Mathematics Program, Assessment Cycle progress report

Introduction:

The Mathematics Department at Trinity Washington University consists of three full-time, tenured math faculty and three math specialists. This make-up is consistent with the group during the 2011 assessment cycle; however, we have had staffing changes. Mr. Kent Kraft (BA in Math, M.Ed., specializing in secondary math) joined our department as a full time specialist in August 2013 and James Gaines (BS in Architecture, MS in Applied and Computational Math) joined us as a temporary specialist for the Fall '15-Spring '16 academic year.

Since our last assessment document, the math department has seen many changes and updates to the program and curriculum. Extensive revision of our pre-foundational course, Math 101S, took place. We then further revised content and pedagogy in our foundational level courses by removing Math 101S from the curriculum and updating the remaining foundational level courses. This portion of our assessment cycle will address the changes that have been made, as well as data collected in regards to these changes.

Additionally, the math department received internal feedback on our last assessment document. There were several suggestions made in regards to our goals and our statements of those goals. We have updated our programmatic goals to ensure they are in line with collegiate and university-wide goals in light of the suggestions made by our colleagues.

Program Level Goals:

After feedback from our 2011 report, we updated our program level goals. We are also currently working on updating our course-level goals. Several instructors have begun generalizing our goals, making better distinctions between course level goals and student learning objectives. Two documents are attached: the first shows the alignment of our program level goals with our courses and course goals, the second shows the current set of course goals and student learning objectives for each course offered by the Math Department.

Our reformulated program level goals are as follows:

Goal 1:

Provide a foundation for critical thinking by developing skills in logic and problem solving in order to build student competencies essential to a liberal arts education.

Goal 2:

Develop the ideas of thinking independently, critically, and creatively while providing a solid mathematical foundation for students intending to major in math or continue on to an advanced degree in mathematics.

Goal 3:

Teach students to think and analyze critically, armed with statistical savvy, to validate and/or question data uncovered through various means in daily life.

Goal 4:

Give students the mathematical knowledge necessary to pursue a degree in education through coursework specifically geared towards educations requirements/credentials.

Goal 5:

Prepare students for careers in business, government, social sciences and industry specifically through applications relevant to these courses of study.

Goal 6:

Provide a solid foundation of mathematical skills to students studying nursing and the allied health professions specifically through applications relevant to these courses of study.

Goal 7:

Provide students with the mathematical knowledge necessary to pursue a degree in Chemistry or Biology, specifically through applications relevant to these courses of study.

Curriculum Map:

To complete a curriculum map, the Math department first created a set of Program Learning Outcomes for degree seeking students. The curriculum map is attached to this document. The Program Learning Goals are as follows:

Students completing the BS in Mathematics degree program will be able to:

1. Graph and describe properties of a variety of functions (including trigonometric, exponential, logarithmic, polynomial, and rational)
2. Define and apply fundamental concepts of calculus (including limits, continuity, differentiability, and integration)
3. Solve problems and applications in a variety of advanced mathematical courses
4. Use technology to enhance/complement problem solving
5. Apply concepts of set theory to understand and prove concepts of mathematics
6. Apply axiomatic approaches to the development of mathematics
7. Read, understand, and formulate proofs in mathematics
8. Communicate complex mathematics orally and in writing

The attached curriculum map outlines where each of these skills are introduced, developed, and mastered in the math major courses.

Current Assessment Projects:

In this section, we include a description of a few assessment projects that are in progress.

1. The use of MyMathLab or MyStatLab in foundational level courses

Since our last assessment, the department has collected data and begun analysis on the use of the MyMathLab (MML) and MyStatLab (MSL) programs in our Math 101S, Math 110, and Math 123 courses.

A. Math 101S:

MyMathLab is an integral part of the Math 101S course. Its use has allowed for standardization of the course over several sections and instructors. This tool also provides instant feedback and help features for the students. The key features for instructors include an easy to use gradebook, the ability to see which homework questions the students are struggling with the most (either by time spent or score earned), and an item analysis of all assignments which shows the instructor how the class performed on each question in the assignment. Data was not collected in order to specifically address the question of whether or not these features directly impacted student learning outcomes, though the general success of the Math 101S course is connected in part to the standardization and the ability to test students with many homework assignments that simply could not have been graded efficiently, with feedback to the student, if it were done by hand. There have been many student comments on course evaluations, however, in which the students express the benefits of MML.

