Introduction.

The BA in Mathematics at CSUS requires that students complete a standard 18-unit lower division course sequence of mathematics courses as well as an introductory course in computer science. These courses include calculus, differential equations and linear algebra, and prepare students for the analytic rigor that underscores upper division mathematics and statistics courses as well as the fundamental tools to apply mathematics in lower division science and engineering. Mathematics majors are strongly urged to take elementary physics with calculus to better appreciate the importance of calculus based mathematical models throughout the sciences. All majors complete 15 units of upper division core study. This core consists of an Introduction to Formal Mathematics (Math 108) as well as a pair of yearlong sequences in Modern Algebra (Math 110A/B) and Functions of a Real Variable (Math 130A/B), classical subjects that form the foundation of all modern mathematics study. Besides these core topics, students are required to take an additional 12-15 elective units from their chosen specialty, emphasizing pure mathematics, applied mathematics, or preparation for secondary teaching. The pure mathematics option contains those subjects most likely to be of assistance in a postgraduate program, while the applied option stresses material in statistics and areas that have applications in industry as well as prepare the student for further study in the applications of mathematics. The secondary teacher preparation option is an approved waiver program for the secondary credential and has a specific set of electives separately approved by the state as a waiver for the state’s content examinations in mathematics.

The BA program provides all mathematics graduates with a common background in the core areas of mathematics: modern algebra and real analysis. With the depth and breadth of training of the major options, students are able to enter graduate programs or use their skills in the classroom or in the corporate and industrial world. As part of the recent program review, in the Report of the External Consultant, Dr. John Sarli from CSU San Bernardino commented that “the Department is in a good position to defend its assessment plan in future reviews precisely because the core of its major is so strong. It is unusual across both university systems in California for an undergraduate degree in mathematics to require a full year each of modern algebra and analysis (typically the second semesters of these subjects are electives), and even more unusual for this requirement to apply to all strands within the major.”
1. What goals or learning objectives/outcomes were assessed in the academic year ending June 30, 2010?

In light of the recent completion of the department’s self study with the submission of the report from the outside evaluator in January of 2010, the department is assessing all five learning goals for the mathematics major. The self study required the department to contemplate all aspects of the major, so this annual assessment report will incorporate much that was learned in the self study.

The Department of Mathematics and Statistics has identified five learning goals for mathematics majors.

(1) The mathematics major at CSUS is expected to develop a fundamental understanding of the process and role of mathematical reasoning.

Professional mathematicians regard mathematical proof as the intrinsic essence of mathematics, and it is expected that undergraduates will arrive at an appreciation for the role of proof in mathematical discourse, as well as a grasp of the methods of proof that permeate all mathematical exposition.

Students should be able to identify various methods of proof, and apply these methods to their work in their upper division courses. Application of these fundamental mathematical methods leads to a deeper insight into the nature of the subject.

(2) The mathematics major at CSUS is expected to develop a fundamental understanding of the main strands of mathematics.

It is generally recognized that advanced study in mathematics requires a solid background in the areas of real analysis and modern algebra. These two strands represent a classical approach to the subject that is still essential learning for any modern study of the subject.

Students are expected to complete a full year of study of both real analysis and modern algebra, and are expected to demonstrate the ability to prove and explain some of the fundamental results from these areas. Students are expected to show a basic understanding of the different methods employed in real analysis and modern algebra, and be able to explain the different approaches to the material.

(3) The mathematics major at CSUS is expected to have an understanding of the breadth of mathematics.

The study of mathematics has been an integral part of mankind’s intellectual history for over two thousand years, and in many ways approaches the pinnacle of mankind’s intellectual accomplishments. During the past two thousand years the nature of mathematical inquiry has expanded to include a wide range of topics, from the classical
studies of geometry and number theory to include modern subjects of interest such as
topology, chaos theory and game theory. Current mathematical studies range over a wide
variety of courses and often include interdisciplinary exchanges.

Students should be able to recognize the various branches of mathematics, and according
to their interests, should be able to describe and understand the basic methods of study in
their chosen option. Students at CSUS will choose between the pure mathematics option,
the applied mathematics option and the teacher preparation option. Each option will
present students with an opportunity to master and apply basic mathematical methods
from these three areas of study.

