Inclusive Excellence in STEM at Bates

A progress report of STEM and STEM adjacent academic units - August 2022

Introduction

by Carrie Diaz Eaton

Bates College is on a continuing journey since its inception to fulfill its mission of "emancipatory education" through its ideals of "social justice and freedom." Recent work among science and mathematics academic units has been driven by broader institutional conversations and by conversations curated because of a recent HHMI Inclusive Excellence award in 2018.

In Summer 2022, HHMI IE supported a cohort of HHMI Scholarship of Teaching and Learning (SoTL) Fellows to document the changes in their departments and share the ongoing work with each other and with the broader college community. This report is a collection of the resulting narratives, highlighting the important work being done across the STEM and STEM-adjacent academic units at Bates. The narratives celebrate the successes, which is important to do when the change is non-linear and over a long time-scale. The writing of the narratives also created the space to pause, learn more, and reflect critically on the path ahead.

The academic units contributing to the report are Biology, Biochemistry and Chemistry, Digital and Computational Studies, Earth and Climate Sciences, Mathematics, Neuroscience, and Physics and Astronomy. The report also includes STEM Scholars, which is a cross-academic unit-supported program. These narratives explore Bates data associated with the success of students marginalized in their academic unit and document process and progress towards change. While contributions were authored by the HHMI SoTL Fellows, we acknowledge the work is that of a community.

Background

While postsecondary education broadly has yet to meet its emancipatory potential, STEM fields have been and continue to be particularly problematic on a national scale (Malcom, 2022). As such, there is a need for STEM at Bates to be particularly engaged and proactive in the ongoing journey towards justice in higher education. The data informing the HHMI IE work involved years of internal research and reflection. The original HHMI IE proposal included this stark picture (Figure 1) of those who wanted to pursue a career in STEM at Bates and those who were supported to do so:

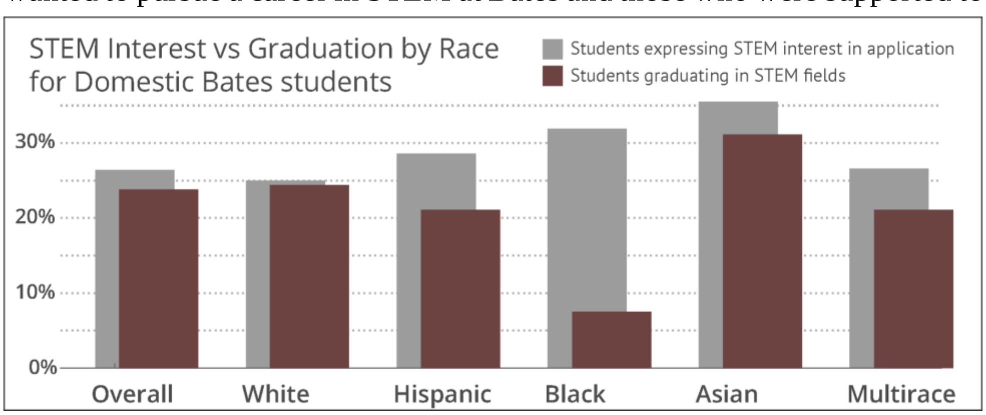

Figure 1. STEM Interest vs. Graduation by Race at Bates College, 2006-2016

"Responding to these disparities, in 2015 we surveyed students and recent alumni who had left STEM fields. While the majority of students reported leaving STEM because of interest in another field, URM[1] students were more likely to report concerns about GPA, preparation, lab experience, or not feeling supported by fellow students and faculty as important determinants of their trajectory. In addition, the majority (70 percent) made the decision to leave STEM in the first year."

In short, even when controlling for background preparation of students, White[2] students who wanted to graduate in STEM, did. For everyone else, Bates was not fulfilling its mission to an emancipatory education. Black students were denied the future to which they aspired and Native student erasure leaves a story untold.

Early survey work also informed the original HHMI proposal. This gave insight to the STEM experience at Bates which prevented students from developing a sense of belonging. These cultural factors included a competitive class environment where PEER students felt unsupported and weeded out (Asai 2020, Seymour et al 2019). Some academic units have done their own deep dives into data relevant to their particular context. Biology noticed Black students in their courses averaged nearly two GPA points below other students in their foundational courses. DCS reported a similar shortcoming across all courses, but with a slightly smaller magnitude (0.2). Physics and Astronomy examined race, ethnicity and gender of declared majors, noticing its lag behind CalTech, MIT and Vassar. Mathematics reported data on passing/non-passing rates of first and second year courses, though not yet analyzed in the disaggregate. In some cases, this internal research was supplemented by external sources of evaluation. DCS administered a pilot of the "Cultural Competence in Computing" survey, which identified strengths in discussions of identity and computing, but work to be done to support racial consciousness. All other academic units reported that discussing data and measuring success has prompted them to open conversations with the Office of Institutional Research (OIR) at Bates.

Pedagogical, curricular, and structural change

The original HHMI IE grant envisioned three emphasis areas: (1) faculty development, (2) first-year course-based undergraduate research (CURE), and (3) STEM Scholars program. As the grant has progressed over the last 4 years, these goals have evolved to respond to varying needs of academic units and students and learn from the professional development offerings.

Faculty development and support. While HHMI IE offered a professional development series targeted towards STEM, academic unit narratives pointed to a broader set of influences. Chemistry,

[1] In STEM in the United States context, URM typically refers to "under-represented racial/ethnic minorities" and refers to Native Americans, Native Hawaiians, Black, and Latinx non-international students, who are under-represented in STEM relative to their representation in the United States. HHMI IE uses the term PEER to mean Persons Excluded from science due to Ethnicity and Race (Asai 2020).

[2] By capitalizing White, I am intentionally calling attention to the mechanisms which support White Supremacy, which in this case includes denying students to achieve their stated educational goals.

DCS, Biology, and Physics and Astronomy all mentioned engaging in Foundational Dialogues as part of informing their department discussions and other other units mentioned upcoming plans for their Foundational Dialogues. Some mentioned work completed or planned as part of the short-term course redesign program. Physics and Astronomy discussed using the Equity Rubric developed by April Hill. Biology, DCS, Mathematics, and Physics and Astronomy all mentioned resources and/or programs offered through their professional societies as sources for discipline-specific external support (e.g. ACM reports, Vision and Change by AAAS, Instructional Practices Guide by MAA). DCS, EACS, and Physics and Astronomy pointed to National Science Foundation-funded national initiatives (C3, URGE, and SeaChange, respectively), as a mechanism for engaging in department conversations and action. Most academic units also mentioned how the work in introductory courses benefited from having a cohort of instructors work together on the redesign and delivery.

Expanding the first year CURE. Engaging students in research is a high impact practice (AACU, 2022). However, co-curricular research offerings are not necessarily accessible to all students, so an alternative is to offer course-based undergraduate research experiences or CUREs (Alkaher and Dolan, 2014). The original HHMI IE proposal focused on integrating research into first year courses and an HHMI IE sponsored Bates faculty learning community on CUREs led to creation of a common set of CURE learning goals that was recently included in a published guide to designing and implementing CUREs (Dolan and Weaver, 2021). However, this original goal has expanded in multiple ways at Bates. Biology has made significant changes to its first two years of curriculum, and now students have CUREs in both their first and second year. Multiple faculty in EACS are incorporating CURE-like modules into their courses across the curriculum. Chemistry and Biochemistry incorporated a multi-week student-led discovery-based project into Chem 107. They are also working to provide a more transparent department-wide application process for other formal and informal research opportunities. This process has already been adopted for their teaching assistant positions.

Pathways through the first two years. Multiple academic units reported reflecting on how students move through the first two years of foundational courses. Biology considered the impact of time-intensive lab courses and shifted from three introductory courses with additional labs to four introductory courses with CURE labs integrated into two classes. In addition, all core classes are now offered each semester. After analyzing retention data, Mathematics moved their 200-level core course, Introduction to Abstraction, out of the short-term and now offers it in both Fall and Winter as a W2. EACS has created theme-based introductory experiences in their first year courses and opened up the major requirements to cater to students who may have taken other core science classes in chemistry, physics, or biology. DCS and Physics and Astronomy discussion of gateway courses included those designed to serve students interested in computer science (DCS 109) or physics (PHY 109) and those designed to serve a more interdisciplinary audience (DCS 105 and PHY 107/8). These latter courses, while introductory to data science or physics, often also serve students who are juniors or seniors. Chemistry and Biochemistry and Math have also introduced a number of pedagogical changes in their first two years of core curriculum - Chemistry and Organic Chemistry and Calculus and Introduction to Abstraction.

Rethinking graduation requirements. Chemistry removed its short-term requirement and a 300-level course, reexamined its physics prerequisite pathways, and opened up room for more flexibility in electives. Biochemistry also revisited its major requirements in response to the changes in the biology curriculum and with an emphasis on broadening its electives list. Mathematics removed two particular course requirements, replacing them with menus for more flexibility. They introduced a 200-level course on Mathematics for Social Justice, intended for math majors, math minors, and the Applying Mathematical Methods GEC, and designed with the new CWG report recommendations in mind. Neuroscience removed an upper-level chemistry course out of the requirement list and added a required course on "Neuroscience in Humanistic Context." While DCS does not have a major, they discussed designing their minor with an intentional emphasis on both programming and critical studies and for flexibility in student interests.

Re-imagining STEM culture. Every academic unit reported employing small-group discussions, active learning exercises, and/or student-led projects. Nearly every academic unit also described adopting project-based learning in their introductory courses if a CURE approach was not fully adopted. Academic units have also changed their assessment strategies. Biology, Chemistry and Biochemistry, DCS 109, and NS/PY 160 switched from high-stakes exams to low-stakes quizzing or check-ins. DCS 105 was designed without exams and NS/PY 357 reported removing quizzes in favor of projects. Mathematics removed high-stakes testing in Introduction to Abstraction in favor of proficiency-based assessment and reported a broader variety in assessment tools across courses. Physics and Astronomy also de-emphasized exam weight and broadened its assessment of students.

Accessibility. Several programs re-examined curricular accessibility at the course level by lowering the cost of taking their courses. Some courses adopted Open Education Resources and some selected course materials that were freely available to students online through the library. Open educational practices were employed in NS/PY 357, where students wrote the textbook. DCS, Neuroscience and Physics and Astronomy also mentioned switching to or choosing to use open source software, such as python or R. DCS and Neuroscience both mentioned the importance of having Bates-provided laptops available for students, and library and information services support was cited as a particularly important resource. EACS addressed accessibility extensively in the context of field-based courses, from offering digital field trips to making room for classes to discuss the impact of race and gender on field-based research experiences. Interestingly, STEM Scholars suggested "more STEM courses should be accessible to students outside of STEM," similar to the descriptions of DCS 105 and "Neuroscience in a Humanistic Context" shared in the narrative. These courses are housed in interdisciplinary programs, which are inherently built to attract a variety of students.

Student support. STEM Scholars is built around supporting students. This program has expanded from a first-year seminar to a four-year cohort experience, building communities of peer support. In addition, Mathematics, DCS, and Physics and Astronomy are working with the Math and Stats workshop on providing robust support for students, including but not limited to course attached tutors in courses in the first two years.

Identity and Metacognition. Practices designed to build student identity and metacognition are a core goal of the STEM Scholars Program, but many academic units also infused these activities into their courses (Tanner, 2012). Biology, Chemistry and Biochemistry, DCS, EACS, Mathematics and Physics and Astronomy all mention using reflections or other metacognitive activities. Biology, Chemistry and Biochemistry and DCS both discuss how they integrate diverse scientist examples into their introductory courses, and the STEM Scholars FYS has a project focused on diverse and inspiring scientists. Physics and Astronomy has integrated deeper conversations on racism and sexism in 211 and is looking into administering surveys to assess physics identity development.

Discussing racism, colonialism, power and privilege in the classroom. Every STEM and STEM-adjacent academic unit at Bates represented in this report has been making space for conversations about power and privilege in the classroom at all levels. Entire courses have been designed to support this work: the STEM Scholars FYS is designed around the thematic area of social justice and STEM, "Mathematics for Social Justice" has now been offered for two years, and "Neuroscience in Humanistic Context" is newly introduced. Project Perecles Fellow, Lori Banks, redesigned Cellular Biochemistry around the theme of health disparities, linking racism to health through the study of biochemical pathways. Chemistry's courses now include "the implications of chemistry related applications and policies on historically marginalized groups, discussions of the beliefs and actions of famous chemists, and how organic chemistry concepts specifically apply to DEI." Discussions in DCS 105 on facial recognition bias in artificial intelligence were recently expanded to encompass historical roots of statistics in the racist pseudoscience of phrenology - conversations also engaged in Introduction to Neuroscience. PHY 211 introduced Phynd the Physicist modules to foster discussions and has been using the homogeneity of the Nobel Prize Laureates in Physics to start their own conversations. have been introduced. EACS has incorporated reflective discussions after both Indigenous Peoples Day and MLK Day. STEM Scholar students encourage this change, reporting that "they also want their professors to discuss the importance and impact of people of color and others marginalized in STEM as well as to acknowledge and teach about the history of racism, discrimination, and exclusivity in STEM."

Challenges, successes, and future directions

Shared in the narrative of STEM Scholars, students now describe the culture of STEM at Bates as "inclusive," "collaborative," and "supportive." For the first cohort of HHMI STEM Scholars graduating this year, 83% are expected to graduate with a STEM degree. Among new STEM Scholars, 90% feel they can do well in and belong in STEM.

Some additional highlights of successes and future directions in narratives below include:

- **Biology:** "[PEER] students averaged a 1.41 course grade (C-/D+) in BIO190 from 2012-2019, and are now averaging a 3.16 in BIO195 (B/B+)." Biology is committing to "develop content within courses that address the role of Biology in creating "race" as a concept and our fields' continued complicity in maintaining white supremacy."
- **Chemistry and Biochemistry**: Many of the sections of introductory chemistry include discussions on marginalization in STEM and have content related to building STEM identity.

The Chemistry and Biochemistry department is also committing to incorporate chemistry labs with social justice focus and launching discussions on data with OIR.