B. Math 110:

Math 110 uses MSL and StatCrunch as the platform that students use for data analysis. This is a shift from the early introduction to SPSS that used to take place in Math 110. This change brings consistency among several sections of the Math 110 course, especially since many adjuncts work on this course. Additionally, SPSS is only required of students who take that Math 210 course. By using StatCrunch, the students have a user-friendly interface, as well as a platform that is accessible from any computer, not just the school computer labs. Additionally, a new book was chosen for Spring 2015, in part to better utilize MSL. The new book offers more online questions and opportunities for student practice. Finally, we are continuing to work within the structure of MSL to best help students. Math 110 is not standardized, allowing the instructors to use different methods within the framework of the course. One instructor has turned off most of the help features and requires students to turn in handwritten notes that accompany the online quizzes. Another instructor has included several small open-ended data collection projects that are easily analyzed by the students through StatCrunch.

C. Math 123:

Math 123, precalculus, is the highest-level math course that uses MML. One challenge in this course is to reduce the dependency that many students have developed surrounding the MML system. Specific challenges include whether or not MML results in inflated HW scores, which in turn might have an effect on overall course grades and student preparation for Math 125, Calculus I.

2. *Updates to courses*

A. Math 101S, 102, 108, and 109

Math 101S has seen extensive revision since 2011. Dr. Kerry Luse and Mr. Joseph Sheridan have presented the results of this revision at two different conferences. The abstracts for each of the talks and the subsequent paper that was submitted is attached to this document. These talks and paper outline all of the steps taken to standardize Math 101S, including the use of MyMathLab and mastery grading on several components of the course. The course developed into a "hybrid" of a standard lecture course and flipped classroom, making use of an additional lab timeslot to allow our students the chance to demonstrate their abilities in the class, building self-efficacy and bonds between students. The main results of our assessment indicated that, for those students who completed the course, our pass rates were much higher than the national average in introductory algebra courses. Unfortunately, however, the course also represented an obstacle to retention of students. Furthermore, an assessment of the algebra needs of other departments revealed that the introductory algebra course was, at times, drilling students on algebra concepts that are not required for their specific course of study. For these reasons, a decision has been made to remove the Math 101S course from the curriculum, instead placing our resources into three quantitative reasoning courses geared towards the humanities, health science and education, and STEM disciplines.

The new foundational level courses (102, 108, 109) will better serve our students by teaching them specifically the algebra they need to know as it relates to their major course of study as well as integrating the algebra into a foundational (as opposed to pre-foundational) level course, thus helping to retain students. A feature of these courses will be in-context activities which will stress the importance and applicability of the specific math skills during the course of the semester. These courses are currently being developed for the Fall 2015 semester. The math department intends to create these courses with built-in assessment features so that we can determine how well the courses are meeting our student needs. Specifically, data will be collected during Fall '15 and Spring '16 with the first formal review of these courses taking place during summer 2016. The courses are being designed with a pair of pre-tests and post-tests. The first includes pre-foundational material that will be covered in some pre-requisite homework and in class/office hours as needed. The second includes course material. We hope to be able to see improvement in both areas. We will also use a common final exam across all sections of the foundational courses. Student performance on this exam will be used to assess what content the students have mastered as well as give an indication of whether or not the in context activities helped students retain knowledge during the course of the semester.

B. Math 110 and Math 210:

The content and objectives of Math 110 have been revised. In order to make sure the course was meeting needs of students, we picked a new textbook (as described above) and increased the course content. We believe the additional content will meet the needs of our students better, in particular, our pre-nursing, forensic science, and pre-medical students. These groups of students are required to take a single statistics course, but the needed statistical objectives were divided between Math 110 and Math 210. The content changes were made partly with this issue in mind. The updates to Math 110 will impact the course content in Math 210 going into the Fall 2015 semester.

Data and Analysis:

1. Usefulness of MML in Math 123

One of our assessment projects was completed during the summer of 2014. Dr. Luse conducted a study on the use of MyMathLab (MML) across several Math 123 sections.