(4) The mathematics major at CSUS is expected to demonstrate an ability to effectively
communicate mathematical thought.

The MAA report on Recommendations for the Mathematical Preparation of Teachers of
Mathematics draws our attention to the goal that mathematics teachers must be able to
communicate mathematical ideas with ease and clarity. This ability should be expected of
all students graduating with a degree in mathematics, and need not be restricted to those
planning a career in teaching. The ability to communicate mathematical thought goes to
the heart of the mathematical process and centers on the need for clear logical
presentation and exposition.

Students are expected to demonstrate effective communication in mathematics in a
variety of ways: presentations of mathematical results such as in the capstone course or in
courses where student presentations are required; responding to questions both in formal
class settings and in group settings; explaining mathematics as part of duties associated
with the Math Lab, Math 9 instruction, Learning Skills instruction, tutoring, AMP co-
ordination and tutoring, as well as other tutorial duties associated with the mathematics
department.

(5) The mathematics major at CSUS is expected to demonstrate a basic understanding of
technology and demonstrate the skill to use technology.

Technological advances have changed the way some mathematical studies are now
conducted, particularly in the area of applied mathematics. The use of computer methods
for certain mathematical exploration means that students need to be aware of the possible
uses of technology in the mathematical arena.

All math majors at CSUS are required to take a lower division course in computer
science, and many choose to study more computing than is offered in this basic
programming course. Students in the applied area have the opportunity to use computer
methods in Numerical Analysis (Math 150) and instructors of Stat 115 often take
advantage of computer packages. At the lower division level, graphing calculators are
used in some of the calculus classes and in pre-calculus.
2. How did you assess these learning outcomes?

Final exams from the courses Math 110A, Math 110B, (Modern Algebra) and Math 130A, Math 130B (Functions of a Real Variable) are reviewed by the department chair and/or the core curriculum committee to ensure that the learning goals of the major are being met by the students who pass the exams and the courses. All these are core courses in the major and each employs a two-hour comprehensive final exam. The instructors submit three exams from each course, one representing excellent work, one representing satisfactory work, and one representing poor work (provided all three examples exist). The students’ names are removed from the exams so that the work is anonymous when reviewed by the committee. The University’s Faculty Assessment Coordinator has deemed this exam review process that is in place as solid. The review is designed to determine whether there are a sufficient number of questions addressing each learning goal to ensure that a student who answers most of the questions correctly will have met the learning goal. An individual question may address several learning goals. The exams were also reviewed to make sure that they accurately reflected the required course content, and to see how similar items appear on the exams.

Mathematical proof is the heart of the upper division core courses in the math major, and the final exams are reviewed to see that they contain detailed expositions of reasoning (goal 1). The areas of modern algebra and real analysis are the two strands of mathematics that represent a classical approach to the subject (goal 2). Students are expected to show an understanding of the different methods employed in real analysis and modern algebra, and be able to illustrate different approaches to the material. The review of the exams will assess whether students meet this goal. Each of the sequences of algebra and analysis contributes to the understanding of the breadth of mathematics (goal 3). The ability to communicate mathematical ideas with clarity is expected of all students graduating with a degree in mathematics. The exams are reviewed to see that they contain questions requiring independent thought and carefully written explanations (goal 4). Although there are ways a student might employ some uses of technology in researching topics for the core courses, the conceptual core of mathematics is not based on the use of technology and as such the core may (but is not expected to) meet goal 5. Courses in applications of mathematics that are required elsewhere in the program do employ technology as an integral part of the curriculum (for example, Calculus or Differential Equations).

The review of exams for the 2009-10 academic year showed that the exams did a good job in meeting the requirements. Virtually all of the questions from the Math 110A/B exams assessed learning goals 1, 2, and 4. There were some true/false questions and some fill in the blank questions on the Math 130A/B exams that do not assess goal 4 well, but all other questions on those exams also assessed goals 1, 2 and 4. Goal 3 dealing with the breadth of mathematics was appropriately directly assessed by a lesser number of questions. Still about 30-40% of the questions dealt with concepts from geometry, number theory, linear algebra and the foundations of mathematics. In all cases, the exams
indicated that the courses were suitably designed to achieve the department’s learning goals.

