External Review of Mathematics & Statistics Department CSU Long Beach

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This memo is our report as the external reviewers for the Mathematics Department at CSU Long Beach. This report is based on our visit to CSU Long Beach on 23–24 March 2017 and our reading of the Mathematics Department self-study and related documents. During our visit, we met with the following people and groups of people at CSU Long Beach (in the order listed, removing repetitions):

- Chair of Mathematics Department
- Provost & Senior Vice President, Academic Affairs
- Vice Provost for Academic Affairs & Dean of Graduate Studies
- Dean of the College of Natural Sciences and Mathematics
- Director, Program Review & Assessment
- Tenured and tenure-track faculty in Mathematics
- Mathematics tutoring centers supervisors
- Students in Math 361A (entire class, with instructor not in room)
- Lecturers in Mathematics
- Mathematics credential advisors
- Mathematics undergraduate associate chair and advisors
- Two Engineering students taking Math 364A (instructor not in room)
- Students in Stat 410/510 (entire class, with instructor not in room)
- Mathematics graduate advisors
- Mathematics education faculty
- Pure mathematics faculty
- Chairs of five CSULB departments that make heavy use of mathematics
- Statistics faculty
- Applied math faculty
- Mathematics staff and lecturers
- Mathematics TAs and GTAs
- Mathematics junior faculty

Before getting to the formal part of the review, we want to express our thanks to everyone involved in our visit to Long Beach. We are grateful to all the people who helped arrange our visit and all the people who took time to talk with us, with special thanks to Tangan Gao for organizing our visit and providing superb logistical support.

Student Success and Student Learning

Developmental (Pre-baccalaureate) and General Education Instruction

General Education courses are central to the department's undergraduate teaching mission. About 60-70% of the undergraduate FTES comes from GE courses. The department is striving to provide students in lower level courses with consistent learning experiences and assessments. Most of the department's service courses have a course coordinator. Instructors are encouraged to make use of the provided homework, quizzes, exams, and syllabi. Given the common practice in math departments of assigning new Lecturers and Graduate Teaching Assistants to developmental courses, this coordinated instruction provides important assistance to new instructors, helping them to better serve at-risk students.

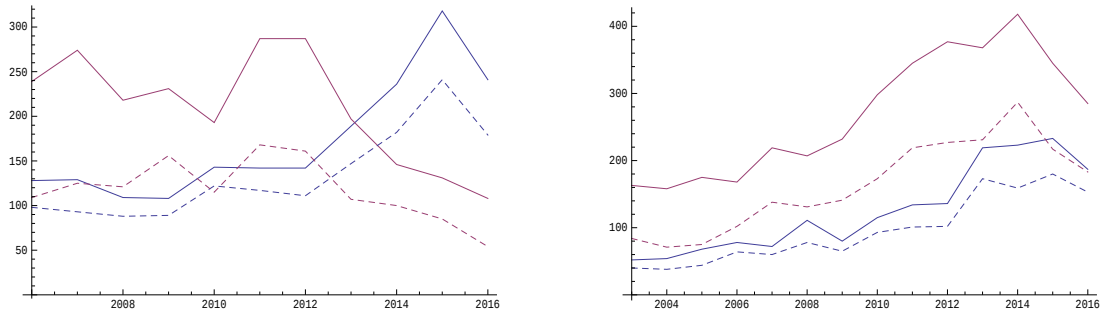
In recent years, the department has taken several important steps in improving the support of students who need to complete pre-baccalaureate coursework in math before advancing to college-level courses. While the long-term academic success, particularly in STEM courses and majors, of students requiring substantial developmental coursework is still limited, the department's outcomes are improving.

The expansion of the TA training program is an excellent investment. Some graduate students with whom we spoke had prior instructional experience. They seemed consistently pleased with their experiences teaching general education and pre-baccalaureate classes—their TA training seemed sufficient to support a smooth transition from K–12 teaching or tutoring at CSULB to being the instructor of a CSULB course. New TAs take MTED 590, *Introduction to College Mathematics Teaching*, in the fall. Graduate students with little or no hands on teaching experience reported feeling stressed during their first term as a TA; some noted that students in developmental courses can be unforgiving of fumbles by novice instructors. Graduate students with limited teaching experience might benefit from a term of less demanding instructional experience, in addition to the TA training, before being put in charge of a developmental course.