Assessment of MML in Math 123 (Dr. Luse)

The main question addressed in this assessment is driven by the observation that many students in several of my Math 123 (pre-calculus) classes had very high homework scores, with lower test scores. In the Fall 2012 semester, 10/18 students had a 10-20 point gap between their homework averages and their test averages, while 4/18 students had a gap larger than 20 points. These students were ultimately successful in Math 125 (Calculus), however, I was curious about exploring a few different ways to adjust this discrepancy. In particular, I was worried that inflated homework scores were making it seem as though students were better prepared for their next class than they really were. I wanted to see if the gap between homework averages and test averages had a significant impact on final grades. That is, if I placed less weight on the homework category, would there be a significant difference? To that end, I wanted to explore the effect on overall grades if the gradebook weights were changed, as follows:

Participation: stayed at 5%
HW: 20% to 15%
Quizzes: 10% to 15%
Tests: stayed at 45% (12.5% for each test, 2.5% for each set of test corrections)
Final Exam: stayed at 20%

The only change is the balance between homework and quizzes. I also wanted to explore whether or not some of the extra help features in MyMathLab may contribute to students getting very high homework averages without fully mastering the content. In an effort to achieve more balance, homework (which is completed online with instant feedback and several help features, including multiple attempts) and quizzes (which much be done by hand, showing all work, and are graded by me) would be weighted the same. More quizzes were added throughout the semester, and students must show work in support of all of their answers.

The data collected while preparing this analysis shows how final grades would be affected by these changes. It also helps to evaluate changes made to the homework sets in MyMathLab (described below). In particular, by tracking the homework scores in relation to quiz/test scores, I am able to consider if homework contributes to high exam scores or if it is not an accurate predictor of exam performance.

MyMathLab is used for homework assignments and the gradebook feature. Students are also able to use the study plan if they desire. At the start of the Spring 2014 semester, I made some changes to how I use the MyMathLab system for homework. In particular, for each assignment, students were given 3 attempts per problem, with less help features. I allowed the students to "view an example", "view the textbook", "view videos", and "ask the instructor"; however, I did not let them use the "help me solve it" feature. Each assignment had a due date, with students permitted to work on the assignments late, with a 2% penalty per day late. All assignments had a final due date on the day of the exam testing that unit of material. My goals were to reduce the dependency on the computer help features and to encourage the students to complete the assignments before an exam, while still making use of the excellent features of MyMathLab and allowing for some flexibility in the due dates. I hoped to see homework scores that followed more closely in line with test scores. That is, I sought an answer to the following question: does a good MML homework average accurately predict success on an exam?

The data from Spring 2014 shows that 6/8 students had a 10-20 point gap between their homework averages and their test averages, and 2/8 students had a gap larger than 20 points. From this data, it appears that the changes made to MyMathLab did not have an impact on the homework-test gap. I will continue to work on ways to use the MyMathLab system to identify whether or not the homework scores are artificially high, and whether or not this is ultimately an issue.

The data presented above are shown in the tables below. I pulled the homework, quiz, and test averages, and final grades for my Math 123 students. I also calculated final grades with adjusted weights, the difference in the final grades, new letter grades, and the HW-Test gap for each student. I also included grades earned by the students who went on to take calculus (not available for Spring 2014). I collected data for the two semesters discussed above, as well as for Fall 2011.

Fall 2011:

Student	HW ave	Q ave	T ave	Final %	Final Letter	Adj Final %	Diff in final %	New Letter	hw-test gap	Calc grade
1	99.7	81.3	77.4	81.9	B-	80.96	-0.94	B-	22.3	D+,[B+]
2	92.8	88.8	83.3	86.6	B+	86.385	-0.215	B+	9.5	B
3	77.2	61.3	39.1	50.0	F	49.19	-0.81	F	38.1	
4	99.4	95	78.7	85.5	B	85.315	-0.185	B	20.7	
5	100	83.8	53.4	66.1	D+	65.28	-0.82	D	46.6	
6	99.9	98.8	86.6	91.1	A-	91.095	-0.005	A-	13.3	A-
7	82.4	83.8	77.2	79.1	B-	79.11	0.01	B-	5.2	
8	99.3	87.5	75.8	82.9	B	82.29	-0.61	B	23.5	C

9	96.8	75	47.5	60.7	D[1]	59.645	-1.055	F	49.3	W
10	99.4	98.8	74.7	83.3	B	83.285	-0.015	B	24.7	
11	62.5	90	54.9	62.2	D	63.56	1.36	D	7.6	F
12	76.5	62.5	58.2	64.4	D	63.68	-0.72	D	18.3	
13	96.4	87.5	70.4	77.8	C+	77.345	-0.455	C+	26	C-
14	96.3	92.5	79.9	84.4	B	84.255	-0.145	B	16.4	C-
15	97.9	96.3	88.2	91.5	A-	91.46	-0.04	A-	9.7	A-
16	100	95	96.2	96.0	A	95.78	-0.22	A	3.8	
17	97.2	78.8	71.4	79.0	B-	77.81	-1.19	C+	25.8	
18	81.7	90	75.7	79.6	B-	79.96	0.36	B-	6	C+
19	94.7	73.8	63.7	72.7	C	71.68	-1.02	C-	31	P
20	99	92.5	87.2	90.8	A-	90.405	-0.395	A-	11.8	
21	98.8	68.8	52.3	63.6	D	62.135	-1.467	D	46.5	F, [B+]
22	83.3	80	63.7	69.6	C-	69.4	-0.2	C-	19.6	F, [W]
23	98.3	87.5	83.5	87.7	B+	87.145	-0.555	B+	14.8	C

