

FIVE-YEAR PLAN FOR GRADUATE PROGRAMS PROGRESS REPORT

I. SUMMARY OF PROGRESS

Implementation of Five-Year Plan

The five-year strategic plan for graduate programs in the Department of Mathematics and Statistics was submitted in June 2012, following a comprehensive self-study during the previous spring. One of the most compelling conclusions of this evaluation process was that few of the Department's graduate students completed their individual programs within the prescribed time, due largely to onerous, broad, and unfocused course and comprehensive exam requirements. In addition, the Department provided inadequate opportunities for students to become expeditiously acquainted with potential advisors and research collaborations. The resulting five-year plan thus focused on five areas of emphasis: **(1)** a radical restructuring of coursework for all programs, including reductions in credit requirements for Ph.D. candidates, and the elimination of universally compulsory course sequences and associated exams; **(2)** faster engagement with potential advisors and more active mentoring with department-sponsored student research presentations; **(3)** active recruiting of promising undergraduates from within our own department, and the recruitment of well-qualified B.S. students from other institutions directly into our doctoral programs; **(4)** statewide delivery of our M.Math. program to mathematics teachers and other professionals using broadcast delivery and intensive summer short courses during the summer session; and **(5)** comprehensive tracking of graduate student productivity, including conference presentations, authored or co-authored publications, funding sources, and post-graduate employment. Significant progress has been made thus far across these objectives:

- (1) Radical restructuring of coursework for all graduate programs**, including **(a)** elimination of compulsory course sequences and their associated comprehensive exams for Ph.D. candidates; **(b)** more directed courses designed to prepare students to engage in research; **(c)** smaller coursework chunks, such as 1- or 2-credit courses, to provide greater breadth and flexibility for programs of study; **(d)** credit reduction for Ph.D. programs, from 60 to 45 for students with a prior M.S. degree, and from 90 to 72 for students with a prior B.S., only.

Progress: **(a)** and **(b)** were completed in 2013, following faculty discussion and consent, and an approved Program Change application for the credit reduction. Items **(b)** and **(c)** are in progress. For example, graduate courses in Statistics have been radically restructured, with outdated courses eliminated; existing courses nearly all deconstructed and modularized (particularly to eliminate overlap) and reduced to one or two credits; and new courses created to encourage research engagement and modernize our offerings (e.g., a one-credit *Introduction to R*, with a follow-up two-credit *Advanced Programming in R*, are now taught back-to-back in the fall, in order to support a range of courses requiring some knowledge of R computing). The same kind of restructuring is being applied now to our graduate offerings in Mathematics: modularized courses have been created for our Mathematical Biology program, and for our developing joint program in Mathematics and Physics.

- (2) *Faster engagement of graduate students with potential advisors, and active mentoring to shorten the time until students begin research***, including **(a)** compulsory research survey seminar in fall for all incoming graduate students; **(b)** spring seminar focused on writing research proposals, culminating in a two-day symposium for student presentations; **(c)** change in coursework requirements; **(d)** smaller coursework chunks to provide greater breadth and flexibility for programs of study.

Progress: The research survey seminar proposed in **(a)** was initiated in fall 2014 as a one-credit course. All first-year M.S. and Ph.D. students were required to enroll, but the new course proved popular and additionally attracted more experienced students. Faculty with active research programs were invited weekly to lead accessible discussions about their ongoing projects and interests, and to share personal insights from their own prior graduate study and career development. This seminar proved highly successful: among other benefits, all first-year students were able to identify advisors by semester's end. We are in the process now of formally adding this course to the USU catalog. As described above, the reduced coursework requirement suggested in **(c)** has been completed, and the restructuring proposed in **(d)** is underway. The remaining task for this objective is to formally organize the spring seminar indicated in **(b)** – the only somewhat minor obstacles involve identifying qualified faculty who can supervise such a seminar as a part of their regular teaching loads, and in determining how to mandate participation (e.g., should all second-year students be required to enroll?). We plan to resolve these issues and initiate the seminar in spring 2016. We note, however, that faculty in our Mathematical Biology, Discrete Mathematics, and Biostatistics and Epidemiology research groups have in the meantime organized seminar series that encourage students in practical aspects of engaging in their research and preparing proposals.

- (3) *More effective recruiting***, by **(a)** attracting promising undergraduate students at USU into our M.S. and M.Math. programs, particularly by encouraging split-form enrollments to reduce the time required to earn an M.S. degree following graduation; **(b)** organizing an annual social and symposium for juniors to discuss pathways to graduate degree programs and research opportunities; **(c)** focusing on the M.S. in Industrial Mathematics, to leverage the ability of many undergraduate majors to finish this program efficiently after earning a B.S.; and **(d)** recruiting promising M.S. students within our own program to continue on to a Ph.D., and encouraging well-qualified outside applicants with a B.S. directly into the Ph.D. program.