There appears to be some tension between a few senior faculty in Mathematics & Statistics and some faculty of departments requiring substantial mathematical training for their majors. Inclusion of modern applications, e.g., data science and graphics, could update key courses and increase their relevance to STEM programs. Increased active learning in service courses could improve the learning experience for all students; in-class experiments and explorations provide excellent opportunities for students to develop intuitive understanding of abstract concepts and learn to recognize mathematics in situ. This could better align some courses with the needs of outside programs while allowing retention of texts and syllabi well-suited for math majors.

Calculus Preparation and Instruction

In the past two years, the primary STEM calculus sequence MATH 122 and 123,



(a) MATH 122 (b) MATH 123

Figure 1: Enrollment and pass rates in MATH 122 and 123, *Calculus I* and *II*. Blue: first time frosh, red: other students; solid: enrolled, dashed: passed.

Calculus I and *II*, has been redesigned. These courses are required for math majors and for several other STEM majors.

The department has implemented an aggressive pre-instruction remediation program for calculus-bound students, using the online placement and preparation system ALEKS PPL. Students intending to enroll in MATH 119A, *Calculus for Biology*, or 122, *Calculus I*, are required to complete several cycles of assessment and guided study in ALEKS PPL: they must assess four times, with at least five hours of work in their ALEKS Learning Module between assessments. Students achieving a score of 80 or better in their fourth ALEKS assessment are eligible to enroll in MATH 122.

In Fall 2015, 83% of the incoming freshmen taking MATH 122 qualified via ALEKS PPL; the remaining 17% qualified based on SAT, ACT, or AP scores. The ALEKS-qualified students have a pass rate of 77%, with 28% of the students earning A's, compared to a pass rate of 71% and 16% earning A's for the remaining incoming frosh. This is particularly impressive given that the students who used ALEKS PPL presumably had lower SAT, ACT, and/or AP scores than students in the other group, and strongly suggests that ALEKS PPL provides valuable in-the-nick-of-time review and remediation.

While we approve of the department's efforts to improve both pre-course preparation and in-course instruction, we are concerned about the drop in enrollments in the last two years (see Figure 1). These decreases are not a priori indicative of difficulties—there may be external factors driving these changes. However, we recommend that the department monitor enrollment patterns and consider adjustments in instruction or placement if enrollment continues to decline.

Instructional Modalities

The self-study observes that

> Most of our service courses were created a long time ago (e.g., MATH

247 Linear Algebra and MATH 370A Applied Mathematics). It is time to rethink their contents and redesign the courses to better serve our students.

We strongly support this plan.

Some faculty, particularly the junior faculty, are implementing active learning in their courses. We applaud this practice and encourage the department to support the development of new instructional materials and strategies in all courses, not just the lower division courses. Traditional lecturing for 75 minutes of can tax the stamina of both the students and the instructor past the point of diminishing returns. In the two classes we visited, lecturing seemed to be the standard instructional protocol; in fact, some of the students seemed unaware that other approaches to math instruction exist.

Professor Chang's flipped version of Math 247, *Linear Algebra*, is an excellent example of an active-learning course. This course uses a mix of instructional videos—many have been created by Professor Chang, but some are from Kahn Academy or other sources—in place of conventional lectures, freeing up class time for interactive work. Making use of existing video content that fits the bill allows instructors to invest their time and energy where it is crucially needed and familiarizes students with valuable online resources; instructors who are interested in flipped instruction but hesitant to commit to creating the required materials should be encouraged to adopt this practice, starting with existing supporting materials and introducing their own videos and other materials over time.

Incorporation of team projects into courses offers a convenient, easily implementable approach to linking course content to applications of current interest. Some of the posters created by Professor Chang's students, e.g., *Predicting CSU Tuition Using Linear Least Squares Regression*, explore topics of immediate practical concern to many students. Such projects might address criticism expressed by the chairs of other STEM programs that some math service courses seem outdated, and help close gaps between conceptual understanding and practical utilization of new skills and knowledge.