Fall 2012:

Student	HW ave	Q ave	T ave	Final %	Final Letter	Adj. Final %	Diff in final %	New Letter	hw-test gap	Calc grade
1	12.308	52.7	24.6	29.1	F	31.085	1.985	F	-12.292	
2	100	95.3	89.3	90.1	A-	89.861	-0.239	A-	10.7	A
3	99.956	84.3	84.6	86	B+	85.197	-0.803	B	15.356	B
4	97.512	75	76	76	C+	74.904	-1.096	C	21.512	
5	92.348	86	79.1	82.7	B	82.352	-0.348	B	13.248	
6	95.252	83	83.5	83.2	B	82.585	-0.615	B	11.752	B
7	96.212	87.3	72.9	76.2	C+	75.765	-0.435	C	23.312	
8	96.484	93	83.4	83.6	B	83.405	-0.195	B	13.084	A
9	97.944	84	83.8	82.4	B	81.682	-0.718	B-	14.144	B+
10	50.116	73	65.7	62.4	D	63.562	1.162	D	-15.584	
11	98.242	89	74.8	77.9	C+	77.406	-0.494	C+	23.442	C
12	93.804	79	82.1	83.3	B	82.598	-0.702	B	11.704	B-
13	99.585	92	85.5	89.1	A-	88.705	-0.395	B+	14.085	B
14	78.696	68.3	31.1	53.9	F	53.385	-0.515	F	47.596	
15	99.712	91.3	95.3	94.2	A	93.758	-0.442	A	4.412	A-
16	82.116	80.3	68.3	75.2	C	74.358	-0.842	C	13.816	D
17	96.172	91.7	78.3	77.6	C+	77.39	-0.21	C+	17.872	C+

[1] In Fall 2011, a grade of 60% was a D. In future semesters, final grades below 62% are F's.

18	99.248	92.3	95.2	93.3	A	92.911	-0.389	A-	4.048	B+

Spring 2014:

Student	HW ave	Q ave	T ave	Final %	Final Letter	Adj. Final %	Diff in final %	New Letter	hw-test gap
1	99.9	96.7	81.7	87.5	B+	87.3	-0.2	B+	18.2
2	98.9	93.3	91.7	93.2	A	92.9	-0.3	A-	10.7
3	99.9	90.8	90.6	92.7	A	92.2	-0.5	A-	15.356
4	82.1	50.8	44.1	53.4	F	51.9	-1.5	F	21.512
5	93.3	72.5	57.6	65.9	D	64.8	-1.1	D	13.248
6	99.5	77.5	66.1	73.6	C	72.5	-1.1	C	11.752
7	98.4	80	58.4	69.4	C-	68.4	-1	D+	23.312
8	97.7	88.3	78.4	83.8	B	83.4	-0.4	B	13.084

As indicated in these tables, changing the weights has very little impact on final grades. In only a few instances are there significant changes in a final grade. For example, in the Fall 2011 data, there are two students with significant grade changes. Student #9 earned a D, but with recalculated grades would have earned an F. This grade calculation change is consistent with the overall grading scale currently in place in my Math 123 courses; specifically, below a 62% is now an F. This student in particular had a 41% on the final exam, and so a passing grade of D was not an accurate indication of being able to move forward. Indeed, the student ultimately withdrew from the calculus course (notice, we do not actually recommend that a student with grade below C take the next course in the calculus sequence). Student #19 would have seen a grade change from C to C-. She went on to take calculus P/NP (and received a P). In the Fall 2012 data, no students had significant grade changes. For Spring 2014, the most significant letter change was a C- to D+, for student #7. This student also had the largest hw-test gap, at 23.312 points. She stopped coming to class for a period of at least one full week, while she considered dropping the class. Ultimately, she stayed in the class but changed her major. She took statistics over the summer, and enrolled in Math 210 (statistical inference) for Fall 2014.

While completing this analysis, I asked myself what student goals are accomplished through homework? If there is no significant difference in overall grades if I make a slight alteration in the category weights, perhaps the role of homework is to give students a low stress, confidence building place to work on the concepts, while at the same time giving their overall grades a slight boost.

