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Mapping and Expanding Climate and Environmental Justice in MIT's STEM Departments

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Mapping and Expanding Climate and Environmental Justice in MIT's STEM Departments

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Research has shown that climate and environmental justice (CEJ) course content is not sufficiently included in environmental and sustainability degree programs, and even less likely in STEM program contexts within higher education. This paper seeks to better understand how CEJ content is included within MIT's STEM departments, and provides analysis and recommendations regarding approaches for its expansion both in STEM areas and across disciplines. The Climate Justice Instructional Toolkit,[3] a curricular development project that houses adaptable climate justice teaching modules and pedagogical recommendations is explored as an initial expansion strategy.

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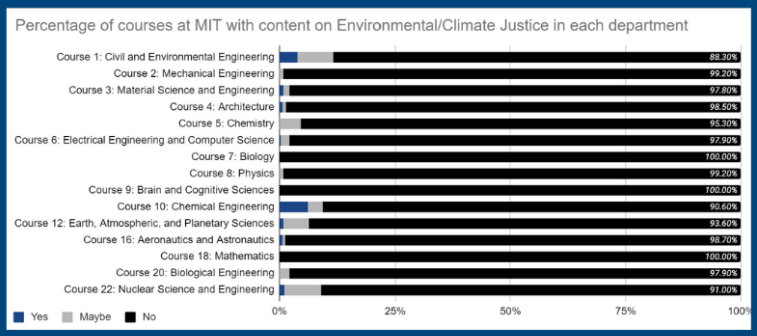
EXECUTIVE SUMMARY

MAPPING CEJ IN STEM AT MIT

MIT's strategic plan has a significant emphasis on creating an ecosystem that can "bring every aspect of the global economy to net-zero carbon emissions no later than 2050", while centering the imperative of equity and justice in the process.

However, there is a dearth of CEJ content at MIT, particularly within its STEM departments, which is consistent with research in higher education.



LITERATURE REVIEW

Environmental education has historically excluded the voices of BIPOC and low-income groups around the globe, the groups who are most impacted by climate change and have limited access to its solutions. A CEJ lens within STEM addresses these gaps in multiple ways:

- It enables creative solutions towards tackling climate change and socioenvironmental challenges by breaking down disciplinary boundaries.
- It enhances student enrollment and learning gains, especially among minoritized students in environmental programs in STEM areas.
- It encourages collective discussions on science and its implications on society and justice, thus challenging technical advancement that perpetuate or reinforce the unjust status quo.

RECOMMENDATIONS

- **Short term:** Make CEJ and sustainability related courses more easily searchable for students who might be interested in this content area.
- **Medium term:** Ensure that courses in MIT's General Institute Requirements (GIRs) include significant CEJ content.
- **Long term:** Focus on providing more courses containing CEJ content in STEM departments as well as curricular and instructional support to faculty.

ANALYSIS

The following observations emerged from studying MIT's course catalog:

- MIT has very few environmental and climate justice courses directly offered by its STEM departments.
- Even outside of CEJ, MIT's performance in offering sustainability focused courses in STEM departments is extremely limited, with most departments having fewer than 5% courses discussing any issue of sustainability.
- There is no systematic way for students to find courses in CEJ at MIT. Ambiguity in terminology and the lack of adequate details in the course descriptions make it difficult for students and potential applicants to know 1) whether MIT's offerings meet their interests and 2) if so, where and how they can find such courses.

1 Introduction: The Imperative of Justice at MIT

In the spring of 2021, in an effort to address the world's growing climate crisis, MIT launched *Fast Forward: MIT's Climate Action Plan for the Decade.*[4] Within this strategic plan, MIT listed the need to invest, invent, and develop new tools, as well as educate and empower the next generation of scientists and practitioners to "bring every aspect of the global economy to net-zero carbon emissions no later than 2050." A key section of the plan is entitled *The Imperative of Justice*, which highlighted the need to decarbonize the economy by centering justice and equity in the process. It stated that "the world will not solve the climate problem without solving the intertwined problems of equity and economic transition."

The challenges listed in the *Imperative of Justice* are representative of the movement for Climate Justice (CJ). The UC Berkeley Center for Climate Justice[5] explains that "*climate justice recognizes the disproportionate impacts of climate change on low-income communities and communities of color around the world, the people and places least responsible for the problem. It seeks solutions that address the root causes of climate change and in doing so, simultaneously address a broad range of social, racial, and environmental injustices*." Climate justice can be seen as a critical component of the broader modern movement of environmental justice (EJ) that began in the early 1980s to seek resolution to the inequitable environmental burdens facing communities of color in the U.S. and across the globe.[6]

Stemming from the *Imperative of Justice* highlighted in *MIT's Fast Forward Plan*, MIT has created various climate-related working groups, student bodies, and research/industry initiatives to build progress and momentum towards confronting the climate crisis and issues of climate justice. However, their primary objectives have mostly centered on research and institutional programming and not as much on building resources regarding CJ education in the classroom at MIT. Currently, little is understood regarding where climate or environmental justice (CEJ) course content exists, what instructional approaches are utilized, and its impact on student learning, research, and the process of technological design.

A potential dearth of CEJ content at MIT is consistent with research in higher education, which shows that the broader umbrella of EJ content is not fully included in Interdisciplinary, Environmental and Sustainability Degree (IES) Programs, and even less likely to be integrated in STEM program contexts.[7] In addition, more recent research[8] on EJ content knowledge and

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[4] *Fast Forward: MIT's Climate Action Plan for the Decade*. (2021, May). MIT. https://climate.mit.edu/climateaction/fastforward

[5] What is climate justice?. UC Center for Climate Justice. (2022, July 16). https://centerclimatejustice.universityofcalifornia.edu/what-is-climate-justice/.