Progress: We will be hosting the event suggested in **(b)** during spring 2015, but through less formal channels there has already been growing encouragement of the split-form approach indicated in **(a)**. Anecdotal evidence suggests that more students are opting for this approach, but we are exploring how to more formally monitor split-form credit, in order to measure our success. More broadly, to boost their own research programs, faculty members have become increasingly active in identifying and recruiting talented undergraduates into our graduate programs. Beginning in 2012, we admitted four USU students into our graduate program, followed by six during 2013-14, and seven for fall of 2014. These students are among our best, and have positively impacted both our research and teaching efforts. With regard to **(d)**, we have increasingly considered highly qualified applicants with a B.S. to join our Ph.D. program directly. While these efforts have already borne some fruit, such students are relatively rare, and we are still examining recruiting strategies and channels that might yield greater success. We are optimistic – based on the B.S. students whom we have recruited directly as doctoral candidates thus far – that even moderate improvements in this effort will significantly and beneficially impact our Ph.D. program.

- (4) Delivery of the professional M.Math. in Mathematics Education via IVC broadcast of courses to regional campuses and distance education centers**, including **(a)** two advanced courses offered each fall and spring, broadcast during late afternoon time slots; **(b)** two additional 5000-level courses taught in Logan during summer sessions, and broadcast to distance education sites; **(c)** offering of both Plan B and C options; and **(d)** funding opportunities to support student tuition.

Progress: Implementing **(a)** has proved problematic. Changing the schedule of 5000 level courses to late in the afternoon resulted in a very substantial loss of enrollment on the Logan campus, and so the Department had to stop this implementation after just one year. Item **(b)** has also proved problematic. For three years the Department offered at least two 4000- and 5000-level courses over summer, courses that both M.Math. students and undergraduate majors had indicated were important for their programs of study. Unfortunately, the enrollments were consistently low: typically 4-6 students. This is not sustainable for the Department, and so for Summer 2015 we are planning to offer only one 5000-level course which has consistently attracted enrollments of 15-20. The change in the summer schedule is a further impediment to offering 5000-level classes. Students attending the Logan campus overwhelmingly prefer the first seven-week session for classes, whereas many of the M.Math. students are in-service teachers and are not able to take classes until early June.

Notwithstanding these issues with course offerings, during our additional study and deliberation over the past 2-3 years we have determined that this degree option – coupled with distance delivery – serves a moderately large market, particularly of teachers in secondary education for whom such a degree provides a meaningful career boost. However, while the number of students in this program has been growing (to the goal of approximately 10-15 ongoing enrollees), this number unfortunately cannot sustain the frequency of broadcast courses proposed in our original plan. We have accordingly modified our approach to allow students to successfully complete the program through distance education, by providing coursework options that fit within our resource limitations. In Fall 2015 and Spring 2016 the Department will offer instructors of a small number (2-3) of the most popular 5000 level classes the opportunity to teach their class a second time, for additional compensation, in an evening broadcast for M.Math. students. It is anticipated that initial funding for this will come from proceeds for summer teaching by the Department, but continuation of the delivery of the courses depends on an ongoing revenue stream to pay for the instruction.

With respect to **(c)**, the M.Math. is a professional degree and does not have Plan A and Plan B options. Instead, students have an opportunity for a guided exercise in scholarship of mathematics and statistics education, similar to the Plan B option in M.S. degrees in the Department.

With regard to finding alternative sources of funding for students in the M.Math program (item **(d)**), the Department is an active participant with the University of Utah in the *Math for America* program, and this program is the source of funding for several students in the M.Math.

- (5) Improved program management**, by tracking and increasing **(a)** student presentations at professional conferences; **(b)** student co-authorship of publications, both during graduate and post-graduate; **(c)** funding sources for graduate study; and **(d)** tracking students after graduation.

Progress: This objective is dually critical and challenging – we have found as we have implemented the overall plan that the specified goals for better program management require the most additional consideration and development. As summarized further in **Section III** (below), accomplishing **(a)-(d)** will necessitate (i) use of an annually updated dashboard for tracking student research productivity; (ii) gathering data retroactively about student progress and outcomes, to provide comparative benchmarks; (iii) a massively improved website, especially for use in alumni networking and outreach; (iv) regular and formal department-level interviews with individual students, in order to

encourage progress and to better understand professional goals and aspirations. This will allow us to monitor their ultimate success, and to calibrate our programs accordingly.

Progress Versus Other Programs

The objectives of the five-year plan were significantly motivated by the Department's self-assessment from a comparison of our program requirements against other peer and aspirational departments. The credit reductions and course restructuring have been patterned against similar developments elsewhere. The two most pressing problems identified during the initial study – the tendency of students to lag in finishing their programs, and the obstacles they faced in engaging expeditiously with advisors and research projects – plague graduate programs across academic institutions and disciplines. We anticipate confidently that our engagement in this effort will improve student progress and outcomes, and hence make our department comparatively more attractive for graduate study.

