Mathematics and Computer Science
Student Learning Outcomes Assessment, 2013-2014

Mathematics Program Assessment: Fall 2013

In this round of mathematics program assessment (2012–2013), we have had a variety of activities and changes:

- Data have been analyzed for Objective 2 (basic manipulative skills) and preliminary recommendations have been made, including some changes regarding the assessment.
- Data collection for Objective 1 (understanding basic concepts of the various branches of mathematics) is underway.
- We have analyzed the first group of senior surveys, and we are responding to issues raised.
- Changes in response to the poor showing in Objective 4 (understanding of mathematical proof) in the last assessment report are still underway, including the adoption of a new book across the curriculum and changes to MATH 275.
- The actuarial track has been confirmed to meet the Society of Actuaries’ requirements for an Introductory program, and is listed on their website.
- A new assessment for an objective from the actuarial track has been developed.

New Assessment

We begin with new data collection and analysis from the 2012-2013 year, which includes analysis for Objective 2, senior surveys, and data collection for Objective 1.

Objective 2 Assessment

In Spring of 2012 and Fall of 2012, we collected data to assess Objective 2:

2. Graduates will be able to demonstrate basic manipulative skills by
   a. using techniques of calculus of one and several variables
   b. solving applied problems using differentiation and integration
   c. transforming and manipulating statements involving formulas and algorithms

This objective was last addressed in the 2010 assessment report, with data collected from MATH 211, MATH 212, and MATH 275 in the Fall semester of 2008. At that time, we concluded that our students’ manipulative skills were strong. In this round, we used the same questions taken from the same courses, and were able to compare results across the two data sets.

In addition, we also submitted three calculus questions to MATH 411 (Introduction to Real Analysis) in Spring 2012 for comparison purposes. (Students in MATH 411 are required to have completed the calculus sequence. We could not assess topics from probability or linear algebra in this class however, because students need not have taken these courses prior to MATH 411.)

We wished to see how performance in later classes compared to the work of students in the intermediate classes of MATH 211 and MATH 212. In the data below, topics that were also tested in MATH 411 are marked with an asterisk; data for the comparisons are presented after the comparisons of the 2012 and 2008 data.

Questions were delivered to students embedded in a test or quiz in the course listed. Each student response was assigned a score on a 0–5 scale by two mathematics faculty members.
A score of 0 indicates a problem left blank, while a 5 indicates a flawless performance. (See Appendix B.) Data from the student responses are reported below. Each table begins with:

- A description of the question.
- The course in which the question was asked. (An asterisk indicates the question was also asked in MATH 411; those results are discussed later.)
- The particular objectives (2a, 2b, or 2c) tested by the question.

Following the heading is the chart of responses, containing:

- The number of students with a given score from Spring or Fall 2012, labeled “2012.”
- The percent with a given score in the 2012 data.
- A cumulative response: The percentage who scored at a given score or higher in 2012.
- After a break, the results from 2008 data (reported in the 2010 assessment report), together with the percentage response and cumulative column are presented for comparison.

After each table, the mean response in the 2012 and 2008 data are provided for the question.

1) Evaluate an iterated integral: (MATH 212; Objective 2a)

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2) Set up a double integral over a region: (MATH 212; Objectives 2a,2b)*

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Questions 3a-3d cover more advanced integration techniques:

3a) Integrating combinations of trigonometric functions: (MATH 212; Objective 2a,2c)

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### 3b) Definite integral using partial fractions: (MATH 212; Objective 2a,2c)

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Average in 2012: 4.6  
Average in 2008: 3.8

### 3c) Integration requiring trigonometric substitution: (MATH 211; Objective 2a,2c)*

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Average in 2012: 3.3  
Average in 2008: 2.1

### 3d) Integration by parts: (MATH 212; Objective 2a,2c)*

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Average in 2012: 4.8  
Average in 2008: 3.8

### 4) Gauss-Jordan elimination for a matrix: (MATH 275; Objective 2c)

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Average in 2008: 3.9

5) Polynomial antiderivative: (MATH 211; Objective 2a)

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Average in 2012: 4.7
Average in 2008: 4.3

6) Antiderivative requiring \( u \)-substitution: (MATH 211; Objective 2a,2c)*

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Average in 2012: 3.4
Average in 2008: 2.9

7) Set up and evaluate a polar integral: (MATH 212; Objective 2a,2b)

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Average in 2012: 3.4
Average in 2008: 2.9

8) Evaluate and simplify a general permutation: (MATH 350; Objective 2c)

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<td></td>
<td></td>
<td></td>
<td>22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Average in 2012:  2.0  
Average in 2008:  4.0

We note that on most questions, overall the response in 2012 was excellent, with 6 of the 11 questions actually averaging a response of 4 or higher, indicating many perfect and nearly perfect responses. The lowest responses came on questions 2, 3c, 6, 7, and 8, with only questions 6 and 8 ranking at an average score below 3.

Most of these lower-scoring questions are multi-step problems which require some judicious interpretation to solve correctly, particularly question 7 on setting up and evaluating a polar integral, question 3c on trigonometric substitution, and to a lesser extent problem 2 on setting up a double integral and problem 8 on evaluating a general permutation. (Question 3d, on which students scored unusually high, requires multiple applications of integration by parts and could also be viewed as such a multi-part problem requiring good judgment to complete correctly. However, most of the students completed this problem using a particular algorithmic approach sometimes known as tabular integration. We think that the exceptionally high score on 3d may be a chance outlier for the particular group of students tested, but we are nonetheless pleased that our students performed well on an important integration technique.)

