Math Department BA/BS Assessment WASC Rubric Assessment

BA Math
BA Math Preparation for Secondary Teaching.
BS Applied Math Concentration in Statistics
BS Applied Math Concentration in Economics and Actuarial Science
BS Applied Math Concentration in Applied and Computational Math

Goal 1 Ability to Use and Construct Logical Arguments
The ability to reason logically to conclusions, including the ability to use precise definitions and to use various forms of logical argument. Assessment point, Math 108, BA Math, Assessed in Fall 2010. Specific LOs to be assessed are

1) Ability to give direct proofs
2) Ability to give proofs by contradiction.
3) Ability to give proofs by mathematical induction.
4) Ability to apply definitions to give proofs.
5) Ability to give proofs and disproofs involving quantified statements.

All BA Math majors take Math 42 and Math 108, which introduce them to logic, basic mathematical definitions and notation, different proof techniques, and how to use this information to read, understand, and construct logical arguments for solving mathematical problems in a variety of areas of theoretical mathematics. BA Math majors are required to take at least one course in at least three of the five theoretical areas listed, abstract algebra, geometry/topology, linear algebra, analysis, and discrete math where these skills are further enhanced. BA Math majors are also required to take a two-semester sequence in at least one of these areas of theoretical mathematics, which should allow them to further develop their proof writing skills. The BA Math curriculum is well aligned well with Goal 1 and students have plenty of chances to learn and improve their proof writing skills. For Goal 1 the Math Department assessment plan is in the developed stage. The BA Math Preparation for Secondary Teaching is a similar degree with more specific requirements and fewer electives than the general BA Math degree so that students who complete this degree will meet the requirements set by the CCTC (California Commission on Teacher Credentialing) for entering a program to obtain a teaching credential in mathematics. Goal 1 is not assessed for BS Applied Math majors since dealing with proofs and theoretical mathematics is less important for these students.

Rubric: All students should be able to use these five proof techniques to solve a variety of simple theoretical math problems encountered in different upper division theoretical mathematics courses. The best students should be able to use all five of the proof techniques listed to solve theoretical math problems of varying levels of difficulty encountered in upper division mathematics courses. The best students should also have the ability to understand which proof techniques are most likely to succeed in solving a specific problem they are faced with and they should also develop the ability to tell when a proposed solution is correct or not.

Goal 2 Ability to Communicate Mathematics Effectively
The ability to read mathematics with understanding and to communicate mathematical ideas with clarity and coherence. Assessment point, Math 104 for BA Math, Math 161B for BS Applied Math, last assessed in Spring 2007, next scheduled assessed in Fall 2012 . Specific LOs to be assessed are
1) Ability to state a problem accurately, articulate assumptions, and describe a method of solution.
2) Ability to conduct independent investigation of mathematical concepts at the undergraduate level.
3) Ability to give written reports and oral presentations that include mathematical context which is mathematically accurate yet accessible to classmates

All BA Math majors take Eng 1A, Eng 1B, and Math 100W to introduce them to the skills they need in writing and technical writing. These skills are further enhanced throughout the mathematics curriculum by having students write out explanations/proofs for their answers and in applied math courses by having students explain the mathematical models they use to solve problems. According to Judy Hilliard the Math 100W instructor math majors are more adept at writing than students in other departments that she has taught for, possibly because their ability to use logic in solving math problems carries over to their writing. In Calculus workshops, students work on extra problems in small groups enhancing their teamwork and oral communication skills. Communication skills are developed further, by having students write reports and give oral presentations in their upper division courses. In addition to Goal 2, Goals 1 and 3 can also be considered as specialized communication skills and it is difficult to totally separate the three of them. For Goal 2 the Math Department assessment plan is in the emerging stage in the WASC rubric. To align this goal more closely with the curriculum the Math Dept might possibly want to come up with more upper division courses where students are expected to write reports and give oral presentations. For example, BA Math students might be expected to write a report or give a presentation in the second course of a two-semester sequence that they are required to take (Math 128B, Math 129B, Math 131B, Math 175). For BS Applied Math students participating in a CAMCOS project (Math 203) where students write a report and give an oral presentation at the end of each semester is an excellent way for students to develop their communication skills. Another possibility would be to have a capstone course where students are required to write a report or give an oral presentation.