Pass rates in the courses were recorded to measure the relative success at achieving the learning goals. Pass rates between 65 and 75 percent in the first course of each sequence indicate successful achievement of learning outcomes. Pass rates between 85 and 100 percent in the second course of a sequence indicate successful achievement of learning outcomes. The higher pass rate in the second course is also an indication that the students who passed the first course are in fact achieving the learning goals and are well prepared for the second course.

For the 2009-10 academic year, the pass rates were as follows:

<table>
<thead>
<tr>
<th>Course</th>
<th>Number of Sections</th>
<th>Pass rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 110A</td>
<td>3</td>
<td>66.2%</td>
</tr>
<tr>
<td>Math 110B</td>
<td>3</td>
<td>84.3%</td>
</tr>
<tr>
<td>Math 130A</td>
<td>3</td>
<td>63.4%</td>
</tr>
<tr>
<td>Math 130B</td>
<td>2</td>
<td>97.7%</td>
</tr>
</tbody>
</table>

The pass rates for Math 110B and 130A are slightly below the range that would indicate successful achievement, but each is within 2% of the desired range. Complete grade distribution of each course appears in the following table:

2009-10 Math 110A/B, Math 130A/B grade distribution

<table>
<thead>
<tr>
<th>Grade</th>
<th>Math 110A</th>
<th>Math 110B</th>
<th>Math 130A</th>
<th>Math 130B</th>
<th>Total</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>3</td>
<td>26</td>
<td>11.8</td>
</tr>
<tr>
<td>A-</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>20</td>
<td>8.4</td>
</tr>
<tr>
<td>B+</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>16</td>
<td>6.8</td>
</tr>
<tr>
<td>B</td>
<td>6</td>
<td>9</td>
<td>7</td>
<td>2</td>
<td>24</td>
<td>10.1</td>
</tr>
<tr>
<td>B-</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>19</td>
<td>8.0</td>
</tr>
<tr>
<td>C+</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>15</td>
<td>6.3</td>
</tr>
<tr>
<td>C</td>
<td>11</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>33</td>
<td>13.9</td>
</tr>
<tr>
<td>C-</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>25</td>
<td>10.5</td>
</tr>
<tr>
<td>D+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>D</td>
<td>16</td>
<td>3</td>
<td>13</td>
<td>1</td>
<td>33</td>
<td>13.9</td>
</tr>
<tr>
<td>D-</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0.8</td>
</tr>
<tr>
<td>F</td>
<td>6</td>
<td>4</td>
<td>8</td>
<td>0</td>
<td>18</td>
<td>7.6</td>
</tr>
<tr>
<td>WU</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>6</td>
<td>2.5</td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
<td>51</td>
<td>71</td>
<td>44</td>
<td>237</td>
<td></td>
</tr>
</tbody>
</table>
In addition to evaluating the final exams in Math 110A/B and Math 130A/B, another method of assessment is a report submitted by the instructor of Math 193 (The Capstone Course for the Teaching Credential Candidate). This year’s report was filed following completion of Math 193 at the end of the spring semester 2010. Students completing the Teacher Credential emphasis of the math major take the Capstone Course, usually within one semester of the conclusion of their degree program. The Capstone Course has several prerequisites, and as such, offers an opportunity to assess students who are close to the end of their undergraduate academic careers. Students enrolled in Math 193 each give several presentations to the class (goal 4). The presentations attempt to relate the concepts of courses required for a math degree to the curriculum of high school and middle school mathematics. This year’s presentations tended to use material from the core subjects more than any other area. The instructor noted that the students had a command of the mathematics from Real Analysis and Number Theory, but that the lectures that required some Modern Algebra were not as well presented. All students took the work seriously and made a concerted effort to present to the best of their abilities. Students had a better recall of the more recently studied mathematics, but some struggled with concepts from Calculus, Precalculus, and Trigonometry. Student who worked in the Math Lab (the tutoring center for all math courses) seemed better prepared to handle the lectures involving these concepts since they had continuous exposure to these topics when tutoring others. Some of the students gave presentations with the aid of their laptop computers and were able to take advantage of the smart room features available in the classroom (goal 5). A more standard use of technology was the use of calculators, and the instructor noted that we are now at a point where all students seem very comfortable using these devices. The instructor also noted that communication skills varied greatly, with some of the students giving clear and logical presentations, while others seemed a little lost and did not articulate ideas terribly well. However, the instructor also remarked that all the students demonstrated improvement as they progressed through the semester.