- **DCS**: "roughly equal proportions of PEER and non-PEER students… take subsequent courses in DCS" and "97.3% [of C3 survey respondents] demonstrated "understanding of topics related to identity (historically and/or in the computing context)." DCS is currently thinking about how to develop a major curriculum sensitive to pathway flexibility and while building on diverse student interests.
- **EACS:** "When surveyed anonymously about whether they thought conversations around Indigenous Peoples' Day belonged in this class (EACS 109, Earth's Climate System), they unanimously answered in the affirmative." EACS is looking forward to analyzing its most recent data received from OIR.
- **Neuroscience:** Adding a question study guide for quizzes increased student performance, particularly for women (more than 4 percentage points) and PEER students (3.5 percentage points). Neuroscience also expressed working with OIR to obtain data as a priority area.
- **Mathematics**: A newly introduced course, "Mathematics for Social Justice," has enrollment demand that exceeds capacity. Mathematics is committing to a prioritized and updated discussion of student retention and performance in its courses.
- **Physics and Astronomy:** Based on major declarations for Winter 22, "Bates physics majors have shifted significantly in terms of the fraction of women (from approximately 20% to 45%) and slightly in terms of the fraction of Black, Hispanic, and Native American students (from approximately 20% to 25%)." Physics and Astronomy have recently launched a self-study based on an Equity and Inclusion Department Change rubric by April Hill.
- **STEM Scholars:** "90% of the students agree that STEM Scholars has had a positive effect on their interest in science and has helped them become part of a learning community." Lori Banks is also leading a new STEM Scholars Advisory Board that will help elevate student voice in future directions.

In addition to celebrating successes, as academic units reflected on their progress, a few challenges seemed to be most shared. Where there are lessons learned from other academic units, we suggest a few next directions.

Reflecting on data. Many academic units had not collected data on major or course outcomes. While the HHMI IE team has collected data, it has been at the overall STEM collective level. Some academic units have started data collection, but their changes have been recent and have not yet seen updated data or it is too early to see the results of such changes. Some academic units had not yet been working with OIR, but this experience prompted an interest in doing so. It may be useful for the HHMI IE team to work in collaboration with OIR to support a workshop series on data gathering and interpretation for academic units. STEM Scholar students reported in the survey that they would like to see professors incentivized and held accountable for building a more inclusive, anti-racist curriculum.

Champion model vs cohort model. In the champion model of change, organizational change is carried out by dedicated individuals, but not necessarily whole departments. While the champion model is effective, and the Fellows' narratives are evidence, there are drawbacks. One department pointed out that since course delivery ultimately depends on who is teaching and with sabbaticals or upcoming hires, it is hard to ensure practices will be employed. Academic units whose multi-section introductory courses were designed or redesigned with a cohort of faculty involved seemed more confident about their sustainability. Another drawback of relying on one or two "champions" is limited bandwidth to employ broader sustainable change across the academic unit. Hiring new faculty with lived experience and/or expertise in addressing social justice in STEM was suggested as one possible solution. In the STEM Scholars survey, students also expressed a desire to have a more diverse STEM faculty. The HHMI SoTL Fellows community also provided a pathway to build their experience about how they are doing and the practices others are employing across the college.

Introductory STEM course class size and lab courses: Also related to the bandwidth discussions above, Neuroscience expressed an interest in adopting CUREs, but had concerns about having the faculty numbers to support the small class sizes required. DCS shared some possible directions for assisting with intensive student support in larger introductory classes through MSW and TAs. It is interesting to note that several departments have moved away from separate labs in favor of integration of project-based learning into course time, increasing the number of courses in the sequence or and eliminating other requirements to remain flexible. It would be beneficial to continue supporting exchange of practices across departments to collaborate on solutions.

Moving towards holistic student support. The STEM scholars narrative also highlighted student feedback on what could use further improvement, and the results point to a broader, more holistic approach beyond the academic. Students would like to see more students of color in STEM, which may point to collaborations with admissions, marketing, and student clubs. They point to the need for their white peers to understand their experiences in STEM, which may involve collaboration with OIE and student organizations. STEM Scholars also suggested additional resources for financial support and counseling as well as increased capacity for mental health and wellness.

Conclusion

Overall in the narratives below, we celebrate significant and recent work undertaken by Bates STEM and STEM-adjacent academic units to rethink practices and policies in order to support students who have been excluded from STEM. While each academic unit shares discussions and progress, each academic unit also shares challenges. However, each challenge is an opportunity to grow together to make continued progress. We share these stories so that we may continue to learn and grow with the broader Bates community.

Biology

by Lori Banks and Larissa Williams

State of marginalized students

Leading up to our 2017 departmental review, Institutional Research compiled course performance data, as measured by course grades, for the department. At the 100-level (BIO190) and 200-level (BIO242 and 270), there were no significant differences between male- and female-identified students, but large differences in students that were first-gen versus continuing-gen, between students with the “lowest” and “low” financial capacity and moderate to highest capacity, as well as between black and hispanic students as compared to asian and white. The former of all of those categories systemically underperformed in their course grades as compared to the latter.

Following our curricular changes (starting winter of 2019), most differences that were seen across college generation, financial capacity, and race have been narrowed. For example, there are no differences in students from differing financial capacity and college generation in BIO195 and BIO202. For race, the only difference that was seen in BIO195 is that black students were 0.5 GPAs below students of other races. However, the curricular change led to an almost 2 grade point increase, where black students averaged a 1.41 course grade (C-/D+) in BIO190 from 2012-2019, and are now averaging a 3.16 in BIO195 (B/B+). There is still work to be done in other upper-level courses, where gaps of 1 or more grade points still exist between students of differing financial capacity, college generation, and race.

Pedagogical and curricular change

Following a 2017 departmental review, the Biology department at Bates sought to change our core curriculum with the goal of aligning it with national standards for Biology education (i.e. AAAS Vision and Change) and evidence-based pedagogy. Through two years of work, the department launched the new core curriculum that has two course-based research experiences in the first two years (BIO195, 204) as well as two concept-based courses (202, 206).

Through iterative and authentic inquiry, course-based research experiences are a distinctive learning environment that have been shown nationally to promote student success in STEM through the enhancement of course engagement, scientific identity, persistence, research and communication skills, and collaboration (reviewed in Dolan 2017, 2021). This pedagogy is especially transformative for PEER (persons excluded because of their ethnicity or race) students who often fail to thrive in traditional curricula. Our BIO195s are topic-based courses that all align to a set of science discovery and pedagogical goals. All 195s culminate in a poster presentation made to the Bates community. In the sophomore year, BIO204 builds upon science and communication skills taught at the 195 level and seeks to develop discipline-based writing skills as well as cutting-edge research skills to answer an interdisciplinary research question. Using a pre- and post-national CURE survey we have demonstrated an increase in interest in STEM degrees and careers, scientific and communication skills, as well as self-efficacy and identity in STEM.

The pedagogical approach for our content-based gateway courses, BIO202 and 206, includes evidence-based practices of active learning, small group engagement, high course structure (Eddy and Hogan, 2017), and many opportunities for metacognitive reflection (Tanner 2017). As well, we highlight the work of diverse science practitioners and work to debunk biological racism through case studies on the evolution of human pigmentation.

Structural changes to encourage retention

We have made several changes to our major to encourage retention of all students who are interested in majoring in Biology. The first major change we made was to remove the lab experiences out of our content courses (190, 240 272). Students at Bates do not receive credit for the lab, so while they may be spending 3 hours in the lab on top of the lecture portion (4 hours per week), they are getting the same "1" course credit as any other Bates course. This disproportionately impacts students who have to work, for example, and may not have as much "free" time in their schedule as students who don't work. A second change we made was to make the pathway through the major flexible. Students can take any of the core courses (195, 202, 204, 206) in the fall or winter. There is only one sequence within the major–that being a student must take 195 before the other 200-level courses.

Additional course to support retention and persistence of marginalized students

During the Fall of 2021, a redesigned version of our BIO321 (Cellular Biochemistry) course went live with 26 students ranging in classification from sophomore to senior. In the new format of the class, we approached the biochemical pathways of metabolism (i.e. glycolysis, the citric acid cycle, and the electron transport chain) from the perspective of the enzyme cofactors (vitamins) that make these processes work. In particular, we explored the cofactors most commonly associated with nutritional health disparities in the US according to a CDC report. That report also shows that Black and LatinX Americans are disproportionately affected at a clinical level by the five most commonly deficient vitamins, so understanding the biochemical outcomes of these nutritional health disparities was the framework for study of the pathways.

As many of the students who take this class are designated as pre-health, the course was organized to reflect clinical training where time is spent learning about homeostatic (normal and healthy) mechanisms as well as the pathological versions of those mechanisms. With our 14-week semester schedule, we had two-week units where in the first week of the cycle we reviewed the "healthy" metabolic pathway, the chemical and biochemical properties of the vitamin/cofactor, and the physiological perspective of tissues and organs that the pathway supports. In the second week, we explored how the metabolic pathway changes in the absence of sufficient vitamin/cofactor, the physiological consequences of those biochemical changes, and finally, the students worked through case study questions that required them to design clinical and basic science studies to expand the available data for treating that particular disease. For the Vitamin D unit, Dr. Lori Banks' Arthur Vining Davis funded Project Perecles fellowship supported a talk from health disparities researcher, Stacy Lloyd, DrPH, of Baylor College of Medicine. She spoke to the class about the social factors that lead generally to health disparities, and the challenges that medical professionals face addressing physiological outcomes that are based in larger social and economic crises. Given the focus on nutritional health disparities, much of her talk focused on the links between Vitamin D deficiency and cancer, as well as social and civic factors that lead to "food deserts." While Vitamin D was central to the first iteration of the course, we hope to rotate the focus of cofactors in the future so that a range of health disparities experts can speak to the class as well.

The goal of the redesign was to center experiences of racially marginalized Americans in the scientific study of the students. As well, the selection of a Black, female researcher as a guest speaker was intended to provide additional representation in the content presented to the students. Together, these not only positively affect the scientific identity of racially marginalized students, but normalize the inclusion of historically underrepresented people in science for all students.

Effectiveness of changes thus far for marginalized students

Quantitatively, marginalized students are earning higher grades in our new core courses as compared to our old core (and almost on par with their white peers) as described above. Through our CURE surveys, deployed in BIO195 and 204, we have been able to ascertain that marginalized students (n=72 students, 32% of all students) are reporting that they are inspired in certain fields of Biology study, learning how to work collaboratively with group members, and how Biology can influence and affect the greater world. In comments obtained through the STEM scholars survey, students report that they feel supported by faculty and the curriculum (and its structure).

Challenges and aspirations moving forward

The Biology department has challenged itself to 1) continue monitoring our assessment data and addressing concerns as they come up, 2) continue our own racial equity professional development, 3) and develop content within courses that address the role of Biology in creating "race" as a concept and our fields' continued complicity in maintaining white supremacy. To the latter goal, our second "Foundational Dialogues" activity in the winter of 2023 will be a conversation with Science Historian, Dr. Evelynn Hammonds, to address these concerns throughout our curriculum.

Chemistry and Biochemistry

by Jen Koviach-Cote

State of marginalized students

We are currently working with institutional research (IR) to formally examine the data concerning differences in academic performance between groups historically marginalized in STEM. However, unofficial, personal experiences indicate that students who are Black or LatinX tend to earn lower grades in our core courses and have lower persistence than our students who are white or API. We recognize that success is measured by more than grades in a course, and look forward to working with IR to find ways to assess the outcomes of all of our students. In order to better understand the experiences of first-generation students and students of color, we have read through the anonymized STEM Scholar survey responses together as a department and discussed some of their implications on our courses and majors.

Pedagogical and curricular change

One of the goals of our foundational dialogues is to formalize learning goals attending to equity and inclusion across our curriculum, including our introductory chemistry series, Chem 107/108. (Appendix A.) Our department typically offers four sections of Chem 107 in the fall and four sections of Chem 108 in the winter. Six of the eight faculty in our department contribute to Chem 107 and/or 108 each year and the remaining two teach the Organic Chemistry sequence (Chem 217/218). In the past 6-7 years, the Chem 107/108 faculty have made a much greater effort to work together in order to standardize content and pedagogical approaches. Faculty share resources and meet regularly, which has been especially helpful for our visiting faculty who teach these courses. That being said, each of our faculty attends to DEI differently and to a greater or lesser extent. We hope that with renewed collaboration across courses as well as the initial conversations which stemmed from the foundational dialogs, that all of our faculty will make a greater effort to attend to DEI in their courses. While we have made progress in the lecture portion of Chem 107 and 108, the teaching lab remains a place where we can make improvements. This is partly due to two successive years in which the lab curriculum was significantly disrupted (first to accommodate the "modules", then while Dana Chemistry was undergoing renovation.)

As described by Doucette et al., DEI related content in Chem 107/108 falls into three main categories: 1) reducing barriers to instruction 2) curriculum and content and 3) inequity in science, society, and Bates. Some of our Chem 107 faculty use reading and reflective writing to address all three of these categories. A draft of the reflective writing assignments for fall 2022 is found in Appendix B.

In order to reduce barriers to instruction, the department has made course-wide policies and pedagogical changes which affect all sections of Chem 107 and 108. We have made attempts to improve advising for first-year students through the FYS faculty. In addition, we have reduced enrollment from 60 per section to 39, we accommodate ALL students who register for 107 and 108, typically by adding sections rather than exceeding the enrollment limit (though this is not always possible), and we have encouraged students with AP/IB credit to use that credit toward 107/108 to reduce the intimidation on students who did not have access to these high school programs. All sections of Chem 107 and 108 use the same open educational resource (OER) textbook, Atoms First, and the same online homework system with multiple attempts and immediate feedback. All sections involve significant active learning exercises and increased personal interaction between faculty and students. This pedagogical change was facilitated by the new active learning classrooms in Bonney Science Center. Recently, we switched from high stakes mid-term exams to low stakes quizzes with the option to earn back points with reflection (Cotner and Ballen), and coordinated quiz dates across all sections. In the lab, assessments have been reduced to key components that can mostly be performed during the lab period with assistance from the instructor. This will be facilitated by the designated breakout space adjacent to the teaching labs in new Dana. While we have not yet converted our labs to course-based research experiences, we have added a new multi-week student-led discovery-based project in Chem 107.

Curricular and content changes as they relate to DEI have largely been instituted by individual instructors. However, we expect that content will become standardized through the foundational dialogues process, facilitated by the processes that are already in place to coordinate intro chem content and pedagogies. Specific examples of content are provided in Appendix C, but general curricular content includes: the implications of chemistry related applications and policies on historically marginalized groups and discussions of the beliefs and actions of famous chemists and whether or how those beliefs/actions should affect our appreciation of those peoples' contributions to science.