Active learning in the classroom could be particularly beneficial for CSULB's largely working commuter student body. We were favorably impressed by the level of activity in the general and Math Education tutoring centers—both were busy when we visited them, in spite of the approaching long weekend—but it is a nearly universal problem that few of the students in most urgent need of additional instructional support make use of the opportunities offered by office hours, campus tutoring services, and peer study sessions. Working students could benefit tremendously from in-class participation in projects and group discussions, and might come away from productive in-class experiences better motivated to make the extra effort to attend office hours, etc.

The common assessment materials used in most of the service courses support learning analytics that could guide further improvements in pedagogy. We encourage the department to pursue data-based comparisons of outcomes and share this data with

faculty, rewarding successful innovations, recognizing the value of pedagogic experiments (even if they are not fully successful), and gently coaxing experienced faculty to try a few new tricks. We hope that over time more faculty will adopt materials and instructional strategies that have been shown to be effective in CSULB courses and elsewhere.

Undergraduate Major Programs

The department currently offers four options for its robust BS in Mathematics:

- The General option is a traditional pure mathematics program, with an emphasis on analysis.
- The Applied option has two suboptions:
  - Suboption I, *Application in Science and Engineering*, is a traditional applied math program, emphasizing differential equations and physics, with optional coursework from EE, CE, or MAE.
  - Suboption II, *Application in Economics and Management*, combines coursework in analysis and economics, adding some statistics and probability.

  Both suboptions include an introductory programming course.
- The Math Education option is designed to prepare students to enter a single subject credential program. The department has recently modified some course content so as to better prepare students teach to Common Core standards.
- The Statistics option includes coursework in analysis and probability in addition to a solid foundation in statistics.

Four-year Graduation Targets

The goal of graduation in four years is not aligned with the academic priorities and non-academic constraints of most CSULB math students. While we are well aware of the present emphasis on four year graduation rates, we are concerned that increased pressure to complete the undergraduate program in four years could deter many students from entering or completing the program.

Only a handful of the students we spoke with were enrolled for the fifteen units that would be needed in an average term to meet the four year completion target. Most students who are working halftime or more cannot maintain the academic workload required to complete the degree program in four years (or two years for junior transfer students); these students are a vital part of the CSU community and should not be made to feel that their progress is substandard.

As described above, in recent years the department has implemented many changes designed to increase student success and reduce time to graduation. We believe that this targeted approach is more effective and better serves the students than a one-size-fits-all push to complete of the program within four years.

Preparation for Proof-Intensive Courses

The transition from service courses, which typically emphasize efficient computation, to courses specifically intended for math majors, which often focus on understanding and crafting rigorous proofs, is both exciting and intimidating for many students. Students who have "always been good at math" often struggle with the novel challenges posed by upper division coursework. Adequate preparation for proof-intensive coursework is crucial for steady progress to degree.

The department requires that students pursuing the General (pure) and Mathematics Education options take MATH 233, *Fundamental Concepts for Advanced Mathematics*, but does not require students pursuing the Applied or Statistics options to take this transitional course. Students in the Applied or Statistics options must take MATH 323, *Introduction to Numerical Analysis*, which is not required for the other two options. It is unclear to us whether MATH 323 is intended in part to replace MATH 233 in the more applied options; if it is, we are concerned that there may not be sufficient time during the term to cover most of the fundamentals covered in MATH 233 as well as the content specific to numerical analysis.

MATH 361A, *Introduction to Mathematical Analysis I*, is perceived by many faculty members of the department to to be the most challenging course in the General option sequence—possibly among all of the undergraduate courses offered by the department. All but the Mathematics Education option require MATH 361A; Math Education students must take MATH 361A or 364A.

Successful completion of their first proof-intensive analysis course is challenging for many students—this problem is by no means specific to CSULB—but relatively low success rates in such courses should not be regarded as an inevitable fact of academic life. Strengthening the preparation for MATH 361A could shrink the leap in mathematical sophistication required in moving from lower- to upper-division coursework, and introducing active learning into the course could use the diversity in backgrounds and interests of the students from the different major pathways to all students' advantage.

