Department of Mathematical Sciences
Assessment Report for 2013 - 2014
Bachelor Arts in Mathematics
Submitted January 15, 2015 to the Office of Institutional Research and Assessment
By Shelly M. Jones, Ph.D., Math Department Assessment Committee

Program Assessment Question	**Response**
1) **URL**: Provide the URL where the learning outcomes (LO) can be viewed.	http://www.math.ccsu.edu/hive/pdf/Learning%20Assessment%20Reports/Assessment_Math_BA.pdf
2) **Assessment Instruments**: For each LO, what is the source of the data/evidence, other than GPA, that is used to assess the stated outcomes? (e.g., capstone course, portfolio review and scoring rubric, licensure examination, etc.)	Each Degree Program Learning Outcome (DPLO) has a set of 3-4 course level learning outcomes that Instructors use to determine the DPLO performance level for each student. Problem sets, in class exams and the final exam are used to determine performance levels.
3) **Interpretation**: Who interprets the evidence? (e.g., faculty, Admn. Assistant, etc.). If this differs by LO, provide information by LO.	Members of the Department's Math Assessment Committee are responsible for the interpretation of the evidence. The results are also shared with Instructors (Adjunct Faculty and Assistant/Associate/Full Professors) who teach the courses selected for the Degree Program Assessment.
4) **Results**: Since the most recent full report, state the conclusion(s) drawn, what evidence or supporting data led to the conclusion(s), and what changes have been made as a result of the conclusion(s).	Assessment results continue to meet the expectations of the Math Department with a majority of students having *Acceptable* and *Strong* performance on the Degree Program Learning Outcomes. Starting in Fall 2014, the math department will require students to take MATH 218 before MATH 377 because two of the four Learning objectives relate to "proving" statements, and the course that introduces students to proofs is MATH 218.
5) **Strengths**: What about your assessment process is working well?	The Mathematics Department has gone from no data collection a few years ago to more consistent data collection over the last two years. We piloted a new rubric for Math 450, the last course students take in the BA degree program.
6) **Improvements**: What about your assessment process needs to improve? (a brief summary of changes to assessment plan should be reported here)	Collecting data from the capstone course would increase the ability for the department to analyze the success of the program as well as make needed changes to the program. A more uniform way is needed at the course data collection level. To make data collection more consistent, the department needs to consider adding common final exam assessment questions and/or use of rubrics in selected courses.

Preamble

Department Mission

Consistent with the mission of the University, as a “community of learners dedicated to teaching and to scholarship,” the Department of Mathematical Sciences serves the mathematical needs of many different student populations. The Department enables students who are under-prepared for college level courses to succeed through a sequence of developmental mathematics courses. It contributes to the general education program by offering college level mathematics and statistics courses for all majors throughout the University. It provides service courses for specialized degree programs in engineering, computer science, education, psychology, business, and other disciplines. It is responsible for the mathematics content and methods courses for pre-service and in-service teachers at all grade levels. It offers appropriate mathematics courses for mathematics majors at the undergraduate and graduate levels including those specializing in statistics, actuarial science and data mining. It provides online courses, particularly for its totally online MS data-mining program. In addition to meeting the needs of current CCSU students the Department also strives to maintain connections with its graduates, those who are teaching in Connecticut schools as well as others in applied fields. The Department encourages the development and application of knowledge and ideas through its support for research, as evidenced by its weekly colloquium. It upholds the University’s commitment to community engagement through its outreach to schools and other institutions in the region we serve as well as its historic commitment to improving mathematics education in the Caribbean.

Bachelor Arts in Mathematics

The BA program in the Department of Mathematical Sciences is designed to give students a deep understanding of the foundations of mathematics. Students will study a variety of mathematical disciplines, including discrete mathematics, analysis, and algebra, and are expected to be able to understand sophisticated mathematical ideas by the conclusion of their studies. The capstone experience is a semester spent studying proof techniques. Graduates should be able to continue their studies in either Master's or Ph.D. programs, or enter the workforce in jobs requiring sophisticated quantitative skills.

Section 1: Learning Outcomes

Table 1. Learning Outcomes and Curriculum Map

	Learning outcomes	**Addressed in these Courses**	
1.	Understand basic analytic arguments using such common notions as epsilon/delta, infinite sums, and limits.	MATH 152 Calculus I	MATH 221 Calculus II
2.	Understand basic algebraic and discrete notions, such as facts about vector spaces and counting arguments.	MATH 218 Discrete Mathematics	MATH 228 Introduction to Linear Algebra
3.	Be able to follow and recreate algebraic proofs, with a good understanding of groups.	MATH 366 Introduction to Abstract Algebra	
4.	Be able to both follow and recreate analytic proofs, including basic ideas involving abstract metric spaces and differential equations.	MATH 377 Introduction to Real Analysis	
5.	Be able to independently investigate more advanced topics in mathematics and present their results to others in a clear way.	MATH 450 Seminar in Proof (Spring semester only)	

Table 2. Degree Program Learning Outcomes.