[6] Mohai, P., Pellow, D., & Roberts, J. T. (2009). Environmental justice. *Annual review of environment and resources*, *34*, 405-430.https://www.annualreviews.org/doi/abs/10.1146/annurev-environ-082508-094348

[7] Carlos Garibay, J., Ong, P., & Vincent, S. (2015). Program and institutional predictors of environmental justice inclusion in U.S. post-secondary environmental and sustainability curricula. Environmental Education Research, 22(7), 919–942. https://doi.org/10.1080/13504622.2015.1054263.

[8] Schusler, T. M., Espedido, C. B., Rivera, B. K., Hernández, M., Howerton, A. M., Sepp, K., Engel, M. D., Marcos, J., & Chaudhary, V. B. (2021, August 12). Students of colour views on racial equity in Environmental Sustainability. Nature Sustainability, 4(11), 975–982. https://doi.org/10.1038/s41893-021-00759-7.

experiences of Black, Indigenous and Students of Color (BIPOC) students confirms decades of theory[9,10] that argued that environmental education was taught with limited perspectives that often excluded the voices of BIPOC and low-income groups around the globe, the groups who are most impacted by climate change and often have limited access to participate in climate related solutions. For these reasons, there is a critical need to better include CEJ content across the curriculum at MIT and across higher education.

In order to achieve this goal, this paper presents research that maps the quantity of CEJ course content in MIT's STEM departments and identifies opportunities for interweaving climate justice issues specifically into STEM education. This paper limits its scope on STEM departments for three major reasons:

- Previous research has shown that EJ course content is less likely to be included in STEM areas.
- STEM has traditionally been at the core of MIT's culture in terms of academic offerings and undergraduate student enrollment.
- We assume that the presence of CEJ content is higher in non-STEM departments and schools like The School for Humanities, Arts & Social Sciences (SHASS) and The Department of Urban Studies & Planning (DUSP), as compared to the STEM departments, and hence, STEM departments warrant more attention.

This research will help us to start quantifying to what extent climate justice education is included in the academic curriculum across MIT's STEM departments, and hopefully catalyze future work to better understand, improve, and expand climate justice across departments and disciplines. Additionally, we also discuss recommendations to improve the status quo by identifying ways to integrate these topics into the subject matter of STEM areas at a broader scale. Finally, the paper expands on one of these recommendations and introduces a curriculum development project called The Climate Justice Instructional Toolkit as one initial strategy to address this gap in climate justice education at MIT and beyond.

2 Why Integrate Climate Justice in STEM? A Brief Literature Review

[9] Taylor, D. E. (1996). Making Multicultural Environmental Education a REALITY. Race, Poverty & the Environment, 6(2/3), 3–6. http://www.jstor.org/stable/41554237.

[10] Cole, A. G. (2007). Expanding the field: Revisiting environmental education principles through multidisciplinary frameworks. The journal of environmental education, 38(2), 35-45.

As described above, recent studies document that EJ content knowledge is not fully included in Interdisciplinary, Environmental, and Sustainability (IES) Degree programs,[11,12,13] and even less likely to be included in STEM areas.[14] This recent empirical work confirms decades of discussion pieces and theory from EJ scholars that argued that environmental education was taught from a limited perspective that discounted the experiences and voices of BIPOC people and communities directly impacted by EJ issues.[15,16,17] As the climate crisis intensifies, researchers from across the sciences have begun to explore both how and why CEJ content knowledge should be included more widely in STEM areas. This section provides a non-exhaustive review of five key reasons why including CEJ content and teaching practices in STEM is of vital importance.

[11] Carlos Garibay, J., Ong, P., & Vincent, S. (2015). Program and institutional predictors of environmental justice inclusion in U.S. post-secondary environmental and sustainability curricula. Environmental Education Research, 22(7), 919–942. https://doi.org/10.1080/13504622.2015.1054263.
[12] Garibay, J. C., & Vincent, S. (2018). Racially inclusive climates within degree programs and increasing student of color enrollment: An examination of environmental/sustainability programs. Journal of Diversity in Higher Education, 11(2), 201–220. https://doi.org/10.1037/dhe0000030.
[13] Schusler, T. M., Espedido, C. B., Rivera, B. K., Hernández, M., Howerton, A. M., Sepp, K., Engel, M. D., Marcos, J., & Chaudhary, V. B. (2021, August 12). Students of colour views on racial equity in Environmental Sustainability. Nature Sustainability, 4(11), 975–982. https://doi.org/10.1038/s41893-021-00759-7.
[14] Coleman, K., & Gould, R. (2019). Exploring just sustainability across the disciplines at one university. The Journal of Environmental Education, 50(3), 223–237. https://doi.org/10.1080/00958964.2019.1582471.
[15] Taylor, D. E. (1996). Making Multicultural Environmental Education a REALITY. Race, Poverty & the Environment, 6(2/3), 3–6. http://www.jstor.org/stable/41554237.
[16] Agyeman, J. (2003). Under-participation" and ethnocentrism in environmental education research: Developing" culturally sensitive research approaches. Canadian Journal of Environmental Education (CJEE), 81-95.
[17] Cole, A. G. (2007). Expanding the field: Revisiting environmental education principles through multidisciplinary frameworks. The journal of environmental education, 38(2), 35-45.