When students in this round of assessment (taken from 2012) are compared with the previous results (collected in 2008), we find that the 2012 students outperformed their 2008 peers on almost every problem, with the exception of problem 2 (setting up a double integral) and problem 8 (evaluating a general permutation). We note that problems 2 and 8 were two lower scoring problems in this round of assessment. (Problem 8 in particular is a strong outlier, on which students in 2012 actually performed on average 2 points lower than their 2008 peers. We should continue to keep watch on related issues involving probability and combinatorics to see if there is a trend, but this one poor score may not be significant by itself.)

Next we consider comparison data comparing the problems given in MATH 411 covering basic calculus topics (from Spring 2012) to the same problems given in MATH 211/212 in Spring 2012 and Fall 2012. Here, all the data is from 2012, but the first set is for the responses in MATH 211/212, while the second group on each table is the results from MATH 411:

2) Set up a double integral over a region:

<table>
<thead>
<tr>
<th>Score</th>
<th>212</th>
<th>Percent</th>
<th>Cum.</th>
<th>411</th>
<th>Percent</th>
<th>Cumulative</th>
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<tr>
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<td>1</td>
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<td>0</td>
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<td>100.0%</td>
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<td>100.0%</td>
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<tr>
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<td>13</td>
<td></td>
<td></td>
<td>7</td>
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</tr>
</tbody>
</table>

Average in MATH 212:  3.6
Average in MATH 411:  3.1

3d) Integration by parts:

<table>
<thead>
<tr>
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<th>Cum.</th>
<th>411</th>
<th>Percent</th>
<th>Cum.</th>
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<td>71.4%</td>
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<td>85.7%</td>
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<tr>
<td>2</td>
<td>0</td>
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<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
<td>85.7%</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0.0%</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
<td>85.7%</td>
</tr>
</tbody>
</table>
Overall, we believe these results indicate that the scores obtained in the tests in intermediate classes are indicative of the scores obtained near the end of the program. (It does appear that on some questions, MATH 411 students were more likely to leave the question completely blank, possibly because the MATH 411 students were not being directly graded on their answers.) In response to question 3d, we had an extreme difference, showing students in MATH 411 performing an average of a full point below those in MATH 212, although it should be noted that this is the question on which the MATH 211 students in 2012 received an exceptionally high score. The rating of the 2012 MATH 411 students for question 3d is actually very close to our rating for 2008 MATH 212 students (from the 2010 report).

Senior Surveys

In 2011, the department reinstated the practice of giving graduating seniors a survey regarding the objectives of the student’s program and requesting suggestions for improvement. Since this time, we have collected five responses (three from the BA Mathematics track, and two from the actuarial track).

On the survey, students were first asked to rank how well each objective of their track was met, using the categories “Not at all”, “Somewhat”, “Mostly”, or “Completely.” Overall, students gave high ratings to most objectives, frequently choosing “Mostly” or “Completely.” If we assigned numbers 0–3 to these scores, all objectives but two had a mean response of at least 2.2 (ranking between “Mostly” and “Completely). The two lowest scoring answers were both from Objective 1: explaining the fundamental concepts of real analysis (ranking at 1.4) and explaining linear algebra and the theory of vector spaces (ranking at 1.8). (Explaining the fundamental concepts of real analysis and communicating results in oral form were the only two objectives to receive a single response of “Not at all,” although the other four responses to the communication objective were “Completely.”) We note that the Fall 2009 assessment of Objective 1 showed some weakness in students, particularly in terms of recognizing the importance of definitions and the use of abstraction. We are currently collecting data for the next round of assessment of this objective.

Students were next given a chance to respond to open-ended questions regarding whether changes should be made to objectives, if courses should be changed to better align with objectives, student satisfaction with advising and scheduling, future employment, and any
additional comments. In the open-ended responses, the surveys brought up several points we are trying to address:

- Several students expressed the desire to have more upper level math courses available. One actuarial student lamented the fact that we had only the minimum number of elective mathematics courses available for his/her major.
- We found several remarks indicating confusion about the role of particular courses in the major. In particular, one student did not understand where Introduction to Real Analysis fit in the sequence, and an actuarial student thought that the finance class was intended to prepare students for the second independent actuarial exam. (The finance class is a somewhat separate topic, and students who continue in an actuarial career may count this towards other certifications later.)

Mostly the response to the surveys was very positive, but we are working to address some of the points above. See the section “Changes, Actions, and Recommendations” for current and upcoming responses to these issues.

**Data Collection for Objective 1**

Objective 1 states:

1. Graduates will be able to explain the fundamental concepts of
   a. real analysis of one variable
   b. calculus of several variables and vector analysis
   c. linear algebra and the theory of vector spaces
   d. probability and statistics
   e. abstract algebra

Data for assessment of Objective 1 was collected from MATH 211, MATH 275, and MATH 311 in Spring 2012, and we are collecting further data from those courses plus MATH 350 this fall. We are again using the same questions used in the previous round of assessment so that comparisons can be made between the last and current round of assessment. Analysis will begin in the Spring semester.