	Learning Outcomes **By the time of graduation, a student will be able to: (Please state in measurable terms).**	**Assessment Measures** **List at least two for each outcome, one of which should involve direct evidence of learning.**	**Indicate when and how often the measure(s) for this learning outcome will be implemented.**
1.	Understand basic analytic arguments using such common notions as epsilon/delta, infinite sums, and limits	Problem sets, in class exams and the final exam.	Every semester during class.
2.	Understand basic algebraic and discrete notions, such as facts about vector spaces and counting arguments.	Problem sets, in class exams and the final exam.	Every semester during class.
3.	Be able to both follow and recreate analytic proofs, including basic ideas involving abstract metric spaces and differential equations.	Problem sets, in class exams and the final exam.	Every semester during class.
4.	Be able to follow and recreate algebraic proofs, with a good understanding of groups.	Problem sets, in class exams and the final exam.	Every semester during class.
5.	Be able to independently investigate more advanced topics in mathematics and present their results to others in a clear way.	Performance in a capstone class and on a final capstone presentation.	Once during senior year.

Section 2: Findings

To collect data each semester, the Department of Mathematical Sciences makes a request to the Office of Institutional Research and Assessment (OIRA) for student rosters of all courses required of the Mathematics BA major (see curriculum map shown above in Table 1). OIRA sends the department an Excel workbook of courses/student rosters, which is subsequently sent to full-time and part-time faculty members teaching those courses. The faculty members submit data on learning outcomes specific to the courses they teach (Appendix A). The Course Learning Outcomes (CLOs) are aligned to the five Degree Program Learning Outcomes (PLOs) seen above in Table 2. Over the first full year of data collection, 2011 – 2012, we collected data for all BA and BSED Mathematics majors only. Since then we've extended the data collection to include all students enrolled in the courses listed above in Table 1. The rationale for extending the data collection was to include more students to ensure student privacy as the reporting numbers (*n*) for the BA and BSED majors were very low in many sections of the courses.   Students are rated for each Course Learning Outcome and that information is used to determine the student's rating for the associated Degree Program Learning Outcome. The ratings are as follows: (2) Strong Performance of the Learning Outcome; (1) – Acceptable Performance of the Learning Outcome; (0) – Does Not Meet the Learning Outcome. Table 3 below shows a summary of the number and percent of students at each performance level for each Degree Program Learning Outcome. The courses assessing each DPLO are bulleted and listed below the learning outcome. See Appendix C for findings specific to the Course Learning Outcomes.

Table 3. Findings for Degree Program Learning Outcomes

	Number and Percent of Students at each Level (2, 1, 0)											
	Fall 2011/Spring 2012			Fall 2012/Spring 2013			Fall 2013/Spring2014					
Program Learning Outcomes	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**			
1. Understand basic analytic arguments using such common notions as epsilon/delta, infinite sums, and limits												
• Math 152	3 (75%)	1 (25%)	0 (0%)	14 (30%)	22 (48%)	10 (22%)	19 (46%)	12 (29%)	10 (25%)			
• Math 221	1 (10%)	5 (50%)	4 (40%)	10 (21%)	35 (75%)	2 (4%)	2 (5%)	23 (52%)	19 (43%)			
2. Understand basic algebraic and discrete notions, such as facts about vector spaces and counting arguments.												
• Math 218	1 (8%)	8 (61.5%)	4 (31.5%)	4 (36%)	7 (64%)	0 (0%)	9 (33%)	13 (48%)	5 (19%)			
• Math 228	12 (40%)	18 (60%)	0 (0%)	7 (41%)	10 (59%)	0 (0%)	15 (37.5%)	22 (55%)	3 (7.5%)			
3. Be able to follow and recreate algebraic proofs, with a good understanding of groups.												
• Math 366	12 (28%)	25 (58%)	6 (14%)	NR	NR	NR	8 (31%)	14 (54%)	4 (15%)			
4. Be able to both follow and recreate analytic proofs, including basic ideas involving abstract metric spaces and differential equations.												
• Math 377	1 (6%)	11 (69%)	4 (25%)	NR	NR	NR	6 (27%)	12 (55%)	4 (18%)			
5. Be able to independently investigate more advanced topics in mathematics and present their results to others in a clear way.												
• Math 450							9 (53%)	8 (47%)	0 (0%)			

Section 3: Analysis

Degree Program Learning Outcomes.

The data submitted for the most recent (2013-2014) Degree Program Learning Outcome #1 show that most students (66%) performed at least at an *Acceptable* performance level with 25% of students excelling by earning a *Strong* performance level of two. The department should however take caution that one third of the reported students are having trouble with DPLO#1. In addition, 43% of the students reported on in Math 221 performed at an *Unacceptable* level and the number of students performing at an *Unacceptable* level increased from one year to the next. This may be problematic and needs to be addressed if it continues to be a trend.

