

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

DEPARTMENT OF MATHEMATICS

UNIVERSITY CORE

2024

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.

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.
- 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 for various courses, and determine success in meeting those goals. This can inform future curricular and pedagogical changes, when appropriate.

- In AY23-4, we examined curricular changes in a few non-Calculus Core offerings. We use student evaluation and data to compare the level of the courses and how well we are meeting certain Core goals. We plan to continue this in AY24-25, including looking at students' success rates over the past few years. We plan to examine another main Core course, MATH1004 Finite Probability and Applications in AY24-25.

The courses we examined this year were

- MATH1007 Ideas in Math. This has been taught by Professor Erika Ward and Andrei Ionov over the past three terms.
 - MATH1180 Principles of Statistics for Health Professionals (for CSON students). This is under the direction of Professor Liyang Zhang who made changes with the support of a TAM grant.
- In AY22-23, we examined our non-major Calculus courses, Math1100 and 1101. In AY24-25, we plan to look at course calendars, final exams, final grades and student evaluations, for Math1100 and Math1101 courses across Fall and Spring to assess consistency of content and alignment with learning goals. (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. 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. In AY23-24, the department has been focused on the Self Study (to be completed in Fall 2024). The data collected this year by the Assistant Chair will be discussed

with the committee over Summer 2024 with the committee and faculty involved in teaching these courses to make recommendations.

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 and S24, Prof. Ward created a version of Ideas in Math focused around the theme of “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.

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. (In Spring 2024, we added questions to the student evaluations to more directly address Core learning goals.)

In our preliminary findings, 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 both 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 higher for the “Math and Democracy” version in the first two areas.
2. Students in the “Math and Democracy” version more strongly agreed with the statement of applicability: “I learned perspectives, principles or practices that I expect to apply beyond the course.”
3. The “Mixed Topics” version was rated as more 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 version did not, but more investigation is needed to understand this.)

- Grade distributions were much higher in the Math and Democracy 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.

We plan to continue to track these numbers, as well as look at the course material, assignments and grade distributions as we consider ways to maintain strong intellectual challenge while also providing students opportunities to connect with the discipline of mathematics meaningfully.

We also plan to compare these to numbers 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.

S23-S24 Student Evaluations (Mean rating)

	Ideas in Math: Mixed Topics S23 Ionov	Ideas in Math: Mixed Topics S24 Ionov	Ideas in Math: Math and Democracy F23 Ward	Ideas in Math: Math and Democracy S24 Ward
Response rate and enrollment	87% (23)	72% (18)	87% (79)	85% (81)
Course overall rating	2.9	3.54	4.49	4.09
I learned perspectives, principles or practices that I expect to apply beyond the course.	3.3	3.92	4.58	4.49
The instructor stimulated interest in the subject matter.	4.11	4.66	4.66	4.64

Hours worked per week¹	2.75	2.54	1.90	1.85
Course was challenging	4.45	4.46	3.94	3.49

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
<i>Learn the nature of mathematical inquiry: abstraction and generalization</i>	“In this course, I made progress in recognizing patterns in problems that seem different.”	4.08	4.49
<i>Study and appreciate applications of mathematics to other disciplines.</i>	“This course helped me see applications of math to different disciplines or to real life.”	4.08	4.79
<i>Communicate solutions clearly and effectively</i>	“This course provided me with practice communicating about how I solve a mathematical problem.”	4.33	4.37
	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:

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.

			“different methods of counting votes yield different outcomes,”)
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Grade Distributions

	Ideas in Math: Mixed Topics S23 Ionov	Ideas in Math: Mixed Topics S24 Ionov	Ideas in Math: Math and Democracy F23 Ward	Ideas in Math: Math and Democracy S24 Ward
A	~50%	50%	94%	96%
B	~50%	48%	4%	4%
C	~4-6%	5%	1%	0%
D	0	0	1%	0%
F	0	0	0	
Total Students	23	18	78	82

- **Math1180** Principles of Statistics for Health Professionals

This course is offered each spring and taken by all first-year CSON students. The course is taught in sections, coordinated by a math faculty. In Spring 23 and 24, Prof Liyang Zhang coordinated this course. Based on observations of student success and conversations with faculty in the the nursing school, he made the following changes:

- Leave out the following material: factorials, hypergeometric distribution, binomial distribution, Poisson distribution, as these are not used in the profession.
- Put extra emphasis on the understanding of hypothesis testing of the sample mean and sample proportion. These concepts are important for interpreting results regarding drug and therapy development.
- Make normal distributions more intuitive: instead of using the mathematical notation of $\alpha 100\%$, $(1 - \alpha) 100\%$, we use words such as middle, tails. Middle

means things can happen by chance, tails mean that it passes a prescribed threshold that one cannot explain it happened by chance anymore.

- Presented actual medical research papers and FDA announcements.
- Purchased scientific calculators to standardize the technology used by students in the class.

Note that the curriculum changes are in line with the second and fourth Core goals:

- understand the power of mathematical reasoning to reach conclusions with assurance²;
- study and appreciate applications of mathematics to other disciplines.

Prof. Zhang is in the process of evaluating the impact of these changes both in his sections and those that he supervises. His preliminary evaluation, based on his sections, is summarized below.

We will continue to track student evaluation and grade data over the next few years to determine the impact of the changes and what further supports are necessary to make sure this course meets its goals.

1. Students are generally more engaged with content from class participation perspective. We can devote more than one month on hypothesis testing and interpretation, although it seems that more time is needed to allow students to understand these more intuitively.
2. It appears the overall difficulty of the course has not decreased. Hypothesis testing is mathematically simpler but to understand it well requires lots of practice. However, student evaluations suggest that the difficulty has decreased somewhat. Grade distribution suggests that students generally performed better on the top end but more students fell into the C and D range. (The Assistant Chair for Undergraduates notes that this may also be due to shifting backgrounds of incoming students. This is something that will be examined further in subsequent years.)
3. The use of a common calculator is a success. No students can take advantage of advanced features in statistical calculators for unfair advantage. There are minor issues of having a limitation of length of calculations.

Student Evaluations (Mean rating)

	Spring 2023	Spring 2024
Course overall rating	3.59	3.76
I learned perspectives, principles or practices that I	3.57	3.93

² In the case of statistics, there is no absolute assurance in the conclusions, but there are ways of quantifying whether something is likely to have occurred by chance or by an actual relationship between variables.

expect to apply beyond the course.		
The instructor stimulated interest in the subject matter.	4.47	4.51
Hours worked ³	3.11	2.67
Course was challenging	4.73	4.5
Representative student comments	<p>“the way the information is presented makes it very challenging to understand what needs to be done.”</p> <p>“If we were taught things that were more applicable to nursing in the future ”</p>	<p>“Appropriate level of difficulty, content was connected to nursing/health professions ”</p> <p>“This course taught me a lot about statistics, which is very valuable for any research–related purpose. As I hope to conduct research as a nurse, this course is very beneficial.”</p>

Grade Distribution

Letter Grade	All sections 2023	Percent 2023	All sections 2024	
A Range	44	39.64%	57	44.88%
B Range	51	45.95%	38	29.92%
C Range	12	10.81%	26	20.47%
D Range	4	3.60%	6	4.72%
	111	100.00%	127	100.00%

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

³ 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.

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 is currently in progress, to be completed by Fall 2024.