**Changes, Actions, and Recommendations**

Previous recommendations from assessment have resulted in changes made to our programs this year. In addition, we make recommendations in this year’s report for future changes. In what follows, we have recommendations both curricular and assessment related for Objective 2, ongoing changes resulting from last year’s assessment of Objective 4, responses to senior surveys, and some results of assessment and changes to assessment for the actuarial track.

**Objective 2: Manipulative Skills**

Overall, the results of our assessment of Objective 2 from 2012 were positive, showing strong results for the current students that were, in most cases, even better than the previously strong results observed in 2008. We do not believe that these results require major or structural changes to the program, but we do make the following four recommendations, one curricular and three regarding future assessments:

- Noting that students struggled most with multi-step problems and problems requiring interpretation, we encourage faculty to make sure such problems continue to be part of our classes at all levels.
- We found the use of the MATH 411 responses a useful addition to the previous data from MATH 211, 212, and 311 for covering calculus techniques, and plan to continue using this approach in future assessments of this objective and others.
The exceptionally low score on the final question from the assessment (on evaluating a general expression involving permutations) warrants keeping a close watch on future assessments involving combinatorics or probability, although this single score may simply be an outlier.

Finally, we note that the questions used this time did not include any differentiation questions. It may be useful to include such a question on the next assessment.

The first recommendation is being passed to the Math Curriculum Committee, where it can ultimately be sent on to the department. The last three can be implemented directly by the Mathematics Program Assessment committee.

**Objective 4: Student’s Understanding of Proof**

In last year’s assessment report, we identified that our students understanding of mathematical proof was weak. This is the second round of assessment to note difficulties in Objective 4; the previous changes to the Discrete Mathematics I course clearly did not eliminate the problem. This topic is also known in the wider mathematical community to be problematic for undergraduates. We recommended additional attention to the elements of proof (including definitions and logic) at all levels of the mathematics curriculum, that the prerequisites to the senior seminar be adjusted to assure students took this course closer to the end of their programs (ensuring a final “buff” of mathematical concepts), and that curriculum continue to look for ways to strengthen the teaching of mathematical proof throughout the program.

Since that time, the Curriculum Committee has continued to aggressively pursue remedies to our students’ identified weakness in this area, noting the significance of this objective and the continued weakness of our students. The Curriculum Committee has taken the following steps since the last report:

- The Curriculum Committee approved changes to MATH 275 (Linear Algebra) to reflect an emphasis on some elementary proof techniques in this course, broadening the base of intermediate courses where these techniques are introduced beyond Discrete Mathematics I (MATH 270). Although MATH 275 is not intended to be entirely focused on proofs, we are strengthening basic elements. In particular:
  - The course description will be changed to include “An introduction to the theory of linear algebra and basic proof techniques...” in the list of topics.
  - A target outcome “Students will demonstrate introductory proof techniques to establish theoretical principles of linear algebra” will be added.
- These changes were approved by the Curriculum Committee, and the department as a whole approved the changes in a November 1, 2012, department meeting. However, the University Curriculum Committee has rejected the new proposal due to formatting issues regarding the inclusion of MATH 275 in Distribution 3. The proposal will be resubmitted.
- Discussion in curriculum of changes to the prerequisite structure of the senior seminar continues, but it has been noted that the seminar course need not focus on proofs, so any changes here are not a complete solution.
- In the Spring of 2012, the Curriculum Committee approved the addition of a standard textbook on proofs to be included with every course from MATH 270 (which serves as our introduction to proofs) upward. The change was announced in the March 17, 2013 department meeting. The selected book, *The Book of Proof*, by Richard Hammack, covers all methods of mathematical proof, and is intended to provide a unified framework by which professors at all levels can refer to proof techniques as the students move from course to course. Students should better see the connections between proofs...
in different subject areas by having a standard reference and hearing the same approaches and terminology referred to at all levels.

- Further changes to our program are underway at this time, particularly as (due to new regulations on credit hours) we may be moving our BA programs to BS programs. Curriculum is taking advantage of the resulting upheaval to consider alternate structures to our program that take into account recent findings from assessment. With regards to student’s understanding of mathematical proof, one proposal involves the separation of the teaching of mathematical proof from Math 270 (Discrete Mathematics I) into a new course devoted only to the teaching of proof techniques and concepts. We are also giving consideration to expanding our program offerings to include more proof-based courses at the upper level. (This also relates to the lack of upper level electives noted in the senior surveys; see the next section.) At this time, all proposals are preliminary, but are taking into account the deficits we have found through assessment.

Responses to Senior Surveys

We deal here with three potential issues that were identified on the Senior Surveys:

- Availability of upper level classes;
- Confusion over the role of various classes in the major; and
- A weaker overall response to the objective regarding students’ understanding of real analysis;

The issue of availability of upper level classes is one the Math Curriculum Committee has been working to rectify. As of this Fall, we have established a rotation of upper level electives which we have not been able to offer before. Complex Analysis is being offered this Fall; a new course in Partial Differential Equations is being offered in the Spring. A new topology course, MATH 453 was approved in the April 25, 2013 department meeting, with a stated objective of providing more options for our majors. There is also currently a sub-committee of the Curriculum Committee meeting to establish a larger set of available electives for the actuarial track majors.

