Assessment Plan
Department of Mathematics
November 2011

1. Mission Statement

   The mission of the Department of Mathematics is (1) to support the College mission, (2) to prepare and nurture those students who pursue programs in Mathematics and Mathematics/Secondary Education, (3) to provide quality mathematics courses to support all programs in the sciences, (4) to serve the curriculum by providing the majority of the opportunities on campus for students to meet the quantitative literacy requirement, and (5) to contribute to the opportunities for students to satisfy the natural science requirement. The learning objectives described below contribute to the various components of this mission.

2. Student Learning Outcomes and Assessment

   The Department of Mathematics has identified several learning objectives for its students. These objectives are all critical to becoming a good mathematician (and mathematics teacher). Our decisions are informed by the guidelines of the Committee on the Undergraduate Program in Mathematics (of the Mathematical Association of America) and by the Guidelines for Assessment and Instruction in Statistics Education (of the American Statistical Association).

   (a) To become good mathematical problem solvers.

   One focus of the Department is to use multiple approaches to solve problems, such as in calculus, where we use analytical, graphical, and/or numerical approaches when appropriate. Students use these multiple approaches throughout the entire Calculus sequence (MA 130, 230, 235), and in some later courses such as MA 303 Mathematical Modeling and MA 335 Differential Equations. Mathematical modeling is a topic that provides students the opportunity to apply their knowledge to solve open-ended real-world problems. In Mathematical Modeling assignments, we ask students to answer questions that can be approached in different ways, and we gauge the effectiveness and the correctness of their responses. (Also, we usually have three students per year participate in the international Mathematical Contest in Modeling, in which teams solve very difficult open-ended problems. Contest solutions are judged externally, and we are notified of the results. During the ten years in which Juniata students have participated, our teams have earned different levels of success: Meritorious, Honorable Mention, and Successful Participant.) Another specific area where problem solving is important is statistics. In MA 220 Introduction to Probability and Statistics, students are often asked questions that require them to choose a particular statistical method. We currently ask a question on the final exam that does this, and we are compiling the results to see if students used the appropriate method. MA 325 Statistical Consulting is a project-based course in which students analyze real data from clients around the Juniata campus. These clients give us feedback that helps us to assess this objective.

   (b) To have strong mathematical proof skills.

   MA 210 Foundations of Mathematics is a core course in the Mathematics and Mathematics/Secondary Education POEs. The first part of the course is devoted to basic proof techniques, and the remainder of the course builds upon this foundation. Students then apply these techniques in MA 360 Abstract Algebra, MA 350 Topics in Geometry,

and MA 370 Real Analysis, and to a lesser extent in MA 316 Combinatorics, MA 365 Number Theory, and MA 375 Complex Analysis. We have identified specific skills and content that students need for their upper-level mathematics courses that they should have learned in Foundations of Mathematics. In Abstract Algebra in Spring 2009, we did a qualitative assessment of how effectively students were able to use the skills they learned in Foundations of Mathematics. Now we are working on a more quantitative assessment of student learning within Foundations of Mathematics. We use exam questions that test particular proof techniques and record (1) whether or not the student set up the proof correctly, and (2) the student's score on the proof. One advantage of this assessment is that students are already highly motivated to perform well on exams. Once we have tested this assessment of Foundations of Mathematics, we plan to extend it to some of the upper-level courses, such as Topics in Geometry. We would like to find out how well the students retain what they learned in Foundations of Mathematics.

(c) To be able to write and communicate mathematical ideas, and to be able to read the mathematical literature.

We offer the CW courses MA 210 Foundations of Mathematics, MA 303 Mathematical Modeling, and MA 325 Statistical Consulting. These courses offer students opportunities to express mathematical ideas, analyze solutions or approximations, and interpret graphs and tables. They rewrite their work after receiving feedback on a first draft. Students gain speaking experience with short presentations in Foundations of Mathematics, and they give longer presentations in our senior capstone course MA 480 Mathematics Seminar, and in some other upper level courses (often different versions of MA 399 Special Topics). Students read and discuss current mathematical literature in Mathematics Seminar. Some students also take MA 485 Mathematics Research, usually during their senior year, where they pursue a research project under the supervision of one of our faculty members. This project requires an understanding of the literature, and it culminates in a paper and a presentation. Some of these students choose to give their presentations at external venues, such as the Allegheny Mountain Section Meeting of the Mathematical Association of America. Faculty and students who attend student presentations fill out evaluation forms with questions asking if the presenter was organized, understandable, knowledgeable, and interesting, among other things. We are currently thinking about how to improve our form, and we are looking at the form used at the Liberal Arts Symposium for ideas. As in (a), we use client feedback in Statistical Consulting to determine whether or not the statistical ideas were communicated well in the paper and in the presentation.

