April 5, 2020

QA Assessment Plan

BQAC. There are three courses offered by the Mathematics Department that satisfy the University's Quantitative Analysis (QA) General Education requirement and are most likely to be taken by, and designed with an eye toward, students who will not be enrolling in more advanced mathematics courses in a future semester. These three courses are MATH 1030, 1050, and 1090. In this plan, each of these three courses will be referred to as a BQAC, a Basic QA Course.

The BQACs have a reasonable amount of overlap in course material, which allows us to assess them collectively. It is the joint assessment of the three BQACs for purposes of satisfying the University's General Education QA requirement which is described below, but before that, we'll begin with a quick introduction to each of the individual BQACs.

Math 1030, Introduction to Quantitative Reasoning. In the calendar year 2019 (Spring, Summer, and Fall, 2019) we offered 21 sections of Math 1030 with a total enrollment of 1,082 students. The ELO's for Math 1030 are that, upon successful completion of Math 1030, a student should be able to:

1. Use Venn diagrams to examine relationships between sets and the validity of simple deductive arguments.

2. Use an appropriate sentence to describe both the absolute and percent change in a given quantity and interpret such statements about the change.

3. Use simple and compound units, making conversions when necessary, and develop accurate comparisons between units.

4. Evaluate the impact of compound interest on simple financial decisions.

5. Use the savings plan and loan formulas to calculate the payment amount into the savings plan when a certain financial goal needs to be achieved, to calculate the mortgage payment or interest paid over the life of the loan and

discuss whether those results are realistic (or not), compare several loans with different interest rates in order to make financial decisions.

6. Compare and illustrate the features of linear and exponential growth using practical examples.

7. Determine simple areas, volumes, and explain the differential effect of scaling on perimeter, area, volume as well as some of the practical implications of scaling.

Math 1050, College Algebra. In the calendar year 2019 we offered 22 sections of Math 1050 with a total enrollment of 1,358. The ELO's for Math 1050 are that, upon successful completion of Math 1050, a student should be able to:

1. Sketch the graph of basic polynomials (second and third order), rational, radical, exponential, logarithmic, and piecewise functions with or without transformations. Be able to identify important points such as x and y intercepts, maximum or minimum values; domain and range; and any symmetry.

2. For rational functions, identify x and y intercepts, vertical, horizontal and oblique asymptotes (end behavior), and domain. Use information to sketch graphs of functions.

3. For polynomial functions, identify all zeros (real and complex), factors, x and y intercepts, end behavior and where the function is positive or negative. Use information to sketch graphs.

4. Understand the connections between graphic, algebraic, and verbal descriptions of functions.

5. Given the graph of a function, be able to identify the domain, range, any asymptotes and/or symmetry, x and y intercepts, as well as find a rule for the function if it is obtained from a standard function through transformations.

6. Define i as the square root of -1 and know the complex arithmetic necessary for solving quadratic equations with complex roots.

7. Solve absolute value, linear, polynomial, rational, radical, exponential and logarithmic equations and inequalities.

8. Find the inverse of a function algebraically and graphically.

9. Perform composition of functions and operations on functions.

10. Understand sequences and be able to differentiate between geometric, arithmetic, and others such as Fibonacci-type sequences giving direct formulas where available.

11. Understand series notation and know how to compute sums of finite or infinite arithmetic or geometric series.

12. Solve systems of equations (3x3 linear) and non-linear equations in two variables.

13. Make sense of algebraic expressions and explain relationship among algebraic quantities including quadratic, exponential, logarithmic, rational, radical, and polynomial expressions, equations and functions.

14. Represent and interpret "real world" situations using quadratic, exponential, logarithmic, rational, radical and polynomial expressions, equations, and functions.

Math 1090, College Algebra for Business and Social Sciences. In the calendar year 2019 we offered 19 sections of Math 1090 with a total enrollment of 650. The ELO's for Math 1090 are that, upon successful completion of Math 1090, a student should be able to:

1. Graph and analyze quadratic, exponential and logarithmic functions; solve quadratic, exponential and logarithmic equations.

2. Understand what a mathematical function is and know how to use linear, quadratic, logarithmic and exponential functions to model real world examples.

3. Know how to solve a system of linear or quadratic equations that arise in business applications.

4. Find solutions to linear programming problems, to maximize a function over a geometric region.

5. Perform simple matrix algebra computations.

6. Use matrices to solve systems of linear equations.

7. Understand what an inverse function is and be able to find the inverse

function, when it exists.

8. Distinguish between simple and compound interest situations.

9. Calculate future and present value of annuities, and know when to use which formula for the life application.

10. Compute an amortization schedule and loan payments, such as automobile or mortgage payments.

Existing individual BQAC assessment. Currently, each BQAC has a faculty member of the Mathematics Department who serves as its course coordinator. The primary role of course coordinators is to ensure the effectiveness of their courses, and this includes assessing whether their courses satisfy their course ELOs. Each semester, course coordinators supervise a common final exam for all of the sections offered for their course, and almost all sections (there are exceptions sometimes for sections taught off our campus) are graded in common by the all of sections instructors. This group approach toward final exams gives course coordinators a good view of student outcomes each semester, and they make adjustments in their courses when they feel it would help. We have no plans to change these existing activities. Most of the BQAC assessment plan described below is a supplement to what currently exists.

BQAC ELOs. We have recently updated ELOs that apply to the BQACs as a group. They're naturally more general than the course specific ELOs above, since they cover all three courses at once, but they are detailed enough to begin to inform us of areas where our courses might be falling short. These ELOs are, that upon successful completion of a BQAC, we want our students to:

1. gain greater comfort in using mathematics to interpret real world events.