The confusion over the role of various courses in the various tracks suggests that students may not clearly understand the role that each course plays in a math major. We are beginning work on a guide for the majors that will indicate the structure of the degree and how the various courses contribute to it. (We note that confusion over where a course like Introduction to Real Analysis fits in the overall sequence may also contribute to students rating their understanding of the related objective as low; they may not realize the broad scope of this objective.) This is particularly useful for the actuarial track, where multiple courses are offered outside of our department; while we in the department can provide some explanation of how a course we are teaching contributes to our majors, other departments will not be providing that information to our majors.

The weak response seniors gave to their understanding of the principles of real analysis may also be related to the indicated confusion of where a course like Introduction to Real Analysis fits in the program. In particular, students may not fully appreciate that this is a capstone of the entire calculus sequence (and in fact, parts of other courses such as Mathematical Probability and Statistics). As such, they may not fully appreciate what the objective covers, and helping to explain this relationship may help students fully understand what they know and have learned. However, we will be looking specifically at Objective 1 in our upcoming round of assessment, so we will get a chance shortly to investigate more directly students mastery of this topic.

Actuarial Track

Based on information obtained from a special session on actuarial programs at the 2013 Joint Mathematics Meetings, we contacted the Society of Actuaries (one of the primary professional
organizations for actuaries). SOA maintains listings of programs that meet various
requirements for the training of actuaries. On confirming that our current program does meet
the requirements of an Undergraduate Introductory program, we have obtained a listing for
Edinboro with SOA website in the spring of 2013; see:
http://www.soa.org/Education/Resources/actuarial-colleges/actuarial-
college-listings-details.aspx

This serves to confirm that our program is on the right track, and further serves to publicize and
help grow the program.

Next, we consider additional Objective A5 for our actuarial track students (beyond the objectives
for the BA in Mathematics), which states:

A5. Students will gain an understanding of professional opportunities and
responsibilities of the future actuary.

This objective for the actuarial track has not yet been assessed. We will begin assessment by the
following method:

- Incoming actuarial majors at our orientation session (and transfer students) will be
  asked to give a brief description of the opportunities and responsibilities of an actuary.
- The same survey will be given to students in MATH 385, the actuarial seminar course
taken near the end of their major by all actuarial track students.
- Responses to both sets of surveys will be rated, and the average response from first years
  will be compared to average response from the senior seminar to see if the quality of the
  response from the latter is higher, indicating a gain in understanding of these topics.

This will provide a direct measure of whether or not the students gain knowledge about what
actuaries actually do over the course of the major. Assessment will begin immediately in Spring
2014 when MATH 385 is next offered. (We will need to wait until Fall 2014 to have comparison
responses from incoming students, however.)

Appendix A: Objectives and Mappings

No changes have been made to the list of objectives or the course mappings at this time. The
complete set is reproduced below for reference.

Learning Objectives for Bachelor of Arts in Mathematics

1. Graduates will be able to explain the fundamental concepts of
   f. real analysis of one variable
   Courses covering this objective:
   - Analytical Geometry and Calculus I (MATH 211)
   - Analytical Geometry and Calculus II (MATH2 12)
   - Analytical Geometry and Calculus III (MATH 311)
   - Mathematical Probability and Statistics (MATH 350)
   - Introduction to Real Analysis (MATH 411).
   
   g. calculus of several variables and vector analysis
   Course covering this objective:
   - Analytical Geometry and Calculus III (MATH 311)

   h. linear algebra and the theory of vector spaces
   Course covering this objective:
   - Linear Algebra I (MATH 275)
i. probability and statistics  
Course covering this objective:
- Mathematical Probability and Statistics (MATH 350)

j. abstract algebra  
Course covering this objective:
- Abstract Algebra (MATH 421)

2. Graduates will be able to demonstrate basic manipulative skills by
   d. using techniques of calculus of one and several variables  
Courses covering this objective:
- Analytical Geometry and Calculus I (MATH 211)  
- Analytical Geometry and Calculus II (MATH 212)  
- Analytical Geometry and Calculus III (MATH 311)  
- Mathematical Probability and Statistics (MATH 350)  
- Introduction to Real Analysis (MATH 411).

   e. solving applied problems using differentiation and integration  
Courses covering this objective:
- Analytical Geometry and Calculus I (MATH 211)  
- Analytical Geometry and Calculus II (MATH 212)  
- Analytical Geometry and Calculus III (MATH 311)  
- Mathematical Probability and Statistics (MATH 350)  
- Introduction to Real Analysis (MATH 411).

   f. transforming and manipulating statements involving formulas and algorithms  
Courses covering this objective:
- Principles of Programming I (CSCI 130)  
- Analytical Geometry and Calculus I (MATH 211)  
- Analytical Geometry and Calculus II (MATH 212)  
- Discrete Mathematics I (MATH 270)  
- Linear Algebra I (MATH 275)  
- Analytical Geometry and Calculus III (MATH 311)  
- Mathematical Probability and Statistics (MATH 350)  
- Discrete Mathematics II (MATH 370)  
- Introduction to Real Analysis (MATH 411)  
- Abstract Algebra (MATH 421)