Rubric: All students should be able to read short articles and book chapters at an undergraduate level and write reports or give oral presentations to explain the material to their fellow classmates and their teacher. All students should be able to explain their solutions/proofs to simple applied and theoretical problems to their fellow students and their teacher. The best students should also be able to explain and motivate their independent/advanced work to classmates and professors such as when they are taking an independent study class or a CAMCOS project (Math 203).

Goal 3 Ability to Perform Standard Mathematical Computations
Assessment point, Math 138, BA Math and BS Applied Math, last assessed in Spring 2008, next scheduled assessment in Spring 2012.
Specific LOs to be assessed are

1) Ability to evaluate limits.
2) Ability to calculate derivatives and integrals.
3) Ability to compute Maclaurin, Taylor and Laurent series and the ability to test series for convergence and divergence.
4) Ability to apply properties of algebraic and transcendental functions.

All BA Math majors should learn basic skills in calculus (differentiation, integration, sequence and series, and multivariable calculus), discrete math (logic, induction, counting/discrete probability, functions and relations), and linear algebra (systems of linear equations, Gaussian elimination, determinants, vector spaces, etc.). Some versions of the MAA Curriculum guidelines also suggest that students should take a differential equations course and at least one course in Statistics. Adding additional required courses to the BA Math degree has been discussed but generally we prefer to maintain the flexibility of the BA Math degree by allowing the students to take more electives so that the degree works for students with a variety of different interests. This flexibility also encourages students who want a double major in mathematics and something else. BA Math majors should learn mathematical skills in many different areas and have at least one area that they study in depth. BA Math degree students are required to take Math 112 or 113 or 115 or 138, Math 128A, Math 129A, Math 131A and 15 other units of upper division math electives. They are also required to take Math 128B, 129B, 131B, or 175 completing a 2-semester sequence in geometry/topology, algebra/linear algebra, or analysis. BS Applied Math majors generally take at least one linear algebra course, one differential equations course, one numerical analysis course, one statistics course and one modeling course. With respect to Goal 3 the Math Dept

assessment plan is in the emerging stage, but Goal 3 likely needs to be expanded to include more basic skills that we expect our students to learn before we reach the developed stage.

Rubric: All BA Math and BS Applied Math majors should learn a variety of mathematical skills in different areas including Calculus, Discrete Math, and Linear Algebra, which are required of all BA/BS math majors, and in addition they should have at least one in-depth math experience obtained by taking a 2-semester upper division math sequence. The most important skills for BS Applied Math majors can be learned in Vector Calculus Math 112, Analysis Math 131A or 132, Discrete Mathematics Math 142,177,179, Differential equations Math 133AB, 134, Numerical Analysis Math 143C/M, and Probability/statistics Math 161AB,163,164. BA Math/BA Math Preparation for Secondary Teaching majors should take a variety of courses in geometry/topology, linear algebra/algebra/number theory, and analysis. The best students in addition to having a variety of mathematical skills at their disposal would also have the ability to understand which mathematical skills are most likely to succeed or not succeed in solving a specific problem they are faced with.

Goal 4 The ability to use technology to solve mathematical problems.
Assessment Point, Math 143C/M, BA Math and BS Applied Math, last assessed in Spring 2009, next scheduled assessment in Fall 2011. Specific LOs to be assessed are

1) Ability to write programs to solve mathematical problems.
2) Ability to use a mathematical programming environment such as MATLAB or Maple.
3) Ability to interpret numerical results.
4) Ability to understand that there are limits to numerical accuracy.

All BA Math majors should learn how to use various kinds of technology in solving math problems in many different areas. Generally most students learn how to use graphing calculators in the Calculus sequence, they are introduced to the use of the general-purpose mathematical software MATLAB in Math 129A and they are required to take at least one programming course. BS Applied Math Concentration in Applied and Computational Math majors are required to take a two-semester sequence in programming, CS 46AB. Ideally students would gain further experience in using technology to solve problems in a variety of upper division math courses like Math 143C, 143M, 161A, 161B, 163, 177, 178, and 179. With respect to Goal 3 the Math Dept assessment plan is in the emerging stage. To reach the developed stage , the Math Dept might also want to consider adding other upper division math courses where students learn how to use technology in solving math problems to give students more chances to enhance their skills in using technology (Goal 4).