As with curriculum and content, topics of inequity in science, society, and at Bates have been largely dependent on the individual instructor. Again, we hope that recent efforts to collaborate mean that all sections of Chem 107/108 will attend to these issues through instruction, discussion and student journaling. Topics include: promoting a growth mindset, developing an individual science identity, the study cycle, metacognition, how to read a scientific paper, and systems and processes in STEM which have contributed to the marginalization of people. In addition, instructors highlight and require that students research the contributions to chemical knowledge by modern and historical chemists who belong to traditionally marginalized groups (for example, see recent Chemical & Engineering News articles which highlight the LGBTQ+ community and chemists working to solve formidable global problems).

Structural changes to encourage retention

The process to encourage retention of marginalized students in both of our majors is ongoing. We recognize that our majors have some of the highest numbers of required courses, especially when pre-requisite courses are included. Part of our foundational dialogues process will be to examine the major requirements and whether or how we can fulfill the learning goals for our majors with a lower course load. However, we have already made the following changes, which we hope makes our majors more accessible.

The Chemistry major removed a short-term requirement and removed the requirement of a 300-level lab course for the major. While upper-level lab courses will count as an elective, they are no longer required. We have also examined the actual need for physics courses as prerequisites for physical chemistry courses, and now only require one semester of physics rather than two semesters. Changes to the course requirements for the Biochemistry major were partly motivated by changes in the core biology courses but also to broaden the scope of allowed courses. When biology changed their curriculum, we dropped one course requirement to maintain the total number of required courses for a biochemistry major and tried to make it easier to meet learning goals with additional courses. We also expanded the options of required and elective courses to make it easier for students to complete a major tailored to their specific interests. We have also normalized the thesis requirements across the department for both majors, and provided these requirements to the students.

Student research is an integral part of our majors. In the last several years, more students have requested formal and informal research experiences in our laboratories earlier in their college careers. While we would like to accommodate all student requests, we do not have the faculty resources or space to do so. Therefore, some of us have instituted an application process for semester and summer research to equalize opportunities, and we are working on a department-wide process for providing research opportunities to all students.

To prevent favoritism and remove hidden menus in teaching assistant selection, we adopted a formal t.a. application process so that all students have the opportunity to be a t.a. and are chosen on the basis of the application. All students in chemistry classes and all majors and minors are notified of the application form to give equal access to all students. While we have not formally assessed the changes to the hiring process, we have found a general increase in the number of student applications for teaching assistant positions.

Additional courses to support retention and persistence of marginalized students

The Organic Chemistry sequence, Chem 217/218 has taken many of the same steps as Chem 107/108 to promote DEI through the pedagogy and curriculum. Specific details are provided in Appendix C. To reduce barriers, we switched from high stakes mid-term exams to more frequent quizzes with the option to earn back points. We experimented with specifications based grading (Tsoi et al.) in fall 2021, which will require some tweaks going forward. Until August 2022, there were no OER options for Organic Chemistry. But we have made the course textbook optional, and multiple formats of the textbook are available at various price points. We make more extensive use of on-line homework, which gives students immediate feedback. In the 217 and 218 labs, we have reduced barriers by using an OER lab techniques text, using Lyceum-based pre-lab quizzes, and providing written and video pre-lab instructions. In Chem 217 lab assessments are based almost solely on the lab notebook and we have reduced the amount of post-lab work required. In Chem 218, we have scaffolded writing assignments and reduced the number of full-length lab reports. We have also increased exploratory and student-directed experiments, including a four-week independent project at the end of Chem 218.

The curriculum and content related to DEI mirrors Chem 107/108 and includes the implications of chemistry related applications and policies on historically marginalized groups, discussions of the beliefs and actions of famous chemists, and how organic chemistry concepts specifically apply to DEI. In the future, we plan to incorporate issues related to social justice in to the labs, as described by Sanders Johnson et al. Likewise, topics of inequity in science, society, and at Bates also mirror Chem 107/108 and include topics such as metacognition, STEM identity, and projects in which the work of modern and historical scientists from historically marginalized groups is highlighted and researched by students.

Effectiveness of changes thus far for marginalized students

Assessment is one area that we very much need to improve upon. We do not have formal or informal assessment data, though we are beginning that process this fall.

Challenges and aspirations moving forward

As described in the previous section, assessment is a major area of growth for our department. We have reached out to IR, and look forward to examining the data that pertain to academic success and retention in our courses and majors. With 1-2 tenure track searches in the next two years, we are actively working to diversify the applicant pools, and have found the suggestions from Kimble-Hill et al. to be particularly useful. This year, we are using our foundational dialogues to re-examine the learning goals for our majors and to consider curricular changes to our major that will support the learning goals. As a first step, we have initiated the process to invite Prof. Jane Liu from Pomona College to work with us this fall. While we have standardized many of the pedagogies and in general chemistry, we are working to standardize DEI content across sections. In addition, the pedagogies and content of our teaching labs, Chem 107 and 108 in particular, is a place for potential growth. Finally, we will all continue to grow as learners ourselves through social justice education.

Digital and Computational Studies

by Barry Lawson and Carrie Diaz Eaton

The Digital & Computational Studies (DCS) Program was officially approved as of the 2015-16 Bates Course Catalog. From its inception, DCS has strived to focus on equity, decolonization, and social justice in its stated values, now offering courses that span critical digital studies, programming and computer science theory, and digital and computational praxis. From academic years (AY) 2017–2022, there were multiple DCS course offerings each semester, and since AY 2015-16 through AY 2020–21 more than 800 unique students had enrolled in one or more DCS courses. DCS introduced the DCS Minor starting in the 2021–22 academic year. The first DCS-minor cohort graduated in 2022, consisting of 20 graduating students. As of the start of the Fall 2022 semester, the minor roster includes another 46 declared students across graduating years 2023–2025.

A recent report from the Association of Computing Machinery (ACM Education Board Retention Committee, 2018) enumerates reasons why diversity in computing matters, including: "issues of equity and fairness [in access to the educational experiences and prerequisites that are essential to the ubiquity of computing-related jobs], the economic and competitive imperative of ensuring a large and diverse U.S. workforce, the fact that better solutions are developed by teams with a diversity of people and perspectives, and the increasing interdependency between American democracy and the ability to understand and navigate the presentation of information through technology". Similarly, a separate recent report (ACM Data Science Task Force, 2021) remarks that "...the field should be open to all, independent of class, race, gender, sexual orientation, gender identity, ethnicity and other factors that do not influence one's ability to succeed in the field. If not, we are faced with an issue of social equity." The same report, drawing from a large body of research in foundational research in teaching and learning, urges that "Data Science faculty – indeed, all faculty, should learn about inclusive pedagogy, and what it means for tools to be accessible or not, and put such techniques into practice."

The DCS faculty are committed to our own continuing education in identifying, and then implementing, best practices to attract, retain, and support traditionally marginalized students.

State of marginalized students

During the 2021-22 academic year, DCS worked with Institutional Research (IR) to collect and analyze data on attracting and retaining students from marginalized groups. The summary report, presented by IR to DCS in February 2022, includes data from courses offered before the rollout of the Minor as well as data from the Fall 2021 semester.

DCS courses recruit roughly equivalent proportions from the pool of first-generation (FG) students and from non-FG students. (Overall enrollment of non-FG students is higher, consistent with the higher number of non-FG students at Bates.) There has been no significant GPA gap between FG students (3.74) and non-FG students (3.76) in DCS courses. Similarly, DCS courses recruit roughly equivalent proportions of PEER[3] and non-PEER students — specifically 16% of Bates-identified PEER students versus 15% of Bates-identified non-PEER students. The proportions of PEER and non-PEER students who take subsequent courses within DCS are also roughly equivalent, although there is a lower proportion of Hispanic students who continue, compared to other PEER groups. There is a noticeable difference in DCS-course GPA for PEER students (3.66) compared to non-PEER students (3.75)[4]. There is also a noticeable difference in DCS-course GPA for Black students (3.53) compared to non-Black students in other PEER groups (3.72). These differences appear to be consistent with, but smaller than, differences across Bates. For example, as given in the IR summary report, the average course GPA for Black/African American students is 3.24 for all Bates courses versus 3.53 for DCS courses. This points to work remaining for us – faculty in DCS and at Bates more broadly – to improve equity in access and equity in success in our courses.

In Spring 2020, DCS administered the Cultural Competence in Computing (C3) Assessment (Washington, 2020), intended to help "measure the cultural competence of students, faculty, and staff". The 3C Assessment provides scores across various respondent classifications (including race, gender, major, academic year) in attitude, knowledge, awareness, and consciousness; and falling into one of six categories of cultural competency: destructiveness, incapacity, blindness, pre-competence, competence, and proficiency. The C3 Assessment was conducted in collaboration with Dr. Nikki Washington, who was also a DCS invited speaker. Our survey results showed 26 respondents (or 97.3% of all respondents) demonstrated "understanding of topics related to identity (historically and/or in the computing context)". However, other areas showed more room for improvement. For example, over 54% scored under the threshold benchmark for competency in the consciousness dimension which includes "understanding of the historical impact of certain actions, words, and beliefs on people from diverse backgrounds, while working actively to address/minimize misjudgments based on them". These results suggest we have significant work remaining to help all DCS students participate in creating a better climate for marginalized students.

Pedagogical and curricular change

Within its executive summary list (pp. i-ii), the ACM Retention report (ACM, 2018) recommends several pedagogical and curricular interventions, including: collaboration and team-based learning; ensuring that all students perceive classrooms and labs as a welcoming environment, including setting clear expectations for behavior in class; and incorporating real-life problems into courses so that students are exposed to a positive societal role of computing.

DCS courses, and in particular its introductory courses[5], incorporate strategies related to these recommendations. Our introductory courses regularly use active learning (Freeman et al., 2014;

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[3] The term PEER, an acronym for Persons Excluded Due to Ethnicity or Race, can be found in https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7148151/.

[4] See Table/Figure 8 from the IR summary report for DCS. The course GPA for PEER students was estimated as an overall average using the average GPA for each reported PEER subgroup (Black or African American, Hispanic, and Multirace) weighted by the number of course grades for that group.

[5] The introductory courses in DCS include DCS 105 Calling Bull, DC/GS 106 TechnoGenderCulture, DCS 109 Introduction to Computing & Programming, and (new, Fall 2022) DCS 111 Programming for the Humanities.

Chasteen, 2020), peer instruction (Dawson and Mitchell, 2014; Porter et al., 2016; Zhang, Ding, and Mazur, 2017), and pair/group work (McDowell et al., 2006; Hanks et al., 2011). We primarily use project-based work (Pucher and Lehner, 2011) with real-world contexts, and provide opportunities for students to correct errors and resubmit (Cook et al., 2022). We also use frequent low-stakes quizzes/"check-ins" (CMU Eberly Center) which are known to increase long-term memory retention (Roediger and McDermott, 2018). We ask students for written reflections on assignments (Dickson and Barr, 2019), allowing them to discuss their own progress on the concepts and to discuss their view of how current concepts relate to the larger goals of the course and to the real world. We use online resources in Lyceum and/or Ed, such as the Q&A/feedback/forum capabilities (Jansson et al., 2021), to allow students to openly – and, if desired, anonymously (Roberts and Rajah-Kanagasabai, 2013) – ask and discuss questions and potential approaches (not solutions) to problems and project work. In lectures, we frequently present biographical sketches of people from diverse backgrounds who have contributed meaningfully to the field (McDonough, 2021). We also make use of "live coding" to model programming, problem solving, and responding to errors (Lewis et al., CS Teaching Tips).

DCS 109 Introduction to Computing & Programming was introduced in Fall 2020, and has since been taught or co-taught by all three appointed faculty in DCS as well as by a visiting assistant professor. This allowed us to collectively work on real-time redesign of the course, leveraging the various expertises of the three faculty members. The topics mentioned in the previous paragraph appear throughout DCS 109. Students engage in project-based work throughout the semester, currently using one of two carefully scaffolded contexts: either ranked-choice voting (RCV), in which students develop solutions to implement a (maximum three-round) RCV algorithm that can operate on real-world voting data; or digital image processing, where students implement solutions to various image-processing algorithms (e.g., rotating an image, cropping, changing image size, various filtering effects) that interface seamlessly with an instructor-provided "Fauxtoshop" visual interface. We continue to work on additional project-based options based on student interest and feedback, including a friendly (non-FPS) computer-based game and (in the forthcoming DCS 111 course) textual analysis. Active learning, peer instruction, and pair programming appear regularly during breakout sessions that appear in lectures. After presenting a new topic or algorithm, typically via "live coding", students work together in small groups on a problem similar to that just demonstrated – in a think-pair-[and sometimes?]-share approach (Cooper, Schinske, and Tanner, 2021). For written reflections, we require a brief reflection on each submitted programming assignment, in which students are asked to reflect on real-world context/applications of the concepts just learned and on their own learning experience and engagement with the assignment. We have also incorporated the idea of a final portfolio developed across the semester, in which students, via guided prompts, are asked to discuss and reflect on various important CS concepts (e.g., list data structures, finding the minimum value in a list, classes and object-oriented programming) they learned throughout the semester, providing reflection and examples of their own work. This idea of a final portfolio has also been used successfully in other upper-level DCS courses. A couple of examples of various biographical sketches used in lectures are an infographic highlighting 7 Black Pioneers in Computer Science and a summary of the contributions of Dr.

Richard Tapia, an internationally recognized scholar in computational and mathematical sciences and a national leader in education and outreach.

Early into designing pathways to DCS, we identified a need among partner disciplines, particularly in social and biological sciences, for a course that would focus on digital and computational skills related to working with data. Several discipline-based courses in statistics were already offered, but DCS could provide a much needed optional first course in critical data studies and programming in R. The resulting course, DCS 105 Calling Bull: Data Literacy and Information Science, focused on the critical examination of data and data products while introducing students to a programming environment and computational thinking. In addition to using many of the practices described above, such as group work, open educational resources, and open source software, this course seeks to re-center students as knowledge producers through the use of open pedagogies (Lambert, 2018; Bali et al., 2020). A 2021 pilot study of DCS 105 indicated that the use of free materials was particularly impactful for students who also had financial aid needs (Taylor, 2021). In Calling Bull, critical data studies are introduced at multiple stages of working with data from context and source to analysis and communication. We also include explicit conversations related to impact on marginalized populations. For example, a module about machine learning (Diaz Eaton, 2021) discusses misuse of machine learning in the pseudoscience world of phrenology. We then introduce the work of Georgia Tech and MIT graduate, Dr. Joy Buolamwini, fighting racism in computing manifesting as faulty image recognition machine learning algorithms. More recent iterations of DCS 105 expand this discussion earlier in the semester. While introducing correlation and what is commonly known as the "Pearson Correlation coefficient," we also read articles about Pearson's involvement in the founding of phrenology and statistics (Quick, 2020). Adding these discussions to early courses set students up for later data science courses which then focus on longer term projects with a depth of context and critical lens (Shrout and Diaz Eaton, 2020).

