they are among the most critical teaching functions of an interdisciplinary statistics faculty member. These activities are critical prerequisites to productive collaborative research that is meaningfully engaged with the subject-matter sciences.

Research Duties

Research duties can be a mix of collaborative and methodological research. Broadly defined, collaborative research adapts statistical methodology to novel applications, with the primary focus of the research being a problem in a subject-matter discipline. By contrast, methodological research typically addresses statistical topics as ends in themselves. If a clear distinction between these two general classifications is important for any promotion decision, it should be made obvious in the letter of offer/position description.

Some General Principles on Research Expectations

1. Collaborative statistical research is expected to have a positive impact on the quality and quantity of a collaborator's research. This can be assessed in many ways, but two examples are 1) repeated collaborative publications and grant proposals with the same research team and 2) a broad array of research collaborations across many disciplines. In either case, the statistics faculty member will often not be first author, senior author, or principal investigator, but some type of co-authorship or co-investigator role is usually the acknowledgement that the collaborating statistician has played a crucial role in the publication going forward or the grant being funded.
2. Differences with expectations from traditional faculty positions: Traditional faculty's research is typically focused on 1) first-author publications and 2) external funding as principal investigator. These two criteria emphatically should NOT be the focus of evaluation for statistics faculty with collaborative research appointments. As mentioned previously, statistics is an inherently collaborative discipline. Put another way, statistics is an enabling discipline for research in any area of science that depends on data and is a consumer of statistical methods. Statistics faculty with substantial collaborative research appointments, therefore, need to be encouraged, rewarded, and judged for merit, promotion, and tenure based on their positive impact on the quality and quantity of research of those with whom they collaborate. It must be understood that statistics faculty with substantial collaborative research appointments should NOT be subject to the same expectations of external funding as are researchers in most other disciplines. Seeking grant funding as PI and administering a grant necessarily comes at the expense of a faculty member's availability for interdisciplinary collaboration. Hence, an overbearing expectation of external funding is self-defeating and in direct conflict with the primary reason for having collaborative statistical sciences at research-active universities.

On behalf of the NCCC 170 and SCC 13 (USSES) Multistate Research Coordinating Committees and Statistical Information Exchange Groups,

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Additional resources addressing the subject of this document

1) Report from Mathematical Association of America (endorsed by the ASA) on supporting statisticians in Math Departments.

Link
http://digital.ipcprintservices.com/display_article.php?id=2022647

2) Manuscript from the journal *Academic Medicine* on a proposed framework for evaluation of collaborative academic scientists.

Link
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4653084/pdf/nihms702575.pdf

3) Section C:29 from the Council on Academic Personnel from the University of California-Irvine on evaluating collaborative research.

Link
http://sites.uci.edu/academicsenate/files/2014/02/FAQ-updated-September-2017.pdf