Rubric: All BA Math and BS Applied Math majors should learn how to use mathematical and statistical software, programming and other technologies. Since a large number of mathematics majors end up as mathematics teachers, it is important for students to be exposed to the uses of technology in teaching in a variety of classes. The best students in addition to having a variety of technology skills at their disposal would also have the ability to understand which of these skills are most likely to succeed or not succeed in solving a specific problem they are faced with.

Goal 5 The ability to use mathematical models to solve practical problems. Assessment Point, Math 178, BS Applied Math, Assessed in Spring 2011.
Specific LOs to be assessed are
1) The ability to extract relevant information from a practical problem and give a mathematical formulation of the problem.
2) The ability to use numerical results to validate (or modify) a model and to understand the limitation of a model.
3) The ability to clearly describe models including an analysis of the strengths and weaknesses of models and their relationship to the underlying problem.

Applied math majors are introduced to modeling in calculus where they encounter a variety of applications and word problems. A systematic study of mathematical modeling is undertaken in Math 178 (or Math 161B for statistics majors) where students encounter numerous mathematical models using a variety of mathematical methods to study applied math problems in many different areas. The BS Applied Math curriculum is aligned well with Goal 5 and students have plenty of chances to learn and improve their mathematical modeling skills throughout the curriculum. For Goal 5 the Math Department assessment plan is in the developed stage.

Rubric: All students should be able to use mathematical modeling techniques in various areas of mathematics and statistics to solve simple applied math problems. The best students would also have a good idea which mathematical models are likely to succeed or not succeed in solving a specific applied math problem they are faced with. In addition, the best students should also be able to use their modeling skills to analyze applied math problems of varying levels of difficulty.

Department of Mathematics
College of Science
WASC Program Outcomes Rubric, Spring 2012

BA Math/BA Math Preparation for Secondary Teaching Goals 1-4 are to be assessed.

A. The Comprehensive List
The list of program learning objectives for the BA Math/BA Math Preparation for Secondary Teaching is an organized set of reasonable outcomes. These outcomes focus on the important skills that a math major should learn in their math courses but the list of objectives also includes some relevant institution wide outcomes such as communication and critical thinking which are also covered in courses outside of the Math Dept. The outcomes are appropriate for the undergraduate level and consistent to large extent with many national disciplinary standards and in some cases the outcomes we have go beyond what is being done other similar institutions. The discussion is valid for both degrees that are mentioned here as there are great similarities between them with one main exception that the BA Math Preparation for secondary teaching is a more focused on requirements for teachers mandated by the state and the BA math degree is more flexible and allows more electives and choices. As a possible improvement in this area the Math Dept is considering an expansion of Goal 3 to include a larger set of skills that students are expected to learn. A more complete set of Standard Mathematical Computations might include some of the skills learned in Calculus, Discrete Math, and Linear Algebra which are required of all BA Math majors. Otherwise we can consider Goals 1-4 to be a comprehensive list of learning objectives for the BA Math/BA Math Preparation for Secondary Teaching programs. Presently the Math Dept Assessment Plan would be considered to be developed but not highly developed in this area.

B. Assessable Outcomes
Goal 1 is introduced in Math 42 and enhanced in Math 108 where it is assessed. The student's skills in using the 5 basic proof writing techniques described in Goal 1 are assessed using embedded exam questions on midterms and finals. Goal 2 is introduced in the basic GE courses that all SJSU students are required to take and enhanced in Math 100W. Goal 2 is assessed in Math 104 one of several upper division courses where students are required to submit a writing project. Goal 3 is introduced in Calculus, Discrete Math, and Linear Algebra which are required of all BA Math majors. Goal 3 is presently assessed in Math 138 using embedded exam questions. Goal 4 is introduced in Calculus and Linear Algebra where students are introduced to graphing calculators and mathematical software and enhanced in a required programming course. Goal 4 is assessed in either Math 143M or Math 143C which are courses where students are required to turn in a programming project. All learning outcomes described in Goals 1-4 can be assessed in the courses listed though in some cases there is no agreed upon rubric that has been approved by the department. This can be discussed at future

department meetings. At this point the Math Dept Assessment Plan is developed but not highly developed in this area.