- Address humanity's greatest threat: Familiarity with social and environmental injustices is a critical tool to enable STEM students to apply their scientific knowledge to address issues of sustainability.[18,19] Additionally, certain issues of social justice — in the areas of health, sustainability, or environmental catastrophes — can only be equitably addressed with the support of tools provided by research and advances in STEM fields.[20,21] Although progress has been made in integrating sustainability and CEJ content into STEM, recent data highlights its continued exclusion.

- Communicate science in an inclusive environmental justice frame: In their research, Polk and Diver (2020) highlight that including concepts from EJ — such as understanding how vulnerable communities are inequitably impacted by environmental issues, recognizing and valuing community knowledge, and reflecting upon and acknowledging one's social identity and potential lack of EJ perspective — can help instructors and students produce and communicate scientific knowledge in a more inclusive and equitable way. They highlight various questions of inclusivity to guide this instructional process. From this lens, any STEM course could have students engage in critical and structured reflection regarding what kind of science they are producing, why they are producing it, and who can access this knowledge based on issues of socio-political and cultural power.

- Improve BIPOC student enrollment and educational climate: Another reason STEM faculty or program leaders should consider including EJ content is that it may have the potential for increasing enrollment of BIPOC students within IES programs across higher education. Garibay and Vincent (2018)[22] found that IES programs with more EJ content (and more compositional diversity) are more likely to see an increase in enrollment of students of color. In their discussion, these researchers emphasize the importance of creating an IES program that acknowledges EJ issues and includes them prominently in the curricular offerings as an important step to improving program racial climate. This finding is backed by previous research as well, not only for student enrollment, but also faculty compositional diversity.[23]

- Improve learning outcomes, especially for minoritized students: More specific to student learning outcomes, the independent party assessment, The National Center for

[18] Schmidt, N. (2020, September 30). Argonne National Laboratory. STEM program inspires students to advance environmental sustainability and social justice in Chicago communities. https://www.anl.gov/article/stem-program-inspires-students-to-advance-environmental-sustainability-and-social-justice-in-chicago.
[19] Gallay, E., Flanagan, C., & Parker, B. (2021, August 9). Place-based environmental civic science: Urban students using STEM for public good. Frontiers. https://www.frontiersin.org/articles/10.3389/feduc.2021.693455/full.
[20] Kirkland, L., & Poppleton, K. (2021, February). Climate change education: A model of justice-oriented STEM education. NSTA. https://www.nsta.org/connected-science-learning/connected-science-learning-january-february-2021/climate-change.
[21] Scott, C. (2017). STEM education and social justice. In *Catalyst: A Social Justice Forum* (Vol. 7, No. 1, pp. 1-2).
[22] Garibay, J. C., & Vincent, S. (2018). Racially inclusive climates within degree programs and increasing student of color enrollment: An examination of environmental/sustainability programs. Journal of Diversity in Higher Education, 11(2), 201–220. https://doi.org/10.1037/dhe0000030.
[23] Padgett, D. A. (2001). Teaching race, class, and cultural issues in Earth Sciences to enhance multicultural education initiatives. Journal of Geoscience Education, 49(4), 364–369. https://doi.org/10.5408/1089-9995-49.4.364.

Science and Civic Engagement's (SENCER) teaching methodologies found that student learning gains in STEM were higher and more directly applicable to problem-solving when STEM was taught through complex, unresolved social issues, more so for women and BIPOC students as compared to others.[24] Other studies corroborate that making justice issues the center of STEM education can encourage women and racially and ethnically minoritized students, who have been historically underrepresented in STEM fields, to participate more in class and potentially feel more included.[25, 26] Additionally, research and pedagogical discussions highlight that students from marginalized communities benefit when instructors are able to situate STEM education within a justice framework and meaningfully connect students' lived experiences to classroom activities and projects.[27, 28]

- Confront unjust technocratic climate solutions: Finally, given the adverse impacts of human actions borne disproportionately by marginalized communities in any societal context, teaching students science-based solutions that are not grounded in social justice will only contribute to perpetrating the unjust status quo. This finding was highlighted by Schusler et al (2021), who interviewed BIPOC students enrolled in IES programs in two U.S. universities. Many of them mentioned how "white environmentalism" was common in such sustainability courses, and sustainability programs that lacked a CEJ lens often purported environmental solutions that would be incompatible for many BIPOC students and their interests.[29] With MIT's technological focus that aims to further innovative, scientific climate solutions that curb climate change, there exists the danger that conversations regarding who decides, who benefits, who accesses, who uses, and who is adversely impacted by such innovations could be missing. To give one example, the university has made massive progress in implementing and advocating for decarbonization efforts through electrification and battery technology. However, the unjust human and environmental costs of extracting necessary minerals to facilitate this transition needs to be more prominently discussed in such technically-oriented courses.[30]

For the above mentioned, MIT's vision of being at the forefront of the climate crisis cannot materialize without integrating CEJ approaches within its STEM departments. The next section