As further described in **Section II** (below), our department has a variety of comparative strengths and uniquely compelling research interests that we can leverage for graduate recruitment and training. Specific to our regional reputation, we have advantages upon which we should continue to build. For example, we have the only Statistics Ph.D. program in the state of Utah. The Department of Mathematics and Statistics at the University of Utah does not have as large a research group in Statistics, and does not produce as many graduate degrees in Statistics as does USU, while the Department of Statistics at BYU currently does not offer a doctoral degree. In addition, our regional campuses give us much more potential for statewide and regional outreach.

II. ONGOING CHALLENGES AND OPPORTUNITIES

The elements of the five-year plan address some significant problems with our graduate programs, but the process of self-examination and improvement has also helped us identify and better understand some of our significant strengths.

- We have dynamic junior faculty who are rapidly gaining national and even international recognition for their high-quality research. For example, Drs. Nathan Geer and Guifang Fu, both Assistant Professors, have recently received significant NSF grants, with Dr. Geer additionally receiving a CAREER Award.
- We have built some remarkable and unique research emphases. Among other examples, the Differential Geometry, Computational Algebra, and Mathematical Physics (DG-CAMP) group is comprised of colleagues from our own department and Physics, with a common research focus on computational tools that yield unprecedented insights into previously almost intractable problems in algebra and geometry. We moreover have a computational emphasis among our Statistics faculty that positions us to train students in the rapidly growing areas of analytics and Big Data.
- We have faculty that have been consistently recognized at both the college and university levels for outstanding teaching and research, and who provide outstanding mentoring for many of our students with aspirations to become college instructors.

What the Department has *not* been particularly effective at doing is carving out a regional and national identity, and to successfully use that identity for recruitment of quality graduate students. The building of research groups, such as the DG-CAMP and Biomathematics groups as described above. Another initiative in that direction is a massive overhaul of the Department's website, to more effectively showcase the programs, research emphases, and faculty participating in these emphases.

The three main challenges to growth of the graduate programs in the Department of Mathematics and Statistics are (i) the number of faculty available as graduate student advisors and mentors, (ii) the teaching loads of the faculty (which is related to (i)), and (iii) funding for graduate students. In this last category, the Department has made progress with obtaining external funding through grants. The new NSF grants of Fu and Geer contain graduate student support and tuition and, in recent years, half a dozen additional faculty have supported graduate students through external research grants. Internally, the Department has benefitted from the awarding of three PDRFs from the Office of Research and Graduate Studies, which have greatly enhanced the Department's ability to compete for top quality Ph.D. students.

As is true in most mathematics and statistics departments at research institutions nationwide, the majority of mathematics and statistics graduate student support at USU is from Teaching Assistantships. Although the number of students taking classes in the Department of Mathematics and Statistics has increased substantially in recent years, the TA budget has not kept pace. Further growth in the Department's graduate programs will require addressing faculty issues and increasing the numbers of research and teaching assistantships.

III. MILESTONES

We have addressed and implemented a majority of the objectives in our plan, and are confident that we can complete this process within the prescribed five years. Even with this progress, however, long-term follow-up (especially with respect to the fifth and last objective, focused on program management) presents both significant challenges and opportunities. We have accordingly identified additional important initiatives (e.g., revamping the department website) that we can undertake to complement and improve our course of action:

- **First, the original proposal specified metrics and goals to measure the plan's success**, including a 90% on-time completion rate (two years for M.S., four years for Ph.D. with prior M.S., and five years for Ph.D. with prior B.S.), at least one conference presentation and one refereed publication for each graduating Ph.D. candidate, and an average enrollment of 10-15 distance M.Math. students. Assessment of these benchmarks requires a more consistent structure for ongoing data collection. We are addressing this by (i) developing an annual report that will provide a dashboard of these and other metrics on an annual basis, and (ii) gathering data on prior years to provide a baseline of comparison.
- **Second, objective (5) in our plan requires better communication with our graduating students and alumni.** While not included in our five-year plan, we have recognized some critical needs for accomplishing this, most significantly a massive overhaul of our website. We will use the website to better showcase the accomplishments of faculty, students, and alumni, helping us to build a sense of community with students during their programs of study, and giving us an important and more polished tool for outreach to our alumni network through email and social media.
- **Third, while modernizing our coursework as a part of objective (1) of the five-year plan, and considering our need for alumni outreach, we have also recognized the need to better understand our students' professional goals, and how they align with their employment outcomes.** To this end, we have initiated annual interviews with our current students. This not only will encourage progress and better advising, but will also help us to gather data regarding job goals. As we better monitor postgraduate, we will be able to calibrate our course offerings and research opportunities to prepare our students more effectively and realistically.