3. Graduates will be able to interpret and solve mathematical problems by
   a. selecting appropriate mathematical tools  
Courses covering this objective:
- Principles of Programming I (CSCI 130)  
- Analytical Geometry and Calculus I (MATH 211)  
- Analytical Geometry and Calculus II (MATH 212)  
- Discrete Mathematics I (MATH 270)  
- Linear Algebra I (MATH 275)  
- Analytical Geometry and Calculus III (MATH 311)  
- Mathematical Probability and Statistics (MATH 350)
b. selecting and implementing technology when appropriate
Courses covering this objective:
- Principles of Programming I (CSCI 130)
- Linear Algebra I (MATH 275)
- Mathematical Probability and Statistics (MATH 350)

c. communicating the results in written and oral form
Courses covering this objective:
- Principles of Programming I (CSCI 130)
- Analytical Geometry and Calculus I (MATH 211)
- Analytical Geometry and Calculus II (MATH 212)
- Discrete Mathematics I (MATH 270)
- Linear Algebra I (MATH 275)
- Analytical Geometry and Calculus III (MATH 311)
- Mathematical Probability and Statistics (MATH 350)
- Discrete Mathematics II (MATH 370)
- Introduction to Real Analysis (MATH 411)
- Abstract Algebra (MATH 421)
- Mathematics Seminar (MATH 480)

4. Graduates will be able to demonstrate understanding of mathematical proof by
   a. applying the structure and results of existing proofs to establish new mathematical results
Courses covering this objective:
- Discrete Mathematics I (MATH 270)
- Linear Algebra I (MATH 275)
- Discrete Mathematics II (MATH 370)
- Introduction to Real Analysis (MATH 411)
- Abstract Algebra (MATH 421)

b. employing a variety of established logical techniques to write a mathematical proof
Courses covering this objective:
- Discrete Mathematics I (MATH 270)
- Discrete Mathematics II (MATH 370)
- Introduction to Real Analysis (MATH 411)
- Abstract Algebra (MATH 421)

c. distinguishing between valid and invalid/incomplete logical reasoning
Courses covering this objective:
- Principles of Programming I (CSCI 130)
- Discrete Mathematics I (MATH 270)
- Linear Algebra I (MATH 275)
- Mathematical Probability and Statistics (MATH 350)
- Discrete Mathematics II (MATH 370)
• Introduction to Real Analysis (MATH 411)
• Abstract Algebra (MATH 421)

For the Actuarial concentration, in addition, students shall:

A1. gain an understanding of interest theory, annuities, discounts, and funds from a mathematical and financial viewpoint
A2. apply statistical models for description, prediction, and inference based on data samples
A3. attain an understanding of the fundamental factors which influence the economy in the context of micro- and macroeconomics
A4. prepare for professional examinations through the Society of Actuaries and the Casualty Actuarial Society
A5. gain an understanding of professional opportunities and responsibilities of the future actuary

The courses required by our program to meet the learning objectives are:

• Principles of Programming I (CSCI 130)
• Analytical Geometry and Calculus I (MATH 211)
• Analytical Geometry and Calculus II (MATH 212)
• Discrete Mathematics I (MATH 270)
• Linear Algebra I (MATH 275)
• Analytical Geometry and Calculus III (MATH 311)
• Mathematical Probability and Statistics (MATH 350)
• Discrete Mathematics II (MATH 370)
• Introduction to Real Analysis (MATH 411)
• Abstract Algebra (MATH 421)
• Mathematics Seminar (MATH 480)

Appendix B: Rubric
The Assessment Committee has used some form of the following five point rubric for evaluating all student responses since 2007. Minor updates to the language were made for clarity as of the Spring 2012 report:

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<th>Points</th>
<th>Description</th>
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<tr>
<td>5</td>
<td>Perfect and complete</td>
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<tr>
<td>4</td>
<td>Not quite polished; small omission</td>
</tr>
<tr>
<td>3</td>
<td>On the right track, with a few mistakes</td>
</tr>
<tr>
<td>2</td>
<td>Minimal: Something is correct, but multiple errors and omissions</td>
</tr>
<tr>
<td>1</td>
<td>A glaring error; unworthy of the course level in question.</td>
</tr>
<tr>
<td>0</td>
<td>No attempt was made.</td>
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</tbody>
</table>
BS Computer Science Assessment

In this round of BS Computer Science program assessment (2012–2013), we have had a variety of activities and changes:

- Based on Professional Advisory Council recommendations and in preparation for the 5-year program review and compliance with the 60-credit hour limit, two new tracks have been added to the BS Computer Science – Web Development and Implementation and Network and System Administration.
- The Application track will become the Applied track and will allow students to “design” their own program.
- A common core of courses for all tracks has been defined. All tracks have an appropriate capstone experience (Internship, Senior seminar, Senior Projects course).
- Data was collected and analyzed for the following objectives: 1a, 1b, 1e, 1h, 2a, 2b, and 4b.
- Rubrics have been modified to streamline for 1a, b, d, f, j, k, and l.

Comments about the following assessments – Senior surveys for last year are scarce. Despite providing ample time to complete the surveys, our return rate for the assessment period resulted in no returned surveys in the Fall of 2012 and 3 returned surveys in Spring of 2013. The 3 surveys returned were BS Computer Science/Application track students. Therefore, there are no indirect assessments for the Theoretical track.