C. Alignment
The BA Math/BA Math Preparation for Secondary Teaching curriculum is generally well aligned with Goals 1-4 and students have many courses in which to increase their performance for each of the goals though again there are some areas where improvement is possible. The Math department might want to consider adding additional upper division courses where students will be expected to write projects and give oral presentations to give students more chances to enhance their communication skills (Goal 2). Also there is a discussion underway in the Undergraduate Curriculum committee about whether or not we should introduce a capstone course for the BA Math degree. The BA Math Preparation for Secondary Teacher already has a general problem solving course Math 201A which serves as a capstone course. The Math Dept might also want to consider adding other courses where students learn how to use technology in solving math problems to give students more chances to enhance their skills in using technology (Goal 4). For now the department will conduct a survey to determine the courses in which the Math Faculty require students to give written and oral presentations and in which courses students are required to practice their programming skills and the use of mathematical software, and other forms of technology and then determine what the department policy should be in terms of assigning students to do written and oral projects and technology projects in upper division mathematics classes. The BA Math Dept curriculum is also closely aligned with curriculum guidelines published by national organizations like the MAA (Mathematical Association of America). MAA (Mathematical Association of America) curriculum and assessment guidelines can be found at the following links, http://www.maa.org/cupm/math-2010.pdf , http://www.maa.org/cupm/cupm2004.pdf , and http://www.maa.org/saum/cases/cupm-guidelines1105-saum.pdf. Presently the Math Dept is developed but not highly developed in this area.

D. Assessment Planning
At this time the Math Dept. has a reasonable multi-year program planning/assessment plan. Our last external review took place in Spring 2009 and our program planning meeting with the provost was held in Fall 2010. In Fall 2010 Goal 1 was assessed in Math 108, Goal 2 will be assessed in Math 104 during Fall 2012, Goal 3 will be assessed in Math 138 during Spring 2012, and Goal 4 will be assessed in Math 143M during Fall 2011. The assessment data is gathered by the instructors of these courses. The data is then reviewed by the Undergraduate Curriculum committee and the Math Dept. chair to determine if any changes are needed in the curriculum or in the assessment plan itself and always we are looking for the points of strengths and signs of weaknesses in the curriculum and how to improve the delivery of the material in order to increase sophistication. Presently the UCC is discussing potential changes to Goal 3 and the way in which it is assessed.   Any proposed changes are presented to the math department faculty for discussion and a vote at a department meeting. The department assessment planning presently is developed but not highly developed.

E. The Student Experience
The department student experience is emerging. Most courses have clear learning outcomes spelled out in details and students know about them but more needs to be done in this area and we intend to do this in the near future and communicate to the students all learning outcomes by advertising them on the mathematics web page and by making clear to the faculty that discussing the learning outcomes with the student should be thought of as an important component of the courses. The Math Department would need to publicize these learning objectives that students are expected to learn in course outlines, green sheets and on the Math Department web page to reach the highly developed stage.

Department of Mathematics
College of Science
WASC Program Outcomes Rubric, Spring 2012

BS Applied Math Goals 2-5 are to be assessed.
Concentration in Applied and Computational Mathematics
Concentration in Statistics
Concentration in Economics and Actuarial Science