Students must successfully complete either MATH 233 or MATH 247, *Introduction to Linear Algebra*, before taking MATH 361A. Some faculty expressed the opinion that the techniques and material covered in MATH 233 are not central to MATH 361A, and that several key elements of proof (e.g., quantifiers) must be taught in MATH 361A. However, we are concerned that students who have taken MATH 233 might have a significant advantage in MATH 361A over those who have taken MATH 247, but not MATH 233.

A few suggestions:

- Familiarize students with some key terminology and proof-relevant constructs in MATH 247, *Introduction to Linear Algebra*. (The course description states "Emphasis on computational methods.") If adequately motivated, this need not alienate students from other disciplines; elementary linear algebra possesses a wealth of simple examples that convincingly illustrate the importance of hypotheses.

- Increase the instruction in formal proof given in MATH 323, and strongly encourage students pursuing the Applied and Statistics options to take MATH 323 before MATH 361A, scheduling both courses so as to facilitate that enrollment pattern. An introductory numerical analysis course, even one that does not emphasize rigorous proof, easily supports discussion of the analysis constructs (e.g., quantifiers). Error analysis is a crucial application of 'epsilon–delta' estimates; numerical differentiation and integration are excellent introductions to rigorous treatments of limits as applied in calculus.

- Dedicate substantial in-class time to group work, including collaborative theorem and proof construction, and critiquing of other groups' constructs. Almost-immediate feedback can help students to improve their understanding of challenging concepts by means of low stakes experimentation. For example, if students are known to have difficulty with quantifiers, develop short in-class exercises involving correct interpretation and use of quantifiers.

Programming Courses

All four options for the Mathematics BS provide students with at least one course focused on effective use of computers in mathematics, statistics, or education. The General, Applied, and Statistics options require CECS 174, *Introduction to Programming and Problem Solving*; the course currently teaches coding in Python. CECS 174 has the prerequisite CECS 100, *Critical Thinking in the Digital Information Age*; thus students have a solid foundation in designing and implementing robust code. The option in Mathematics Education replaces this requirement with MTED 301, *Computer Applications in Mathematics for Teachers*; this course satisfies the California Level I teaching credential computer technology standard.

We are glad to see a programming requirement in all options, given the increase in marketability even elementary programming skills can bring to job-seeking math majors. We encourage instructors to utilize students' programming experience in their upper-division courses. Such use should not be restricted to numerical calculations. Some general debugging strategies, such as are covered in CECS 100, can be profitably applied to mathematical proofs. Many students find it easier to master conditionals when coding than when formulating proofs, and mastery of the construction of nested loops can help students learn to parse quantifier combinations (e.g., for every *such-and-such* there exists a *whatever*).

Proposed Computational Mathematics BS

The department is currently considering adding a new degree program, a BS in Computational Mathematics. We fully support the department's plans to offer computation-focused courses that will provide students with highly marketable skills in data analytics and related fields, but recognize the risk that introduction of a new BS degree program could cannibalize the existing Applied Mathematics suboptions of the Mathematics BS program, potentially redirecting students who would otherwise choose the Applied option, rather than attracting additional students and resources. At present, there does not appear to be consensus among departmental faculty and administrators regarding the best approach to providing thorough training in computational science at the undergraduate level.

The current courses MATH 323, *Introduction to Numerical Analysis*; 472, *Fourier Analysis*; 473, *Scientific Computing*; and 479, *Mathematical Modeling* appear to emphasize traditional ODE and PDE modeling of systems arising in the natural sciences, but much of the content of these courses is also central to graphics and data analysis, which do not rely on traditional ODE/PDE modeling. MATH 485, *Mathematical Optimization*, doesn't have an upper division ODE prerequisite, but does require MATH 233, *Fundamental Concepts for Advanced Mathematics*, for students in the Math major, while Math 233 is not required for the Applied and Statistics options in the Math BS. We encourage the department to carefully consider which courses and prerequisite requirements could be adjusted to optimize use of courses in multiple degree programs and options.

