

Developing and Teaching an Honors Calculus Course in a Community College

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Abstract

In this article, we describe, from personal experience, the different aspects of developing and teaching an honors calculus course in our community college. More specifically, we address the following issues:

- What distinguishes an honors calculus course from a standard one?
- Which high impact practices are applied in the course?
- What are some of the obstacles to a successful implementation of an honors calculus course at a community college such as ours, and how they may be overcome?
- What are the benefits of making such a course available to our students?
- Why are honors course offerings, in general, important at a community college?

In this work, we will describe our individual educational journeys as instructors of this specific course and relate our experiences to other mathematics courses we teach as well as to honors course offerings in other disciplines at our college. Upon reflection, we hope to provide some helpful suggestions, both practical and pedagogical, to those faculty members who intend to

design and offer an honors course at our college as well as other community colleges across the nation.

Keywords: Honors Calculus; Community College; Mathematics Education; Technology in the Classroom

Introduction

The City University of New York (CUNY) is a leading urban public university serving more than 270,000 students with 24 campuses in New York City (Office of Institutional Research, CUNY, 2012). Like most large urban universities, CUNY has a very diverse body of students. Eugenio Maria de Hostos Community College (Hostos) is the smallest of the seven community colleges within the CUNY system with a population of about 7,000 students as of spring 2013 (Office of Institutional Research, Hostos, 2013). Hostos is located at the heart of the South Bronx and takes pride in its historical role in educating students from diverse ethnic, racial, socio-economic, cultural and linguistic backgrounds:

The mission of Eugenio María de Hostos Community College is to offer access to higher education leading to intellectual growth and socio-economic mobility through the development of linguistic, mathematical, technological, and critical thinking proficiencies needed for lifelong learning and for success in a variety of programs including careers, liberal arts, transfer, and those professional programs leading to licensure. (Hostos Community College, 2013)

In accordance with this mission, the College attracts many of the academically weakest CUNY students. In any given recent semester, almost 85% of freshman entering Hostos require remediation in mathematics, while one-fifth of all students are enrolled in a remedial mathematics course (Office of Institutional Research, Hostos, 2013). As of spring 2013, the College's population was approximately 60% Hispanic, 25% black, and 67% female (Office of Institutional Research, Hostos, 2013). Hostos is officially designated as a Hispanic Serving Institution (HSI). This data attests not only to the importance of appropriate and effective remedial mathematics education but also illustrates the uniquely diverse composition of a typical Hostos classroom. Based on multiple studies it is well known and accepted that a single method of teaching cannot be appropriate for all students. Susan and Linda describe this fact as follows:

By now it is axiomatic to point out that student bodies are increasingly diverse, not only in terms of ethnicity and gender, but also in terms of age, nationality, cultural background, etc. This diversity can affect classroom settings in many ways, including the diversity of learning styles. (Susan and Linda, 1998)

Based on the needs of our students it is appropriate that one of the main tasks of the Mathematics Department at Hostos is to assist students in exiting remediation and successfully entering college level courses to pursue their academic careers. However, many students entering the College, while, perhaps, lacking sufficient English language skills or general education foundations, are equipped with relatively impressive backgrounds in mathematics, and cannot be overlooked by the department but rather need to be encouraged and challenged to continue to cultivate their mathematical abilities.

After all, Hostos offers Associates in Science (A.S.) degrees in Mathematics, Liberal Arts and Sciences, Chemical Engineering, Electrical Engineering, Civil Engineering, Mechanical Engineering and Forensic Science. All of these programs require a solid mathematical foundation way beyond remediation. As a matter of fact, most of these majors require proficiency beyond a typical three-semester calculus sequence. Currently, 6% (about 400) of Hostos students are enrolled in one of these programs. Many of these students are very talented, dedicated and hard working, and would benefit greatly by a challenging and engaging curriculum.

The College-Wide Honors Program

For several years, Hostos has had an active and growing Honors Program whose mission is described below:

The Hostos Community College Honors Program provides an enriched academic, cultural and social experience to intellectually inquisitive and motivated students. The program offers students an academic environment that values and promotes critical thinking, analytical writing, and research and information competency skills through an innovative and challenging curriculum. Attendance at cultural events, conferences, honors seminars and an Honors Institute provides an intellectual community that encourages and supports students in pursuing their goals.

The program will offer greater academic opportunities to a previously underserved population, to prepare talented and ambitious students for the challenges of higher education, and to support a successful transition to senior colleges and expanded career

options. A fundamental program goal is to promote self-confidence and increase self-esteem in students who need the encouragement to excel and the courage to continue their education and fulfill their life goals and dreams. (College-Wide Honors Program, Hostos Community College, 2013)

Such programs exist in many other colleges within and outside of CUNY. To be an honors student, students need to go through a rigorous application process. After they are accepted in the honors program, each student needs to finish a certain number of “honors contracts,” or, alternatively, enroll in one of the honors courses offered during the semester. To satisfy an “honors contract” the student is mentored by an appropriate faculty member in conducting independent research related to the content of a course they are currently taking. At the end of the semester they write and present a detailed report of their work to the faculty members of the College-Wide Honors Committee. In addition, the students prepare a brief presentation of their research, usually in the form of a poster, to the rest of the college community during an assigned Honors Presentation day. Students must complete such a contract, or enroll in an honors course, each semester that they are enrolled in the college, in addition to fulfilling the other requirements of the program. The satisfactory completion of each contract or honors course will result in a special designation on their transcript identifying their participation. As members of the program they receive access to the Honors room, a designated space where they can work on their projects with their fellow honors students. In addition, they receive assistance from dedicated honors tutors and participate in Honors Colloquia, further preparing them for an advanced level of academic involvement in the future.