Structural changes to encourage retention

The ACM's Retention (2018) and Data Science Task Force (2021) reports both recommend various structural changes and strategies to encourage retention of students from traditionally marginalized groups. These include: regular data-gathering efforts about student progression through courses and the program; reporting student and faculty demographics; assistance by experts in gathering and analysis of collected data; involving instructors of introductory courses in data gathering; providing programs, services, and pathways that enable students of varying computational backgrounds to succeed; and proactive advising.

As examples of data-gathering conducted by DCS, refer back to discussion of the Bates IR summary report for DCS, as well as the 3C (Cultural Competence in Computing) Assessment conducted in collaboration with Dr. Washington.

In designing the DCS Minor, we focused on flexibility (pathways) for students, allowing for student choice within categories of DCS courses. Students must take six DCS or DCS-cross-listed courses, with at least one course in two of three categories: Programming & Computer Science Theory, Critical Digital Studies, and a broadly-defined Digital & Computational Praxis (Computational

Modeling and Statistics, Data Analysis, Computational Creativity and Art, and Digital Community Engagement). All courses are "tagged" to belong to at least one of these categories, and students can double-count: for example, a course that is tagged as Critical Digital Studies and as Praxis (Community Engagement) allows a student to meet the two-categories requirement with that one course. Students may, with approval, substitute up to two of the courses using another option, such as an internship or a course taken outside Bates (e.g., a course in the Roux Align Program for students interested in a more computer-science focused path). We also currently allow students to use up to two Short Term courses as part of the six courses required, with each Short Term course counting as one course (despite being listed as a ½-credit course).

DCS collaborates with the Bates Mathematics & Statistics Workshop (MSW) to provide academic and tutoring support for students in DCS courses. DCS faculty can recommend students as potential tutors, who are then interviewed, selected, and trained by MSW staff. Course-attached tutors work closely with students in their particular DCS course, typically attending class once per week (where they can help students during break-out sessions), holding weekly drop-in tutoring sessions in the evening, and offering one-on-one sessions by sign-up. Tutoring sessions are highly utilized by students in DCS courses, proving critical to their learning and success. Based on our discussions, MSW staff are careful in recognizing and training students to be thoughtful and supportive across a diverse student population.

DCS also has a commitment to use only Open Educational Resources (OER) and freely-available software and tools (e.g., Python, R, Google Collab, Atom, Visual Studio Code) in all of its courses, including introductory courses. OER may increase course performance and reduce failure and withdrawal outcomes (Colvard, Watson, and Park, 2018); at the least, OER has been shown across multiple studies to have no negative influence on student learning while resulting in an increase in student participation (Hilton, 2016). With respect to freely-available programming languages and software tools, many – but not all – are platform-independent and are free for students to download and install on their own computers. However, because students come with a variety of platforms (Mac, Windows, Chromebook, and occasionally Linux), often with a range of operating system releases for any one such platform, and because platforms and software are dynamic in nature, corresponding structural support for courses requires significant faculty effort. For example, support for assignments that allow students to have immediate visual feedback – identified as an effective creativity-enhancing component in computing courses (Sharmin, 2021) – often requires substantial re-working each semester. Corresponding software installation instructions frequently require re-testing and updating as new operating system versions, new programming language versions, and updated versions of supporting software (e.g., XMing, VcXsrv) are released.

DCS faculty are also proactive in advising and engaging students. In addition to traditional one-on-one advising, we participate in events such as the annual Bates Academic Units & Resource Fair; hold announced advising sessions (e.g., to discuss upcoming courses, information about the Roux, and/or study abroad opportunities); and actively communicate with students about events and opportunities via listserv and social media. We also have faculty who regularly participate in the STEM Scholars program, which provides for students an open channel of communication with

DCS faculty. We also employ students as part of this community-building effort — as attached tutors and graders for academic support, and also a student community engagement coordinator who maintains our Instagram page. In the immediate future, we will design a user-friendly web page and graphics that describe DCS-related curricular pathways and DCS-related career opportunities.

Effectiveness of changes thus far for marginalized students

As discussed above, based on the analysis provided in the IR summary report, we do see roughly equal proportions of PEER and non-PEER students who move on to take subsequent courses in DCS. There is a noticeable difference in DCS-course GPA for PEER students, ~0.1 lower compared to non-PEER students (see above). There is also a noticeable difference in GPA for Black/African American students, ~0.2 lower compared to non-Black students in other PEER groups. Based on the IR-provided analysis, these differences are consistent with differences present across Bates more broadly, although we note that the differences seen within DCS are smaller in comparison. We also see from the C3 Assessment results discussed above that work remains to be done in creating a better climate within DCS for marginalized students.

Because the DCS Minor is new as of 2021-22, with new courses being added each year for the past several years, we will need to revisit this data collection and analysis. We also believe that the continued participation of DCS faculty in the STEM Scholars Program will help attract more students from that program, based on early interaction with DCS faculty and early exposure to opportunities available through DCS pathways.

Challenges and aspirations moving forward

One of the primary challenges for the DCS Program relates to its relative infancy as a program — the minor is new, there is not yet a major, and new courses are introduced each year. It is important for us as a program to continue collecting data to critically evaluate our successes and failures in attracting and retaining students from a variety of backgrounds. This is, and will continue to be, a work in progress. It is important that we in DCS also continue our practice to set aside meeting time throughout the year to discuss pedagogical approaches being used in our courses, so that we can stay abreast of work in each other's courses.

One of our aspirations is to carefully develop and propose a major curriculum for DCS. We plan to provide multiple pathways for students, building on our approach for the DCS minor, and consistent with suggestions by the ACM reports (2018; 2021) and in work challenging us to examine power, privilege, and identity in CS education (Rankin, Thomas, and Erete, 2021). Our aim is to allow interested students to choose from among a collection of computing- and data-analysis/processing related pathways, while interrogating the values and assumptions of the digitized and computational world, regardless of their background or preparation prior to arriving at Bates. We will leverage research-based best practices in structuring our major and program (e.g., NCWIT Engagement Practices Framework) and assignments (e.g., EngageCSEdu).

We are interested in ways to "flatten" or shorten the prerequisite pathway as much as possible for entry into 200- and 300-level courses. For example, we continue to discuss ways that, say, a 300-level course fulfilling the Programming & Computer Science Theory (PCST) category can be taken by students who have not necessarily taken a strict sequence of 100- and 200-level PCST courses. This requires flexibility in course design, by providing a variety of language-agnostic structural supports and scaffolding in assignments to allow students to succeed based on a multi-faceted set of prior experiences and preparation.

In summary, the DCS-affiliated faculty are committed to the ongoing work to attract, retain, and support students from traditionally marginalized groups. We recognize the previous work of DCS-affiliated faculty and success of that work, while also admitting our shortcomings as evidenced by results from data gathering efforts. We recognize the importance of our own continuing education in these areas, and look forward to continued efforts associated with the goals of our Foundational Dialogues proposal — in establishing shared languages and practices and in building an anti-racist program in DCS — which involves learning-community work in inclusive pedagogy, historical roots, and curricular pathways. We are also committed to ongoing critical analysis of our own work through additional regular data gathering, analysis, and to corresponding and thoughtful change.

Earth and Climate Sciences

By Bev Johnson

Introduction

The Geosciences are among the least diverse in STEM (Goldberg, 2019; Gonzales and Keane, 2020; National Center for Science and Engineering Statistics, 2021); even after 40 years of efforts, there has been little increase in diversity in the field (Bernard and Cooperdock, 2018). There are a multitude of reasons for the lack of diversity in the Geosciences, including deep-seated power structures that reward white male able-bodied field scientists over others, the presence of racial bias and racism, colonialism, and ableism, to name a few (Dutt, 2019, Marin-Spiotta et al., 2020; Liboiron, 2021; Mattheis et al., 2021, Ali et al., 2021).

The Earth and Climate Sciences Department (formerly the Department of Geology) is in a pivotal moment in our history. In 2019, we undertook a departmental review/self study to plan for 2 pending retirements. We learned about our own low enrollments for students from underrepresented groups and began to interrogate our own biases and exclusionary practices in our teaching and course content, beginning with the Hackman Workshop in 2018. As part of our planning process, we have centered equity, inclusion, and antiracism to the best of our abilities in our self study and in our new vision for the future of our department. Since 2019, we have made revisions to our courses and pedagogies, created a new curriculum for the major, and created a new name for the department, These changes are currently underway as we continue to work towards created a more inclusive, equitable, and anti-racist department.

This is a progress report that describes our work towards creating a more inclusive, equitable, and anti-racist department. It includes an assessment of enrollment data from 2008-2018 and descriptions of (1) changes we have made at the course level, (2) changes in the design of the major, and (3) the rationale for a new department name (from Geology to Earth and Climate Sciences). We are still very much in the process of learning.

Enrollments of marginalized students in our courses and major (as one metric of success)

Between 2008 and 2018, enrollments of students from underrepresented groups (URG; defined here as American Indian or Alaska Native, Asian, Black or African American, Hispanic, Multiracial, and Native Hawaiian or Other Pacific Islands) in Geology (now EACS) courses ranged between between 9 and 22% (with an average of approximately 12% per year) for any given year (Figure 1). Approximately 10% of our majors were from URG between 2008 and 2018.

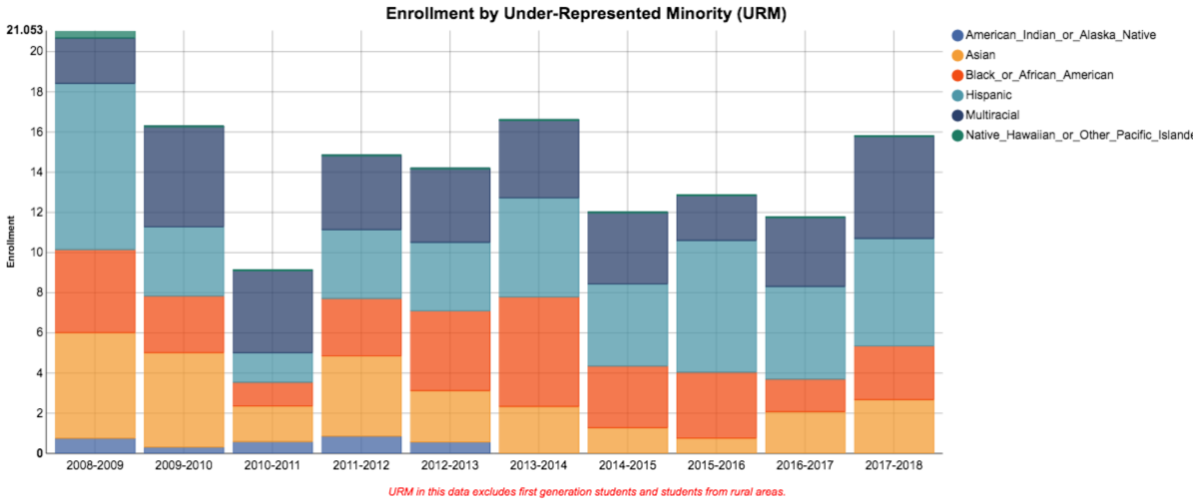
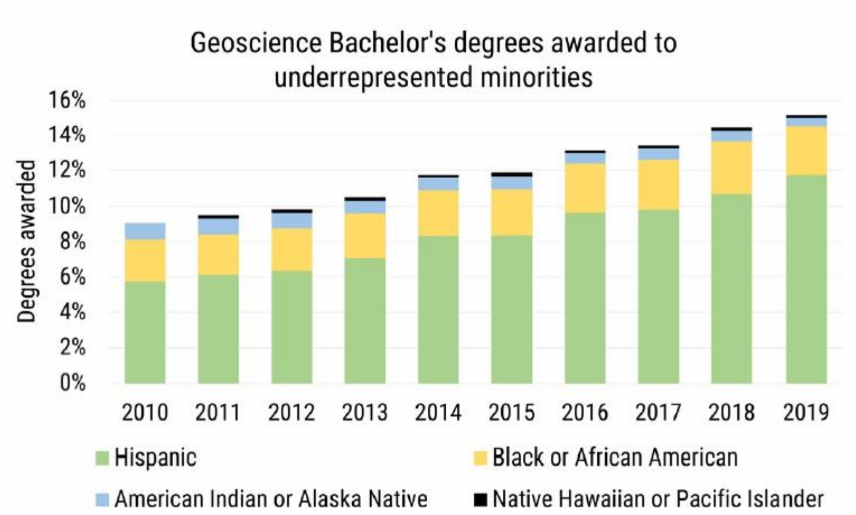


Figure 1. Proportion of enrollments of students from underrepresented groups (URG; defined here as American Indian or Alaska Native, Asian, Black or African American, Hispanic, Multiracial, and Native Hawaiian or Other Pacific Islands) in Geology (now EACS) courses between 2008 and 2018. Data obtained from IR for Department of Geology (currently EACS) self study, 2019

Although the numbers are quite variable from year to year, enrollments of students from URG tended to be dominated by Asian, Black or African American, Hispanic and Multracial students; American Indian or Alaskan Native enrollments were low (less than 1% between 2008-2013, and dropped to zero between 2014 and 2018). We have no record of Native Hawaiian or Pacific Islanders in our courses over this time period (Figure 1). It is also important to note the small number of data in these datasets, so statistically significant trends are difficult to identify. Nevertheless, the proportions of students from URG at Bates are in rough agreement with national trends of bachelor's degrees in Geoscience (Figure 2, from Gonzales and Keane, 2020).



Credit: AGI, data derived from IPEDS

Figure 2. Proportion of enrollments of students from American Indian or Alaska Native, Asian, Black or African American, Hispanic, and Native Hawaiian or Other Pacific Islands) in the Geosciences from

2010 to 2019 (Figure copied from Gonzales and Keane, 2020). (Note, Asian and Multiracial are not included in this figure.)

Over this same time period, enrollments of first generation students were between 3-11 % per year in Geology and 5-17% of all first generation students at Bates (Figure 3). Approximately 5% of our majors were first generation between 2008 and 2018.