When students are performing at an *Unacceptable* level for a Degree Program Learning Outcome, faculty is able to look more closely at the Course Learning Outcomes for possible causes. By having both Course Learning Outcomes and Degree Program Learning Outcomes, faculty is able to pinpoint the problem at the course level and address it in subsequent semesters in that particular course. For example, when looking at the Learning Outcomes for Math 221, we see that students are having trouble with all three learning outcomes but especially with LO#2: Students will be able to determine convergence of sequences and series. Faculty will be asked to look more deeply at this LO to determine its importance to the program and whether or not course material needs revising to address over 50% of the students performing at an *Unacceptable* level. In addition, having more than one course for assessing a DPLO is helpful in seeing growth as students proceed to more complex courses.

The number of students assessed for DPLO #2 is fewer than that for DPLO #1 because there are fewer non-math majors in Math 218 and Math 228. The performance levels for DPLO #2 are good with 88% of students scoring at or above an *Acceptable* performance level, 24% have a *Strong* performance and only 12% perform at an *Unacceptable* level. The number of students reported on from last year to this current year (2013-2014) has increased from N = 28 to N = 67. The number of students at the *Unacceptable* level also increased from last year (0%) to this year (12%). This is a trend that needs to be carefully tracked in upcoming years and addressed if the trend continues.

Math 366 and 377 are upper level math courses and usually has only one section per semester or year. The data reported for DPLO #3, show that 85% of students perform at an *Acceptable* level or better. The data reported for DPLO #4, show that 82% of students perform at an *Acceptable* level or better. These are acceptable results and what the math department would expect. We cannot make comparisons to last year's data because we did not have any data reported for Math 366 or Math 377. When compared to data from two years ago, DPLO #3 has similar results and DPLO #4 has improved in the latest data reported (2013-2014).

All students did well on DPLO#5 with 53% showing a Strong Performance on the written and oral capstone assignment.

Analysis by Course: Course Learning Outcomes.

Calculus I (MATH 152)

The number of math majors taking Math 152 will always be very small because most math majors arrive at CCSU ready for higher level mathematics (courses higher than Math 152); however, now that we are collecting data on all students taking Math 152, we would expect that some students taking the course would struggle, which may account for the high number of students performing at an *Unacceptable* level of 0.

Discrete Mathematics (MATH 218)

MATH 218 is a transitional course to upper-level mathematics; therefore, it is not surprising that some students struggle. Course Learning Outcomes #3&4 need to be looked at more closely. This is a very important course, because it serves as a gateway for other major courses. It seems that the topic that most students struggle with is proofs by mathematical induction.

Calculus II (MATH 221)

These results are surprising; the first two learning objectives correspond to topics that students generally find challenging, so we would not expect the scores to be so high. One thing that is especially surprising is the third objective, which is generally considered to be the easiest topic in the course, but has lower scores than the other topics. Perhaps the students struggle at the beginning of Calculus II because they did not learn the material from the end Calculus I as well as they should have, and it takes some time for them to be comfortable with the new material from Calculus II. This is something that Instructors will be asked to pay attention to.

Introduction to Linear Algebra (MATH 228)

MATH 228 is generally considered one of the easier courses in the math major, so it is not surprising that the outcomes were met. Even though there are four learning outcomes for Math 228, the first two (system of linear equations and matrices) reflect the fundamental concepts of the subject, and the entire course is based on students' understanding of these two concepts. We can see that students performed very well on them with 100% of students performing at an outstanding performance level of two. The other two outcomes CLO#3 &CLO#4 (linear transformation and vector spaces) are more abstract and students in general find them more challenging to master. The results are however improving with no students performing at an *Unacceptable* level on CLO#3&4.

The results for the beginning of the course are extremely high, while those for the end of the course are lower. It seems that most students have no difficulty with the early sections of the course; this is expected, as the material is not very difficult. We could consider increasing the amount of material in this course, or changing to a more theory-focused textbook, without making it significantly more difficult for the students.

Introduction to Abstract Algebra (MATH 366)

The data are as expected. The level of difficulty of the course increases slightly near the end, but overall it remains one of the more challenging major courses. We see that, while a small number of students struggle throughout (perhaps they are unprepared because they forgot the material from the prerequisite), overall there are more students who perform well or very well, and this is good news for our program.

Introduction to Real Analysis (MATH 377)

MATH 377 is offered each semester with one section of students. This is probably the most challenging course in the math major, and the fact that many students perform at an *Acceptable* level or *Strong* level is good news. The majority of students (95%) received scores showing at least an *Acceptable* performance or better on the first learning outcome for the course, 77% on LO#2 and 91% on LO#3.

Seminar in Proof (MATH 450)

This course is normally taken at the end of a student's BA program. A student needs to have completed MATH 366 or 377 before taking it; a student who has not already taken both must take the second one concurrently. Consequently, the students taking this course are well prepared, as reflected by the results. Overall, the course objectives with the lowest results are the ones having to do with the motivation; some students who can explain the proof well have a harder time explaining why it is important. This is not surprising, because explaining the motivation requires doing some independent research about the topic, and students have had less experience with doing that than they have with writing correct and complete proofs.

