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

DEPARTMENT OF MATHEMATICS

UNIVERSITY CORE

2025

1. Q1: 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.

Of the BC Core learning goals, the one most directly applicable is #1, especially the bolded parts

- Demonstrate the **critical, mathematical, informational, analytic**, expressive, and **creative** skills that are essential tools of the educated person well-prepared for a meaningful life and vocation.

2. Q2: 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. Q3: 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 a few different 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. In 2025-26, we are considering having select problems used each year on final exams to compare results year to year.
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.
III. The Undergraduate Committee or individual faculty consult with departments whose programs relate to our Core courses to see if we are addressing the mathematical skills or habits needed by those programs.

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 (including those directly related to core objectives) for various courses, and determine success in meeting those goals. This can inform future curricular and pedagogical changes, when appropriate.

Here is where we are in that plan.

- In AY23-4, we examined curricular changes in a few non-Calculus Core offerings (Math1007 and Math1180). We use student evaluation and data to compare the level of the courses and how well we are meeting certain Core goals. We continued this comparison in AY24-25 with the sections of Math1007 this year, including some sections with a new topic of “Math and Games”.

- This year we began to look at another main Core course, MATH1004 Finite Probability and Applications in AY24-25. More detail on this is below.

- In 2025-26, we will consider when to next focus on assessment of core goals in our Calculus offerings, both those for majors and non-majors. (In AY22-23, we examined our non-major Calculus courses, Math1100 and 1101 for learning goals related to applicability of mathematics (the last of the 4 stated learning objectives). Some assessment of core goals in Calculus I and II for Math and Physical Science Majors (Math1102 and Math1103) is addressed in the E-1-A for the Major in previous years.)

4. Q4: 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. The two members of the committee (Ward and Belding) who work mostly directly with Core are focused on the assessment of Core, while all members focus on assessment of the Major.

The sub-committee looked at 1007 and 1004 and will share findings and recommendations (if any) with the UG committee and, more importantly, the faculty and graduate students involved in teaching these courses to make recommendations. We anticipate this happening in August, so it can be useful for Fall teaching.

5. Q5: 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?)

- **Math1007 Ideas in Math** This course is designed to introduce the student to the spirit, beauty and vitality of mathematics. The emphasis is on development of ideas more than problem solving skills.

  Traditionally, the course is a "survey course", covering a few unrelated topics in mathematics. Common topics include number patterns, primes and cryptography, topology, knot theory, graph theory. We refer to this as the "Mixed Topics" version of the course. This version uses homework, midterm exams and a final project as assessment.

  In F23-F24, Prof. Ward created and offered a version on the theme "Math and Democracy" including apportionment, voting methods and measures of fairness and gerrymandering. The course uses weekly quizzes and homework and three projects for assessment.

  If F24-S25, Prof. Ward created and offered a version on the theme "Math and Games" which include probability, modular arithmetic, and other topics.

  We are interested in how the courses compare in student evaluations of the course overall, intellectual challenge and applicability beyond the course, and grade distributions, as well how well both versions of the course meet the Core learning goals. As of now, we are using indirect evidence, via evaluations. Starting in Spring 2024, we added questions to the student evaluations to more directly address Core learning goals.

Below we extend the results from last year with the information from this year. Based on student evaluation data (see below), we found that from a student perspective, both versions of the course are addressing at least three of the four core learning goals.

1. In all three types of courses, students report a) making progress in identifying patterns in problems, b) seeing the applicability of math and c) practicing communicating about math. The mean rating was slightly higher for the “Math and Games” version in the first and third than the others.
2. Students agreed with “I learned perspectives, principles or practices that I expect to apply beyond the course.” in all courses. This was more strong in the “Math and Democracy” and “Math and Games” version, than mixed topics. This might be a result of instructor emphasis. It was interesting to note that “Math and Games” , which might seem to be more niche, was able to help students see applications and connections outside the course.
3. The “Mixed Topics” version was still rated as the most intellectually challenging and more time consuming in terms of hours per week. (This may be because this class had `traditional’ midterm exams while the other versions did not, but more investigation is needed to understand this.)
4. Grade distributions were much higher in the Math and Democracy and Games version, which may be due to the nature of only projects as assessments versus more `traditional’ midterm exams. Again, more investigation is needed to understand this.