General Rubric

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<th>Score</th>
<th>Excellent</th>
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Senior Survey Scale (n=3, application students only)

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</tbody>
</table>

Assessment of Objective 1

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<td>CSCI 330</td>
<td>ABET Rubric applied to programming assignment</td>
<td>Senior Surveys</td>
<td>Fall 2012</td>
</tr>
<tr>
<td>e</td>
<td>CSCI310</td>
<td>Rubric applied to programming assignment measuring performance</td>
<td>Senior Surveys</td>
<td>Spring 2013</td>
</tr>
<tr>
<td>h</td>
<td>CSCI320</td>
<td>Rubric applied to programming assignment</td>
<td>Senior Surveys</td>
<td>Spring 2013</td>
</tr>
</tbody>
</table>

Results (a) – The rubric for this objective measured program documentation, algorithm development, use of appropriate data structures and use of existing libraries. Since this outcome saw little improvement over the last assessment and the results were somewhat low (averaging between 2.5 developing and 3 good), several suggestions come to mind. First, documentation and design need to be emphasized in the entire programming sequence (CSCI 130, CSCI 230 and CSCI 330). The CS Curriculum committee might consider a standard for documentation and how much emphasis should be placed on designs in each of the courses. Second, difficulties highlighted by the instructors in
using the rubrics indicate that the rubrics and perhaps the performance criteria be re-evaluated. Senior Survey Results: 4.0 – Completely met.

**Results (b)** – The rubric measured the creation of modular designs, creation of software based on a design, and the integration of modules to make a functional system. The results for this objective were consistent with the last assessment and remain at the satisfactory level. Senior Survey Results: 2.67 – Somewhat met - Mostly met.

**Results (e)** – The performance criteria for this objective involved the creation of a working program that would collect performance data pertaining to the microcomputer architecture and understanding the performance measures. The results (2.44 developing/good) show that the students need more hands on practice with microprocessor programming. The complexity analysis needs a more in-depth understanding of the algorithm and instruction set of the microprocessor and students who previously took Computer Organization and Architecture course seemed to have performed better in the assignment. In comparison with the previous assessment, it is difficult to tell whether both assessments were similar. Senior Survey Results: 3.67 – Mostly met - Completely met.

**Results (h)** – This objective involved the creation of a working program based on good programming practices and based on business and accounting principles. Students performed well on this assessment (3.5 – good/excellent) and this was consistent with previous assessments. Senior Survey Results: 3.67 – Mostly met - Completely met.

Objectives d, g, and l were scheduled for assessment, but data was not available.

**Action Items proposed to meet Objective**

- Computer Science curriculum committee should consider development of a documentation standard
- Algorithm development should be stressed throughout the entire programming sequence (CSCI130 – CSCI230 – CSCI330) and the Computer Science curriculum committee should address how much emphasis should be placed on this across sections
- Recapitulating assembly language programming, time and space complexity, and algorithms and data structures in CSCI 310 would be helpful.

**Action Items proposed to enhance assessment tools**

- Rubrics and performance criteria should be reconsidered for Objective 1a.

### Assessment of Objective 2

<table>
<thead>
<tr>
<th>Objective</th>
<th>Course</th>
<th>Direct Assessment</th>
<th>Indirect Assessment</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>CSCI 408</td>
<td>ABET Rubric applied to homework assignment</td>
<td>Senior Surveys</td>
<td>Spring 2013</td>
</tr>
<tr>
<td>b</td>
<td>CSCI330</td>
<td>ABET Rubric applied to programming assignment</td>
<td>Senior Surveys</td>
<td>Fall 2012</td>
</tr>
</tbody>
</table>

**Results (a)** – The performance measures used to measure critical thinking ability involved critiquing the work of other students and the production of a plan based on the analysis of both risk and benefits. New measures were used since the last assessment, because there were significant problems with the previous assessment. Therefore, no comparison to previous assessments can be made. Students did, however, performed very well on this assessment where the results averaged 3.5 (good/excellent). These results are satisfactory. Senior Survey Results: none.

**Results (b)** – This measure was shared the same measure used in part to assess Objective 1b. The criterion was that students could create the necessary program modules based on a design that was developed in class. The results were again satisfactory (3.2 good) and as in Objective 2a
above have been derived from a much different assessment than in the past. Senior Survey Results: 3.67 – Mostly met - Completely met.

**Action Items proposed to meet Objective**
- None

**Action Items proposed to enhance assessment tools**
- None

### Assessment of Objective 4

<table>
<thead>
<tr>
<th>Objective</th>
<th>Course</th>
<th>Direct Assessment</th>
<th>Indirect Assessment</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>CSCI125</td>
<td>ABET Rubric applied to a student survey on community service and civic responsibility</td>
<td>Senior Surveys</td>
<td>Fall 2012</td>
</tr>
</tbody>
</table>

**Results (b)** – The rubric and assessment were changed slightly from the previous assessment in that the rubric has only 2 values: Met 1 / Not Met 0. Students were asked to provide their experiences involving community service or civic opportunities. Forty-nine out of 50 students met this assessment. Therefore, the results are exceptional. Senior Survey Results: 2.33 – Somewhat Met.

**Action Items proposed to meet Objective**
- None

**Action Items proposed to enhance assessment tools**
- None

### Assessment of Objective 5

<table>
<thead>
<tr>
<th>Objective</th>
<th>Course</th>
<th>Direct Assessment</th>
<th>Indirect Assessment</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>CSCI125</td>
<td>ABET Rubric applied to a student essay on importance of professional organizations</td>
<td>Senior Surveys</td>
<td>Fall 2012</td>
</tr>
</tbody>
</table>

**Results (a)** – Students were asked to write a short essay concerning the importance of professional societies. The average score on the assessment was 2.44 (developing to good). This is satisfactory for first year students. Senior Survey Results: 3.0 – Mostly Met.