Overall

The results for Calculus I and Calculus II are lower than for all other courses. This seems to indicate that the students who do not succeed in the program struggle at the beginning and change majors before they make it to the upper-level courses. This is desirable; it is a bad idea to have large numbers of students succeed in the early courses and drop out of the major in their senior year, because they will then not have enough time to pick another major and graduate "in time".

Section 4: Use of Results

The course level learning outcomes are providing faculty with specific data about required courses for the BA major. To improve course material as appropriate to address some of the weak results both at the course and degree program levels, the following recommendations will be made to instructors that teach the following courses:

<u>Calculus I (MATH 152)</u>

The results reported are as expected because students typically find computing derivatives relatively easy, and tend to struggle much more with application problems. This is consistent with the data. Instructors should make sure they do not spend an excessive amount of time on the material from Chapter 3 of the textbook (Derivatives), because they would then have to go through the material from Chapter 4 (Applications of derivatives) faster.

<u>Discrete Mathematics (MATH 218)</u>

It seems that the topic that most students struggle with is proofs by mathematical induction; therefore, Instructors should make sure they spend an appropriate amount of time on this topic. It is a single section, or perhaps two sections, in most textbooks, so perhaps there is a tendency to want to go through it too fast?

<u>Calculus II (MATH 221)</u>

Instructors will be asked to pay attention to whether or not they feel students are well prepared when entering Calculus II fro the prerequisite Calculus I.

<u>Introduction to Real Analysis (MATH 377)</u>

Because two of the four objectives relate to “proving” statements, and the course that introduces students to proofs is typically MATH 218, the math department should require students to take MATH 218 before MATH 377 (this change is being officially made this Fall 2014 semester).

Section 5: General Education

The Department of Mathematical Sciences contributes to the general education program by offering college level mathematics and statistics courses for all majors throughout the University. Data collection for Math 105 – Survey of Mathematics for Liberal Arts is used to assess the math department's progress on fulfilling the University-wide Learning Outcome to strengthen the quantitative skills of all CCSU students.

This course fulfills Skill Area II and is intended for those students who are not majoring in mathematics or the natural sciences. There is no credit given to students with credit for MATH 218 and the course may not be used to meet the requirements for a major, a minor, or certification in mathematics. Math 105 provides students with an introduction to a broad range of topics in mathematics. There is one Course Learning Outcome: Students will gain facility in solving real world problems using mathematics. Faculty teaching this course use the performance levels of (2) Strong Performance of the Learning Outcome; (1) – *Acceptable* Performance of the Learning Outcome; (0) – Does Not Meet the Learning Outcome. See Table 4 for data reported.

Findings.

Table 4. Mathematics 105 (General Education)

	Number of Students at each Level (2, 1, 0)								
	Fall 2011/Spring 2012 (n=22)			**Fall 2012/Spring 2013 (n=144)**			**Fall 2013/Spring 2014 (n=76)**		
Course Learning Outcomes	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**
To gain facility in solving real world problems using mathematics	13 (59%)	7 (32%)	2 (9%)	81 (56%)	51 (35%)	12 (9%)	47 (62%)	23 (30%)	6 (8%)

In Spring 2013, the department began collecting data for another general education course, Statistics 104, Elementary Statistics which fulfills Skill Area II. This course includes intuitive treatment of some fundamental concepts involved in collecting, presenting and analyzing data. Topics include frequency distributions, graphical presentations, measures of relative position, measures of variability, probability, probability distributions (binomial and normal), sampling theory, regression, and correlation. See Table 5 for data reported.

Table 5. Statistics 104 (General Education)

	Number of Students at each Level (2, 1, 0)								
	Fall 2012/Spring 2013 (n=44)								
General Education Learning Outcome #6	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**
Strengthen quantitative skills by using statistical techniques to solve problems	8 (18%)	32 (73%)	4 (9%)`						

Analysis.

For general education, the mathematics department offers Math 105 and Statistics 104 to assess the University's Goal to strengthen students' quantitative skills. Over the last two years, the majority of students (91%) in Math 105 has successfully strengthened their quantitative skills by gaining facility in solving real world problems using mathematics. In addition, the majority of students (91%) in Math 104 has successfully strengthened their quantitative skills by using statistical techniques to solve problems.

Use of Results.

It is not appropriate to make changes at this time based on only one or two years of complete data. During the summer and fall of 2014, the assessment committee will convene to discuss data for three years of Math 105 and two years of Statistics 104. We will make recommended changes at that time.

Mathematics (BA) Assessment Committee: Rachel Schwell, Eran Makover, Luis Recoder, Yuanqian Chen, Nelson Castaneda, Roger Bilisoly, Krishna Saha, Shelly Jones. Fred Latour has also consulted with the committee.

