Quantitative Assessment Project: Annual Activity Report (2002- 2003)

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The University of Wisconsin-Madison Quantitative Assessment Project (QAP) seeks to help faculty to enhance the quantitative component of General Education at UW-Madison.[1] The QAP began in 1990 as the University's response to a Regent mandate to assess quantitative abilities of emerging juniors. With Madison's subsequent adoption of a general Quantitative Reasoning (QR) requirement, the QAP expanded its focus to General Education courses. Assessing the effects of the QR requirements over time is still one of our objectives, as well as monitoring undergraduate quantitative ability through examining courses carrying science distribution credit.

The heart of the QAP approach is a collaborative effort with one or more faculty members in some particular course, designed to identify quantitative abilities which will be assumed by the course, to assess the extent to which students have these abilities at the start of the course, and to provide immediately helpful feedback to both students and faculty on the result. From these individual collaborations, the QAP notes similarities in course expectations, in testing and feedback problems, in attempts to modify courses, and offers this experience to faculty who want to work to enhance their courses.

The pursuits of the Quantitative Assessment Committee have continued expanding in various directions. We continue to sample courses and match assessment closely to the requirements and expectations of instructors. However, we are using the information provided by the UW-Warehouse database to assess students and to help several departments (such as Pharmacy and Mathematics) to evaluate their prerequisites. We can go beyond grading tests and correlating them with the student's math background. We are now able to ask and answer questions with infoaccess that we could not do before, we can now follow and answer questions on students' progress, as you will see in this report.

We have continued with the assessment of the Math 130-131-132 series again. All three courses are taken by prospective future teachers, students in the School of Education and in the School of Human Ecology. We are now working on tracking these students' Math progress, and in summarizing the overall results on this assessment.

Finally, we continue increasing the number and type of contacts with departments throughout the university as well.

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[1] "General Education" is, broadly speaking, the part of education which is not specific to a departmental major.

Course Assessment Procedure:

Courses are selected the semester before they are assessed. We ask department chairs, deans, as well as course instructors to recommend courses that meet our criteria. Faculty members who have participated in the past may request another assessment or refer interested colleagues to us. If an instructor contacts us with quantitative concerns about a course, we try to include it immediately. Since assessing the effects of the QR requirements over time is one of our goals, we communicate with instructors slated to teach QR-B courses. Courses carrying science distribution credit have also helped monitor general undergraduate quantitative ability. We continue to include courses at the junior level in order to assess the quantitative preparation of students beginning core courses in their majors. These upper level courses typically involve the application of material from prerequisite mathematics and statistics courses to the subject material in the major, which has been covered more qualitatively in introductory courses. Some of these courses have been designated QR-B; others have QR-B prerequisites (such as calculus or introductory statistics) and demand a higher degree of quantitative ability.

A test is designed after meeting with the course instructor(s), examining the textbook, and looking over past course exams for quantitative content. We work with the instructor to design a pretest of skills which (a) students are expected to have at the start of the course, (b) will be used in the course, and (c) will not be explicitly taught in the course. Our draft of the test is revised by the instructor to focus on the topics of most concern to him or her. We emphasize that the test is not an assessment of the course or instructor, but of the instructor's expectations of the quantitative abilities of students enrolled in the course.

The test is given during the first two weeks of the semester, usually during lecture or in discussion sections. Its format is written answers, not multiple choice, in order to provide us with information on areas of specific student difficulty.

Graduate students from the Department of Mathematics, Economics and Engineering grade the tests, writing comments on each exam to help students understand their mistakes, and recording detailed information on student progress on each problem.

The graders record students' responses on a separate key so that we can return the tests to students immediately after grading, while we continue to analyze the results. In addition to the grader's comments, students are provided with solutions to the problems and references to specific sections of the common campus mathematical textbooks so that they can review necessary skills and address any deficiencies early in the semester.

A report of the results of the test, with a breakdown of the success on each problem, is provided to the course instructor, usually within two weeks of the test date. The detailed grading key prepared for each test allows us to analyze which topics cause the most problems for this group of students. The report also includes a summary of the mathematics and statistics courses taken by the students (what percentage has taken calculus, was there a large difference in performance based on previous courses taken, etc.)

By giving and returning tests early in the semester, students have a better understanding of faculty expectations, the importance of Math prerequisites, and the topics that they need to review in order to avoid problems later.

The report of results allows faculty to adjust for student ability, spending more or less time on certain topics or offering a review. Some departments have changed courses' mathematics prerequisites in response to student performance on these tests or upon reexamination of the quantitative content.

