Department Assessment Plan

Department of Mathematics, Statistics, and Computer Science
Macalester College

Adopted January 31, 2014

I. Department Student Learning Statement

Our mission in the Department of Mathematics, Statistics, and Computer Science is to contribute to the broad education of Macalester students with a particular emphasis on patterns of thought, methods, and communication skills that are quantitative, logical, computational, and analytic in character. For our majors, we give a deep grounding that can support future professional activity. For non-majors from quantitative and analytic disciplines, we provide the foundational concepts and skills that assist them to progress in those fields. We help all students — the general education student as well as majors in our own and partner disciplines — to acquire an appreciation of the beauty and significance of our disciplines, including their relation to ongoing events in the broader world.

To accomplish our mission, we teach classes, carry out research, engage our professional communities, support student internships and student research, and sustain student participation in professionally formative activities such as contests and conferences. We provide leadership at the college, regional, and national levels and encourage excellence in teaching and professional exposition. We pay particular attention to the ways that the disciplines that compose the department are linked together and our view that successful formation in any one of those disciplines must involve contact with the others.

Majors in Mathematics and Applied Mathematics and Statistics

II. Math and AMS Learning Goals and Outcomes

These are the outcomes anticipated for each and every departmental major in the respective areas of Mathematics (MATH), Applied Mathematics and Statistics (AMS), and Computer Science (CS). Many students will exceed these.

Majors in Mathematics

Learning Goals

A student majoring in Mathematics gains knowledge of mathematical theory, computational ability, experience with applications of mathematics, the ability to communicate technical results, mathematical independence, and a general appreciation of mathematics.

Learning Outcomes

By the time that students complete a MATH Major in our department, they will be able to ...

1. (MATH-1) Explore an open-ended problem and gain insight by applying a relevant mathematical framework.
2. (MATH-2) Investigate or solve a mathematical problem using computational software.
3. (MATH-3) Communicate mathematics to technical and non-technical audiences.
4. (MATH-4) Construct a logical argument in the form of a mathematical proof.
5. (MATH-5) Synthesize the material from a mathematical journal article at the level of the *American Mathematical Monthly*.
6. (MATH-6) Apply mathematical methods to real-world data.

Majors in Applied Mathematics and Statistics

Learning Goals

A student majoring in Applied Mathematics and Statistics gains experience with a breadth of applied problem-solving and modeling techniques, computational skills to carry out analyses, the ability to communicate technical results, and the foundational knowledge required to adapt to novel contexts.

Learning Outcomes

By the time that students complete an AMS Major in our department, they will be able to ...

1. (AMS-1) Choose from the core techniques of applied mathematics and statistics to find some reasonable mathematical or statistical formulation for a wide range of real-world settings, and critique both the modeling phase and interpretation phase of existing models.
2. (AMS-2) Write computer programs to analyze and display data, simulate and solve models, and present results.
3. (AMS-3) Present a modeling setting, a corresponding mathematical formulation at the level of the core topics, and a reasonable evaluation and interpretation of the model to both technical and non-technical audiences.
4. (AMS-4) Work collaboratively as part of a multi-disciplinary team, including being able to communicate effectively using the terms and reasoning of another discipline.
5. (AMS-5) Synthesize technical journal articles at the level of the SIAM Review or The American Statistician.

III. Math and AMS Assessment Strategies

In this section we detail the assessment strategies associated with each of the learning outcomes in each of the majors.

Majors in Mathematics

1. (MATH-1) Explore an open-ended problem. Gain insight by applying a relevant mathematical framework.
    - Assess capstone project presentations using capstone rubric completed by faculty members in attendance on Capstone Day.
    - Assess capstone project papers/posters/presentations in capstone classes. A mathematics faculty member will score a sample of capstone work using a departmentally-designed rubric.
    - Perform an audit of courses offered in the assessment year to see which courses, and what kinds of assignments in those courses, provide opportunities for student explorations.
    - Use the Senior Survey to ask graduating seniors about their confidence in their ability to explore and gain insight into an open-ended mathematical problem.