SECTION 6- ASSESSMENT PLAN for the B.A. in Mathematics

SUMMARY of FOUR-YEAR PLAN (Five years shown)

2011-2012	First full year of data collection: Assess required courses leading to the Mathematics BA (Mathematics 152, 221, 218, 228, 366, & 377). Assess General Education course (Mathematics 105); Analyze data. Note: Data collected only for BA and BSED students.
2012-2013	Continue assessing required courses leading to the Mathematics BA. Assess General Education courses adding a Statistics Course (Mathematics 105 & Statistics 104); Analyze data. Note: Data collected on all students in courses listed above.
2013-2014	Continue assessing the required Mathematics BA courses and General Education Courses: Analyze data. Recommend appropriate changes based on results. Pilot data collection for BA Capstone course, Math 450.
2014-2015	Complete paperwork for any changes that require curriculum committee approval. Implement changes to courses or program by spring semester (or fall depending on timing of course). Continue assessing the required Mathematics BA courses and General Education Courses: Analyze data. Assess BA Capstone course: Analyze data.
2015-2016	Analyze five years of data (2011-2016). Continue to implement changes to courses and/or program. Adjust assessment goals if necessary.

Section 6: Four-Year Assessment Plan

1. Identify where improvements are needed based on the evidence deemed from the data.
   a. The Math Department Assessment Committee will continue to meet to calibrate the Course Learning Outcomes (CLOs) that are used to determine the level of progress related to the Degree Program Learning Outcomes (PLOs). The alignment of the CLOs and PLOs need further discussion and possible tweeking.
   b. Continue to improve the data collection process. The department is working on automating the process.
   c. More data needs to be submitted by more faculty on a consistent basis.

2. Propose a strategy on implementing improvements.
   a. Increase the number of faculty submitting data including General Education faculty.
   b. Currently, the Assessment Committee Chairperson makes a request to OIRA for class rosters by course and section. Over the first three semesters of data collection this process has been improved to first include BA's only then BA's and BSED students and finally it has been determined that because the Math Department provides courses for many degree programs that we should be collecting data on all students passing through the department. As such data collection now includes collecting data for all students registered for the courses that are required for the Math BA Degree.
   c. In addition to increasing the number of students being reported, we would also like to make the data collection process almost entirely electronic so as to make the process a little less time consuming for the faculty teaching the required courses and for those faculty who prepare the report. This would mean somehow directly linking the CLOs into the appropriate columns of the PLOs table. We are currently writing a grant proposal for funding to support electronic data collection.

3. The goal is to gather more data so that an appropriate analysis can be performed to continue to make improvements to the program based on student learning outcome performance.

4. Spring 2014 is targeted for discussions on better aligning the CLOs and PLOs. Fall 2014 data collection with updated CLOs if needed.

5. The targeted students are underclassmen in content courses such as Math 152, 228, 366 and 377 will be the target audience for the updated CLOs that are better aligned to the PLOs.

6. Data collected will be compared from year to year and over multiple years to see if improvement has happened.

7. Data will be analyzed at the end of each spring semester (or summer or early fall depending on faculty schedules).

8. The BA Mathematics Assessment Committee has periodic meetings to discuss issues relating to the BA program assessment. Any changes made will be discussed and approved at these meetings. Course changes are brought to the entire department if that becomes necessary. Program changes will proceed through the Curriculum Committee process if necessary.

ASSESSMENT PLAN for the B.A. in Mathematics

Pilot & YEAR ONE	2 Area needs improvement - evidence of need	3 New assessment strategy or course modification	4 Why will this work to improve LO	5 Target Group	6 Which data will be collected	7 When will data be analyzed	8 Decision-making Procedures	9 Date of introduction of changes
Spring 2011	Pilot data collection	Collect data about individual courses by sending class rosters to teaching faculty	Course learning outcomes will help faculty know how well each course is aligned with the program learning outcomes	All BA majors	Faculty will rate students on Course learning outcomes	By the beginning of the fall semester	Math Assessment Committee will meet to discuss findings	N/A
Fall 2011/ Spring 2012	Overall improvement in quality of assessment reports	Consultations with all members of the Math Assessment Committee	Members of the Committee teach the required courses and would have important insight to offer	All BA and BSED majors	Faculty will rate students on Course learning outcomes	By the beginning of the fall semester	Math Assessment Committee will meet to discuss findings	N/A
Spring 2012	Assessment of General Education in Mathematics	Collect data about general education course, Math 105, by sending class rosters to teaching faculty	The Course Learning Outcomes will help faculty know how well this course is aligned with the University Learning Outcome for Quantitative Reasoning	Students in General Education courses offered by the Math Department	Faculty will rate students on Course learning outcomes	By the beginning of the fall semester	Math Assessment Committee will meet to discuss findings	N/A