Next steps:

- **We plan to continue to track these questions in AY25-26**, as another instructor offers a mixed topics version. We will also look at course material, assignments and grade distributions as we **consider ways to maintain strong intellectual challenge and provide students opportunities to connect with the discipline of mathematics meaningfully.**
- We comment that student’s self-reported answers about time spent and intellectual challenge may not capture their full experience. For example, there is an intellectual challenge in translating real world problems to math. Often in 1007 and 1004, figuring out what mathematical computations or tools to use is often more the challenge, versus the computations. As this is different from what students often consider as “hard” in math (such as complicated formulas or computations), these challenges may not factor in their response. **In the future, we will develop/modify some questions to better understand this. We will also look at the student reflection essays** written in the sections of Dr. Ward for evidence of time spent and intellectual challenge.
- We also plan to **compare results of these questions in 1007 to those in Math1004**, another more commonly offered Math Core course. We are currently considering offering more sections of Math1007 if we find that this course is meeting the core goals more consistently or effectively than Math1004.

- Last but not least, **we will consider assessing an additional goal for Math Core courses: that students view math as a subject where one can improve their skills and understand better if they try.** This growth mindset and confidence is often lacking in students in introductory level math courses. As one student said in Dr. Ward's Math1007 in S24, "she doesn't just teach math, she teaches students to believe they can learn it." This goal is perhaps implicit in the other core goals, but we think that explicitly naming and addressing it could be helpful for instructors and students.

S23-S25 Student Evaluations (Mean rating)

Flavor	**Mixed Topics**	**Mixed Topics**	**Math and Demo-cracy**	**Math and Demo-cracy**	**Math and Demo-cracy**	**Math and Games**	**Math and Games**
Instructor	**Ionov**	**Ionov**	**Ward**	**Ward**	**Ward**	**Ward**	**Ward**
Year	**S23**	**S23**	**F23**	**S24**	**F24**	**F24**	**S25**
Response rate and enrollment	87% (23)	72% (18)	87% (79)	85% (81)	77.5%(31)	70.7% (29)	84.6% (66)
Course overall rating	2.9	3.54	4.49	4.09	4.26	4.3	4.3
I learned perspectives, principles or practices that I expect to apply beyond the course.	3.3	3.92	4.58	4.49	4.35	4.3	4.51
The instructor stimulated interest in the subject matter.	4.11	4.66	4.66	4.64	4.55	4.56	4

Hours worked per week[1]	2.75	2.54	1.90	1.85	1.71	1.63	1.95
Course was intellectually challenging	4.45	4.46	3.94	3.49	3.23	3.93	3.9

S24 Student Evaluations (Mean rating)

Core Learning Goal	**Evaluation Question (Agreement with 5 is strongly agree and 1 is strongly disagree.)**	**Ideas in Math - Mixed Topics S24 Ionov**	**Ideas in Math - Math and Democracy S24 Ward**	**Ideas in Math - Math and Democracy F24 Ward**	**Ideas in Math - Math and Games F24 Ward**	**deas in Math - Math and Games S25 Ward**
Learn the nature of mathematical inquiry: abstraction and generalization	**"In this course, I made progress in recognizing patterns in problems that seem different."**	4.08	4.49	4.35	4.59	4.59
Study and appreciate applications of mathematics to other disciplines.	**"This course helped me see applications of math to different disciplines or to real life."**	4.08	4.79	4.61	4.81	4.66

[1] Choice 1 is <1 hour a week, Choice 2 is 1-3, Choice 3 is 4-6, Choice 4 is 7-9, Choice 5 is 10 or more. Thus a rating of 3.11 indicates students on average spent about 4-6 hours per week.

Communicate solutions clearly and effectively	**"This course provided me with practice communicating about how I solve a mathematical problem."**	4.33	4.37	4.23	4.47	4.59
	Please describe briefly one thing you learned in the course that you hope to remember 5 years from now. (It could be a specific topic, a general concept, an approach to problems, etc.)	Students listed a variety of topics from the course (topology/knots, cryptography).	Students listed topics (voting methods, gerrymandering) as well as made general comments about the connection of math and politics. (eg: "different methods of counting votes yield different outcomes,")	Similar to previous year.	Students listed topics from course (coding, ciphers, probability) as well as the idea that math is in everything and improved group work.	