If there are insufficient resources to support and enrollments to justify both these courses and analogous courses with a more 'modern' emphasis, the department might want to consider introducing a Computational Mathematics option in the Mathematics BS and revising some of the existing courses—including the prerequisites—so that most of the courses could do double duty for both the Applied and Computational options. We encourage the department to consult with outside departments, particularly engineering programs, to identify common course needs.

Graduate Program

Graduate Students

The most recent data shows that the Department of Mathematics & Statistics has 182 graduate students enrolled in its masters programs. This makes the department's graduate program one of the largest masters degree programs in mathematics/statistics in the country (and only a few American universities with doctoral programs have more graduate students in mathematics/statistics).

We had two opportunities for good discussions with large groups of graduate students. One of these opportunities was with the approximately 45 students we met who are

enrolled in STAT 410/510; a big majority of these students are graduate students. We met them at their usual class time in the usual classroom, but with the instructor absent. Our second opportunity to meet with graduate students was a discussion with about a dozen graduate teaching assistants and graduate assistants, again with no faculty present.

Overall, we found the graduate students to be very satisfied with their experience at CSU Long Beach. The graduate students consider the departmental faculty, in general, to be fine teachers who care deeply about helping their students to learn. The graduate students reported that faculty, in general, welcomed students to their office hours and provided appropriate assistance to help students succeed. Several graduate students contrasted this welcoming attitude with their undergraduate experiences at southern California campuses of the University of California, where some CSU Long Beach students reported that it had been difficult to have a conversation with a faculty member outside of class time. A nontrivial percentage of the graduate students with whom we talked had also been undergraduates at CSU Long Beach. That these students decided to stay at CSU Long Beach for their graduate education rather than go elsewhere is good evidence that they had an excellent experience as undergraduates at CSU Long Beach.

About 76% (three year average) of students admitted to a graduate program in the Department of Mathematics & Statistics at CSU Long Beach actually enroll in the program. This high success rate in attracting graduate students is a strong indication of the good reputation of the program.

The data in the self-study about years-to-graduation with the masters degree shows a healthy program. Specifically, the average time to degree in the masters program in the Department of Mathematics & Statistics in under three years, in contrast to the other departments in the College of Natural Sciences and Mathematics (all with averages over three years).

Course Times

The only serious complaint that we heard from the graduate students involves class times. Only a small percentage of the graduate students are supported by teaching assistant or graduate assistant positions in the department. Thus most of the graduate students work, many of them with full-time jobs. These students very strongly requested a larger selection of classes that meet in the late afternoon (many students can arrange to get off work a bit early to attend class) or the evening. Similarly, faculty office hours in the morning or early afternoon do not help these students.

We note that in the current semester, no MATH/MTED/STAT courses start after 5:30 pm. As a sample contrast, we note that the Electrical Engineering Department at CSU Long Beach offers five graduate classes this semester that start at 7 pm (our guess is that many of the Electrical Engineering graduate students also have full-time jobs).

The Mathematics & Statistics Department is aware of this problem, as the self-study states:

> many of our senior faculty are less willing to teach evening courses, and thus staffing our graduate courses has become more difficult.

We recommend that the department make a renewed effort to offer more evening graduate classes to accommodate the work schedules of many graduate students. For some faculty, teaching in the evening may have advantages in terms providing additional flexibility during the day. Teaching in the evening could be an inconvenience for other faculty, but if the evening teaching times are rotated among appropriate faculty, then the burden might not be too large on any individual faculty member. Offering more evening graduate courses may be one of the obligations that goes along with maintaining a thriving graduate program.

By the way, offering evening classes that meet only once per week for almost three hours (as is done by the Electrical Engineering Department) may not work well in mathematics/statistics. The content of a graduate course in mathematics/statistics generally requires time to sink in, which is not provided by class meetings of almost three hours.

Class Size

On the issue of class size of graduate courses, the self-study states:

> Graduate courses (500/600 level) are usually capped at 20 students.