YEAR TWO	2 Area needs improvement - evidence of need	3 New assessment strategy or course modification	4 Why will this work to improve LO	5 Target Group	6 Which data will be collected	7 When will data be analyzed	8 Decision-making Procedure	9 Date of introduction of changes
Fall 2012/ Spring 2013	Data collection process and consistent submission of data by faculty	N/A	There must be a rich database present to ensure a meaningful analysis of data.	All students enrolled in courses required of the Math BA Degree	Faculty will rate students on Course learning outcomes	By the beginning of the fall semester	Math Assessment Committee will meet to discuss findings	N/A
Spring 2013	Assessment of General Education in Mathematics	Collect data about general education course, Statistics 104, by sending class rosters to teaching faculty	The Course Learning Outcome well help faculty know how well this course is aligned with the University Learning Outcome for Quantitative Reasoning	Students in General Education courses offered by the Math Department	Faculty will rate students on Course learning outcomes	By the beginning of the fall semester	Math Assessment Committee will meet to discuss findings	N/A

YEAR THREE	2 Area needs improvement - evidence of need	3 New assessment strategy or course modification	4 Why will this work to improve LO	5 Target Group	6 Which data will be collected	7 When will data be analyzed	Decision-making Procedures	9 Date of introduction of changes
Spring 2014	Data Collection for Capstone Course	N/A	Students must be assessed at the end of their program to ensure courses leading to this capstone experience adequately prepares them	Seniors	Newly developed rubrics will be piloted	By the beginning of the fall semester	Math Assessment Committee will meet to discuss findings and rubric	Spring 2015
	Synthesize all data (three years) gathered & analyzed	N/A	This is the first time there will be enough data to make a meaningful determination of how to move forward	All BA and BSED majors	N/A	Spring/ Summer 2014	Math Assessment Committee will meet to Synthesize all data and make recommendations to Math Department	Fall 2014 and Spring 2015

YEAR FOUR	2 Area needs improvement - evidence of need	3 New assessment strategy or course modification	4 Why will this work to improve LO	5 Target Group	6 Which data will be collected	7 When will data be analyzed	8 Decision-making Procedures	9 Date of introduction of changes
Fall 2014/ Spring 2015	PLO #1, specifically in Math 152. Any other areas where students are performing at an Unacceptable Level.	Disaggregate the data for Math BA and BSED majors only. Analyze separately and compare to all-students data.	Checking to see if Math BA students are performing at Acceptable Level	Math BA students	Course and Program Learning Outcomes	By the beginning of the fall semester	Math Assessment Committee will meet to discuss findings	Fall 2015 Or Spring 2016

APPENDIX A

Mathematics (BA) Learning Outcomes by Mathematics Content Course

152:

- Compute and understand limits
- Compute and understand derivatives
- Solve application problems using derivatives

218:

- Prove mathematical statements
- Understand sets and functions (including properties and applications)
- Prove suitable mathematical statements by induction
- Solve basic combinatorial problems

221:

- Compute definite and indefinite integrals using varied techniques
- Determine convergence of sequences and series
- Apply integration to compute areas and volumes of revolution

228:

- Solve systems of linear equations
- Perform computations involving matrices
- Apply and verify linearity of transformations
- Understand and apply vector space definition and properties

366:

- Understand and apply definitions of group, subgroup
- Understand and apply definitions and properties of cyclic group, permutation group, factor group
- Understand and apply definitions and properties of homomorphism, isomorphism

377:

- Understand the topology of the real line
- Rigorously determine/prove convergence of sequences
- Rigorously determine/prove continuity and uniform continuity of functions
- Understand distinct types of convergence of sequences of functions

APPENDIX B

Mathematics Major

Core (32 credits):

MATH 152 Calculus I	4 credits
MATH 218 Discrete Mathematics	4 credits
MATH 221 Calculus II	4 credits
MATH 222 Calculus III	4 credits
MATH 228 Introduction to Linear Algebra	4 credits
MATH 366 Introduction to Abstract Algebra	4 credits
MATH 377 Introduction to Real Analysis	4 credits
MATH 450 Seminar in Proof	4 credits

and Directed Electives (6 credits) selected from:

MATH 250 Symbolic Computation	4 credits
MATH 300 Mathematics Internship	3 credits
MATH 355 Introduction to Differential Equations with Applications	4 credits

MATH 383	College Geometry	3 credits
MATH 398	Independent Study in Mathematics	1-3 credits
MATH 421	History of Mathematics	3 credits
MATH 440	Selected Topics in Mathematics	1-3 credits
MATH 455	Introduction to Partial Differential Equations with Applications	4 credits
MATH 468	Symbolic Logic	3 credits
MATH 469	Number Theory	3 credits
MATH 470	Mathematical Methods in Operations Research	3 credits
MATH 477	Numerical Analysis	3 credits
MATH 491	Advanced Calculus	3 credits
STAT 315	Mathematical Statistics I	3 credits
STAT 416	Mathematical Statistics II	3 credits
STAT 425	Loss and Frequency Distributions and Credibility Theory	3 credits
STAT 455	Experimental Design	3 credits
STAT 456	Fundamentals of SAS	3 credits
STAT 465	Nonparametric Statistics	3 credits

STAT 476	Topics in Statistics	3 credits
ACTL 335	Theory of Interest	3 credits
ACTL 465	Actuarial Models I	4 credits
ACTL 480	Topics in Actuarial Science	1-3 credits
ACTL 481	Review-SOA/CAS Course I	3 credits
ACTL 482	Review-SOA/CAS Course II	3 credits

In addition, two laboratory science courses are required.