[24] Research and results – 2001-2007. SENCER. (n.d.). https://sencer.net/sencer-results/.
[25] Doucette, S.R., Shaver, I., Morrison, D., & Price, H. (2023). Teaching STEM through Climate Justice and Civic Engagement. SECEIJ. https://new.seceij.net/articletype/teaching-and-learning/teaching-stem-through-climate-justice-and-civic-engagement/.
[26] Schusler, T. M., Espedido, C. B., Rivera, B. K., Hernández, M., Howerton, A. M., Sepp, K., Engel, M. D., Marcos, J., & Chaudhary, V. B. (2021, August 12). Students of colour views on racial equity in Environmental Sustainability. Nature Sustainability, 4(11), 975–982. https://doi.org/10.1038/s41893-021-00759-7.
[27] Polk, E., & Diver, S. (2020). Situating the scientist: creating inclusive science communication through equity framing and environmental justice. Frontiers in Communication, 5, 6.
[28] Morales-Doyle, D. (2017). Justice-centered science pedagogy: A catalyst for academic achievement and social transformation. *Science Education*, *101*(6), 1034-1060.
[29] Schusler, T. M., Espedido, C. B., Rivera, B. K., Hernández, M., Howerton, A. M., Sepp, K., Engel, M. D., Marcos, J., & Chaudhary, V. B. (2021, August 12). Students of colour views on racial equity in Environmental Sustainability. Nature Sustainability, 4(11), 975–982. https://doi.org/10.1038/s41893-021-00759-7.
[30] Powell, A. (2023, April 25). Benita Kayembe Takes Hard Look at Hidden Human Cost of Electric Cars. Harvard Gazette. https://news.harvard.edu/gazette/story/2023/04/benita-kayembe-takes-hard-look-at-hidden-human-cost-of-electric-cars/.

explains the methodology used to examine the quantity of CEJ content knowledge within STEM departments at MIT.

3 Methodology

This study began as a part of the *D-Lab: Water, Climate Change, and Health* course by Susan Murcott and Julie Simpson in spring 2023, by surveying the courses offered at MIT and evaluating whether or not they might have any content related to 1) sustainability/environment and 2) environmental and climate justice (CEJ). For consistency, we adopted the following definition of climate justice by University of California Center for Climate Justice:

> *"Climate Justice recognizes the disproportionate impacts of climate change on low-income communities and communities of color around the world, the people and places least responsible for the problem."*[31]

In addition to climate justice, we also considered whether the courses had any concepts or ideas from the broader field of environmental justice. The Environmental Justice Working Group (EJWG) at Stanford refers to environmental justice as work that:

> *"... requires us to center the voices and leadership of marginalized communities in 1) the fight for equitable access to environmental benefits, and 2) the prevention and mitigation of the disproportionate impacts of environmental harms for all individuals and communities, regardless of race, ethnicity, gender, sexuality, religion, nationality, age, ability, and income/wealth."*[32]

These definitions were selected among many since they are used by MIT's peer institutions who are known to be doing work that involved integrating CEJ more widely across their institutions.

The process of mapping was done by going through the course descriptions of each course for the Fall 2022 and Spring 2023 semesters listed in the course catalog. Based on this information, a course was marked as 'Yes', 'No', or 'Unclear' on two parameters – whether the course description had any content related to environmental sustainability, and whether it had any content related to environmental and climate justice. The results from this exercise have been aggregated and presented below. We would like to acknowledge Bethany Costanzo, a Northeastern Co-op student (and intern at ESI) that helped with the organization of the data.

It was internally discussed that this process can be made more efficient through the use of an algorithm that, once coded, can analyze the information in a shorter period of time. However,

[31] What is climate justice?. UC Center for Climate Justice. (2022, July 16). https://centerclimatejustice.universityofcalifornia.edu/what-is-climate-justice/.

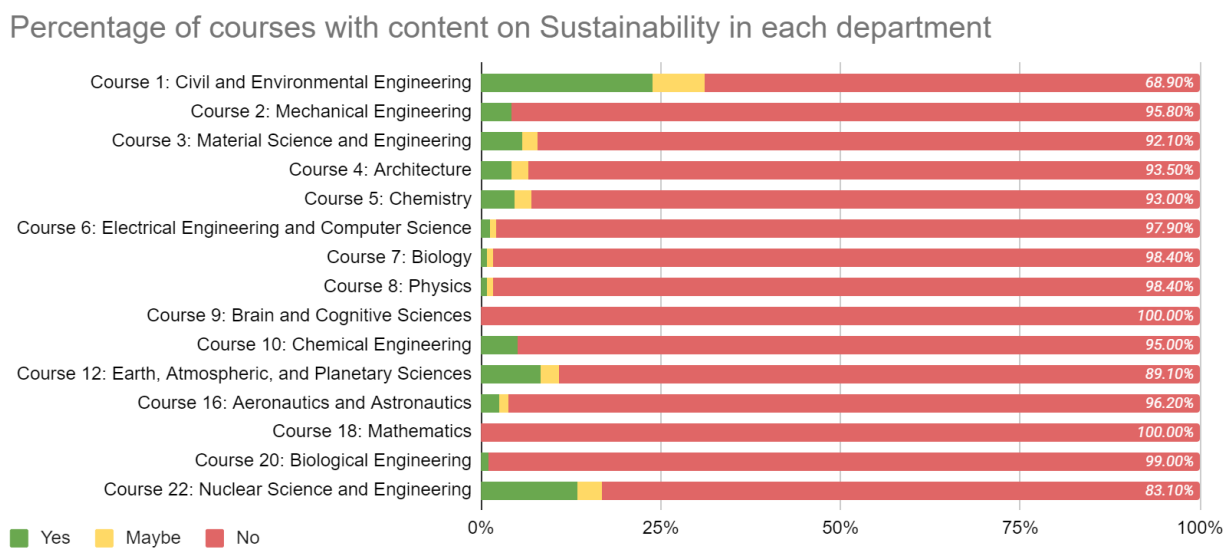
[32] Environmental Justice. Stanford EJ Working Group. (2023, November 3). https://www.ejstanford.com/