**Action Items proposed to meet Objective**
- None

**Action Items proposed to enhance assessment tools**
- None

### Objectives to be measured during this academic year

The following objectives will be measured next year: 1f, 3c, 4a, 5b. Also during this academic year and in response to the changes in the program tracks, program objectives will be modified in accordance with the new tracks.
Learning objectives for the BS Computer Science

th – theoretical track, ap-application track, gm-game track, all-all tracks

Objective 1: Graduates will be able to apply the tools, theory and practices of computer science.
   a) CS students apply basic programming skills (all)
   b) CS students develop software systems (all)
   c) CS students perform basic installation, configuration, and maintenance of operating systems (ap)
   d) CS students employ standard project management practices to specify, design, implement and evaluate projects (all)
   e) CS students understand the capabilities and limitations of microcomputers (ap)
   f) CS students understand computer architecture (all)
   g) CS students design and implement efficient databases (ap)
   h) CS students employ the use of a business language to produce business applications (ap)
   i) CS students apply the knowledge learned from the classroom to an internship experience (ap)
   j) CS students understand how a network works (th)
   k) CS students understand how operating systems work (th)
   l) CS students understand algorithms and data structures (th)
   m) CS students can produce game systems (gm)

Courses: CSCI 125, 130, 230, 280, 308, 310, 312, 313, 320, 330, 340, 380, 385, 408, 440, 475, 485, 496

Objective 2: Graduates will be able to apply critical thinking, analytical and logical skills to solve problems.
   a) CS students employ critical thinking (th)
   b) CS students analyze and synthesize problem information in order to develop a solution (all)
   c) CS students apply mathematical skills (all)

Courses: CSCI 130, 230, 330, 308, 408, 485
   MATH 208, 211, 212, 270, 275, 300, 370

Objective 3: Graduates will possess the ability to communicate in a professional manner.
   a) CS students produce readable and understandable documents (all)
   b) CS students design, compose, and effectively deliver professional presentations (all)
   c) CS students demonstrate effective listening skills in team and group settings (all)
   d) CS students can find information in published works and cite their sources using one of the published standards (th)

Courses: CSCI 125, 308, 310, 408, 485

Objective 4: Graduates will recognize and understand the professional, social and ethical responsibilities associated with computer science.
   a) CS students demonstrate that they are aware of legal and ethical issues relevant to the computer science discipline (all)
   b) CS students understand the value of CS professionals participating in, and promoting, community service and civic engagement (all)

Courses: CSCI 125, Capstone

Objective 5: Graduates will recognize the need for continuous learning.
   a) CS students recognize the value of memberships in the professional societies (all)
   b) CS students recognize the value of further study in computer science or related fields (all)

Courses: CSCI 125, Capstone
AS Computer Science Assessment

In this round of AS Computer Science program assessment (2012–2013), very few changes have occurred because of the time spent on the revisions to the BS programs:

- Data was collected and analyzed for the following objectives: 1a, 1b, 1d, 2a, and 4b.
- Rubrics have been modified to streamline for 1a, b.

- Comments about the following assessments – Senior surveys for last year are scarce. Despite providing ample time to complete the surveys, our return rate for the assessment period resulted in no returned surveys in the Fall of 2012 and 3 returned surveys in Spring of 2013. The 3 surveys returned were BS Computer Science/Application track students. Therefore, there are no indirect assessments for the AS computer Science.

General Rubric

<table>
<thead>
<tr>
<th>Score</th>
<th>Excellent</th>
<th>Good</th>
<th>Developing</th>
<th>Beginning</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Performance Measure

Senior Survey Scale (none returned)

<table>
<thead>
<tr>
<th>Score</th>
<th>Completely Met</th>
<th>Mostly Met</th>
<th>Somewhat Met</th>
<th>Not Met at all</th>
<th>No Opinion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Objective

Assessment of Objective 1

<table>
<thead>
<tr>
<th>Objective</th>
<th>Course</th>
<th>Direct Assessment</th>
<th>Indirect Assessment</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>a,b</td>
<td>CSCI 330</td>
<td>ABET Rubric applied to programming assignment</td>
<td>Senior Surveys</td>
<td>Fall 2012</td>
</tr>
<tr>
<td>d</td>
<td>CSCI 310</td>
<td>Rubric applied to programming assignment measuring performance</td>
<td>Senior Surveys</td>
<td>Spring 2013</td>
</tr>
</tbody>
</table>

Results (a) – The rubric for this objective measured program documentation, algorithm development, use of appropriate data structures and use of existing libraries. Since this outcome saw little improvement over the last assessment and the results were somewhat low (averaging between 2.5 developing and 3 good), several suggestions come to mind. First, documentation and design need to be emphasized in the entire programming sequence (CSCI 130, CSCI 230 and CSCI 330). The CS Curriculum committee might consider a standard for documentation and how much emphasis should be placed on designs in each of the courses. Second, difficulties highlighted by the instructors in using the rubrics indicate that the rubrics and perhaps the performance criteria be re-evaluated.

Senior Survey Results: none.