Note that we provide information only. Instructors in the course may decide to give students handouts on specific quantitative topics, or to hold review sessions or workshops. If they feel a more

systematic response is needed, they make changes in their syllabus or talk with their department about changes in course content or prerequisites. Any initiative for change in the course must be taken by the faculty involved in the course, not by the QAP. Some instructors choose to set up customized workshops, add review sessions, or provide handouts on specific quantitative topics. Changes in curriculum, course content, prerequisite courses, or additional workshops are the responsibility of the concerned faculty and departments. Neither the Quantitative Assessment Committee nor the Department of Mathematics interfere with their autonomy.

1. Assessment Activities 2002-20023

Thirteen courses were assessed by the quantitative assessment project during the Fall and Spring semesters. Tests were taken by 2144 students. More than 95% of enrolled students took the assessment test, reflecting a high degree of commitment from the involved faculty, as well as making the results a more credible measure of general student ability.

Courses Assessed –Fall Nine courses participated in the quantitative assessment project during the Fall semester. Tests were taken by 1358 students during the first two weeks of classes.

Food Science 440: *Principle of Food Engineering,* (15), applies quantitative methods from calculus to material introduced qualitatively in previous courses in the major. It is a prerequisite to the QR-B course offered in this department.

Economics 310: *Statistics: Measurement in Economics,* (118), Introduction to analysis of economic data. A QR-B course with Math 211 or Math 221 as prerequisites.

Pharmaceutics 352 (144): We will be giving assessment tests in the pharmacy school to students entering the Professional Pharmacy Program. This will help the Pharmacy School to design or require the necessary Math courses that their students will need to succeed in their program.

Math 130, 131, 132 are designed for future teachers and are open only to students in the School of Education and in the School of Human Ecology. These courses may not be used for satisfaction of degree
requirements within the College of Letters and Science.

Math 130 *Arithmetical Problem Solving. (56).* This course emphasizes problem solving and mathematical writing. Topics will be chosen from: rational numbers; decimals; logic and set theory; place value; scientific notation; number theory; functions and relations; exponentiation; algebra. Prerequisites: Intermediate Math competence (usually 3 units HS Math) & placement score, or Math 100 or 101.

Math 131 *Geometrical Inference and Reasoning.*(19). Discovery, conjecture, and proof through geometric explorations in the following areas: lines; polygons; formal constructions; tessellations; polyhedra; symmetry; rigid motions; length; area and volume. Prerequisites: Math 130 or cons inst.

Math 132 *Mathematical Models.*(91). Developing and using mathematical models to solve problems. (1) Using equations and algebraic and analytic tools; (2) probabilistic reasoning and descriptive statistics. Prerequisites: Math 130 & 131.

Math 117 & 221 *Calculus and Analytic Geometry (877).* Introduction to differential and integral calculus and plane analytic geometry.

EMA 521: *Engineering, Mechanics & Astronautics*: Aerodynamics (38). Math 234 is a prerequisite.

Courses Assessed – Spring Six courses participated in the quantitative assessment project during the Spring semester. Tests were taken by 786 students during the first two weeks of classes.

Math 130 *Arithmetical Problem Solving. (99).*
Math 131 *Geometrical Inference and Reasoning*. (85).

Math 234 *Calculus: Functions of several variables (505)*. Introduction to calculus of functions of several variables.

Math 541 *Modern Algebra (22)*

Consumer Science 657: *Consumer behavior* (14).

Psychology 210: *Psychometric methods (61):* Use of probability and Statistics in psychology.

Impact

The nature of our assessment procedure makes faculty more aware of the quantitative content in their courses. Many faculty were not aware of the degree of quantitative material and their assumptions of student proficiency until we interviewed them. Designing a test of expected skills causes them to focus on the importance of specific topics to applications in that course. Most faculty who participate in the project find that they do have specific questions about their students' quantitative abilities that our assessment can answer.

Over the last nine Fall semesters, Professor Rich Hartel has used an assessment pretest as part of his efforts to improve Food Science 440. The pretest has proved to be a good indicator of how well students do in the class. By identifying specific areas of difficulty, he has developed a workshop for students in this class to review necessary mathematical skills. Students improve their math skills while relating them to the course material. Professors Hartel, Howell, and Hyslop have written a workbook, *Math Concepts for Food Engineering*, based on their successful workshop. Another concern in their department was that many students took calculus their freshman year, but delayed technical Food Engineering courses until their senior year. Efforts have been made to include more quantitative reasoning in other Food Science courses, to reinforce Math skills throughout the curriculum. This year the prerequisite switched from Math211 to Math 221. This was a direct consequence to the results of our assessment test, the instructor realized that the students were not sufficiently prepared. It would be interesting in the future to see if that change tracks with greater success on the calculus portion of our exam. We are now using the data obtained during the last nine assessments to look for certain patterns in students' success.