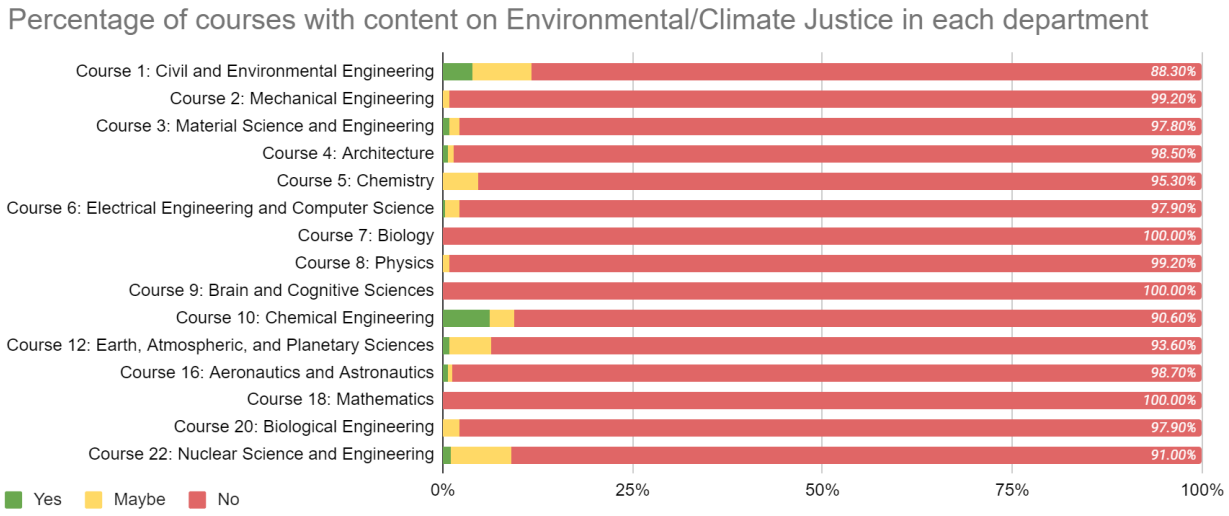
we noticed that the language used to describe climate justice related courses was often vague, thus making a simple script likely to be ineffective. The possibility of scanning through an entire department's course offerings through the Search (Ctrl + F) command was also ruled out for the same reason. Additionally, we also realized that going through the course descriptions was useful to understand if and how difficult it was for students who might be interested in CEJ classes to identify courses that offer related content.

Another approach that was suggested was to crowdsource information about courses that fit this bill from MIT department heads and students. There could have been multiple ways of doing this – by disseminating surveys through student groups, putting up posters with QR codes, or reaching out to department heads or professors and requesting them to list relevant courses in their departments. However, we decided against this approach since it would not provide a comprehensive mapping or ensure a standardized approach (since awareness might vary across groups). Additionally, the intention was to adopt and analyze the method of looking for CEJ courses that is accessible and likely to be used by students themselves rather than building a crowdsourced repository of relevant courses.

4 Findings

The following section summarizes the findings from the course mapping roster for fifteen STEM departments:
Course 1: Civil and Environmental Engineering, Course 2: Mechanical Engineering, Course 3: Material Science and Engineering, Course 4: Architecture, Course 5: Chemistry, Course 6: Electrical Engineering and Computer Science, Course 7: Biology, Course 8: Physics, Course 9: Brain and Cognitive Sciences, Course 10: Chemical Engineering, Course 12: Earth, Atmospheric, and Planetary Sciences, Course 16: Aeronautics and Astronautics, Course 18: Mathematics, Course 20: Biological Engineering, Course 22: Nuclear Science and Engineering.





5 Observations and Analysis

Based on the above results, we can make a few conclusions:

1. MIT has very few environmental and climate justice courses directly offered by its STEM departments.

The best performing department in this regard is Chemical Engineering, and yet, it only offers 6% (and potentially up to 9.5%) of courses containing CEJ content. In addition to pure sciences like Mathematics and Brain & Cognitive Sciences, certain unexpected disciplines like Architecture and Mechanical Engineering also have the least CEJ content in their courses. The absence of related courses in these departments might reflect the degree to which STEM students from these departments at MIT are familiar with topics of CEJ.

Similarly, Coleman and Gould's study (2019) found that during the attempt to make sustainability a requirement at University of Vermont, EJ content was not given the same priority as sustainability (in 17% of required courses compared to 41%) in STEM related courses.[33] This dearth of EJ content in STEM areas is also documented in an earlier study that reviewed 297 IES programs across higher education,[34] illustrating a persistent barrier for EJ content to be included within STEM contexts.

While it can be argued that most CEJ courses are likely to be in departments like the Department of Urban Studies and Planning (DUSP), D-Lab, and Anthropology (or other areas in the School for Social Sciences and Humanities (SHASS)) at MIT, the reasons mentioned previously make a case for ensuring that CEJ is not a subject for social scientists alone. Additionally, even if there are opportunities to cross-register across departments, there is a strong case to be made for providing CEJ education that is interwoven with the content in STEM courses.

2. Even outside of CEJ, MIT's performance in offering sustainability focused courses in STEM departments is extremely limited.