Results (b) – The rubric measured the creation of modular designs, creation of software based on a design, and the integration of modules to make a functional system. The results for this objective were consistent with the last assessment and remain at the satisfactory level. Senior Survey Results: none.

Results (d) – The performance criteria for this objective involved the creation of a working program that would collect performance data pertaining to the microcomputer architecture and understanding the performance measures. The results (2.44 developing/good) show that the students need more hands on practice with microprocessor programming. The complexity analysis needs a more in-depth understanding of the algorithm and instruction set of the
microprocessor and students who previously took Computer Organization and Architecture course seemed to have performed better in the assignment. In comparison with the previous assessment, it is difficult to tell whether both assessments were similar. Senior Survey Results: none.

Objective e was scheduled for assessment, but data was not available.

**Action Items proposed to meet Objective**
- Computer Science curriculum committee should consider development of a documentation standard
- Algorithm development should be stressed throughout the entire programming sequence (CSCI130 – CSCI230 – CSCI330) and the Computer Science curriculum committee should address how much emphasis should be placed on this across sections
- Recapitulating assembly language programming, time and space complexity, and algorithms and data structures in CSCI 310 would be helpful.

**Action Items proposed to enhance assessment tools**
- Rubrics and performance criteria should be reconsidered for Objective 1a.

### Assessment of Objective 2

<table>
<thead>
<tr>
<th>Objective</th>
<th>Course</th>
<th>Direct Assessment</th>
<th>Indirect Assessment</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>CSCI 330</td>
<td>ABET Rubric applied to homework assignment</td>
<td>Senior Surveys</td>
<td>Fall 2012</td>
</tr>
</tbody>
</table>

**Results (a)** – This measure was shared the same measure used in part to assess Objective 1b. The criterion was that students could create the necessary program modules based on a design that was developed in class. The results were again satisfactory (3.2 good) and as in Objective 2a above have been derived from a much different assessment than in the past. Senior Survey Results: none.

**Action Items proposed to meet Objective**
- None

**Action Items proposed to enhance assessment tools**
- None

### Assessment of Objective 4

<table>
<thead>
<tr>
<th>Objective</th>
<th>Course</th>
<th>Direct Assessment</th>
<th>Indirect Assessment</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>CSCI125</td>
<td>ABET Rubric applied to a student survey on community service and civic responsibility</td>
<td>Senior Surveys</td>
<td>Fall 2012</td>
</tr>
</tbody>
</table>

**Results (b)** – The rubric and assessment were changed slightly from the previous assessment in that the rubric has only 2 values: Met 1 / Not Met 0. Students were asked to provide their experiences involving community service or civic opportunities. Forty-nine out of 50 students met this assessment. Therefore, the results are exceptional. Senior Survey Results: none.

**Action Items proposed to meet Objective**
- None

**Action Items proposed to enhance assessment tools**
- None
Assessment of Objective 5

<table>
<thead>
<tr>
<th>Objective</th>
<th>Course</th>
<th>Direct Assessment</th>
<th>Indirect Assessment</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>CSCI125</td>
<td>ABET Rubric applied to a student essay on importance of professional organizations</td>
<td>Senior Surveys</td>
<td>Fall 2012</td>
</tr>
</tbody>
</table>

**Results (a)** — Students were asked to write a short essay concerning the importance of professional societies. The average score on the assessment was 2.44 (developing to good). This is satisfactory for first year students.  
Senior Survey Results: none.

**Action Items proposed to meet Objective**

- None

**Action Items proposed to enhance assessment tools**

- None

**Objectives to be measured during this academic year**

The following objectives will be measured next year: 3c, 4a, 5b. Also during this academic year and in response to the changes in the program tracks, program objectives will be modified in accordance with the new tracks.
Learning objectives for the AS Computer Science

Objective 1: Graduates will be able to apply the tools, theory and practices of computer science.
   a) CS students apply basic programming skills
   b) CS students develop software systems
   c) CS students perform basic installation, configuration, and maintenance of operating systems
   d) CS students understand the capabilities and limitations of microcomputers
   e) CS students design and implement efficient databases
   f) CS students apply the knowledge learned from the classroom to an internship experience
      Courses: CSCI 125, 207, 130, 230, 308, 320, 330, 280, 310, 313, Internship

Objective 2: Graduates will be able to apply critical thinking, analytical and logical skills to solve problems.
   a) CS students analyze and synthesize problem information in order to design and evaluate a solution
   b) CS students apply mathematical skills
      Courses: CSCI 130, 230
      MATH 208, 300

Objective 3: Graduates will possess the ability to communicate in a professional manner.
   a) CS students produce readable and understandable documents
   b) CS students design, compose, and confidently deliver professional presentations
   c) CS students demonstrate effective listening skills in team and group settings
      Courses: CSCI 125, 308, 310

Objective 4: Graduates will recognize and understand the professional, social and ethical responsibilities associated with computer science.
   a) CS students demonstrate that they are aware of legal and ethical issues relevant to the computer science discipline
   b) CS students understand the value of CS professionals participating in, and promoting, community service and civic engagement
      Courses: CSCI 125

Objective 5: Graduates will recognize the need for continuous learning.
   a) CS students recognize the value of memberships in the professional societies
   b) CS students understand the purpose and advantages of further study in computer science or related fields
      Courses: CSCI 125