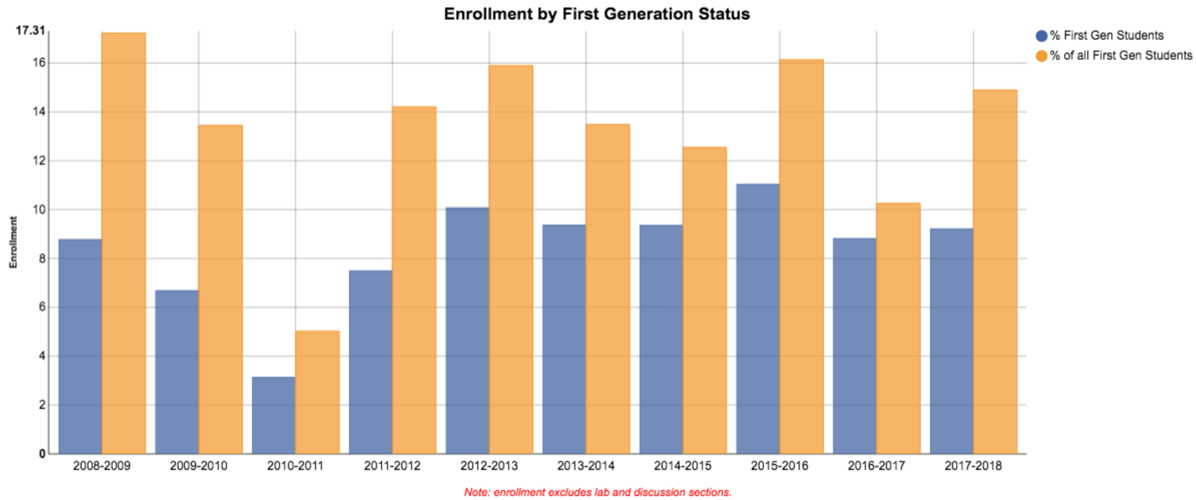


Figure 3. Proportion of first generation students enrolled in Geology. Data obtained from IR for Department of Geology (currently EACS) self study, 2019

Between 2008 and 2018, Geology enrollments by gender were fairly equally distributed with an increasing trend of more males in the later part of the record (Figure 4). The percent of women Geology majors averaged 48.5%, which is about 10% higher than the national average of 38% through the same time period (National Center for Science and Engineering Statistics, 2021; Keane, 2016).

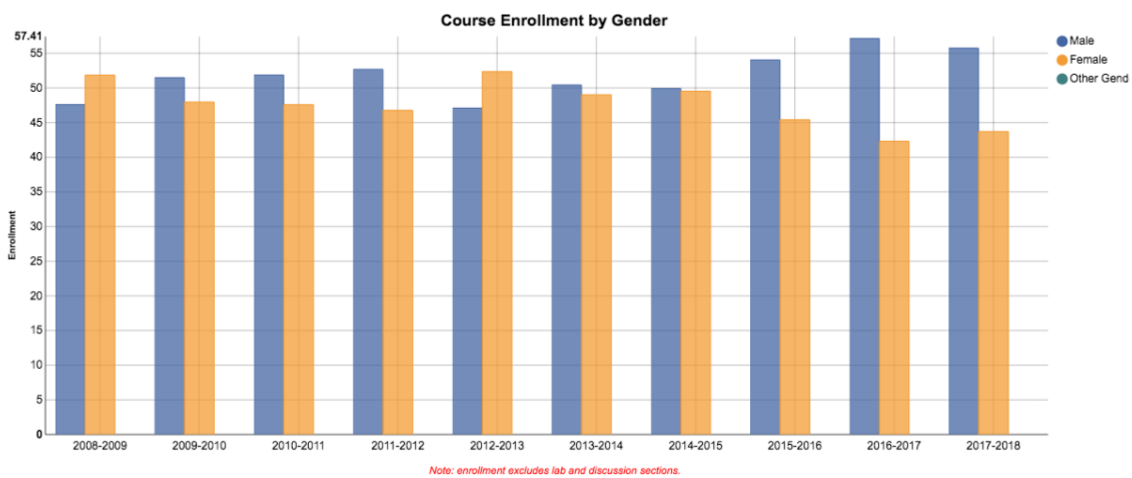


Figure 4. Course enrollment by gender for Geology courses. Data obtained from IR for Department of Geology (currently EACS) self study, 2019

We have recently obtained enrollment and disaggregated datasets from 2019-2022, and look forward to working up these data in the future. At this point, given the dominance of VAPs in the department and various leaves currently in place (Johnson on sabbatical 2022-23; Robert on Family Leave Fall 2022), careful analyses of these more recent data will likely not happen until Johnson and Robert are back on campus together (Fall, 2023).

Content and Pedagogical Changes and CURES at the Introductory Courses

The datasets from 2008-2018, our departmental self study in 2019, our work on the Bates STEM Initiative and HHMI proposal, and various workshops and reading groups stimulated intentional changes in the department (see below). Additionally, our more recent work as participants in the NSF sponsored 16 week workshop titled "Unlearning Racism in Geosciences (URGE)," Bedelia Richards' "Race Talk" workshop, and our own reading groups have helped us implement various approaches in the classroom and our departmental culture and curriculum— We hope to work with IR to access some of our changes beginning in the fall of 2023 when Johnson and Robert are on campus. Here, I provide some examples of changes we have implemented over the last several years. See Appendix A for a list of changes that have occurred or that are underway. There is still a lot to do, but it is a starting point.

Community of Practice. Under guidance from the URGE workshops and leadership, our URGE POD (Genevieve Robert, Rebecca Minor, Phil Dostie and myself) created a community of practice which highlights our values and includes basic expectations for members of the department in indoor- and outdoor settings (after Clancy et al., 2014; Marin-Spiotta et al., 2020). We follow the recommendations of Clancy et al. (2014) and Marin-Spiotta et al. (2020) and emphasize workplace climate education, bystander intervention, inclusion, collegiality, and safety from harassment and discrimination, and provide steps for reporting harassment and assault in our course materials. This is intended to be a living document and undergo revisions on an annual basis.

Field work is key to understanding the real world context of problems in earth and climate sciences. These experiences provides opportunities for active learning, co-creation of knowledge and place-based learning (Jones et al., 2022) and can be positive for some (Beltran et al., 2020; O'Connell et al., 2021) and also feel discriminatory and destructive for others (Pickrell, 2020).

The geology/EACS department has an excellent reputation for field-based courses, which draw in many active, 'outdoorsy' students, while unintentionally excluding others. Students can easily feel alienated if they are not prepared for the challenges of doing field work. Worse, students working in groups can feel intimidated or harassed by each other or the faculty members.

Parts of the Community of Practice document (see text beginning on page 2) have been modified and used in various field-based courses, including 2 off-campus short terms taught in 2022 (EACS S16, Paleoseismic Investigation/Himalayan Frontal Thrust with Professor Arora and EACS S15, Glacial and Postglacial Landscapes of SE Alaska with Professor Portes). In addition, we employ the recommendations of Lawrence and Dowey (2022) when designing and communicating with students about field work, and we emphasize their top 6 focal points: planning; emphasizing "Fun not Fear" and "Skills over Hills"; providing flexible options; practicing anti-prejudice; and, communication.

We have also spent some time developing digital field trips (Alice Doughty funded by HHMI in 2020, for example). This is an area that begs for more work; we can use field trips that are already built (using the Virtual Field Trip Google Earth Library; Wang et al., 2022) and can continue to develop our own (Mead et al., 2019; Whitmeyer and Dordevic, 2021).

Group work is an important part of all of our classes. At the beginning of our introductory courses, we take time to discuss and reflect on pitfalls in group work. Depending on the course, we have students reflect on their strengths and map out their assets to various degrees (after Stoddard and Pfeifer, 2018). They discuss how they want to communicate and work with each other. We think this provides an important framework for group work to occur equitably and in a timely manner, but we have yet to assess this aspect of our courses. We have purposefully adjusted our lab/field assignments so that a more diverse group of students is better able to succeed.

Racial justice is inextricably tied to EACS. We have begun to introduce racial justice readings, discussions, and reflections to our courses (after spending some time setting up group communication norms.) For example, for MLK Day, students must attend and summarize a talk or panel they have attended, read an essay highlighting a racial justice issue in EACS (e.g., storm impacts on folks living in flood zones, impacts of waste disposal on communities of color, depending on the scientific content getting covered) and then reflect on how what they learned at MLK is connected to the essay provided or to the field of Earth and Climate Sciences. We spend an entire class period in this discussion. Similarly for Indigenous Peoples' Day, students are assigned an article on the impact of mining on an Indigenous Community and the extractive nature of Geology. They attend Indigenous Peoples' Day and the next class period is spent discussing how the extractive nature of our field impacts Indigenous Communities and the science we are practicing. Students seem to appreciate these class discussions. When surveyed anonymously about whether they thought conversations around Indigenous Peoples' Day belonged in this class (EACS 109, Earth's Climate System), they unanimously answered in the affirmative. One student wrote the following:

> *"Yes! Science has been/is a justification and tool of colonization. It is imperative that scientists understand this reality to change the field of study."*

Racial justice is also very much an area of growth for us. To effect change, one must raise awareness, envision change and provoke change (summarized in Zamina-Gallaher's, 2019 interview of Dr. Dafina-Lazarus Stewart). We may be raising awareness on some level, and look forward to continuing to learn how best to incorporate issues of racial justice into the EACS curriculum.

Student research experiences are central to EACS approach to learning. All of our courses give students the opportunity to do independent research from the FYS and 100-levels through thesis on some level. This may take the form of (1) mapping igneous rocks at the Lewiston Quarry to learn about geological materials, time, and processes, (2) measuring the water quality of local bodies of water, and (3) tracking sedimentation/erosion at Seawall Beach. In all cases, students are generating datasets that have not been published and/or are unique and are interpreting them in the context of what is known. In FYS 476, Coastal Hazards, students are asked to measure the carbon stock of a salt marsh. They look at maps and previous datasets to design a field campaign and laboratory analyses. They collect data in the field, bring samples back to the lab, analyze samples and then communicate their findings through writing, posters, and/or presentations.

Various members of the department have used the CURE backwards design worksheet created by April Hill to include CURE-like modules in their introductory classes. But we have yet to formalize the assessment or compare our approaches to other Field Based CUREs (Korz et al., 2016; Cooper et al., 2019; Trott et al., 2020).

Structural changes made to the major to encourage retention of majors

The Department of Geology changed its name to the Department of Earth and Climate Sciences (EACS) and its major, effective fall 2020. The rationale for the changes to the department name and major is centered on increasing accessibility, equity, inclusion, and antiracist practices in EACS, as highlighted below.

New curriculum. The EACS major was created Fall 2020, for the class of 2024. It ensures maximum access (all introductory EACS courses count towards the major) and flexibility. We have reduced the number of barriers for declaring a major; our introductory courses are all topical and each one serves as a gateway to the major. Furthermore, we accept other cognate sciences as part of the major.

New department name. Recent studies that stress the importance of the Geosciences in meeting society's growing needs through continued study of the earth, atmosphere, oceans and biota from interdisciplinary and disciplinary perspectives (NSF, 2000; USGS, 2007; Mosher et al., 2014; Mosher, 2015 webinar; AGI, 2016). Scientific issues relating to climate variability and change, and energy, mineral, and water resource security, ecosystem and environmental stewardship, and hazards risk assessment, adaptation and mitigation all require critical input from the Geosciences. Our new department name (EACS) indicates obvious attention to societal needs. The evolving curriculum connects racial justice to societal needs from a Geoscience perspective. Students learn about various aspects of EACS in the context of societal issues that matter most to them. We hope that these intentional shifts create a more accessible and welcoming academic culture for students, staff and faculty from URG.

"Geology" is traditionally defined as the study of the solid earth, its physical structure, its history, and the processes whereby it is transformed. It is a term that is not easily understood or defined, particularly for students who have never taken a class before. "Earth and Climate Sciences", on the other hand, is intuitively easier to understand. It provides an immediate sense of the relevance of our field to peoples' lives. The new name clearly indicates what is studied, the earth and its climate. This includes the solid earth and the earth's surface.

With the name change, we provide curricular opportunities centered on the solid and interior of the earth (earth materials, plate tectonics and geodynamics, sedimentology) as well as important processes at and connections with the surface of the earth (sedimentology, environmental geochemistry, hydrogeology, earth systems, climate change, and climate modeling). This new name more clearly reflects who we are and what we do.

We seek to make our curriculum more visible to our students and colleagues interested in Earth and Climate Sciences. The term "Geology" is relatively unfamiliar to our incoming students. Some high school students are exposed to relevant content in Earth Science and Environmental Science classes, but the wide range of topics we cover is not immediately visible to the outsider under our current name.

It is important to note that personnel changes will lead to different courses and pedagogies.

Other Content and Pedagogy Changes

Genevieve Robert hopes to get funding for a Short Term redesign of EACS 223 (Earth Materials) in ST 2023. She will add elements of equity, inclusion, antiracism and anticolonialism content to the class.

Bev Johnson has modified her FYS, FYS 476 (Coastal Hazards), but has not taken the time to do a proper assessment of the changes in terms of retention of students from URM groups, or improvements in self efficacy.

Effectiveness of These Curricular Changes for Students of Color

We have recently received the most up to date datasets on enrollment and disaggregated grades. We have not had time to look at them and compare results from prior and post changes in the major, curriculum, courses, and name change. I suspect it will be challenging to find trends in certain aspects of the data due to COVID and instability in our staffing over the last couple of years. We look forward to looking at these data, and doing more targeted assessment of our approaches to creating a more equitable and inclusive learning environment.

Challenges and Aspirations Moving Forward for EACS

There is a lot of work ahead for EACS. Once Johnson is finished with her AY 22-23 sabbatical, we plan to: work with IR to formally assess the changes we are making at the course level and across the curriculum as a whole; analyze the data we have from between 2018 to 2022 to see if any patterns emerge and learn from those; plan out and execute our Foundational Dialogs programming; plan, as needed, to meet the Racism, Power, Privilege and Colonialism requirement; carry out inclusive and equitable searches for 2 tenure lines (Earth Surface Processes and Climate Dynamics/Modeling); and continue to learn from each other and our colleagues at Bates and in the earth and climate science community at large.