A. The Comprehensive List

The list of program learning objectives for the BS Applied Math is an organized set of reasonable outcomes. These outcomes focus on the important skills that a math major should learn in their math courses but the list of objectives also includes some relevant institution wide outcomes such as communication and critical thinking which are also covered in courses outside of the Math Dept. The outcomes are appropriate for the undergraduate level and consistent to a large extent with many national disciplinary standards and in some cases the outcomes we have go beyond what is being done at other similar institutions. The discussion is valid for all three concentraations that are mentioned here.   as there are great similarities between them with one main exception that the BA Math Preparation for secondary teaching is a more focused on requirements for teachers mandated by the state and the BA math degree is more flexible and allows more electives and choices. As a possible improvement in this area the Math Dept is considering an expansion of Goal 3 to include a larger set of skills that students are expected to learn. A more complete set of Standard Mathematical Computations might include some of the skills learned in Calculus, Discrete Math, Linear Algebra, Ordinary Differential Equations, and Applied Statistics, which are required of all BS Applied Math majors. Otherwise we can consider Goals 2-5 to be a comprehensive list of learning objectives for the BA Math/BA Math Preparation for Secondary Teaching programs. The BS degree in our department has three concentrations : Computational Mathematics, Statistics and Economics and Actuarial Science. The details of these concentrations are clearly distinguished from each other but they lead essentially to similar learning outcomes. Presently the Math Dept Assessment Plan would be considered to be developed but not highly developed in this area.

B. Assessable Outcomes

Goal 2 is introduced in the basic GE courses that all SJSU students are required to take and enhanced in Math 100W. Goal 2 is assessed in Math 161B, one of several upper division applied math courses where students are required to submit a writing project. Goal 3 is introduced in Calculus, Discrete Math, and Linear Algebra which are required of all BA Math majors. Goal 3 is presently assessed in Math 138 using embedded exam questions. Goal 4 is introduced in Calculus and Linear Algebra where students are introduced to graphing calculators and mathematical software and enhanced in a required programming course. Goal 4 is assessed in either Math 143M or Math 143C which are courses where students are required to turn in a programming project. Goal 5 is introduced in Calculus and enhanced in a variety of upper division courses including Math 129A, Math 133A, and Math 178 where it is assessed. Learning outcome 5 which considers the ability to use mathematical models to solve practical problems is central to applied mathematics. All learning outcomes described in Goals 2-5 can be assessed in the courses listed though in some cases there is no agreed upon rubric that has been approved by the department. This can be discussed at future department meetings. At this point the Math Dept Assessment Plan is developed but not highly developed in this area.

C. Alignment

The BS Applied Math is generally well aligned with Goals 2-5 and students have many courses in which to increase their performance for each of the goals though again there are some areas where improvement is possible. The Math department might want to consider adding additional upper division courses or a capstone course where students will be expected to write projects and give oral presentations to give students more chances to enhance their communication skills (Goal 2). The Math Dept might also want to consider adding other courses where students learn how to use technology in solving math problems to give students more chances to enhance their skills in using technology (Goal 4). For now the department will conduct a survey to determine the courses in which the Math Faculty require students to give written and oral presentations and in which courses students are required to practice their programming skills and the use of mathematical software, and other forms of technology and then determine what the department policy should be in terms of assigning

students to do written and oral projects and technology projects in upper division mathematics classes. The BS Applied Math, Concentration in Applied and Computational Mathematics is also closely aligned with curriculum guidelines published by national organizations like SIAM (Society for Industrial and Applied Mathematics). Applied Math curriculum guidelines can be found at the following links, http://www.siam.org/about/mii/Report.pdf, http://www.careercornerstone.org/math/math.htm, http://siam.org/students/resources/guidelines.php . The BS Applied Math, Concentration in Statistics is also closely aligned with curriculum guidelines published by national organizations like AmStat (American Statistical Association). Information about the recommended undergraduate Statistics curriculum can be found at the following links, http://www.amstat.org/education/curriculumguidelines.cfm , http://www.amstat.org/publications/jse/v10n2/00-055r2_tarpey.doc , http://www.amstat.org/education/pdfs/BS-curriculum.pdf. The BS Applied Math, Concentration in Economics and Actuarial Science is also closely aligned with curriculum guidelines published by national organizations like SOA (Society of Actuaries) and CAS (Casualty Actuarial Society). Information about the recommended undergraduate Actuarial Science curriculum can be found at the following link, http://www.beanactuary.org/. Presently the Math Dept is developed but not highly developed in this area.

D. Assessment Planning
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