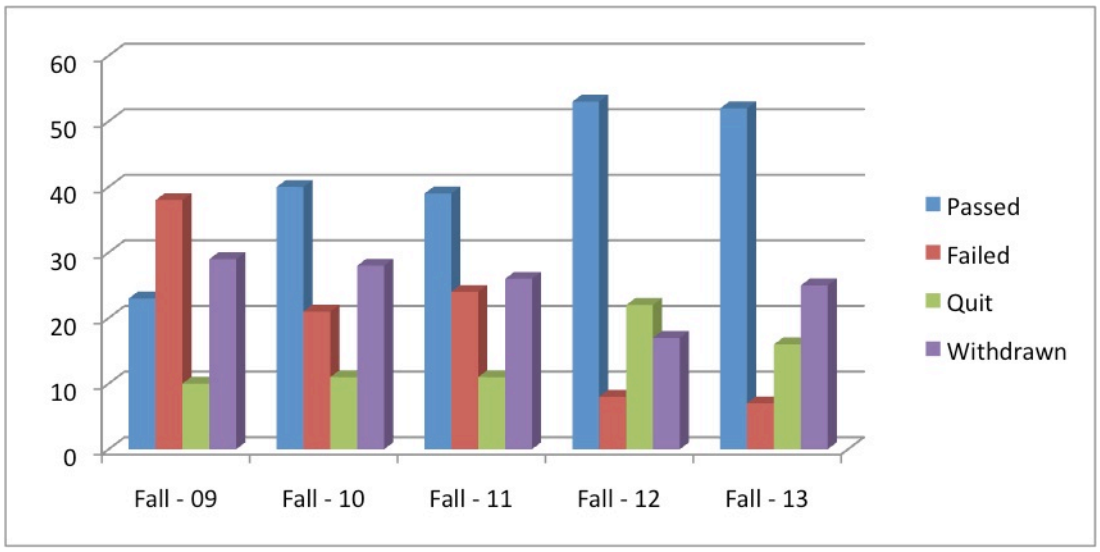
While I continue to reflect on this question, and overall best practices for using MyMathLab effectively, I plan to use the even category weights for homework and quizzes to continue

studying the impacts. In particular, I will focus my attention on the role of quizzes. Additionally, I will continue to use the MyMathLab gradebook to keep track of homework-test gaps using the 20-point gap benchmark for early interventions with my students and their advisors.

2. Updates to courses

Data collection driving the updates to the foundational level courses

Routine assessment of the foundational level courses is completed by the Math Specialists in year-end reports. While evaluating Math 101S, it was observed that the revised course showed much improvement in pass rates, but drop-out/withdrawal rates that were higher than we would like.



One conclusion drawn from the data is that students who complete the course (meaning they complete all course requirements including the final exam) pass the course and register for classes the next semester. However, there are many students who do not complete the course. In trying to answer the question of why these students aren't completing the course, the Math Specialists, Math faculty, and CAS Dean worked together to develop a new approach. A decision was made to remove the Math 101S course from the curriculum while preserving some of its best student-serving features (such as extra class meetings, use of MyMathLab software, optional study sessions) in the remaining foundational level courses.

The decision was based on three main criteria:

1. Evidence suggesting that students who are placed into remedial math courses are less likely to return
2. Evidence suggesting that students who are given context driven information related to their intended major are more engaged and therefore more likely to succeed and re-enroll

3. Evidence suggesting that Math 101S contained more algebra than may be required by the major programs at Trinity

In order to assess the algebra needs by major at Trinity, Dr. Ramamurti met with representatives from all departments. The algebra needs (as reported by our colleagues) are summarized in the attached tables.

Revision of Math 102 for STEM majors, Math 108 for pre-nursing and education majors, and Math 109 for humanities majors took place during the summer of 2015. Some of the key features are the inclusion of context-driven activities designed to show the usefulness of the mathematics to the students and "just-in-time" algebra help for students that are struggling with pre-algebra concepts. The new courses were taught for the first time in the fall of 2015 and we will begin assessment of these courses during the summer of 2016.

Conclusions:

Many of the Department's assessment projects were put on hold or altered due to the removal of Math 101S and our focus on the re-design of the other foundational level courses. Our next assessment cycle will involve our initial review of the new courses. We also hope to come back to our assessment of the statistics courses, Math 110 and Math 210. These courses were both updated and adjusted using a new textbook. Future assessments will consider the effectiveness of these changes on student learning outcomes.