A minor is required for this major.

Course Descriptions

MATH 152 Calculus I (4 credits)

Topics include limits and continuity, derivatives, applications of derivatives, transcendental functions, antiderivatives and definite integrals with applications

MATH 218 Discrete Mathematics (4 credits)

Topics include logic, induction, recursion, combinatorics, matrices, graph theory, set theory, and number theory.

MATH 221 Calculus II (4 credits)

Further applications of integration, techniques of integration, improper integrals, L'Hopital's Rule, and infinite series including Taylor series and representation of functions are offered.

MATH 228 Introduction to Linear Algebra (4 credits)

Vector spaces, systems of linear equations, determinants, linear transformations and matrices are considered.

MATH 313 Number Systems from an Advanced Viewpoint (2 credits)

The course provides an examination of the content of the elementary school mathematics curriculum from the point of view of secondary mathematics teachers.

MATH 323 College Geometry (3 credits)

Euclidean Geometry is studied from a modern viewpoint, with emphasis on the structure of deductive systems and methods of proof. The real number system is used as a model for Euclidean geometry, betweenness, separations and convexity, measure, congruence, parallelism, similarity, and construction.

MATH 366 Introduction to Abstract Algebra (3 credits)

Certain fundamental structures such as groups, rings, integral domains and field are considered.

MATH 377 Introduction to Real Analysis (4 credits)

In depth introduction to the theory of functions, including integration, differentiation and series.

MATH 450 Seminar in Proof (4 credits)

Students will study a number of important theorems in mathematics, examining the proofs of these theorems in depth. Each student will make a presentation to the class before the end of the semester. Topics will vary based on student and faculty interest. This is a capstone course for the BA major.

APPENDIX C

Findings for Course Learning Outcomes

Table 3. Mathematics 152

	Number of Students at each Level (2, 1, 0)														
	Spring 2011 (n = 2)			**Fall 2011/Spring 2012 (n= 4)**			**Fall 2012/Spring 2013 (n = 46)**			**Fall 2013/Spring 2014 (n=41)**					
Course Learning Outcomes	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**
I. Compute and understand limits	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	19	15	7			
II. Compute and understand derivatives	1	1	0	3	1	0	18	24	4	18	15	8			
III. Solve application problems using derivatives	1	1	0	2	1	1	10	26	10	4	17	20			

Note: Spring 2011, some sections of Math 152 had no BA majors. AY 2011-12 is combined BA and BSED students. From AY 2012-13 and on includes all majors. n/a denotes invalid data (the learning outcome was stated incorrectly in year one; therefore, the data was not useful).

Table 4. Mathematics 218

	Number of Students at each Level (2, 1, 0)														
	Spring 2011 (n=7)			Fall 2011/Spring 2012 (n=14)			Fall 2012/Spring 2013 (n=11)			Fall 2013/Spring 2014 (n=27)					
Course Learning Outcomes	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**
I. Prove mathematical statements	3	3	1	5	6	3	3	8	0	10	12	5			
II. Understand sets and functions (including properties and applications)	3	0	4	8	4	2	10	1	0	13	10	4			
III. Prove suitable mathematical statements by induction	3	1	3	5	1	8	2	7	2	11	12	4			
IV. Solve basic combinatorial problems	2	5	0	1*	4*	0*	4	7	0	7	14	6			

Note: Spring 2011 (BA students only), one student did not attend class after the first test and is not included in the table above or in the "*n*". Fall 2011 is combined BA and BSED students. Fall 2011, two students are not included in table. *One section of Math 218 (n=9) did not cover course learning outcome IV. NR – not reported by faculty. Spring 2013 one student was not involved in class and is not reported in the "*n*" or in the table.

Table 5. Mathematics 221

	Number of Students at each Level (2, 1, 0)														
	Fall 2011/Spring 2012 (n=11)			Fall 2012/Spring 2013 (n=48)			Fall 2013/Spring 2014 (n=44)								
Course Learning Outcomes	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**
I. Compute definite and indefinite integrals using varied techniques	2	5	3	42	5	0	5	25	14						
II. Determine convergence of sequences and series	2	6	3	29	18	1	3	19	22						
III. Apply integration to compute areas and volumes of revolution	3	7	1	20	26	2	11	18	15						

Note: Three students did not finish the semester in Fall 2011 (BA only), not included in the "*n*". Fall 2011 is combined BA and BSED students.