2. (MATH-2) Investigate or solve a mathematical problem using computational software.

- A mathematics faculty member will score a sample of computational assignments using a departmentally- designed rubric.
- Use the Senior Survey to ask graduating seniors about their confidence in their ability to solve a mathematical problem using computational software.

3. (MATH-3) Communicate mathematics to technical and non-technical audiences.
   - Assess a sample of capstone project presentations using capstone rubric completed by faculty members in attendance on Capstone Day.
   - Assess capstone project writing on papers or posters in capstone classes. A mathematics faculty member will score capstone writing using a departmentally-designed rubric.
   - Perform an audit of the kinds of capstone projects being done in capstone courses: collect data on group projects, presentation format (paper, poster, class presentation), and the type of project.
   - Use the Senior Survey to ask graduating seniors about their confidence in their presentation abilities.

4. (MATH-4) Construct a logical argument in the form of a mathematical proof.
   - Assess a sample of proof writing examples from the upper level courses with proof writing expectations. A mathematics faculty member will score a sample of proof writing assignments using a departmentally-designed rubric.
   - Use the Senior Survey to ask graduating seniors about their confidence in their ability to write a mathematical proof.

5. (MATH-5) Synthesize the material from a mathematical journal article at the level of the *American Mathematical Monthly*.
   - Perform an audit of the reading completed in upper level courses with reading expectations.
   - Use the Senior Survey to ask graduating seniors about their ability to read and explain the content in articles at this level.

6. (MATH-6) Apply mathematical methods to real-world data.
   - Perform an audit of the courses being taught in the assessment year to see what kinds of assignments use real-world data.
   - Use the Senior Survey to ask graduating seniors about their confidence in their ability to apply mathematics to data.

Majors in Applied Mathematics and Statistics

1. (AMS-1) Choose from the core techniques of applied mathematics and statistics to find some reasonable mathematical or statistical formulation for a wide range of

real-world settings, and critique both the modeling phase and interpretation phase of existing models.
    - Assess written assignments from upper level courses with modeling expectations. A mathematics faculty member will score a sample of the assignments using a departmentally-designed rubric.
    - Assess a sample of capstone project presentations using capstone rubric completed by faculty members in attendance on Capstone Day.
    - Use the Senior Survey to ask graduating seniors about their confidence in their ability to choose the appropriate technique in a real world setting.

2. (AMS-2) Write computer programs to analyze and display data, simulate and solve models, and present results.
    - A mathematics faculty member will score a sample of computational assignments using a departmentally- designed rubric.
    - Use the Senior Survey to ask graduating seniors about their confidence in their ability to write computer programs to analyze and display data, simulate and solve models, and present results

3. (AMS-3) Present a modeling setting, a corresponding mathematical formulation at the level of the core topics, and a reasonable evaluation and interpretation of the model to both technical and non-technical audiences.
    - Assess a sample of capstone project presentations using capstone rubric completed by faculty members in attendance on Capstone Day.
    - Assess project writing on papers or posters in upper-level classes. A mathematics faculty member will score a sample of writing using a departmentally-designed rubric.
    - Use the Senior Survey to ask graduating seniors about their confidence in their presentation abilities.

4. (AMS-4) Work collaboratively as part of a multi-disciplinary team, including being able to communicate effectively using the terms and reasoning of another discipline.
    - Assess degree of collaboration required to complete assignments in select upper division courses.
    - Audit pathways for completing integrative experience.
    - Use the Senior Survey to ask graduating seniors about their ability to work in a team.

5. (AMS-5) Synthesize technical journal articles at the level of the SIAM Review or The American Statistician.
    - Perform an audit of the reading completed in upper level courses with reading expectations.
    - Use the Senior Survey to ask graduating seniors about their ability to read and explain the content in articles at this level.