We once again assessed the three courses in the Math 130 series in both semesters. We obtained similar results to previous semesters. In appendix A, one can look at the overall results for Math 130 for the last seven semesters assessed. Prof. Richard Asked has been greatly involved in the development of this test. At the national level, he is an advocate of better and deeper understanding of basic Math skills in the education of students as well as teachers. Our overall results have been reviewed and discussed by educators and mathematicians at recent national meetings in Washington D.C., with the hope of designing a better curriculum for future elementary school teachers.

The Department of Psychology has being working on an assessment program of their own. Their methodology was to ask students about their courses, and how useful had they been, especially for those who had already graduated. However, there was a need for the kind of assessment like the one we provide, specially for students who will study methodology and instrumentation. The instructor was pleased with our assessment and hopefully we will continue providing this service to them. Most of the students did very well on this test.

The School of Pharmacy contacted us to assess the students entering several of their professional and graduate programs. They continue actively using the data we provide to change their quantitative requirements and to require some students to take Math courses during the summer.

In Math 117 & Math 221, we gave the same test in both courses. We wanted to check how good is the placement test by looking at the difference in scores on the test between both courses. As expected, students in Math 221 did better than the students in Math 171. However, we are going to continue tracking these two groups and we will keep on working on these results.

2. Assessment using the Retention Database

A committee headed by Kathy Luker has developed a "Retention Database" which is part of Infoaccess. Joel Robbin served on this committee. Since the database has become available, the QAP has steadily increased its use of it. We have worked to answer several questions that have been posed to us by the Math Department.

A) They wanted to know if throughout the years there has been an inflation of the grades in the department. We made a table with the average grades per semester of all the courses in the last 15 years.

B) The undergraduate and honors' advisor in the Department of Mathematics wanted to know which students should place out of Math 221 and go directly to Math 222, and who should take Math 221, given their AB advanced placement score. Originally students who obtained a three or better on the test place out of Math 221 and could take Math 222. However our study of the data showed that students who obtained a three and took Math 221 performed much better in Math 222 than those who did not take it. When the students obtained a grade of four or five on the placement test there was not much difference in their performance in Math 222 whether they took Math 221 or not.

C) We analyzed the information obtained through infoaccess that tells us the number of students who took Math112 sometime from Fall 1992 through Summer 2001, and how many of them continued and took Math 221 and Math 222 sometime after Fall 1992 through Fall 2002.

First we analyzed all the students who took Math 112 during this period and we obtained the number and percentage who continued to Math 221 and Math 222. Then we separated the students by the time of the year they first took Math 112 (Fall, Spring or Summer), and we obtained the corresponding numbers. We wanted to know if there was a difference between these groups. Finally we became aware that 2.9% of the students who took Math 112 during this time repeated the course. Our report provides analogous numbers for these students.

Results:

10,836 students took Math 112 from Fall 1992 through Summer 2001. Out of these 10,836 students 1,368 took Math 221 (sometime after Fall 1992 through Fall 2002): **12.62%**. And out of these 10,836 students only 474 took Math 222 (sometime after Fall 1992 through Fall 2002): **4.37 %**

8,016 students took Math 112 for the first time in the Fall semester, from Fall 1992 through Fall 2000. Out of these 8,016 students 1,116 took Math 221 (sometime after Fall 1992 through Fall 2002): **13.9%**. And out of these 8,016 students only 376 took Math 222 (sometime after Fall 1992 through Fall 2002): **4.69%**

2,563 students took Math 112 for the first time in the Spring semester, from Spring 1993 through Spring 2001. Out of these 2,563 students, 224 took Math 221 (sometime after Spring 1993 through Fall 2002): **8.74%**. And out of these 2,563 students only 84 took Math 222 (sometime after Spring 1993 through Fall 2002): **3.28%**

257 students took Math 112 during Spring semesters from Summer 1993 through Summer 2001. Out of these 257 students, 28 took Math 221 (sometime after Summer 1993 through Fall 2002): **10.9%.** And out of these 257 students only 14 took Math 222 (sometime after Summer 1993 through Fall 2002): **5.45%.**

302 students repeated the course twice, and only 18 of these students took Math 221 (**5.96%**) and 6 took Math 222 (**1.99%**). Twelve students repeated the course three times. None of these students took Math 221 or Math 222.

