

FORM E-1-A FOR BOSTON COLLEGE DEPARTMENTS/PROGRAMS

DEPARTMENT OF MATHEMATICS

UNIVERSITY CORE

2023

1. *Have formal learning outcomes been developed? What are they? (What specific sets of skills and knowledge does the department expect students completing its Core courses to have acquired?)*

In a Core course in Mathematics, students should:

- learn the nature of mathematical inquiry: abstraction and generalization;
- understand the power of mathematical reasoning to reach conclusions with assurance;
- communicate solutions clearly and effectively;
- study and appreciate applications of mathematics to other disciplines.

2. *Where are these learning outcomes published? Be specific. (Where are the department's expected learning outcomes for its Core courses accessible: on the web, in the catalog, or in your department handouts?)*

A statement of the department's commitment to assessing the success of our students, with descriptions of our goals, is available on the University Core website at [Core Requirements - Morrissey College of Arts and Sciences](#) .

3. *Other than GPA, what data/evidence is used to determine whether students have achieved the stated outcomes for the Core requirement? (What evidence and analytical approaches do you use to assess which of the student learning outcomes have been achieved more or less well?)*

The traditional department procedure is to collect evidence in two ways, direct and indirect.

- I. The Undergraduate Committee periodically reviews final exams in specifically identified courses and rates carefully chosen problems with regard to the learning goals.
- II. The Undergraduate Committee reviews student evaluations for those identified courses. In some cases, instructors are asked to add extra questions, designed by the Committee, to directly address the learning goals. In Calculus courses, use of pre and post-surveys is also used to assess learning goals.

More specifically, In AY 22-23, the Assistant Chair for Undergraduates (J. Belding, AY22-23) developed a multi-year Assessment Plan for Core Courses.

One key intended outcome is to identify common and necessary foundational content and learning goals for various courses, and determine success in meeting those goals. This can inform future curricular and pedagogical changes, when appropriate.

- In AY22-23, we have begun by examining our non-major Calculus core offerings, MATH1100 and 1101 in terms of content, recent curricular changes and course structure. For Math 1101, we used pre/post course survey data to assess how well these courses are meeting Core goals, specifically “**study and appreciate applications of mathematics to other disciplines**”.
 - In AY23-24, we plan to look at course calendars, final exams, and student evaluations, for Math1100 and Math1101 courses across Fall and Spring to assess consistency of content and alignment with learning goals.
 - In AY23-24, we also plan to examine our curriculum and learning outcomes for non-Calculus Core offerings:
 - MATH1180 Statistics for Health Professionals (for CSON students). This is under the direction of Professor L. Zhang who is working with the support of a TAM grant.
 - MATH1004 Finite Probability and MATH1007 Ideas in Math. This is under the direction of Professor E. Ward, who is considering ways in which we might redesign the courses to promote more problem-solving and engage more student interest.
 - Assessment of Calculus I and II for Math and Physical Science Majors (Math1102 and Math1103) is addressed in the E-1-A for the Major.
4. *Who interprets the evidence? What is the process? (Who in the department is responsible for interpreting the data and making recommendations for curriculum or assignment changes if appropriate? When does this occur?)*

The department's Undergraduate Committee, chaired by the Assistant Chair for Undergraduates is charged with assessment. For the results for AY22-23, a subset of the committee who work closely with these courses (Belding, Goldstein) have discussed and analyzed data and made recommendations.

5. *What were the assessment results and what changes have been made as a result of using this data/evidence? (What were the major assessment findings? Have there been any recent changes to your curriculum or program? How did the assessment data contribute to those changes?)*

- **Math1101, Calculus 2 for Life and Social Sciences:**

This course was redesigned in 2019 and piloted in 2020 in two sections. The goal was to address **an increased need for applying the concepts of calculus** and working with functions of multiple variables and parameters (in part sparked by conversations with other departments). We also saw a decreased need for topics such as volumes of revolution and advanced integration techniques. The redesign included less integration, more differential equations and a new unit on multivariable functions and derivatives, with increased applications to life sciences and economics throughout. As the pilot was very successful, we incorporated the new curriculum in all our sections of MATH1101, beginning in Fall 2020.

More recently, to examine the effectiveness of this curriculum in promoting applications of calculus compared to the previous in terms, we analyzed data from a pre- and post-course survey for courses taught before and after the redesign (S2020). The main questions was:

“Do students' attitudes toward the relevance of mathematics to other fields change over the term, and does this differ for the redesigned curriculum when compared to the previous curriculum?”

Students' incoming attitudes were the same in both cases, but in the redesigned course they shifted to a slightly more favorable attitude about general relevance of math and calculus, while the students in the previous version of the course shifted to a less favorable attitude. The result was statistically significant ($p < 0.001$).

While there could be different reasons for this positive shift for students in the redesigned course versus a negative shift in the other, one possible explanation is that through the new curriculum, students are better able to experience how calculus and mathematics are used in other disciplines, including their intended majors.

Given the positive results related to the Core goal “**study and appreciate applications of mathematics to other disciplines**”, as well as the fact that this curriculum responds to other department's needs for math, we plan to continue to use this curriculum in all MATH1101 sections.

Next steps include analyzing if this curriculum results in improved success in the course, as measured by grades and D/F/W rates, and maintaining consistency of curriculum term to term.

- **Math1100 Calculus I for Life and Social Sciences**

The audience for Math1100 is generally students focused on the life and social sciences and humanities. More than 85% have had Calculus before in high school and for the

majority, this will be their last Calculus course. Since Fall2020, various instructors have been re-thinking what would most help these students grow mathematically and have experimented with some curricular changes for Calculus.

The goal is to better meet some of our Core goals such as “**learn the nature of mathematical inquiry: abstraction and generalization**” and “**study and appreciate applications of mathematics to other disciplines**” in ways that students can use in future work.

This Fall 2022, in the 400-person multi-section course, two main new priorities were introduced: working with functions with parameters (including how changing parameters affects behavior of limits, extrema, and rates of change) and using a problem-solving framework. These topics support students to more confidently approach unfamiliar problems and look for the mathematical structure in new formulas and functions they may encounter in other fields, such as a rate equation in biochemistry or a demand model in economics.

As a starting point for assessment of these changes, students were asked on course evaluations for two large sections of the course¹ about their agreement with:

“I feel more confident working with a function with parameters compared to when I started the course.”

Student responses were very encouraging: 51% strongly agreed and 36% agreed. 12% were neutral and 1% disagreed.

Based on this, the course coordinator for F23 (Prof Belding) will update course materials about parameters and work to improve their use across all sections of the course.

Next steps include gathering student evaluation data for all sections, fall and spring, as well as using pre- and post-course survey data to look more closely at the impact on confidence on working with parameters and problem-solving, as well as other course goals.

6. *Date of the most recent program review. (Your latest comprehensive departmental self-study and external review.)*

The department conducted a self study in the Fall of 2007, which was followed by an external review on April 24-25, 2008. The next review will take place in AY 2023.

¹ There was a 77% response rate (78/101 students).