IV. Math and AMS Four-Year Timeline to Implement Assessment Strategies

YEAR 1

Assess assignments in upper-level courses, perform an audit of courses, and administer the senior survey to address:

MATH-5/AMS-5: Synthesize Material from Journal Article
MATH-4: Proofwriting
AMS-1: Model Formulation & Critique

YEAR 2

Assess capstone presentations and capstone projects in capstone courses, perform an audit of courses, and administer the senior survey to address to address:

MATH-1: Explore an Open-Ended Problem
MATH-3/AMS-3: Communication
AMS-4: Collaboration

YEAR 3

Assess computational/statistical skills in computationally focused courses, perform an audit of courses, and administer the senior survey to address to address:

MATH-2/AMS-2: Computation
MATH-6: Data

YEAR 4

Perform an assessment of our introductory courses.

Majors in Computer Science

II. Computer Science Learning Goals and Outcomes

Learning Goals

A student majoring in Computer Science gains an understanding of the breadth of computer science as a discipline, acquires deep knowledge in the theory and application of computing in selected areas, and appreciates how computer science connects to and can be applied to other fields. A major gains experience solving complex computing problems, working as a member of a team, communicating technical material, and using a wide variety of computing tools. The student is prepared to continue learning throughout their career in the computing field.

Learning Outcomes

By the time that a student completes a major in computer science, he or she…

1. (CS-1) has developed skills necessary for practicing computer science, using current techniques and tools.
2. (CS-2) is able to analyze problems of varying complexity from other fields and apply the appropriate design and development principles to solve them.
3. (CS-3) has acquired knowledge and aptitude for the use of abstraction in the design of computational systems.
4. (CS-4) is able to use mathematical foundations, algorithmic tools, and computational theory when evaluating problems and their possible solutions.
5. (CS-5) is able to explain the structure of a computing system, the design of its basic components, and the connections between hardware instructions and software.
6. (CS-6) is able to effectively contribute to a team of three or more, organized to accomplish a common software development goal.
7. (CS-7) communicates clearly to a variety of audiences in both written and oral forms about his or her own technical work and about current research literature.

III. Computer Science Assessment Strategies

Strategies we will use for each Learning Outcome

By the time that a student completes a major in computer science, he or she…

(CS-1) has developed skills necessary for practicing computer science, using current techniques and tools

- *Direct Assessment:* Assess a sample of individual student code from assignments in courses in three different languages, keeping track of tools used by the student.

- *Indirect Assessment:* on a final course evaluation in advanced courses (COMP 346, 380, 445) and the senior survey, ask students about how many gains they have made using particular languages and development environments.

(CS-2) is able to analyze problems of varying complexity from other fields and apply the appropriate design and development principles to solve them.

- *Direct Assessment:* Assess projects from advanced courses (COMP 445, COMP 346, COMP 380, COMP 484, COMP 440).
- *Indirect Assessment:* on a final course evaluation in advanced courses (COMP 445, COMP 346, COMP 380, COMP 484, COMP 440) and the senior survey, ask students how confident they are in their ability to meet this goal.

(CS-3) has acquired knowledge and aptitude for the use of abstraction in the design and implementation of computer systems.

- *Direct Assessment:* Evaluate student responses to exam questions from COMP 124 and COMP 240 related to this outcome. Faculty member not teaching the course would review selected arbitrary subset of exams.
- *Indirect Assessment:* Add a question to the course survey of COMP 124 and COMP 240 asking the students about their level of confidence in meeting this objective.

(CS-4) is able to use mathematical foundations, algorithmic tools, and computational theory when evaluating problems and their possible solutions.

- *Direct Assessment:* Assess assignments from COMP 221 and COMP 261. Faculty not teaching the course will score work using a departmentally designed rubric. Analyze performance of students on exam questions directly designed for this goal.
- *Indirect Assessment:* Add a question to the course survey of COMP 221 and COMP 261 and the senior survey asking the students about their level of confidence in meeting this objective.