(d) To have experience with mathematical technology, including computer programming.

All students with POEs in Mathematics or Mathematics/Secondary Education are required to take CS 110 Computer Science I. The mathematical software package Maple is used (for classroom demonstrations and frequent assignments) in most mathematics courses, and the statistical program Minitab is used in our statistics offerings. Students also use the mathematical typesetting program LaTeX in MA 210 Foundations of Mathematics and MA 303 Mathematical Modeling. In MA/CS 340 Numerical Analysis, students are given several programming assignments in which they are free to implement their solution in the compiled language of their choice (usually Java or C++). Students with POEs in Mathematics/Secondary Education also take ED 201 Educational Technology, which introduces them to a variety of software packages for use in the high school mathematics classroom. To assess this technology experience, we can document the numbers of students taking Mathematical Modeling, Numerical Analysis, and

Educational Technology, as well as those taking computer science courses beyond CS 110.

(e) For our Mathematics/Secondary Education students, to be prepared to teach high school mathematics.

This has always been a very important part of the mission of the Department. We offer courses that satisfy the requirements of the Pennsylvania Department of Education and are in the spirit of the Committee on the Undergraduate Program in Mathematics. In addition to courses in calculus, linear algebra, and probability and statistics, we offer courses such as MA 350 Topics in Geometry, which uses the axiomatic method to prepare students to teach high school geometry, and MA 303 Mathematical Modeling, which exposes students to various applications of mathematics. Students with the Mathematics/Secondary Education POE take the Praxis Specialty Test in Mathematics: Content Knowledge. From 2003 to 2009, seventeen of these students took the Praxis mathematics exam. Sixteen of the 17 passed the exam, while the seventeenth missed by just one point. We can also check the feedback about our student teachers from Dr. Kathy Jones of the Education Department and from the cooperating teachers in the high schools.

(f) For Juniata students taking MA 103 Quantitative Methods, to be "quantitatively literate" citizens upon completion of the course.

This outcome is for general Juniata students and not mathematics students, but it is an important one for us since we offer five sections of Quantitative Methods (QM) each year to help students satisfy the "Q" requirement of the College. Forty percent of the graduates in a recent class satisfied their "Q" requirement by taking QM. As stated above, the goal of QM is to prepare students to be quantitatively literate. While there are many notions of quantitative literacy, for the purposes of assessing QM we operationalize this as critical thinking within the disciplines of mathematics and statistics. In particular, the assessment of quantitative reasoning consists of a pre-assessment on the first day of class and a post-assessment on the last day of class. Originally these assessments were primarily based on traditional math skills, but in order to align them more closely with the course goals, they are now being transitioned to performance tasks. These tasks are a form of authentic assessment similar to those used in the Collegiate Learning Assessment (CLA), and they provide an opportunity for students to apply higher-order skills such as problem solving and quantitative reasoning. During the semester various course assignments emphasize components of quantitative reasoning included in the rubric for the assessments, including (1) evaluating evidence, (2) analyzing evidence, (3) synthesizing data, (4) drawing conclusions, and (5) acknowledging alternatives to their conclusion. Currently, some sections of QM, but not all, have been using these performance tasks. The preliminary results of a Scholarship of Teaching and Learning (SoTL) project indicate that this approach with performance tasks and explicit focus on the elements of quantitative reasoning works to improve student outcomes, so this approach will soon be available for all sections of the course.

3. Summary of Program for Improvement

As stated above in parts (a)-(f) of "Student Learning Outcomes and Assessment", we have mechanisms in place for the collection of assessment data for many departmental courses. In addition to these data, we also collect information from Senior Exit Interviews, which we have done since 2001. Faculty, both individually and collectively, will review the data and

make the changes necessary to improve the courses and the Mathematics program in general. These changes may be in topics covered, course delivery, or particular assignments.

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