3. As a result of faculty reflection on these results, are there any program changes anticipated?

There will be no major changes to the core curriculum based on reflection of the results. In the report of the external consultant, as part of the Program Review of the Department of Mathematics and Statistics, it was noted that the organization of the options for the math degrees (B.A., B.S., and M.A.) and the concentrations for the B.A. (pure, applied, and teacher preparation) reveals an unusual level of cooperation among the colleges without significant attenuation of the subject matter content. This is mainly accomplished through the 15 semester unit core of the mathematics required for all degree options. The Department continues to maintain that this core is fundamental to the math major. This core prepares math majors for all the options available to those with a degree in math.

In light of the Capstone Course report, which noted some weakness in presentations of topics using Modern Algebra, the Core Curriculum committee plans to discuss ways in which instructor of Math 110A/B may be able to relate the topics of those courses to the
curriculum in high school mathematics. Making these connections will allow for better understanding of the topics in the high school curriculum, and as a result, those students who plan to become secondary teachers should be better prepared.

4. Did your department engage in any other assessment activities such as the development of rubrics, course alignment?

The chair of the Department of Mathematics and Statistics met with all the chairs of the College of Engineering and Computer Science (ECS) in an effort to facilitate communication about the mathematics courses required for majors in that college. Degrees offered in this college include Civil Engineering, Computer Science, Computer Engineering, Construction Management, Electrical and Electronic Engineering, and Mechanical Engineering. The discussion mainly concerned Precalculus (Math 29) and Calculus (Math 30). In Fall 2009, only about 16% of ECS freshmen take Math 30 in their first semester of enrollment at Sacramento State. Historical two-year retention rates and six-year graduation rates are each about 10% greater for ECS freshmen that take Math 30 during their first semester.

The ECS chairs and faculty are concerned that the diagnostic tests required to enter Math 29 and Math 30 are keeping ECS students from moving into/through the calculus sequence. In light of this, the Math faculty began a series of discussions concerning the diagnostic tests required of students entering certain math classes, including Math 29 and Math 30. As a result of these discussions, an effort was made to administer a greater number of diagnostic tests during the latter half of the spring semester. There was also a concerted effort to inform students of these tests. The Intermediate Algebra Diagnostic test was administered for the first time through efforts of the Advising Center in the college of Natural Sciences and Mathematics in April 2010. Both the Intermediate Algebra Diagnostic test and the Calculus Readiness test were offered on two occasions by the Math Department at the end of the Spring 2010 semester. Students who had already registered for any math course in fall 2010 requiring a diagnostic test were sent email by the instructor of the course in which they were enrolled informing them of the availability of these test times. Pre-business majors were also informed of these tests by the Business Advising Center. Taking the tests early should have two positive effects. First, it allows students who are currently taking a course on which the diagnostic exam material is based, to take the exam when that material is fresh in their minds. Second, students who fall short of a passing score by a few points may be able to review the material on their own and retake the test at the beginning of the subsequent semester and hopefully be successful at that time.

The Math Department faculty have also begun a discussion of possible changes to the diagnostic testing policy. These discussions are in their preliminary stages and will continue in the upcoming academic year.
5. What assessment activities are planned for the upcoming academic year?

Coherent learning outcomes are the engine that should be driving the assessment process. The Core Curriculum Subcommittee will work on clarifying the five Learning Goals of the department. The goals as currently articulated are a good guide for the curriculum, but they could be rewritten in order to imply what students do to demonstrate learning. By rewording Learning Goals 1-3, a reader from outside the Department can understand the basis of the assessment plan without trying to determine the meaning of vague terms such as “role” and “breadth”. It might be worthwhile to be specific about the expectations for algebra and analysis in the statements of the goals themselves. As part of its evaluation of the Learning Goals, the Core Curriculum Subcommittee may keep exemplars of test questions and student responses.