(CS-5) is able to explain the structure of a computing system, the design of its basic components, and the connections between hardware instructions and software.

- *Direct Assessment:* Evaluate student responses to exam questions from COMP 240 related to this outcome. Faculty member not teaching the course would review selected arbitrary subset of exams.
- *Indirect Assessment:* Add a question to the course survey of COMP 240 asking the students about their level of confidence in meeting this objective.

(CS-6) is able to effectively contribute to a team of three or more, organized to accomplish a common software development goal

- *Direct Assessment*: Assess team project documents and software coming from the software design course (COMP 225). Faculty not teaching the

course will score work using a departmentally designed rubric.

- *Indirect Assessment*: Use the Senior Survey to ask graduating seniors about their ability to work in a team and what experiences (internships, courses, summer research) enhanced their ability to do so.

(CS-7) Communicates clearly to a variety of audiences in both written and oral forms about his or her own technical work and about current research literature

- *Direct Assessment:* Assess senior capstone papers using a scoring rubric. Assess papers written for projects in COMP 445, COMP 346, COMP 380, COMP 484, COMP 440 using a scoring rubric. Assess senior capstone talks by having faculty complete a scoring rubric.
- *Indirect Assessment:* on the senior survey, ask students how confident they are in their ability to write about technical material to 1) computer science peers and 2) a lay audience; and how confident they are in presenting technical material to those same 2 audiences (four questions total).

IV. Computer Science Four-Year Timeline to Implement Assessment Strategies

This timeline has been devised as a way to make it a continually rotating, or iterating process that repeats assessment of the objectives during the 4-year time period and can be repeated during the next four years, with revisions as necessary as our objectives change.

YEAR 1 (2014-2015)

New: (Shoop and Fox) Direct: Assess assignments in core courses to address these objectives:

CS-3 Abstraction
CS-5 Computer Systems

This will involve creating rubrics and gathering appropriate assignments and exams from courses. Note: Sen is on sabbatical all year. Shoop and Fox plan to gather assignments and exams and work on developing the rubrics. Direct assessment will occur during summer 2015.

New: Indirect: Develop questions for course survey for objectives CS-3, and CS-5. (Shoop and Fox)

New: Indirect: (Shoop and Fox) Revise senior survey to include more questions for the following objectives and administer the survey in spring of 2015. Note that we have a

separate survey section for CS majors and we cover a great deal of this already in the current version.

CS-1 Skills of a practicing computer scientist
CS-2 Applying CS to other fields
CS-6 Teamwork
CS-7 Communication

YEAR 2 (2015-2016)

New: Direct: assess objective CS-1, CS-2, CS-7 in an advanced course offered during this academic year. (Sen)
New: Begin process of direct assessment of CS-7 by creating a rubric for senior capstone papers. (Shoop)
New: Indirect: Develop questions for course survey for objectives CS-1 and CS-2. (Fox)
Continued: Indirect assessment of CS objectives 1, 2, 6, and 7 via senior survey.

YEAR 3 (2016-2017)

New: Direct: assess objective CS-1, CS-2, CS-7 in an advanced course different from the one in 2015-2016. Note: reuse rubrics from 2015-2016. (Fox)
New: (Shoop, Sen, Fox) Direct assess:

CS-4 Algorithms and Theory
CS-6 Teamwork
CS-7 Senior capstone paper specifically

New: Indirect: Develop questions for course survey for objective CS-4. (Fox)
Continued: Indirect assessment of CS objectives 1, 2, 6, and 7 via senior survey. (Shoop)

YEAR 4 (2017-2018)

New: Direct: assess objective CS-1, CS-2, CS-7 in an advanced course different from the one in 2016-2017. Note: reuse rubrics from 2015-2016. (Shoop, Fox, Sen)

Continued: Repeat Direct assessment of objective CS-3 and CS-5.
Continued: Indirect assessment of CS objectives 1, 2, 6, and 7 via senior survey.
Continued: Indirect assessment of objective CS-7 of senior capstone.