We do not know whether this was an anomaly, but the STAT 410/510 class that we visited had over 40 students, a majority of whom were graduate students. Having such a large class, including a mixture of undergraduate students who might tend to lower the level of the course, is not an optimal experience for graduate students (although the students in this particular class loved the course due to the excellence of the instructor).

If the class size we saw for STAT 410/510 is typical for that class, then we recommend that this course be offered separately as STAT 410 and STAT 510 rather than as a combined class. Separating this course into an undergraduate course and a graduate course could lead to better experiences for both groups of students.

Comprehensive Exams

To receive a masters degree at CSU Long Beach, a student must either pass the department's comprehensive exam or write an approved masters thesis or complete an approved project. A large majority of students in the Department of Mathematics & Statistics choose the comprehensive exam option. Comprehensive exams are offered in each of the four areas in which a student could choose to emphasize: applied

mathematics, applied statistics, mathematics education, pure mathematics. Students who choose the comprehensive exam option must pass two exams in one of these four areas.

We looked over the written comprehensive exams from recent years. These exams seem to be at the appropriate graduate level.

Students who choose the comprehensive exam option must take both their comprehensive exams during the same semester. We were told that the dates on which the two exams are given are often separated by only a week.

A few students mentioned to us that they would appreciate being able to take the two exams in different semesters. We do not have strong feelings about this issue, but it might be worth consideration by the department. The current policy of the department is that passing a comprehensive exam requires a grade of C or better. Perhaps the option of taking the comprehensive exams in different semesters could be coupled with a higher required passing grade (B-?).

Thesis/Project

The thesis/project option is used by only a small minority of graduate students in the Department of Mathematics & Statistics. Projects seem to be uncommon even compared with theses; we were told that this is due to the difficulty of getting employers to allow the use of actual data. Perhaps more emphasis on allowing some noise to be introduced into the data (thus protecting the employer's proprietary information) could lead to more projects. Because theses are more common than projects, our remarks in the rest of this section will focus on theses, but many of these remarks could also be applied to projects.

We counted the number of masters theses in the department by electronically searching the CSU Long Beach library. This search shows that the department produced an average of about six theses per year for the decade ending in 2014 (we stop at 2014 because the library lists no theses from the department for 2015 and 2016, which may be due to slowness in entering theses into the library's database rather than a lack of theses). This was an increase from the average of 2 theses per year in the decade ending in 2004. In recent semesters, the number of students enrolled in MATH/MTHED/STAT 698 (a required course for the thesis) averages about 7 per semester; thus an increase in theses may be in the pipeline.

Even with a projected increase in theses, the percentage of students writing theses is small (the department awarded an average of 58 masters degrees per year for the two most recent years reported in the self-study). A thesis is not the right choice for all students, but we believe that the educational advantages of writing a masters thesis are compelling enough to recommend that a higher percentage of the department's graduate students should write theses. Students have been taking exams for most of their lives. Even the comprehensive exams are not so different from the final exams in

the corresponding courses. In contrast, writing a masters thesis will be a new kind of experience for most graduate students. This new experience can be useful for students whether they are going on to a doctoral degree or whether they intend to work in industry (where soft skills, such as writing ability, often help determine career success).

The current culture in the department is that only the best students should write theses. We recommend that this culture be changed—graduate students at all levels of mathematical proficiency can benefit from writing a masters thesis. To encourage more students to write masters theses, it should be clear that expectations for a masters thesis differ drastically from expectations for a doctoral thesis. The results of a masters thesis need not be publishable original research. A masters thesis should include some work by the student that is more than a literature summary (for example, the student might work out a special case of a known theorem), but the discovery and proof of a new theorem should not be expected.

An increase in theses in the department will require a serious increase in the amount of faculty time spent supervising theses. Indeed, the requirement of faculty time to supervise theses may be one of the causes of the departmental culture that steers most students away from theses. To deal with this situation, we recommend that teaching credit, perhaps $\frac{1}{3}$ unit, be given for each completed thesis written under a faculty member's supervision; this would be in addition to the $\frac{2}{3}$ unit credit for each student enrolled in MATH/MTHED/STAT 698. With this accounting, a faculty member would receive teaching reduction of one 3-unit class after successfully supervising the thesis and 698 course for three graduate students, which seems reasonable. This may be enough to encourage more masters theses in the department.