D) Professor Milewski taught Math 221 last semester. Two hundred and eight hundred students took a free-response test with him during the first two days of class (September 3-4). He had three types of sections. The Biology section (this is a section for students who are majoring in Biology), the WES section and what we called the rest, students who were not on these two groups. We wanted to know how well our assessment test predicted how the students did on the course. We compared their score on the test vs. the grade they obtained. The test was designed to show the extent to which students had the mathematical skills useful for the course. The teaching assistants in the course graded the papers, recording information about steps students had taken when solving the problems. The graders also coded the *degree of success* achieved on each problem using the following scale:

A Completely correct
B Essentially correct—student shows full understanding of solution but makes a minor mistake
C Flawed response, but close to a correct solution (could do this type of problem with a little review or help)
D Took some appropriate action, but far short of a solution
E Blank, or nothing relevant to the problem

A test score was computed by awarding one point for each *A* or *B* code and zero points for each *C*, *D*, or *E* code. This score reflects the number of problems that each student had essentially or completely correct (this score was computed for all sections and each individual section). The maximum score for this test was nine.

The results are shown in the following tables.

TOTAL									
Score (The maximum score was 9)	A	AB	B	C	BC	D	F	TOTAL	AVERAGE
0	0	0	1	0	1	0	1	3	1.666667
1	0	0	1	2	4	2	2	11	1.636364
2	0	1	1	5	6	2	4	19	1.736842
3	1	2	7	4	7	6	3	30	2.066667
4	5	4	14	4	9	3	5	44	2.431818
5	5	1	9	8	9	2	3	37	2.445946
6	4	5	4	5	2	4	2	26	2.538462
7	12	3	11	1	1	0	0	28	3.428571
8	1	0	2	3	0	1	1	8	2.3125

9	2	0	0	0	0	0	0	2	4
Average score = 4.490385								208	2.423077

BIOLOGY									
SCORE	A	AB	B	BC	C	D	F	TOTAL	AVERAGE
0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0
2	0	1	1	0	0	1	0	3	2.5
3	0	0	2	0	1	2	0	5	2
4	0	0	1	1	2	1	0	5	2.1
5	1	0	0	0	2	0	0	3	2.6667
6	0	1	2	3	0	2	0	8	2.375
7	2	0	2	0	1	0	0	5	3.2
8	0	0	0	1	0	0	0	1	2.5
9	0	0	0	0	0	0	0	0	0
Average score = 4.9								30	2.45

WES									
SCORE	A	AB	B	BC	C	D	F	TOTAL	AVERAGE
0	0	0	0	0	0	0	0	0	0
1	0	0	1	0	0	0	0	1	3
2	0	0	0	1	0	0	1	2	1.25
3	0	1	2	1	0	0	2	6	2
4	2	0	4	0	1	0	0	7	3.142857
5	0	0	1	2	1	0	0	4	2.5
6	1	1	1	0	0	0	0	3	3.5
7	2	1	2	1	0	0	0	6	3.33333
8	0	0	0	0	0	0	0	0	0
9	1	0	0	0	0	0	0	1	4
Average score = 4.6666								30	2.8

THE REST									
SCORE	A	AB	B	BC	C	D	F	TOTAL	AVERAGE
0			1		1		1	3	1.666667
1				2	4	2	2	10	1.5
2				4	6	1	3	14	1.642857
3	1	1	3	3	6	4	1	19	2.105263
4	3	4	9	3	6	2	5	32	2.328125
5	4	1	8	6	6	2	3	30	2.416667
6	3	3	1	2	2	2	2	15	2.433333
7	8	2	7					17	3.529412
8	1		2	2		1	1	7	2.285714
9	1							1	4

Average score = 4.371622								148	2.341216

3. Plans

Most faculty members contacted about participating in quantitative assessment do so willingly and we perceive a greater enthusiasm on behalf of the faculty engaged in this project. As you can see in our report, we are asked to give an assessment test in some courses year after year given that the instructors find the information we are giving them useful.

However we keep investing some effort in increasing the visibility of our work both on and off the campus. This included initiating meetings with faculty in several departments, sending information about our work to faculty members in the UW System and at other institutions, speaking about assessment at mathematics organization meetings, and using email interest groups to make contacts about assessment.

Presently, we are working with people in the Department of Psychology, they have an ambitious assessment program and we are trying to help them with its quantitative part. We have also been in contact with faculty in other schools who are interested in our program, such as the Journalism School as well as the School of Engineering who are working with us.

We have received inquiries about our program by people from several institutions, among them: Mary Ann Baker from Indiana University, and James Bierden (Professor of Mathematics and Secondary Education at Rhode Island College). We shared our methodology with them, as well as some files with many of the question we use in our tests.

We have become more visible around campus and it is our hope that more people can use our services. The use of infoaccess is allowing us to ask and answer more questions about the students' performance. This has given us the ability to compose more complete reports.