2. be comfortable with basic graphical and other visual tools used in mathematics.

3. understand the role of mathematical functions (including sequences).

4. be familiar with advanced algebra skills, such as finding solutions to exponential, logarithmic, or quadratic equations; matrix algebra; and finding solutions systems of linear equations.

Components of assessment. Our BQAC assessment plan has five components. We'll assess using final exam performance, by identifying students who've underperformed as measured by course grade, by collecting student feedback, by collecting instructor feedback, and by measuring increases in student knowledge as a result of completing courses. Each of these components is described below.

Assessment using final exams. Annually, in Fall semesters, we will collect data from the final exams taken by students in each BQAC.

Each question on the final exams will be classified as belonging to one of the four BQAC ELOs that were listed above. (If more than one applies, we'll choose the first in numeric order 1-4 that applies.) We will randomly select 20 students from each section of a BQAC taught (or all the students if less than 20 are enrolled) and we'll record for these 20 students, for each question on their exam, whether they wrote a satisfactory answer on their exam. (For the purpose of this assessment, "satisfactory" is interpreted to mean that the student demonstrated a general understanding of the concept being examined, though some minor error, say in arithmetic, may be present.) Each course instructor will provide a summary of the selected 20 students that consists of their semester course grade, and the percentage of satisfactory scores obtained by their students in each of the four categories of BQAC ELOs. Aggregate averages will be computed for all of the selected 20 students, and also for the subset of students with at least a B- course grade. (Particular attention will be paid to topics that are not being mastered by our highest performing students.)

The 20 students from each section will then be used to construct aggregate scores for each of the three BQACs, as well as an aggregate score for BQACs as a whole.

In each of the three BQACs, the sections with the highest, lowest, and median averages among the selected 20 students will be read by a common faculty member responsible for BQAC coordination. This will provide a good cross section of 180 exams (from about 1,300 total exams) that can be read to gain insight into student outcomes.

From this annual process, we'll be able to identify patterns that indicate how our instruction may be falling short. For example, if we notice that students seem to continuously misuse the quadratic formula, then we can develop new

strategies for our instructors to teach the quadratic formula.

In the long run, we also hope to be able to use this data to inform us about other matters. Internal to the Mathematics Department, we could perhaps use this material to assess individual instructors. We might also see if the results provide insights into whether student learning correlates to the time of day a class meets, the number of days per week that a class meets, the number of students enrolled in a class, the general quality of classroom used (does it really matter if a classroom is dimly lit?), whether it's an online course, or an off-campus course, etc.

Assessment of underperforming students. We want to make sure that our classes are serving all of our students, and not leaving students behind. We'll identify all students who score 80% on homeworks for the semester (a reasonable goal in these courses), participate in all exams and at least 80% of quizzes during the semester, and yet fail the course. If there are such students, we would want to understand their personal experience with the course as best we could, because we'd like to eliminate such occorances, if they exist.

Using the value of 80% as a cutoff in this assessment is a somewhat arbitrary choice. Hopefully over a little time we could adjust it lower, to a value that produces only a couple of students a year who are underperforming by this measure. Then we'd have a better feel for what is required of our students to succeed in our courses.

Assessment through student feedback. Every semester, we'll have students from each BQAC anonymously submit a yes/no answer to the following question: "Did this course provide you with tools or insights to better understand your world outside of this course?" We'll allow them to elaborate if they'd like.

If our BQACs are successful, then we'd expect a high percentage of students to reply positively. Then we'd try to increase that percentage over time.

Assessment through instructor feedback. Upon completion of a semester, each of our BQAC instructors will provide a short written opinion of specific material that they thought their students learned really well, and what they thought their students didn't learn as well as they would have liked them to. This will generate about 60 instructor opinions yearly. All responses will

be read with particular attention for agreement among instructors about material that our courses could improve in.

Assessment of increased knowledge. Upon completion of a BQAC, we want our students to know the essential material from their courses. However, we also want to make sure that they didn't know that material when the semester began. That is, we want to make sure that significant learning takes place in our classes. For this purpose, Math 1030 instructors have each of their students take a quiz on the first day of the course. The quiz is on material that the students will study during the semester, and a group of similar questions are asked on the final exam. Typically, students score about 25% on the day-one quiz, and about 65% on the corresponding collection of questions on the final exam. We'd like to continue to use this mechanism to measure student improvement.

Math 1050 and 1090 do not take a similar quiz at the beginning of the semester, but we think that's fine. Students enrolling in any BQAC have a similar mathematics background, and all BQACs have a reasonable overlap in material covered on the final, so using this tool only in Math 1030 still provides us with excellent data that we can apply to each of our BQACs.

Cross course coordination. Each BQAC – Math 1030, 1050 and 1090 – has an assigned course coordinator (a faculty member from the Mathematics Department), and the Director of Undergraduate Studies for the Mathematics Department assists in cross-coordination for these three courses. The assessments explained above will require cooperation between these four individuals, and in addition to that, these four faculty members will meet at least annually to collaborate on possible improvements for our BQACs, and to appreciate the general success of the courses.

As the bulk of information analyzed in our plan will be generated at the end of the fall semester, the annual meeting and improvement session will occur early in the Spring semester, no later than February. Annual reports of these assessments, if requested, will be available by March.

Implementation. All parts of this plan will be implemented by Fall 2020.