Grade Distributions

Flavor	**Mixed Topics**	**Mixed Topics**	**Math and Democracy**	**Math and Democracy**	**Math and Democracy**	**Math and Games**	**Math and Games**
Instructor	**Ionov**	**Ionov**	**Ward**	**Ward**	**Ward**	**Ward**	**Ward**

Year	**S23**	**S23**	**F23**	**S24**	**F24**	**F24**	**S25**
A	~50%	50%	94%	96%	87.5%	92.7%	87.2%
B	~50%	48%	4%	4%	7.5%	0	9%
C	~4-6%	5%	1%	0%	5%	2.4%	2.6%
D	0	0	1%	0%	0%	2.4%	1.3%
F	0	0	0		0%	0	0%
Total Students	23	18	78	82	40	41	78

- **Math1004 Finite Probability**

From our recent self-study, we learned that 17% of students graduating in 2024 took Math1004 as their Math Core, which is a significant amount. This is also an uncoordinated course, with up to 10 different instructors a year. For this reason, we want to look closely at this course and whether there is reasonable alignment between different sections, as well as how this course is meeting core learning goals.

In AY24-25, we took a preliminary step to assess how well Math1004 is meeting our Core learning goals. We collected F24-S25 instructor reports and syllabi to gather information about the content and order of material covered, the types of assessments, and instructor impressions of successes and challenges with the course. We reviewed reports from 7 of the 8 instructors who taught the course this academic year. (One instructor did not respond.)

This review gave us valuable information, including the scope of data that will be available across sections and how we might assess. In particular, we know that

- Most courses use the same text and draw from a repository of materials from past instructors.
- All courses give exams including a final, and 6/7 give quizzes. This could be helpful for learning goals #1, 2, 3.
- Half of the courses use homework presentations, which could be relevant to the learning goal #3 (communicating math).
- The percent of A/B is 88% or above in 6 of the 7 courses, suggesting that the course is “successful” for most students grade-wise. (There are obviously instructor factors too which we will consider separately.)
- 1 instructor included projects as an alternative assessment with self-reported success. These projects relate to the learning goal #3 (communication) and #4 (application). Some examples include Pascal’s wager about belief in God; and Bayes’ Theorem and

Covid Tests). The instructor wrote *"I think this largely achieved the goal of providing an alternative form of assessment (welcome to both the students and myself) in which students were able to connect course materials with other topics (in the spirit of "applications")."* These projects have been collected in order for others to use in future and we will be encouraging instructors to consider incorporating them.

- Half of the instructors mentioned student use of Chat GPT/AI/LLM, sometimes positive and others potentially problematic. This should definitely be discussed, as its use may shortchange some of the core learning goals.

The plan for assessment going forward is as follows:

- Collect Indirect evidence: Track the student evaluation responses to the same questions we've been using for Math1007, including the extra three questions we have added to evaluations that were designed to align with core goals #1, 3, and 4.
- Collect direct evidence: Create 1-2 common questions (to be kept secure) that all instructors will give on the final exam. Create these to align with both goal 3# (communication) and specific content related to goal #2 (math reasoning). For example, we might choose a probability concept which has common pitfalls and ask a question about it on an earlier exam and then again on the final and compare results as well as student communication about it.
- In 2024, Prof Ward, with the help of a TAM grant, created a new outline for the course content to better motivate the development of the math tools to solve statistics and probability problems. This change may improve results for the learning goal #4 (apply mathematics). We may want to compare how sections using this outline versus the traditional one fare in terms of progress on that goal and student success overall. We will also track use of projects.

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 Summer of 2024, which was followed by an external review in Fall 2024. Results from the external review board were received in May 2025. There were not any direct comments in that review related to Math Core.

Below is an excerpt from our Self-Study relevant to how students fulfill their Math Core.

From this we see that 70% of BC students fulfilled their Math Core via a Math Department course. It is also interesting to note that despite the change to allow CS 1 to count for Math Core for MCAS students, only 8% of students are taking that option. We also note that MATH1100 and MATH1004 are the most common courses students take to fulfill Math Core, with 44% of the class of 2024 taking one of these two courses. This points to a need to continue to invest in these large courses, in terms of developing curriculum to support the content and core goals, providing adequate teaching staff and

support, and last but not least, ensuring that all students have the opportunity to succeed in these courses.

Course	**Percent of 2024 graduates who took this for Math Core**
MATH1100 Calculus 1 for Life and Social Sciences	27%
Another Calculus Course (1003, 1101, 1102, 1103 or 2202)	17%
MATH1004 Finite Probability	17%
MATH1007 Ideas in Math	3%
Math Course for Nursing or Education	6%
Course outside Math Department	9% Business 8% Computer Science 1% Applied Psychology (LSEHD)
Course unknown (likely taken outside BC)	3%