References

Appendix A

Mathematics

by Katy Ott and Evyn Steger

State of marginalized students

Starting in the year 2018, the mathematics department has implemented a series of changes to the major and to a collection of foundational courses at the 100- and 200-level aimed at improving student outcomes. These changes, and the ongoing discussions surrounding equity in our classrooms and in our department, were prompted by a presentation of data on student success in math courses. This data showed a large disparity in course performance between white/Asian students and Black/Hispanic students. As a department we have come together to consider some of the long-standing practices and traditions in the major and to ask ourselves, "What is the purpose of this policy or requirement, and how does it impact our students?" This self-examination has led to pedagogical and structural changes in Math 105 and Math 106 (Calculus I and II) and in Math 221 (Introduction to Abstraction), and to structural changes to the math major requirements. It has been a balancing act between making meaningful, evidence-based changes that are implementable across the department while maintaining faculty agency in the classroom. This process is ongoing as we continue to educate ourselves on matters of equity and inclusion, and we will address some challenges to the work in the narrative below.

The Math Department has not explored data on the success of marginalized students as a specific focus group since 2018, but we are able to speak to the success of our students overall. The department has been excited to see an increase in enrollment in recent years, especially in introductory courses, while the number of math majors and minors remains high (Annual Enrollment and Majors and Minors). We are also pleased to observe that students are doing well in introductory and foundational courses (Math 105, 106 and 221), as made evident by a downward trend in D/F/W rates[6] in recent years for the calculus courses, and consistently low D/F/W rates in Introduction to Abstraction, as seen in these charts.

The math department acknowledges that moving forward, it is important for us to understand how recent changes in pedagogical and curricular practices are impacting marginalized students. Therefore, we are eager to delve into the data that Institutional Research has made available and plan to begin this process this coming Fall. Our work will begin by initiating conversations among the entire department that will be integrated into our Foundational Dialogues and our upcoming Departmental Review once an appropriate framework is in place.

Pedagogical and curricular changes in Math

The Calculus I and II courses are foundational to the math program, and are therefore instrumental in establishing a standard for equity and inclusion practices among our department that positively

[6] D/F/W rate refers to the percentage of students earning a D, F, or W (withdraw after Add-Drop) in a course, aggregated across all sections.

impact marginalized students. One of the immediate changes the department made three years ago was to adopt an open educational resource (OER), *Active Calculus* by Matt Boelkins. An important impetus for this change was a 2019 report prepared by Bates College Library, which prompted us to prioritize lowering textbook costs for students. As described in a 2018 article published by the *International Journal of Teaching and Learning in Higher Education*, OER have been shown to have a positive effect on improving end-of-course grades and decreasing D/F/W rates for all students (Colvard, Park, and Watson, 2018).

The benefits of using *Active Calculus* extend beyond the free digital format available to students. In accordance with the recommendations of the Mathematical Association for America (MAA) Instructional Practices Guide (MAA IP, 2018), the new textbook emphasizes working with data and developing a deep understanding of calculus through activity-driven learning and exposure to various applications of this knowledge. This textbook is structured in such a way that students are constantly engaging in active learning through the use of preview activities and multifaceted student-led in-class activities. Research shows that active learning in the mathematics classroom leads to improved student learning and future success in STEM courses (see, *e.g.*, Freeman, 2014 and Kogan and Laursen, 2014). We have also integrated a weekly discussion section into the course wherein students are consistently collaborating and exploring applications of calculus in a low-stakes setting. In discussion, students continue to learn ways to analyze data through calculus-based approaches, often including a computational component or spreadsheet analysis, and also spend a significant amount of time explaining their thinking and their methods through both written and verbal communication. Moreover, there is a larger emphasis in *Active Calculus* placed on the differential equations unit, specifically on interpreting and developing models involving differential equations.

Furthermore, we are now able to assess student success in Math 105 and 106 each semester through common learning objectives, which include both content-based learning goals and identity and self-efficacy-based goals for students. Calculus professors meet regularly before and throughout each semester to discuss common questions which can be used to assess the content-based learning objectives on assessments, and this practice also provides professors with the opportunity to collaborate and share insights on pedagogical approaches, successes and challenges, and additional student outcomes that are observed when we have multiple faculty teaching the same course. The common learning objectives and weekly meetings have also proved invaluable for mentoring visiting faculty. We are able to assess the identity-based learning objectives through a student self-assessment given near the end of the course which also proves valuable in providing faculty teaching these courses with student feedback.

To ensure curricular changes align with the department's goals for calculus students, which accentuate conceptual understanding alongside competency in calculus techniques, we ask ourselves questions like, "Are we teaching this because it benefits our students, or just because it has been taught like this forever?" With these recent changes which have helped to reframe the calculus sequence, we hope that our students, who we understand and appreciate undoubtedly come from diverse backgrounds, perceive learning math and pursuing a STEM major as a path that is accessible to anyone willing to put in the effort.

Evidence-supported pedagogical changes that contribute to student success in our introductory courses also include regular implementation of various forms of collaborative learning (*e.g.*, group work), developing student metacognition skills, and utilizing various methods of assessment and grading (MAA IP, 2018). For example, several professors are giving exams that include an oral component, a take-home component, or emphasize written explanations alongside worked solutions. Proficiency-based grading is used frequently within several math courses so that students are continuously involved in the process of revising their work and improving upon it. These are examples of assessment practices that are "not a single event but a continuous cycle" as recommended by Steen in the MAA's Notes volume *Assessment Practices in Undergraduate Education* (Gold, Keith, and Marion, 1999). With encouragement from their professors, we also hope that students are learning to control and monitor their thinking by taking ample time to reflect on their learning and study habits (this is largely done through a weekly written summary in discussion), regularly setting goals and evaluating progress towards meeting them, and understanding the importance of assessing the validity of their solutions, as well as what the implications are of their conclusions drawn when working with real-world data. If students can successfully cultivate this type of intellectual curiosity and independence in these early fundamental courses, they will likely be more successful in future STEM courses.

Structural changes to encourage retention

The department has also looked to implement changes beyond the calculus sequence with the goal of improving the academic experience for our majors and minors. We have carefully considered the math major requirements, looking to expand the pathways to the major and remove potential roadblocks. In accordance with with the *Committee on the Undergraduate Program in Mathematics (CUPM) Guide* (Schumacher and Siegel, 2015), specifically recommendation #3: "Mathematical sciences major programs should include concepts and methods from data analysis, computing, and mathematical modeling," the math department has changed the upper-level major requirements from requiring Math 301 *and* Math 309 (Real Analysis and Abstract Algebra) to allowing students to choose *two* options from Math 301, Math 309, and a course in Modeling and Differential Equations (*e.g.*, Math 219, Math 255, or Math 355). The original requirement was essentially preparing students for graduate school in theoretical mathematics (a path that only one or two of our students pursue per year) and de-emphasizing advanced coursework in applied mathematics.

Additional changes to the math major have to do with Math 221, Introduction to Abstraction. This class is an introduction to proof writing through abstract mathematics, and a gateway into the math major because many upper-level courses use it as a prerequisite. Traditionally Intro to Abstraction was offered only in Short Term. Due to its grueling 9:00 am - 3:00 pm schedule, it was colloquially known across campus as "Math Camp." For many years, the math department celebrated this course for its inquiry-based approach and its focus on community building. But we as a department became aware that only offering this class during Short Term was impeding some students' progression into higher level math courses. For example, if a student had to drop out of Math Camp during their second year, they would not be able to enroll in upper level math classes until their senior year, making it nearly impossible to complete the major requirements. We now offer Math 221 in the regular semester, both Fall and Winter. At the same time, we agreed to offer Math 221 as a W2 course, thus helping our majors complete a graduation requirement within the major. Prior to this change, the math department only offered a W2 course intermittently, and it was becoming increasingly rare due to high demand for math courses and staffing challenges. Since its move to the full semester, Math 221 continues to be offered as an active learning class. We have also eliminated the four high-stakes exams that were traditionally given (one per week in Short Term), and in their place, faculty have adopted standards-based grading using a set of agreed-upon learning targets for proof writing and abstraction (Syllabus). As with calculus, we also have committed to using an open source textbook. On the flip side, we have noticed a loss in community building since moving Math 221 out of the Short Term, and the department is in ongoing discussions about ways to reincorporate this element into the class and the major.

Finally, we wish to highlight is the addition of a new elective: Math 233, Mathematics for Social Justice, which is available for math majors, math minors, and the Applying Mathematical Methods GEC. This course was spearheaded by Adriana Salerno and it represents a meaningful and bold step by the math department towards addressing equity, diversity, inclusion, and anti-racism in the math curriculum. Researchers have confirmed that culturally relevant teaching practices contribute to educational equity (McGee 2014). Additional research has shown that an equity frame that emphasizes the role of mathematics in democracy and addressing inequality results in student learning and achievement (Gutstein 2003; Winter 2007). To the best of our knowledge, there are relatively few social-justice mathematics courses offered at the 200-level (it is more somewhat more common to see 100-level or Quantitative Reasoning courses for non-math majors). The course has been well-received based on demand; enrollment in the 2021 and 2022 sections of Math 233 was at capacity (29 students) with students being turned away. The Math Department is committed to offering the elective regularly and we are collecting course materials in a shared Google Drive so that multiple faculty are prepared to teach the course. The course developed by Salerno and Ott (Syllabus) also aligns with the 2021 Bates College Curricular Working Group recommendations (CWG report, 2021) and thus we feel that the math department has taken a proactive position with regard to potential future changes to General Education Requirements.

Effectiveness of changes thus far for marginalized students

We are able to see the effectiveness of some of the curricular and pedagogical changes made to the calculus courses through looking at the results of assessing the calculus learning objectives each semester over the past two years (Math 105 and Math 106 at a glance), which show that students are consistently performing at a partial or highest level of proficiency. However, these objectives and the methods used to assess them have been in continued development, so we are yet to obtain more than one year's worth of consistent data to report. There were also numerous challenges experienced during the pandemic that we would argue have a notable effect on the results. We refer to the data provided in paragraph two and to anecdotal evidence from students (in course surveys, homework journals, self-assessments, etc.) to give us a sense of the effectiveness of changes thus far, and we hope to have more evidence in the coming months and years. Many of the changes to our major and to our introductory courses (Math 105, 106, and 221) are newly implemented, so we acknowledge that we will need to wait to determine their effectiveness until such a time as we have more objective data, particularly that highlights the success of marginalized students within our department, to draw conclusions from.

Challenges and aspirations moving forward for Math

This work inevitably entails experiencing and overcoming challenges, and so far we have found that the lack of data that has been shared among the department is our biggest challenge. Seeking out the current data for our classes, initiating these conversations with colleagues, and finding time to discuss the implications of the data we can obtain through an appropriate lens needs to be a priority for our department.

Fortunately, our department has many aspirations for the future of this work and feel that we are in a good place to celebrate the successes we have encountered thus far. We are continuing to develop new courses and offer opportunities that are of particular interest to students, and with the introduction of two new tenure-track faculty members this year, we are excited that we will soon be able to offer more content in machine learning, statistics, and topological data analysis (TDA). We are also considering a course on the history of (non-western) math, which could go a long way in increasing awareness among students of diverse representations in mathematics.

In conclusion, the Math Department is ready to embrace the idea of challenging ourselves through the Foundational Dialogues to gain an understanding of colonialism in mathematics, and white supremacy in our classrooms and in the mathematics community at large. This process, along with our upcoming Departmental Review, offer ample opportunities for great reflection, gathering of data, and seeing if these changes are making the impact that we hope.

Neuroscience

By Michelle Greene

State of marginalized students

The neuroscience program has not yet reviewed data with IR. It is reasonable to assume that marginalized neuroscience students at Bates are similar to those across the United States. Neuroscience is a relatively young academic field. The Neuroscience program at Bates College was founded in 1997. The number of neuroscience BS/BA programs grew from 30 in 1996 (Ramos et al., 2011) to 246 in 2019 (College Navigator of the National Center for Education Statistics (NCES)). Harrington (2021) notes that the vast majority of neuroscience programs (71%) are housed in Primarily White Institutions (PWIs). Undergraduate degrees conferred in neuroscience increased from 87 to 3457 between 1995 and 2015, yet the proportion of these degrees awarded to BIPOC students did not significantly change (Ramos et al, 2017). Thus, the field of neuroscience as a whole is not serving all students, and there is little reason to believe that Bates is immune from these patterns.

Pedagogical and curricular change

Changes at the introductory level

Introduction to Neuroscience (NS/PY 160) has historically been taught as a traditional STEM lecture course. This includes the use of an expensive textbook and four high-stakes exams as the primary method of assessment. We have been incorporating a number of innovations to increase the success of all students.

In Winter 2022, we changed our assessment strategy to allow students to show mastery in a variety of ways. Chief among these was replacing the four high-stakes exams with weekly quizzes that were each worth 5% of the total semester grade. The remaining 50% of the grade came from small, low-stakes assignments that were designed to motivate students to keep up with the readings and to apply what they were learning to events in the world. Following Lindsey Hamilton's talk on grading equity, we additionally started to provide the multiple choice questions (but not the possible answers) for each quiz ahead of time and provided dedicated in-class time for studying alone and with peers and asking questions of the instructor. Anecdotal evidence has suggested that this study guide helped students understand which content was most important, allowing them to make maximal use of their studying time.

Although we are eager to keep assessing this strategy, the preliminary results are very encouraging. We examined the average grade on the first four quizzes (before the intervention), and compared it to the average grade after the intervention. We did this separately for sex and URM status. As shown in the table below, although all groups benefited from the intervention, we found that marginalized groups benefited more. Women received more than twice the benefit of men (4.2% versus 2.0% quiz improvement), and URM students benefited more than white students (3.5% versus 3.1%).

	White	URM	Total
Male	1.6	2.7	**2.0**
Female	4.1	4.6	**4.2**
Total	**3.1**	**3.5**	**3.2**

In addition to the changes in assessment, we have also adopted a free and open textbook to reduce the financial burden of taking the course. This was particularly important as ILS has noted that neuroscience has traditionally been in the top 5 academic units for textbook costs (See Appendices), and this has been driven in large part by the $233 textbook that was previously used. We have been mindful to teach the full historical context for topics such as physiognomy and phrenology and their links to the eugenics movement. We have discussed the problematic history of psychosurgery and frontal lobotomy, as well as the research ethics with human participants and animals. Finally, we have been experimenting with ways to use a Thursday class session that can foster community and make neuroscience relevant to students' daily lives. These have included community-engaged learning (mixed results depending on the needs of community partners at any given time), small group discussions of neuroethics topics, and "show and tell" where students bring in neuroscience content from the news and discuss how these stories portray these results and how this can link to cycles of misinformation.