Teaching by Graduate Students

The graduate students who are doing some teaching, either as teaching assistants or as graduate assistants or as tutors, told us that this is a wonderful experience. These graduate students are clearly dedicated to doing well for their students. Many of these graduate students want to become teachers themselves, at some level. Some of these students expressed anxiety about the first time they were put into a classroom. The new course for graduate teaching assistant training should help reduce this anxiety. We encourage the continued use, and possible expansion, of graduate students in the department's teaching mission.

Faculty Development

Faculty Research/Scholarship

Several faculty members in the Department of Mathematics & Statistics expressed to us frustration that they find it difficult to be productive in research/scholarship due to high teaching loads and limited support for research/scholarship. We believe that the department should and can raise its research profile.

The reason that the department should raise its research profile is partly for self-defense (other departments in the College of Natural Sciences and Mathematics are increasing their research emphasis) and partly to offer an even better experience to its students. Faculty who are research-active are more likely to get their students, both undergraduates and graduate students, involved in research. Student research is highly beneficial with respect to any reasonable metric. Undergraduates who get involved in research are more likely to graduate, they are more likely to go to graduate school, they are more likely to be successful in graduate school, etc. As discussed earlier in this report, we recommend that a higher percentage of the department's graduate students should write theses. All these projects require research-active faculty.

The reason that the department can raise its research profile is that it already has a good research base and it has been hiring research-active new faculty over the last decade and more. Furthermore, mathematics/statistics has an unusual advantage in the physical infrastructure needed to support high-quality research as compared to other departments in the College of Natural Sciences and Mathematics. Specifically, science departments often need expensive equipment and technicians to support high-quality research; CSU budgets are often not adequate to provide such equipment and staff support. In contrast, mathematicians/statisticians can usually do their work without expensive equipment. Thus outstanding mathematicians/statisticians who are considering coming to CSU Long Beach will not suffer a competitive equipment disadvantage as compared to their colleagues at well-funded research universities. These factors, combined with CSU Long Beach's highly desirable location in southern California, mean that the department has the potential to recruit faculty who will raise the research profile of the department and provide additional research opportunities for the department's students.

The biggest impediment to the research productivity of the faculty is the high teaching load. Teaching twelve units per semester is not compatible with having an active research/scholarship program. We recommend that the department move to a teaching expectation of nine units per semester for faculty who are active in research/scholarship (less for assistant professors). Ideally, this would be done in coordination with similar policies throughout the university (or at least throughout the college).

Future Faculty Hiring

We met separately with each of the four faculty groups within the Department of Mathematics & Statistics: applied mathematics, applied statistics, mathematics education, pure mathematics. Each of these four groups told us that they do not have enough tenured/tenure-track faculty in their area to carry out all their responsibilities as well as should be done. We agree with all four groups.

With the expected upcoming retirements in the department, there is even more pressing need to continue with a vigorous tenure-track hiring program. We strongly recommend that very high standards, for both research and teaching, be used is future tenure-track hiring. The academic job market, the advantages of working at CSU Long Beach, and

the lack of equipment requirements all point in the direction of outstanding future hires in the Department of Mathematics & Statistics.

Several faculty discussed with us their frustration at the procedure for recommending the appropriate fields for tenure-track hiring, as each group predominantly votes to hire in its group. We cannot offer a good solution to this problem, except to recommend that each group present its best evidence and let the decision be made at the Dean or higher level.

Departmental Faculty Meetings

Some faculty expressed a desire for more frequent departmental faculty meetings, which we were told happen about once per semester. We recommend aiming for a departmental faculty meeting about once per month during both semesters, which means about three or four departmental faculty meetings per semester. These meetings can lead to more departmental cohesion and good discussions about issues facing the department.