Other than Civil and Environmental Engineering, Nuclear Science and Engineering, and Earth, Atmosphere and Planetary Sciences, most other departments have fewer than 5% courses discussing any issue of sustainability, even if solely technical. Offering more courses that tie academic learning to our current global crises and lived experiences of the current generation is important, especially given the acknowledgement across the university — particularly from students and faculty — on climate change being their topmost academic priority for MIT, and the call to undertake bold institutional action towards becoming a "college of climate".[35] MIT is at a unique position to address challenges related to climate change globally, and failing to provide students with adequate educational opportunities in this regard would be a lost opportunity.

3. There is no straightforward or systematic way for students to find courses in CEJ at MIT.

For example, a search for the term 'Environmental Justice' only returns 22 courses across all departments, whereas we know from first-hand experiences and student feedback that there exist many more that do not show up in this search. Similarly, ''Climate Justice' in the course catalog only returns one D-Lab course (*D-Lab: Water, Climate Change, Health*). While it is likely that course syllabi offer a more comprehensive picture of concepts covered in the class, syllabi are much more difficult to access as compared to the course catalog. Moreover, access to or a

[33] Coleman, K., & Gould, R. (2019). Exploring just sustainability across the disciplines at one university. The Journal of Environmental Education, 50(3), 223–237. https://doi.org/10.1080/00958964.2019.1582471.
[34] Garibay, J. C., & Vincent, S. (2018). Racially inclusive climates within degree programs and increasing student of color enrollment: An examination of environmental/sustainability programs. *Journal of Diversity in Higher Education*, *11*(2), 201. https://www.tandfonline.com/doi/abs/10.1080/13504622.2015.1054263

[35] Listening Tour. MIT. https://president.mit.edu/listening-tour.

request for the syllabus will be dependent on how interesting the student finds the course description or on feedback that they might have received from other peers that were previously enrolled in the class.

This ambiguity in terminology and the lack of appropriate details in the course descriptions makes it difficult for students interested in CEJ to know 1) whether MIT's offerings meet their interests and 2) if so, where and how they can find such courses. This issue is even more pronounced for students within a STEM department who are not familiar with the informal insights circulating about CEJ courses that might be available to someone in one of the social science departments.[36]

It has been found in research conducted by Garibay and Vincent (2018) that prospective BIPOC students look for environmental sustainability curricula that signal the program's values (i.e. justice-orientation) and compositional diversity in order to understand whether the program is likely to have a welcoming environment for them.[37,38] Thus, it can be hypothesized (subject to further analysis) that if prospective BIPOC students that are interested in environmental sustainability are unable to find CEJ-related content in MIT's course catalog, it can potentially impact BIPOC student enrollment.

6 Recommendations

Based on the above observations, we propose the following recommendations to provide more CEJ-related learning among students within the academic setup at MIT:

1. In the immediate term, MIT should **make CEJ and sustainability related courses more easily searchable** for students who might be interested in this content area. While MIT can benefit from creating a database of CEJ courses on campus across all departments in order to track progress across years, the easiest and fastest way to achieve this goal would be to encourage faculty to have appropriate course descriptions or to have searchable/filterable tags on the Course Catalog.

2. Have **courses in the MIT required General Institute Requirements (GIRs) that include significant CEJ content**. Given the university-wide acceptance that MIT needs to "marshal a bold, tenacious response to the run-away crisis of climate change,"[39] It is essential that every MIT student receives exposure to CEJ and ideas on how they can

[36] Additionally, this ambiguity also suggests that the findings from this research will need to be triangulated through department feedback, and verified for accuracy.
[37] Garibay, J. C., & Vincent, S. (2018). Racially inclusive climates within degree programs and increasing student of color enrollment: An examination of environmental/sustainability programs. Journal of Diversity in Higher Education, 11(2), 201–220. https://doi.org/10.1037/dhe0000030.
[38] Carlos Garibay, J., Ong, P., & Vincent, S. (2015). Program and institutional predictors of environmental justice inclusion in U.S. post-secondary environmental and sustainability curricula. Environmental Education Research, 22(7), 919–942. https://doi.org/10.1080/13504622.2015.1054263.
[39] Dizikes, P. (2023, May 1). Join Us in Something Important and New. MIT News. https://news.mit.edu/2023/join-us-something-important-and-new-kornbluth-inauguration-0501.

use their STEM education to address the challenges of this generation as a part of their MIT education. An alternate way to do this would be to create a GIR that requires all MIT students, irrespective of major, to opt for a CEJ course in any department during their first two semesters. This is likely to be easier, as it allows for flexibility for students to opt for topics of their interest, facilitates diversity of ideas and learning, and also will not require a completely new, generic module to be created, as in the case of the above example.

3. Moving forward, MIT can also focus on providing more courses containing CEJ content in STEM departments, such that the courses are concurrently relevant to the STEM subject as well as climate justice and sustainability concerns.

4. The ideal long-term scenario would be for MIT to integrate CEJ content across existing courses in the form of case studies, modules, student project topics, datasets, etc. The Appendix of this paper provides a sample that discusses such avenues for integration within MIT's Civil and Engineering Department's course content. This approach — of centering CEJ as the main theme rather than providing a single, siloed module — takes a systems lens to ensure that every student, irrespective of their concentration, graduates from MIT with a critical and interdisciplinary understanding of environmental and climate justice and their role in achieving the same. For example, Coleman and Gould's (2019) study[40] of a new environmental sustainability requirement across departments at The University of Vermont suggests that colleges and universities may be able to play an important role in enabling our society to reconceptualize environmental sustainability as a justice-oriented issue by requiring sustainability courses in a wide range of disciplines and departments, and by infusing all discussions of sustainability (including those within STEM disciplines) with EJ considerations. There are multiple examples of past institutions and researchers successfully focusing on instructional approaches that support BIPOC students,[41] adopt a "co-generative dialogue" model that taps into students' lived experiences,[42] provide a more inclusive learning context,[43] potentially improving program climate,[44] and foster a rich context for long-term community engagement with local organizations.[45]

[40] Coleman, K., & Gould, R. (2019). Exploring just sustainability across the disciplines at one university. The Journal of Environmental Education, 50(3), 223–237. https://doi.org/10.1080/00958964.2019.1582471.