Changes to upper-level curriculum

The hallmark of the neuroscience major is a set of four 300-level laboratory courses. These are Physiological Psychology (animal behavior and its instantiation in neural circuits); Cognitive Neuroscience (the neural correlates of language, perception, consciousness, etc.); Neurobiology (cellular and molecular neuroscience); and Computational Neuroscience (formal models of mind and brain). Each course has been (or is in the process of being) re-designed with equity in mind.

Computational Neuroscience (NS/PY 357) has been re-designed in several ways. To address equity gaps in laboratory resources, the course moved from a proprietary programming language (Matlab) to an option source option (Python) in 2019, aided by a DCS Digital Re-Design Award in 2018. The 2019 offering required students to download the rather large Anaconda package on their personal computers in order to access the Jupyter notebooks that were used in laboratories. Thus, from 2020 onward, the course used Google Colab, which has the same functionality but can be accessed from the browser of any computer and relies on Google's computing resources rather than those of the local computer.

In 2019, this course moved from an assessment scheme that emphasized daily quizzes to a project-based approach in which students wrote and/or revised an open-access textbook for the class. This design change served several purposes. First, the work involved structured collaboration in a rotating set of writing and editing teams. This structure fostered collaboration and built bonds. Additionally, this type of practice has been shown by Belanger et al., 2020 to increase students' sense of belonging because they can identify with a particular role within the group. The second benefit of the project was that writing for other beginners forced students to build meta-cognitive skills and reflect on how to disseminate content so that others could understand (Tanner, 2012). Drane, Micari & Light (2017) found that student-led STEM activities led to better class scores and major retention than the traditional version of the course. More significantly, marginalized students saw more of these gains than non-marginalized students. Further, students were given a large amount of freedom in their project design. The project rubric was collaboratively developed, and students were allowed to express their learning in the way that was most relevant to them, a practice taken from culturally responsive teaching (Gay, 2018). Finally, this open pedagogy project involved writing for the public (as opposed to writing solely for a professor). Advocates in open pedagogy note that such “non-disposable” assignments hold more value to the student (Jhangiani, 2016). We have worked with Krystie Wilfong in the library to place each version on Scarab, the Bates institutional repository. This has provided students with a citable DOI for their work that many have been proud to put on their resumes.

Neurobiology (NRSC 308) has completely redesigned the lab portion of the course. The new labs highlight a broader spectrum of methods and approaches that are used across neuroscience, and time is taken to highlight how these methods can be used to work as a neuroscientist across several career paths. This course works with immortalized cell lines, and the new labs provide opportunities to speak about the problematic origins of these cells (e.g. HeLa cells). Additionally, this course covers the scientists behind the discoveries and how systemic power structures have excluded women and scientists of color. Finally, this course has moved to all-anonymized grading to reduce the impact of implicit bias on course grades.

Physiological Psychology (NRSC 366) has been fully re-designed as a flipped course. All lectures have been pre-recorded, and most of the in-class work has involved small group problem solving and discussion. While these changes are in line with the high-impact practices of active learning (e.g. Prince, 2013), anecdotal evidence has suggested that student opinions of the flipped model are mixed, similar to what has been reported in the literature (Bishop & Verleger, 2013). The laboratory of this course has also been completely restructured. We have included a new module on the ethics of animal experimentation. Additionally, data analysis modules have been added using open-source python software on Bates-provided laptops. Finally, the lab portion of the course has moved away from a “one big lab report” model to multiple, scaffolded lower-stakes assignments. For example, students created the figures, legends, and results for the first lab report, the methods section for the second report, and created an article-style resort for the final project. By building up to the full lab report throughout the semester, we can introduce novel aspects of scientific writing in a scaffolded manner.

Cognitive Neuroscience (NRSC 331) is currently in the process of being re-designed. It will be taught by a VAP in Fall 2022 and 2023 following the retirement of Nancy Koven.

Structural changes to encourage retention

The neuroscience major was restructured in 2017. Previously, there were three 300-level laboratory courses, and students were required to take all three for breadth and as alternatives to methods courses that are common in other academic units. The net addition of one line enabled neuroscience to add a fourth lab class (Computational Neuroscience). This topic was chosen based on student demand and literature that notes how critical data science skills are for 21st-century neuroscience (Akil et al., 2016). This change allows students the flexibility to choose two of the four options. For example, a student who is interested in cellular and molecular neuroscience might choose Physiological Psychology and Neurobiology while a student who is interested in human neuroscience might choose Cognitive Neuroscience and Computational Neuroscience. This allows for more flexible schedules for students and makes it easier to complete the major.

In addition to the changes to lab courses, we have added an extra section of Introduction to Neuroscience to meet the enrollment pressure from students. We have also done an audit of the courses that are required for the major and dropped Chem 218 from these requirements in reflection of the fact that there were very few upper-level courses that required this knowledge. This allows for more flexibility in fulfilling the major's requirements. Finally, we have broadened the scope of neuroscience electives to explicitly include a requirement for "Neuroscience in Humanistic Context". These courses examine the problems of mind and brain from non-STEM perspectives, such as philosophy, literature, law, and art.

Effectiveness of changes thus far for marginalized neuroscience students

The neuroscience program is looking forward to examining data with IR.

Challenges and aspirations moving forward for neuroscience

The neuroscience program remains inspired by the CURE model for introductory content. Unfortunately, we do not have the staff necessary to implement this for Introduction to Neuroscience. At present, we offer 80 seats per year. It is worth noting that each section is always at or over full capacity, and it is likely that 120 seats per year is a more realistic reflection of student demand. Thus, at least 6 sections of a CURE course would need to be offered just to keep pace with existing offerings. With only 2.4 FTE in the neuroscience program, this is not possible.

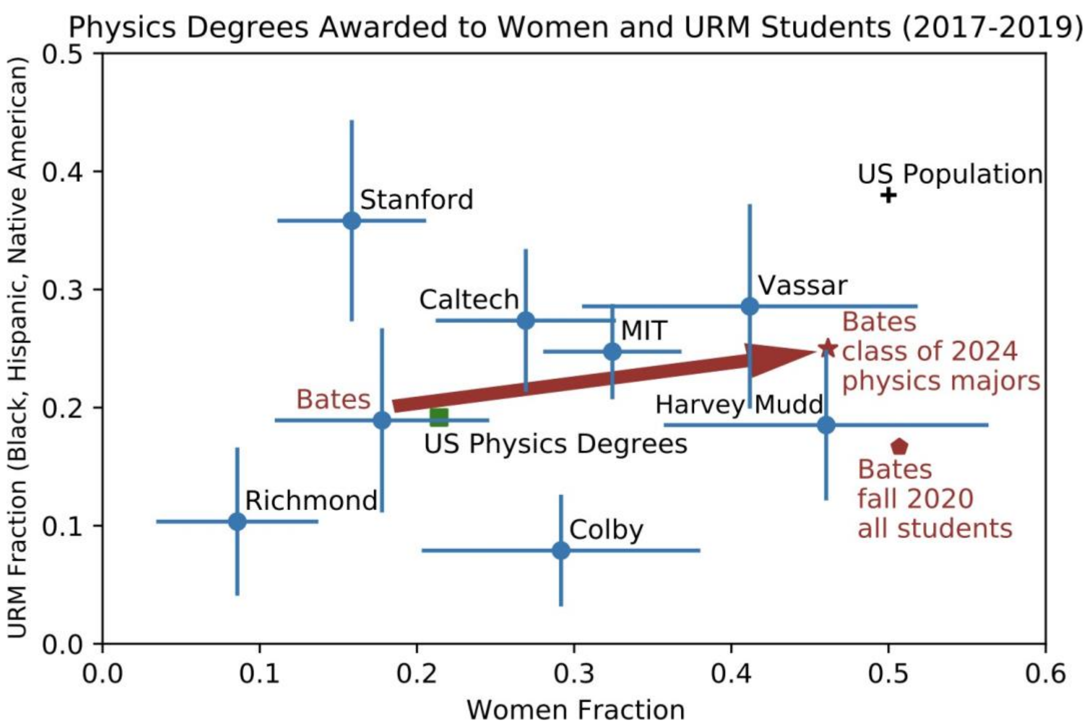
We are inspired by collaborating with other academic units to help add flexibility to the major. One potential model is from the College of the Holy Cross (detailed in Basu et al., 2021) who worked with colleagues in physics, chemistry, math, and other disciplines to provide "just in time" instruction in key topics that eliminated the need for students to take full-semester courses.

Physics & Astronomy

by Aleksandar Diamond-Stanic

State of success for marginalized students

The Department of Physics and Astronomy at Bates College has been involved in curriculum transformation work over the past three years (2019-2022) supported by the Howard Hughes Medical Institute (HHMI) Inclusive Excellence (IE) grant to Bates College. This includes the development of new introductory courses for students interested in the physical sciences (PHYS 109 Energy, Matter, and Motion) and the life sciences (PHYS 107 Physics of Living Systems 1 and PHYS 108 Physics of Living Systems II). These new courses were designed to replace the introductory sequence that was in place for several decades (PHYS 107 Classical Physics and PHYS 108 Modern Physics). The assessment of these new courses in the context of our inclusive excellence work is ongoing, and our vision of success includes marginalized students who are thriving, rather than simply persisting. One positive sign is that among the students to declare physics majors in the class of 2024 (the first class to take PHYS 109 in their first year), more than 40% are women, including four women of color (three of whom would be classified as domestic underrepresented students by the American Institute of Physics). For context, here are some demographic data that place our department in a national context:



Specifically, we show data for physics departments across the United States from the American Institute of Physics for the graduating classes of 2017, 2018, and 2019 (note: the error bars are Poisson uncertainties based on counting statistics). We compare these data to the entire US population (from the 2020 US Census) and the entire Bates student population (using fall 2020 data from the Bates College Office of Institutional Research, Analysis, and Planning). We also show data for the physics majors in the class of 2024. As a baseline, prior to our HHMI-supported work, Bates was consistent with national averages for physics majors in terms of race and gender, specifically the fraction of physics degrees awarded to (1) Black, Hispanic, and Native American students, and (2) Women. During this 2017-2019 period, Bates lagged behind a number of peer and aspirational institutions in terms of the fraction of women (e.g., MIT, Vassar, Harvey Mudd) and the fraction of students from historically marginalized racial groups (e.g., Stanford). That said, the data from the Bates class of 2024 (who declared their majors in winter 2022) show that Bates physics majors have shifted significantly in terms of the fraction of women (from approximately 20% to 45%) and slightly in terms of the fraction of Black, Hispanic, and Native American students (from approximately 20% to 25%), which are both positive trends.

Pedagogical and curricular changes

The development of these new introductory courses (PHYS 109 for students interested in the physical sciences and PHYS 107/108 for students interested in the life sciences) began after the department's decadal review process during the 2017-2018 academic year and a facilitated retreat in December 2018. Specifically, the external committee report that we received in May 2018 included a primary recommendation that we create two separate introductory sequences: one for prospective majors and one aimed specifically at life sciences students. Regarding the motivation for this split, the expectations and motivations of first-year students interested in a physics major are often quite different from those of juniors and seniors who take introductory physics to supplement their interests in other disciplines (e.g., these students are often on pre-health tracks or pursuing the Bachelors of Science degree at Bates, for which physics is a requirement). The external committee report also recommended that we use active learning techniques and collaborative projects (e.g, for cohort development and mutual support in PHYS 109), as well as a "studio physics" approach that folds experimental investigation into class time (e.g., for the redesign of PHYS 107/108). Four faculty members were involved in the development of these new introductory courses during the 2019-2020 academic year, and four faculty members have now taught them during the 2020-2021 and 2021-2022 academic years.

The PHYS 109 course (designed for prospective majors) takes a less traditional approach in terms of content, using an energy-first method to build up motivation before diving into vectors and forces. For course materials, we developed lightboard videos and custom lecture notes as the primary text for the course, with supplementary information from open educational resources (specifically OpenStax University Physics). We also developed the lab portion of the course to center around data the students obtain themselves (using mobile devices that we provide) and then subsequently analyze using modeling techniques in Python.

The course materials for PHYS 107/108 have also shifted significantly, with new content focused on medical imaging, radiation therapy, thermodynamics of the human body, and other topics that are particularly relevant for students interested in the life sciences (but were not covered in the previous introductory sequence). We adopted an electronic textbook that is freely available to Bates students (Introduction to Biological Physics for the Health and Life Sciences), and we developed new pre-class videos, leaving more time in class for students to practice their problem solving.

Regarding changes to pedagogy, in PHYS 109 we emphasize the development of problem-solving skills and conceptual understanding during low-stakes, pre-class assignments and by working through examples and think-pair-share voting-card questions during class. We have homework assignments throughout the semester (typically one every two weeks during a normal semester) that include opportunities to submit corrections. We also provide an explicit set of homework and assessment guidelines to frame the purpose, audience, and expectations for student work. Furthermore, we dedicate class time before each assignment is due for students to work collaboratively with their peers in pre-assigned groups to discuss ideas for solving the problems (with attention to student demographics in the groups). We have also developed final projects in which students learn (and then present) about the research being done by students, recent alumni, and faculty in the Department of Physics and Astronomy.

The most significant pedagogical change in PHYS 107/108 is the switch to the "studio physics" format in which students engage collaboratively with both problem solving and lab experiments in the same physical space. Students spend the majority of the class time working together with classmates, as most new content is provided before class through videos, readings, and pre-class assignments. We also designed these courses to have significant involvement from Assistants in Instruction and Course-Attached Tutors to provide academic support, both inside and outside of the classroom. Finally, we adopted new "exam wrappers" in which we invite students to reflect on the factors influencing their performance in the course, and provide them with the opportunity to correct their work.

Structural changes to encourage retention

The biggest change with our new introductory sequence is that it allows for multiple pathways into upper-level coursework. In previous decades, a student who did not register for PHYS 107 in the fall semester (and who did not request instructor permission to take PHYS 108 in the winter semester) would have to wait an entire year before starting their first physics class at Bates. With the development of PHYS 109, which offers a one-semester on-ramp to our 200-level courses and is offered in both the fall and the winter semesters, there is less pressure on incoming first-year students during the initial course registration process. Furthermore, we have maintained a pathway for any student who happens to take the PHYS 107/108 sequence during their first two years and wants to take more physics; several students have already done this and declared physics majors.

