Department/program Outcomes Assessment Report (DOAR)

Department or program: Mathematics

Academic year: 2008-09

Name of person filing this report: Judy Holdener

Date of departmental outcomes assessment meeting: Friday, May 15, 2009

Who was present: Chris Camfield, Marian Frazier, Brad Hartlaub, Judy Holdener, Brian Jones, Carol Schumacher (Noah Aydin provided his feedback in written form)

Report on your discussion of learning outcomes for majors in your program, addressing the following items:

1. What are your program's learning goals? *Please make sure that the Associate Provosts' office has a current electronic version of your mission statement and assessment plan (which should include your program's learning goals for majors).*

   A. To educate students so that they gain the skills necessary to effectively read, write, and speak mathematics to a level to which they aspire.
   B. To prepare majors and minors for graduate study and careers which utilize mathematics
   C. To foster quantitative reasoning skills, improve clarity of thought, increase mathematical awareness, and overcome math phobia and misconceptions for all of our students
   D. To ensure that the Department provide mathematical support to other disciplines and to meet the reasonable mathematical curricular needs of other departments

2. What assessment tools (e.g, senior exercise, portfolios, surveys, standardized tests, comprehensive examinations, exit interviews, etc.) did you use to assess the performance of your majors relative to your department's goals? Please be specific.

   A senior exercise paper (including proposal, annotated bibliography, and multiple submitted drafts), and the ETS Major Field Test in Mathematics was administered to all seniors. Of course our majors were also assessed in multiple ways in the context of individual courses, including daily/weekly homework, exams (both in-class and take-home), in-class presentations, papers, and projects.

   We also had reports (and discussion of said reports) of the outcomes and assessment in three courses taken largely by our majors: Math 222 (*Foundations*), Carol Schumacher reporting; Math 216 (*Nonparametric Statistics*), Brad Hartlaub reporting; and Math 333 (*Differential Equations*), Chris Camfield reporting.

3. What key traits did you consider in evaluating student attainment of your department's goals on the exercises listed in question 2?

I will concentrate on our senior exercise here, because it is evaluated by our department as a whole, and it serves as a major assessment tool for us. The senior exercise in Mathematics has three components:

1. The student independently studies a topic of interest.
2. The student writes a paper on the topic.
3. the student takes a standardized test: the ETS Major Field Exam in mathematics

The department evaluates each senior exercise (the result being either distinction, pass, or fail) by looking at the following "traits":

- Meeting Deadlines (*Failure to meet a deadline (except in extenuating circumstances) may result in failure of the senior exercise.)*
- General Acceptability of the Work Submitted at Each Stage (*Unacceptable work turned in at any stage can result in failure of the senior exercise.)*
- The Paper (*In order to help students know how they are progressing, faculty members in the Department of mathematics will provide written or verbal feedback on the proposal and on the draft of the paper.)*
- The ETS Major Field Test in mathematics

Each student paper is evaluated based on a number of factors as well: accessibility (a peer should be able to read the paper), mathematical depth (the paper should include at least one proof of a major result), mathematical correctness, organization (does the paper tell a story?), and style (e.g., grammar). Adequate performance on both the ETS Major Field Test and on the paper will assure passage of the senior exercise. But these two components are not weighted equally. A student can pass the senior exercise with a poor performance on the ETS exam by writing a sufficiently good paper. A mediocre paper and a dismal performance on the ETS exam may result in failure of the senior exercise. To achieve distinction on the senior exercise, both the paper and the test must be examples of high quality work.

4. Characterize student achievement relative to the key traits identified in question 3 – roughly what fraction or percentage of students demonstrated exemplary, competent, and marginal attainment, respectively, for specific traits you linked to each goal?

Trait	**% exemplary**	**% competent**	**% marginal attainment**
Meeting Deadlines	36.5%	45.5%	18%
Acceptability of work at each stage	9%	82%	9%
Paper	18%	55%	27%
ETS test	18%	64%	18%

Note: With the exception of the ETS data, the percentages included in the table above are somewhat impressionistic. I did not know at the time of our Department meeting that I would be assigning

percentages to the competency levels, so I didn't gather the hard data when I was in a good position to do so. As a result, the percentages given in the first three rows of the above table are based on the memory of the faculty 6 months after the grading of the papers. (For the ETS test, I defined "exemplary" as anything above the 90th percentile, "marginal" as anything below the 50th percentile, and "competent" as anything in between.)

5. What conclusions have you drawn from this year's assessment of student performance relative to your goals? What are your students' particular strengths or weaknesses?

A. To educate students so that they gain the skills necessary to effectively read, write, and speak mathematics to a level to which they aspire.