[41] Schusler, Tania M., Charlie B. Espedido, Brittany K. Rivera, Melissa Hernández, Amelia M. Howerton, Kailin Sepp, Malcolm D. Engel, Jazlyn Marcos, and V. Bala Chaudhary. "Students of Colour Views on Racial Equity in Environmental Sustainability." Nature News, August 12, 2021. https://www.nature.com/articles/s41893-021-00759-7.

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As a first step to achieve this, there have been recent attempts to create initiatives for infusing sustainability and climate science into STEM areas at MIT. For example, the Environmental Solutions Initiative (ESI) is currently running a fellowship, called the Climate, Environment, and Sustainability Infusion Fellowship (CESIF), to tackle this issue. It features nine STEM faculty and instructional staff across seven departments. The fellowship is a two-year process in which faculty members meet during the semester to initiate changes to their teaching, share resources and ideas, and gain insights from speakers with pedagogical expertise at the intersections of STEM and sustainability. Moving forward, we recommend more such initiatives, projects, and events that focus on supporting faculty members and instructors in gaining not just sustainability, but also CEJ expertise and instructional approaches tailored to infusing CEJ within their disciplinary niche.

5. Provide CEJ curricular and pedagogical support to faculty members and instructors across disciplines in the form of easily adaptable curricular resources, info-sessions, and workshops. A useful example in this regard are researchers who illustrate how climate justice and civic engagement can be used as a framework for teaching STEM.[46] As opposed to merely including climate justice content as an *add-on* within STEM courses, they argue that climate justice could be centered as the focus, and through the exploration of climate justice issues and civic engagement, critical STEM learning objectives can be reached. More formal and long-term interventions could take the form of committees, communities of practice, and faculty development projects. For example, researchers have created a project entitled Climate Justice in Undergraduate STEM Incorporating Civic Engagement (C-JUSTICE), a National Science Foundation (NSF) funded grant to engage with faculty across the curriculum on incorporating climate justice content.[47] Similar to C-JUSTICE, the Environmental Solutions Initiative (ESI) at MIT has launched the Climate Justice Instructional Toolkit, a curricular development project that will house adaptable climate justice teaching modules for teaching across disciplines. This Toolkit will be explained more in the following section.

All of the above proposed recommendations might be relevant at different times in the university's journey of integrating CEJ offerings into its curriculum. A potential timeline that accounts for the difficulty and relevance of different recommendations is below:

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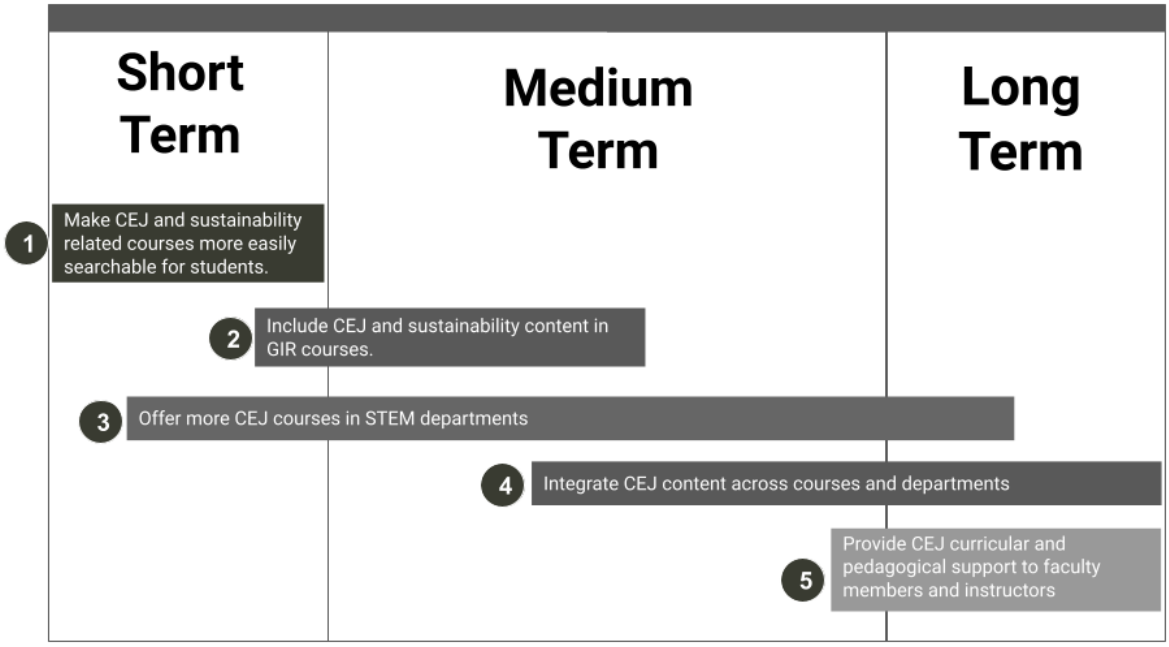

7 The Climate Justice Instructional Toolkit

Stemming from the recommendations for providing curricular and pedagogical support, the Environmental Solutions Initiative (ESI) at MIT has begun a project entitled The Climate Justice Instructional Toolkit (referred to as the Toolkit). The Toolkit (supported by the Alumni Class Funds Grant) will provide CEJ pedagogical resources, adaptable teaching modules, and instructional aids that can serve as supportive tools to enhance professor and instructor teaching content and approaches across Departments, Labs and Centers (DLCs) at MIT. More specifically, it includes a collection of foundational climate justice modules with instructor guides, a collection of research and guidance for climate justice instruction, data sets, and resources for students.