In addition, we have developed a new short-term course (PHYS s31 Spacetime, Waves, and Photons) that is designed for the cohort of potential physics majors who took their first physics class during either the fall or winter semester of that academic year. This course includes curated content from the previous PHYS 108 Modern Physics course and further lab experience for students before they take upper-level courses like PHYS 231 Laboratory Physics.

Finally, we have been making changes to our advising structures, so that information about our new courses and flexible pathways is clear to students. In the previous advising model, the department chair was assigned as the major advisor for all physics majors, but we have now distributed the advising across all faculty in the department, including shared resources. We also now explicitly discuss advising and course recommendations (and career paths in physics) in our courses prior to registration each semester.

Additional course changes to support retention and persistence of marginalized students

Our primary work has been with the development of the brand new courses discussed above, but we have also begun implementing changes in upper-level courses in terms of content and pedagogy. One pedagogical example is with the development of more think-pair-share and voting-card questions for the courses typically taken by sophomores (PHYS 211 Newtonian Mechanics and PHYS 222 Electricity and Magnetism). In PHYS 211, which is taught in the fall semester when many students are considering major declarations and career paths, we have incorporated specific discussion of careers in physics and identify-related questions of who does physics. For example, in terms of new content, we have used the Phynd the Physicist activity to address stereotypes that students bring with them into the classroom about what physicists look like, specifically addressing race, gender, and intersecting identities. We have also incorporated discussion of the Nobel Prize in Physics (which is announced during the fall semester) to learn about both the research that is being honored, and about how sexism and racism have impacted who has received this award over the past century (e.g., with only 4 women among the 200+ recipients of the Nobel Prize in Physics to date, with all four of them being white women). We have also reduced the weight of exams in grade calculations, incorporated more opportunities for homework and test corrections, and experimented with having students create final portfolios to highlight their growth and what they have learned during the semester.

Effectiveness of changes thus far for marginalized students

Beyond the positive demographic shifts in the class of 2024 physics majors (as highlighted above) and anecdotal evidence that comes from conversations with students and colleagues (e.g., about inclusive pedagogies and the lived experience of marginalized students), we do not yet have a clear assessment of the effectiveness of these curricular changes. We are working with the Office of Institutional Research and the Dean of the Faculty's Office to analyze student performance (as assessed by grades), including how that has changed between the baseline of PHYS 107/108 (e.g., over the last decade) and the past two years with our new introductory courses. Furthermore, we are interested in student experiences beyond grades, and motivated in part by our Foundational Dialogues conversations as a department, we are working (again with Institutional Research) to develop a survey for recent and current physics students. The goal is to incorporate questions that were developed by the Task Force to Elevate the Representation of African Americans in Undergraduate Physics & Astronomy (TEAM-UP) to assess student belonging, physics identity, and academic and personal support.

Challenges and aspirations moving forward

Members of the department have participated in a wide variety of equity-focused professional development opportunities in the last few years, and we recognize that this work is ongoing. We recently engaged in a self-assessment based on an Equity and Inclusion Department Change Rubric, developed by April Hill, and we identified several areas in which we are just beginning our work (e.g., in terms of anti-racist pedagogies, celebrating BIPOC communities, and removing structural barriers). We also identified the need for more assessment of the effectiveness of curricular changes (as discussed above). As we continue this process of self-reflection, professional development, and curricular transformation, it is clear that further training on issues of race, power, privilege, white supremacy, and colonialism as they relate to our discipline will be beneficial. Looking at our own curriculum and the experiences of our students, we are particularly interested in issues such as (1) how we connect with incoming first-year students, (2) how students experience the transition to 200-level and 300-level courses, and (3) how we can leverage connections with recent alumni (to learn about where our majors go, to connect them with current students, and to learn more about their experiences in our department). We have learned about initiatives from professional societies, and three national programs in particular have come up in departmental discussions, which will continue to follow: APS (American Physical Society) IDEA (Inclusion, Diversity, and Equity Alliance), the TEAM-UP task force discussed above, and the SEA CHANGE project in Physics & Astronomy created by the AAAS (American Association for the Advancement of Science).

Bates STEM Scholars Program

by April Hill

State of marginalized students entering STEM Scholars

STEM Scholars are students across academic units studying in STEM and STEM adjacent disciplines at Bates College. All of the students in STEM Scholars come from populations or identities that have been historically and/or contemporarily minoritized in STEM (i.e., students who identify as first-generation to college, Black, Hispanic/Latinx, Asian/Asian American/Pacific Islander/Native Hawaiian, Native American/Alaska Native, two or more races, Pell eligible or low financial capacity, students from rural Maine, or women in math, computing and physics). Prior to the creation of the STEM Scholars program, we knew that there were equity gaps for students from most of these backgrounds in our STEM courses and majors. We also knew, from student surveys and focus groups, that these students were not always (or often) developing a sense of belonging in STEM at Bates, that they felt like the culture was too competitive, that the courses and curriculum was set up to "weed them out" and that they didn't always feel supported by their professors. The program was created to specifically address these issues through building a cohort-based community with features similar to programs like the Meyerhoff Scholars Program (e.g., Maton et al., 2017) or the Posse STEM Program with an embedded curricular component of a first year seminar. We also took guidance from lessons learned from HHMI Capstone Programs (DiBartolo et al., 2017) to create a multi-year cohort-based program that includes both curricular and co-curricular elements. After three years of the full program (from first-year seminar to fourth-year Peer mentoring), we have learned that some of these equity and self efficacy issues are shifting (see below) in terms of success for STEM Scholar and other STEM students. As well, faculty are developing a better understanding of the barriers that students with these identities face along with the valuable assets and skills these students bring to STEM and that students should play a role in defining their own success.

Pedagogical and curricular change

In early 2019, we conducted a faculty/staff learning group to study evidence-based practices for the pedagogy to be used in the STEM Scholars courses and had discussions about the content and skills that the program would support through a framework of an anti-deficit minded, STEM enrichment, cohort-based program with goals around fostering positive STEM and success identity, community, and metacognitive practice (a partial list of sources evaluated is listed in Appendix A). A set of learning goals for STEM Scholars was co-developed to guide instructors who would be teaching the STEM Scholars courses (Appendix B). The pedagogy would center around active learning, inclusive teaching, and helping students develop a strong sense of belonging and success identities in STEM. In terms of content, the First Year Seminar was the target introductory course and "content" includes development of personal narratives around each student's "STEM Story", investigating, writing about and celebrating the lives of scientists from diverse backgrounds, reading, evaluating and communicating about issues related to social justice and STEM, and developing STEM competencies through investigating a current area of scientific research interest and engaging the public on findings of this work (see FYS syllabus in Appendix C for more details). The FYS STEM

Scholars also has a community-engaged learning component where students work on projects relating some aspect of their work with the Lewiston community. For example, students contributed their “STEM Stories” to BatesConnect, an online platform that offers learning tools to Maine’s K-12 teachers for sharing in middle school classrooms and some recent STEM Scholars authored and illustrated an inspirational children’s book on cultural identities and STEM imagination.

Structural changes to STEM Scholars to encourage retention

While the STEM Scholars can major in any area, the structural change to encourage retention and completion of their chosen STEM major, was to deploy the required First Year Seminar (FYS) as a gateway course to help students develop their STEM success identities by engaging with concepts and skills in a collaborative community to directly support student’s self-defined vision of success. As well, we created 0.5 unit courses for the winter term of the first year (after FYS) for the students to continue developing their STEM skills as they work on collaborative projects together and took part in workshops and seminars to unveil the “hidden curriculum” at Bates and in STEM. This is followed by 0.5 U courses in the fall and winter terms of the sophomore year where the students explore STEM courses, majors and careers with internal and external scientists and take part in professional development activities around areas such as personal goal setting, developing success frameworks, resume building, and applying to internships and research opportunities. In some iterations, the sophomore STEM Scholars have engaged in research projects with internal and/or external scientists (e.g., NASA) and in other iterations they have participated in book discussions with the Maine Humanities Council on authors like Octavia Butler to delve into identity-specific issues and frameworks supporting discovery of their own “super powers”. Students also continued to participate in peer mentoring triangles. Another structural change is that STEM Scholar students have a consistent STEM advisor in their first year (which is not true for all STEM students at Bates) and an expanded set of STEM advisors during their second year with multiple opportunities to make connections with faculty and staff in disciplines of interest to them. As well, STEM Scholars juniors and seniors have the opportunity to engage in professional development of peer mentoring and leadership roles in mentoring first and second year students. The peer mentor work can help encourage retention in STEM and increase self-efficacy in the sciences and mathematics fields.

Effectiveness of changes thus far for STEM Scholars marginalized students

Each year, we conduct surveys of the STEM Scholars, so we have three year’s data where students have reflected on their experiences in the program and their experiences in STEM at Bates. One observation from the data is that after the first year of the program, when students were asked to describe the *culture of STEM at Bates*, two of the most frequent words used were “competitive” and “challenging.” This year (two years later and with a high response rate), the most frequent word used to describe the *culture of STEM at Bates* was “inclusive,” followed by “collaborative” and “supportive.” We also still see “rigorous,” “challenging,” “engaging,” and to a smaller extent, “competitive.” When asked about ways that the STEM Scholars program has impacted their experiences at Bates, students cite numerous impacts including that the program supported their sense of belonging and helped them develop meaningful connections with their peers and professors, that it helped them clarify their STEM interests and become connected to resources for support, and that it provided study strategies and ways to navigate Bates.

While this is a snapshot of what students are thinking, we feel hopeful that culture is changing and we look forward to deeper reflection on their responses to learn how we can support them in all of the ways that they define their success. We also have data on persistence of the STEM Scholars in STEM majors and at Bates. For the first class who took part in the program (n=36) and who will graduate in 2023, 83% are on track to graduate with a STEM degree (71% of FG students, 92% of Hispanic students, and 83% of Black students to name a few). This is in contrast to earlier data from the decade before 2017 that showed 41% of STEM interested first-generation students, 23% of Black students, and 38% of students with low financial capacity graduated with a STEM major as compared to nearly 60% of STEM interested white students. While the STEM Scholars do not represent all of the STEM interested students of color, FG, or low financial capacity students at Bates, the data shows that students who do take part in the program have high persistence rates compared to historical data at Bates.

Challenges and aspirations moving forward

Some of the current/future challenges are centered on sustainability of the program. In that regard we are working with Advancement on fundraising to endow the program as resources will be needed when the HHMI grant ends for funding faculty, staff and students associated with the program. This includes faculty teaching the 0.5 U courses and other parts of the program (i.e., Peer mentoring, outside speakers, etc). As well, we aspire to create a STEM Scholars advisory board (STEM Scholar students led by one faculty member) so that the program can evolve in response to student voices and needs. In the coming year, this advisory board will be led by Dr. Lori Banks with students from the sophomore, junior, and senior STEM Scholars class.

We also learned about challenges and aspirations by analyzing the responses of our STEM Scholars from surveys conducted in the fall 2021 and spring of 2022 (Classes of 2022-2025). Students were asked a series of scaled and open ended questions and we received 93 responses (65 fall, 28 spring) in all. Answers to the scaled questions indicated that greater than 90% of the students feel that they can do well in STEM and that they belong in STEM. As well, greater than 90% of the students agree that STEM Scholars has had a positive effect on their interest in science and has helped them become part of a learning community. When students were asked open-ended questions about the academic culture in STEM at Bates, ways that students thriving in STEM could be improved, and how STEM Scholars impacted their experiences, they provided meaningful and insightful feedback. The following summarizes some of the messages that students shared about challenges and opportunities moving forward.

There are still challenges that students are facing in STEM at Bates. When STEM scholars were asked specifically to address how the academic culture in STEM at Bates negatively impacted their experiences, some key themes emerged. Of the students who responded directly to this question (n=86), 16% said that course difficulty, workload, pace, grading design, and/or rigor negatively impacted their experience. Further, 14% of STEM scholars talked about how a competitive atmosphere among peer learners in STEM negatively impacted their experience in STEM courses. 9% of the STEM scholars indicated that they felt behind or underprepared from a lack of previous educational experiences or resources in STEM that fellow students may have had access to. Moreover, 10% indicated that they had experienced STEM courses with unsupportive or discouraging professors who ultimately did not help ameliorate or address students' concerns. Notably, when discussing the root causes of their negative experiences, a concerning number of students alluded to racism, bias, and/or beliefs in white supremacy held by fellow students or their professors. Specifically, 5.8% of the students said that group work created environments where white students could exclude students of color from study groups. Within these groups, students often felt as if white peers viewed them as incapable or underestimated their skills or knowledge. Additionally, 3.4% of the STEM scholars said they felt insecure, disadvantaged, or set up to fail because of their race, and 4.7% indicated that a dearth of faculty of color negatively impacted their experience. Another 4.7% talked about how a culture of white supremacy, division of students of color from white students, and/or lack of awareness about white supremacy culture produced a negative impact. This is likely an underestimation of respondents who would cite issues around identity if specifically asked, as 6.9% of STEM scholars discussed (1) feeling alone, (2) being part of a closed-off community, and/or (3) having difficulty finding friends. Some talked about Imposter Syndrome, feeling alienated as the only females in their courses, feeling like neuroatypical students are not valued, or exhausted from having to re-explain their learning differences to each new professor. Other areas that negatively impacted a few of the students' included students who felt like STEM was not a major focus at Bates, that there are not enough STEM offerings at Bates, that academic structures were not consistently supportive or were difficult to navigate, that high stakes exams and grade pressures were impacting them negatively, and that large classes made it difficult to get support. These student voices provide us with an opportunity to address issues that negatively impact their experiences.

When asked what would be some features of an "improved" Bates College in terms of Inclusive Excellence, the STEM Scholars had ideas. Many of the students said that Bates needs to have a more diverse faculty, especially more faculty of color. They indicated that they would like to see more students of color as well. They talked about their professors, suggesting more accountability for creating inclusive courses, curricula, and policies and for cultural awareness about their students. They also want their professors to discuss the importance and impact of people of color and others marginalized in STEM as well as to acknowledge and teach about the history of racism, discrimination, and exclusivity in STEM. Equally important to the STEM Scholars was that they want their peers, and particularly their white peers, to understand about their lived experiences, racism, white supremacy, and privilege, and they suggested training about implicit bias, microaggressions, cultural awareness, inclusive group work, and other forms of education or discussions with their peers that would help reduce competition, exclusivity, anxiety, and stress around belonging at Bates. A few other areas of consideration were that more STEM courses should be accessible to students outside of STEM to create more campus-wide inclusion, that more resources, especially financial, are needed for some students, that more paid research and internships opportunities be made available, and that more mental health and wellness support is needed.