Focus on Mathematics: Development of Honors Calculus

A few years ago, with the support and encouragement of the Hostos Honors Committee, the Mathematics Department developed an Honors Calculus course. The course was developed jointly by the authors of this article with the assistance of Professor Czarnocha Bronislaw. Our aim was to develop a course that incorporated the following characteristics:

1. Deeper “proof based techniques of teaching” – not just giving students formulas to remember but rather showing the logic and mathematical reasoning techniques on which the formulas are based;
2. Use of technology, in particular, Mathematica – a popular and very user-friendly computing software (discussed later in the article)
3. A writing component in the form of a “writing project” – which should be both orally presented in front of the class and compiled as a written research project.

Introducing Mathematical Proofs into the Classroom Teaching Environment

Traditionally, the major distinction between a regular course and an honors course, especially in mathematics, is exposure to mathematical reasoning and proofs. In fact, the authors decided to use a separate supplementary book to introduce students to the techniques of formal proofs. Students are encouraged to think as mathematicians and develop general critical thinking. Some of the examples comparing traditional calculus with honors calculus are given in the following table:

Traditional Calculus	Honors Calculus
Usually, the precise definition of limit is not given	Precise definition of limit is part of the required syllabus
Proof of the chain rule is omitted	One full lecture is spent on the proof of the chain rule
The details of the proof of the Fundamental Theorem of Calculus (FTC) is usually omitted	The understanding of the proof of the FTC is expected, and is one of the main objectives of the course

Since Hostos Community College has joint degree programs with a senior college in Civil, Mechanical, Chemical and Electrical Engineering, many of the calculus students are enrolled in these degree programs, and, while understanding proofs is a useful objective, a more readily applicable objective was needed. Distinguishing an honors calculus course from a traditional one based solely on mathematical proofs would not fully serve the students, especially those pursuing an engineering degree. This it brings us to the next point.

Incorporating Technology into the Mathematics Classroom Teaching Environment

Randy Bass points out one of the main benefits of bringing technology into the classroom:

Technology can play a key role here as new digital, learning, and analytics tools now make it possible to replicate some features of the high-impact activity inside classrooms, whether through the design of inquiry-based learning or through the ability to access and manipulate data, mount simulations, leverage “the crowd” for collaboration and social learning, or redesign when and how students can engage course content. (Bass, 2012)

Integrating technology into the classroom not only enhances the teaching and learning experience but also facilitates high impact practices. The technology used must be appropriate and effective for the class, and not simply used for the sake of “using technology”. Many instructors use different software in their mathematics courses including Maple, MyMathLab and MathXL. We choose to use the Mathematica system in our curriculum. For all City University of New York (CUNY) students this particular package is free for download for on-campus and at-home use. Taking advantage of this opportunity, as well as the software’s ease of use, we created several labs (usually one lab per week) for which Mathematica is used to explore and discover topics in calculus. The idea is to model the structure of Hostos’ physics and chemistry courses that contain a lab component. Typically, a theory is taught in a lecture and then the corresponding applications are stressed and reinforced during a lab day. The table below shows a few examples:

Lecture	Lab
The idea of derivative is introduced	Students visually explore how the slope of the tangent line can be approximated from the slope of secant lines
Algebraic ways of calculating derivatives is introduced	Explore and discover the power rule using visualization
Specific applications of derivative are discussed	More complicated and elaborate examples of applications of differentiation are explored
Theoretical background of the integral is taught	Understanding the definite integral of more complicated functions is accomplished

As a secondary benefit students also learn how to use Mathematica to solve general problems. This knowledge can be carried further and applied in higher level mathematics and engineering classes.

Instituting Formal Writing into the Mathematics Classroom

Although, officially, Honors Calculus is not designated as a Writing Intensive course, it contains all of the components of such a course. In particular, there is a required final written project that all students must complete. The written project does not only introduce students to mathematical research, it also encourages group activity and team based work. It has been often noted that African-American and Mexican-American students are more likely to prefer working with others to achieve common goals (Banks, 1988). In related literature, it is also commonly pointed out that the “dialogue approach” is very effective in that it emphasizes the interactive, cooperative, and relational aspects of teaching and learning (Tiberius, 1986). It is also important to note that “writing” itself is a high impact practice, and is, thus, especially appropriate for honors students.

In the honors syllabus, there are typically two projects – one is a short presentation given sometime in the middle of the semester and the other is a longer one (the final written project) to be completed by the end of the semester. The short one is usually presented orally in front of the classroom by the students. During this presentation other faculty members are invited to sit in during the presentation and give feedback. This exercise helps students overcome stage fright and builds confidence.

The final written project topic is decided in advance, jointly with the instructor, so that students have enough time to go through the literature, do some research and compile all of their work using appropriate methods. Students are encouraged to use formal writing and cite their sources accordingly. They are also strongly advised to seek the assistance of the Hostos Writing Center when needed.

Conclusion

So far, this experiment has been a success. The department has now been offering Honors Calculus for several consecutive semesters. Our next step is to follow up with the students' academic pathways, collect the relevant data and present a comprehensive analysis of the students' level of achievement. The department and the college continues to be very enthusiastic about the course, and, most importantly, the students' desire to enroll has been steadily increasing.

Today, many community colleges are providing students with honors credit and accolades. Through the various advantages associated with honors courses, students enrolled in community colleges can enhance their competitiveness as they prepare for graduation and the challenging job market. (Chen 2013)

Hostos Community College is proud to join the community colleges described above and continues to strive to serve our students appropriately in order for them to fully recognize and realize their potential.

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