To enable all tenured/tenure-track faculty to attend the departmental meetings, we recommend that a fixed day/time be established for the departmental meetings (for example, Wednesday at 3 pm or Friday at noon) and that no tenured/tenure-track faculty member should be assigned to teach at that time. The expectation then is that all tenured/tenure-track faculty should attend the departmental faculty meetings as part of their work expectation. When faculty are absent from a departmental meeting, this should be noted in the minutes of the meeting along with the reason (attending a conference, sick, etc.).

Strengths, Weaknesses, Opportunities, Threats

Strengths

- Students at both the undergraduate and graduate levels reported to us that the quality of teaching in the Mathematics & Statistics Department is quite high, on the average. Students in the department are clearly happy to be at CSU Long Beach. Faculty in the department are clearly committed to providing a high-quality experience for their students.
- The Department of Mathematics & Statistics has kept its curriculum current by adding several new courses over the past decade, including courses in hot areas such as biostatistics.
- The Department of Mathematics & Statistics has a terrific group of newer faculty who have been hired in the last decade or so. This newer group of faculty has helped to diversify the department, providing good role models for students at CSU Long Beach.

Weaknesses

- Students reported to us that the predominant teaching style in the department at both the undergraduate and graduate level is a 75-minute lecture. Active-learning strategies have not been incorporated into faculty teaching styles by a majority of faculty. Different faculty will find that different teaching strategies work best for them, but we encourage a larger percentage of the faculty to experiment with active-learning strategies. We make this recommendation because of evidence showing that many students learn better when faculty use active-learning strategies as part of their teaching style.
- As discussed earlier in this report, the percentage of graduate students who select the thesis/project option is low. We encourage a change in departmental culture away from the attitude that only the best students should write theses. To make more theses possible, we encourage the department to adopt a more generous policy of faculty teaching credit for successful masters theses.

Opportunities

- We encourage the department to continue to provide opportunities for the excellent newer group of faculty to flourish. The junior and mid-career faculty should be given ample opportunity to play a larger role in departmental affairs.
- Because of continued strong enrollment in mathematics/statistics courses and upcoming (and past) retirements, the department will need to continue with regular tenure-track hiring in future years. A faculty position at CSU Long Beach is highly desirable for many reasons. Thus the department can maintain high hiring standards while offering start-up packages that are quite modest in comparison to laboratory sciences. Only candidates who will be outstanding teachers and researchers should be considered.
- If research-active faculty have a lighter teaching load, they will have more time and energy to pursue outside funding. Getting grants in mathematics is now extraordinarily competitive, but the department should encourage and support grant-writing activity, including to private foundations as well as to the obvious federal agencies.
- According to the self-study, the department's Statistical Consulting Group

  > provides statistical help to CSULB faculty, staff, and students, and external investigators unaffiliated with the university.

  Even more students should be encouraged to work at the Statistical Consulting Group, which should be a wonderful experience for students. Also, we were surprised to learn that the Statistical Consulting Group does not charge for its

services. We recommend that the Statistical Consulting Group start charging fees for its services. Faculty with grants may have funds allocated in their grants for statistical consulting. Faculty without appropriate grant funds can be given a discount (perhaps even a 100% discount). Off-campus organizations should not have a problem paying for statistical consulting. The funds generated by a fee structure could be used, for example, to provide professional travel funds to students and faculty who participate in the activities of the Statistical Consulting Group.

Threats

- The CSU Board of Trustees has begun to take steps to eliminate developmental math courses, replacing them with extra just-in-time help in college-level courses for students who are not ready for college-level mathematics. This action, if it happens, would have a serious impact on the Mathematics & Statistics Department in at least two ways:

    1. A large number of students who previously would have been deemed as not ready for college-level math courses will suddenly appear in freshman-level math courses. The department will need to find innovative ways to help these students succeed without lowering academic standards.
    2. With the elimination of developmental classes, there may be fewer sections in which graduate teaching assistants will be the instructor of record. Thus graduate students may have fewer opportunities to teach a class on their own (perhaps balanced by more opportunity to teach extra class meetings to deal with just-in-time material). This reduction in independent teaching responsibilities could lessen the quality of the graduate student experience, especially for graduate students who plan on a career in teaching at some level.