As is often the case, most of our discussion this year focused on our students' ability to read and write mathematics. Generally, we recognize that success in mathematical writing takes practice, and we are more lenient with students at the introductory levels. We expect students at the upper-level to be much more proficient. Nonetheless, we see many of the same problems at all levels (just in varying degrees):

1) *Ability to "tell a story."* Faculty found that student papers often lack effective transitions from one idea to the next. A table or a graph will appear out of nowhere without an introduction or explanation. Additionally, students are not always able to write effective introductions. Sometimes the conclusion is nonexistent.
2) *Economy of exposition and mathematical rigor*: A couple faculty mentioned concerns about the students' inability to handle mathematical rigor. Sometimes students dance around a mathematical statement, leaving out the necessary rigor. At other times, students treat difficult mathematical ideas in a minimal, cursory way. In these same papers, students will expand *at length* about very simple ideas. More generally, we find that students have difficulty balancing exposition with symbolic statements. While we recognize that such balance requires a certain degree of mathematical maturity, we would like our seniors to make better progress.
3) *Lack of proof-reading*. Faculty discussed their concern about the fact that students, operating at the last minute, don't seem to be taking the time to clean up the final version of their papers. Again, this problem appears to be prevalent at both the intro-level and the upper-level. In fact, we spent much of our assessment meeting discussing ways to address the problem with future senior exercise papers. In the end, we decided that papers containing numerous typos would be "returned for proof-reading" at the draft stage. Faculty will not provide helpful feedback on a draft until it is a *clean* draft.

As we noted last year, we still find that our students are often times reluctant to be active readers of mathematics. There seems to be little attempt on our students' part either on the more micro scale (filling in details of proofs which

have been "left to the reader" – a common practice in mathematical writing) or on the more macro scale (synthesis of ideas, determining which were the truly vital or central points of an argument). Several of us noted that many students prefer to have the professor explain the mathematics to them.

B. *To prepare majors and minors for graduate study and careers which utilize mathematics.*

We have continued to do well in this regard. Feedback from recent graduates has been very positive, and Kenyon graduates pursuing academic careers are landing good jobs. At a time when many universities have had to freeze faculty positions, Kenyon graduates finishing up their Ph.D.'s in Mathematics this year have done fairly well:

Jan Cameron (Class of 1998) finished his Ph.D. in Mathematics at Texas A&M and accepted a tenure-track position at Vassar College.

Christine Breiner (Class of 1999) finished her Ph.D. at Johns Hopkins University and accepted a three-year post-doc at MIT. (Christine turned down a three-year post doc at the University of Pennsylvania and the opportunity to teach in a tenure-track position at Williams College.)

Eric Kahn (Class of 2004) finished his Ph.D. at the University of Kentucky and accepted a tenure-track position at Bloomsburg University in Pennsylvania.

Despite the success of our recent graduating classes, this year's senior class is the weakest we have seen in years (maybe even in the past ten years). Faculty have noted that math majors in the Class of 2009 were not as engaged in the department or in their coursework as other recent classes have been. None of the seniors earned distinction in Mathematics this year, and none of them pursued Honors. Only one (out of eleven) is heading straight to graduate school. Additionally, after a long-standing streak of placing well above the 99^{th} percentile nationally (as an aggregate) on the ETS Major Field Test in Mathematics, this year's class came in at the 95^{th} percentile. Given the extraordinary strength of last year's senior class and the recognition that performance levels come in waves, the faculty are not overly concerned about this dip in performance. Nonetheless, we think it is worth noting here.

C. *To foster quantitative reasoning skills, improve clarity of thought, increase mathematical awareness, and overcome math phobia and misconceptions for all our students.*

We continue to work with students at all levels on these goals. We have a number of courses in which overcoming math phobia is a central task, and two of these courses were

taught this year: Math 110Y-111Y (*Calculus with Elementary Functions*) and Brad Hartlaub's new course, Math 192 (*Statistics in Sports*). While Math 110Y-111Y has done wonders for students, increasing their quantitative literacy and repairing damage done in previous (badly taught) math courses, the enrollment this year was only 6. Students who are under-prepared in mathematics typically aren't willing to commit to a full year of college mathematics. Nonetheless, we feel strongly that a yearlong immersion is what is needed, and we would like to find ways to increase the enrollments in Math 110Y-111Y.

By all accounts, *Statistics in Sports* was a very successful course. Enrollments were high and the students were enthusiastic. According to Brad, the biggest challenge was in reaching the two different student audiences taking the course (one being the students taking the course for QR credit and the other being the students with an introductory statistics course already under their belts.) Reaching diverse audiences is always a challenge in the teaching of mathematics. In any case, we would like to be able to continue offering this course and are thinking of creative ways to make it happen. Perhaps we could cut back on the number of sections of Math 106 every other year to build room into our curriculum. Courses like *Statistics in Sports* not only increase quantitative literacy, they make students enthusiastic about mathematics.

D. To ensure that the department provide mathematical support to other disciplines and to meet the reasonable mathematical curricular needs of other departments.