Table 6. Mathematics 228

	Number of Students at each Level (2, 1, 0)														
	Spring 2011 (n = 14)			Fall 2011/Spring 2012 (n=30)			Fall 2012/Spring 2013 (n=17)			Fall2013/Spring2014 (n=40)					
Course Learning Outcomes	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**
I. Solve systems of linear equations	12	2	0	30	0	0	17	0	0	37	2	1			
II. Perform computations involving matrices	14	2	0	30	0	0	17	0	0	35	4	1			
III. Apply and verify	4	4	6	21	9	0	14	3	0	20	19	1			

linearity of transformations															
IV. Understand and apply vector space definitions and properties	5	7	2	12	17	1	8	9	0	15	22	3			

Fall 2011 is combined BA and BSED students only. NR – not reported by faculty

Table 7. Mathematics 366

	Number of Students at each Level (2, 1, 0)														
	Spring 2011 (n=9)			**Fall 2011/Spring 2012 (n=43)**			**Fall 2012/Spring 2013**			**Fall 2013/Spring2014 (n=26)**					
Course Learning Outcomes	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**			
I. Understand and apply definitions of group, subgroup	4	3	2	25	13	5	NR	NR	NR	14	9	3			
II. Understand and apply definitions and properties of cyclic group, permutation group, factor group	2	4	3	18	20	5	NR	NR	NR	9	13	4			
III. Understand and apply definitions and properties of homomorphism, isomorphism	2	4	3	14	24	5	NR	NR	NR	15	8	3			

NR – not reported by faculty

Table 8. Mathematics 377

	Number of Students at each Level (2, 1, 0)														
	Spring 2011 (n=9)			Fall 2011/Spring 2012 (n=16)			Fall 2012/Spring 2013			Fall 2013/Spring2014 (n=22)					
Course Learning Outcomes	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**	**2**	**1**	**0**			
I. Understand the topology of the real line	5	1	0	11	4	1	NR	NR	NR	7	14	1			
II. Rigorously determine/prove convergence of sequences	4	2	0	7	7	2	NR	NR	NR	9	8	5			
III. Rigorously determine/prove continuity and uniform continuity of functions	2	3	1	3	10	3	NR	NR	NR	6	14	2			
IV. Understand distinct types of convergence of sequences of functions	0	5	1	1	11	3	NR	NR	NR	NR	NR	NR			

Note: Spring 2011 three students were not scored because they stopped showing up for class after the first week. NR – not reported by faculty.

Table 9. Mathematics 450

Course Learning Outcomes	**Number of Students at each Level (2, 1, 0)**		
	Spring 2014		
	2	**1**	**0**
1.1 Completeness /Thoroughness	10	5	2
1.2 Correctness	8	9	0
1.3 Motivation	7	9	1
2.1 Completeness /Thoroughness	11	6	0
2.2 Correctness	10	7	0
2.3 Motivation	8	9	0

Table 10. Mathematics 450 Assessment Rubric for Written Assignment

(1) The student will be able to present a mathematical topic or proof in writing.	2 - Strong performance	1 - Acceptable performance	0 - Unacceptable performance
1.1 Completeness /Thoroughness	The student's written presentation is thorough. It includes a large amount of relevant information about the topic or proof, and reflects a deep understanding.	The student's written presentation covers some useful information about the topic or proof, but is missing some important parts.	The student's written presentation is superficial. It is missing a large amount of relevant information and provides only limited information about the topic or proof.
1.2 Correctness	The student's written presentation contains no, or few, mathematical mistakes.	The student's written presentation contains a significant number of mathematical mistakes.	The student's written presentation contains pervasive mathematical mistakes that would impede a reader's understanding of the subject.
1.3 Motivation	The student's written presentation makes clear why the topic or proof is important.	The student's written presentation contains limited information about why the topic or proof is important.	The student's written presentation does not contain information about why the topic or proof is important, or the information is incorrect.

Table 11. Mathematics 450 Assessment Rubric for Oral Assignment

(2) The student will be able to present a mathematical topic or proof orally to his or her peers.	2 - Strong performance	1 - Acceptable performance	0 - Unacceptable performance
2.1 Completeness /Thoroughness	The student's oral presentation is thorough. It includes a large amount of relevant information about the topic or proof, and reflects a deep understanding.	The student's oral presentation covers some useful information about the topic or proof, but is missing some important parts.	The student's oral presentation is superficial. It is missing a large amount of relevant information and provides only limited information about the topic or proof.
2.2 Correctness	The student's oral presentation contains no, or few, mathematical mistakes.	The student's oral presentation contains a significant number of mathematical mistakes.	The student's oral presentation contains pervasive mathematical mistakes that would impede a reader's understanding of the subject.
2.3 Motivation	The student's oral presentation makes clear why the topic or proof is important.	The student's oral presentation contains limited information about why the topic or proof is important.	The student's oral presentation does not contain information about why the topic or proof is important, or the information is incorrect.