I met with several faculty in Biology and Chemistry this spring to talk about how well the Mathematics Department is supporting their curricular needs. The feedback was generally positive, but faculty expressed serious concerns about the under-preparedness of many of their introductory students in the area of quantitative reasoning. In particular, faculty expressed concerns about students who cannot compute percentages or handle fractions. They get seniors in their spring offerings of QR courses who are weak in mathematics and who have avoided taking a QR course until their last semester on campus. Some are in danger of not graduating because of the QR requirement. Such avoidance behavior does not make for a healthy learning environment, and it is difficult to succeed in the sciences without a solid foundation in mathematics (the language of science). As we work to increase the number of first generation college students at Kenyon, we will need to provide more academic support for those who are under-prepared. Again, I think it is time that Kenyon thinks carefully about creating a more significant Math/Writing Center to provide the academic support that so many of our students need.

6. How has your department or program responded to the conclusions you have drawn from your assessment of your students' outcomes? Have you altered your courses or curriculum in any way, or are you contemplating doing so?

The senior exercise is always a topic of considerable discussion. This year the discussion focused on the relatively high number of students who submit papers without proof-reading them beforehand. In the past we have tried to address the problem by encouraging students to have a peer proof-read their work. While some students have taken our advice, the problem persists. The most concrete change made during this year's assessment discussion was the decision to give faculty the option to return a senior exercise paper at the draft stage of the process. If a student submits a draft containing numerous typos, we will return the paper for proof-reading and provide feedback only after the student has submitted a clean draft.

Another topic of continual discussion is how we can make Linear Algebra and Differential Equations into a more coherent two-course sequence. Because these courses feed into what we hope will become an applied math track, changes in this sequence cannot be addressed until we hire an applied specialist (the tenure-track replacement for Dana Paquin). Our attempt to hire a new person this year failed, so we will be searching again next year.

Finally, the Mathematics Department will be undergoing an external review in the Spring of 2010. Curricular issues of focus include the applied math track and how to balance the enrollment pressures in statistics with the need to offer a range of courses in applied and classical mathematics. Additionally, we are thinking about ways to increase enrollments in Math 110Y-111Y (Calculus with Elementary Functions).

7. Are your assessment tools proving adequate? Do you plan on modifying the list of tools used by your department to assess student performance?

By and large we are pleased with our tools. However, I found it difficult to address question #4 (identifying percentages to the competency levels of "key traits"). It doesn't make sense to me to change the way we report our results without letting faculty know in advance (i.e., at the beginning of the year.) It is hard to assign percentages to the competency levels of "key traits" without knowing in advance that we have to compute percentages. I didn't get the template for this report until after our department's assessment meeting, and we grade our senior exercise papers in the fall semester. So while I conferred with colleagues to answer this question in the most accurate way possible, my percentages are impressionistic. Assessment at Kenyon is starting to remind me of what I experienced at the Air Force Academy (which is not a good thing.) Assessment coordinators want hard data to allow for numerical comparisons over time. While the intentions are good, comparisons of numbers are not helpful when the numbers aren't meaningful. If we want hard data, then PLEASE…let's take the time to think about how we get this data, and let's give faculty a heads-up so we have time to collect meaningful data. Forcing a number at the end of the process for the sake of the number is not a good approach to meaningful assessment. Such an approach will make faculty cynical about assessment.

8. Have you made progress this year on problems that may have become evident through outcomes assessment in a previous year?

The biggest change that occurred as a result of last year's outcomes assessment meeting was the creation of a new Department policy for take-home exams. As we explained in last year's report, the Math Department makes significant use of take-home exams in upper-level math courses, because such exams allow us to test the students' ability to solve complex problems and proofs, as well as the students' ability to write up their results. Because take-home exams reflect the nature of mathematics in the "real-world", involving problems and proofs that require rumination and false-starts, we find the take-home exam to be an indispensable tool for both learning and the assessment of learning. Students are given an extended period of time, often 48-72 hours within a roughly 5-day window, and they are not to collaborate with each other. Despite our attempts to be clear about the "no collaboration" policy, we have found an increasingly casual attitude among our students to leaving work – everything from scratch work on paper or whiteboards to completed drafts – unattended in common areas for extended periods of time. The casual attitude of our students has led to multiple AIB cases over the past couple years.

In the fall the faculty met and created the following policy for take-home exams. (Actually, it is the second paragraph of the policy that is new. The first paragraph was already in place.)
Faculty members using take-home exams now include this policy - or something very similar to it - on the cover sheet of every exam. We believe the policy will help to hold students responsible for the reasonable security of their notes and drafts.

> *On this take-home exam, you are not to use any resources besides your textbook and class notes. This means, among other things, no consultation of other books, any online sources, or any people besides your instructor. You may ask me clarifying questions at any point, but beyond that you are on your own.*
>
> *You are also responsible for taking reasonable precautions to make sure your notes, drafts, and scratch work are not accessible to anyone besides you before the due date of the exam. This means, among other things, that you should not work on any whiteboards in public areas, that you should not leave paper with your work in cubbies or on tables in public areas, that you should not leave drafts on unattended computer screens or printouts unattended on public printers, and that you should not discard paper with your notes or draft work in public trash/recycle bins until after the take home exam is due.*