Currently, we have created a set of foundational modules which consist of: *An Introduction to Climate Justice, Climate Justice Policy, Global Climate Justice, Indigenous Climate Action, Climate Justice and Emotions, The Just Transition, and Mapping Environmental Justice*. We also have built more discipline-specific modules, such as Engineering Climate Justice and Climate Justice for Inclusive STEM Research and Communication, and we plan to create more of these. Each module comes complete with learning objectives, broader introductions to the topics (with instructor notes), student centered activities (such as discussion questions, debates, and group presentations), and case studies revolving around longer-form academic articles, as well as MIT research projects and news stories.

At this point, six faculty members and instructors at MIT have begun to either implement aspects of the Toolkit into their courses (such as specific modules, slides, and activities), or have met with The ESI and reviewed the modules to provide feedback regarding their needs, and how they may integrate them into their teaching. After receiving feedback from these faculty members, we believe the the Toolkit could be used to:

- Find resources and generate ideas for teaching climate justice, regardless of the disciplinary context. Researchers illustrate that climate justice can be used as a foundational framework that can provide real-world, socially just, and inclusive context to infuse into scientific learning.[48,49] From this angle, it also could provide an important way to create a more inclusive classroom climate.
- Mix, match, and redesign slides, activities, or resources from the differing modules to build a personalized slide deck that matches their teaching context.
- Review research on climate and environmental justice instruction to gather ideas for learning objectives, student activities, or larger semester projects. This is especially important in the area of integrating community engagement or inclusive and anti-racist practices into the instructional process, as these approaches require longer-term experimentation and commitments.
- Flip the classroom, meaning instructors assign a module to their students to have them review a particular climate or environmental justice topic outside of class. Then, class time can be used for discussion and relate the topics to foundational disciplinary course content.
- Provide students with an opportunity to self study, or for graduate students and postdocs to run smaller courses during IAP and Summer Sessions.

We see the Toolkit as a long-term, evolving, and iterative project that will go through different versions as we gather data regarding its uptake and effectiveness within the classroom. Most importantly, the Toolkit is a way to start the conversation and provide examples and resources for integrating climate justice across disciplines. We also plan to use it as a key resource during climate justice education info sessions, workshops, and future communities of practice for both instructors and students.

To access the Toolkit please use the link in the footnotes below.[50] If you would like to provide feedback or contribute to the Toolkit, please contact the project lead Chris Rabe.[51]

8 Limitations and Future Research

[48] Doucette, S.R., Shaver, I., Morrison, D., & Price, H. (2023). Teaching STEM through Climate Justice and Civic Engagement. SECEIJ. https://new.seceij.net/articletype/teaching-and-learning/teaching-stem-through-climate-justice-and-civic-engagement/.
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[51] https://environmentalsolutions.mit.edu/people/chris-rabe/

This research was initiated as a part of MIT's course titled *D-Lab: Water, Climate Change, Health*. Going forward, the ESI team might build on the groundwork laid by this research by doing one or more of the following:

1. Continue to validate the findings of this research study:
    a. Complete the analysis of CEJ content within all departments and provide a comparison across STEM and non-STEM departments.
    b. Cross-verify with department heads regarding the data mapped and verify the accuracy of these findings, since the methodology used for this analysis (by reviewing course catalog descriptions) has limitations in its reliability and accuracy.
    c. Strengthen this analysis by conducting an empirical study on CEJ teaching and education at MIT in particular, and how it impacts students experiences and learning.
2. Disseminate findings of this research across the university:
    a. Communicate the value of CEJ across departments and identify faculty who might be interested in this topic across departments and collaborate with them by building a community of "academic leaders for CEJ."
    b. Hold events with faculty members and instructors teaching CEJ to showcase where and how this teaching is implemented, and its potential impact on student learning and experiences.
3. Contribute towards developing the knowledge resources for implementation of recommendations proposed above:
    a. Conduct a survey to analyze the needs of faculty and students in addressing the gap in CEJ education in each of their departments, especially within STEM, including if and how an educational toolkit might be helpful in this regard.
    b. Based on these insights, create resources and training for faculty to address the gap and integrate CEJ content into STEM education at MIT. Iterate new resources and modules of the Toolkit based on findings of its uptake and effectiveness, and plan for on-going workshops and other events for faculty, instructors and students to gain new insight on CEJ education.

9 Conclusion

The primary goal of this paper was to conduct preliminary research to understand the quantity of CEJ content knowledge within STEM disciplines at MIT. Overall, we found that there is a vital need to integrate more CEJ content within STEM as the best performing department, Chemical Engineering, only contained CEJ content between 6% and 9.5% of its courses. In addition, we sought to explain why and how CEJ education represents a critical tool to better include BIPOC students, and content that more directly addresses how the world's most vulnerable groups are inequitably impacted by climate change. Part of this discussion relates to the role that CEJ education may play in centering notions of justice, equity, and social identity

within the process of technological design and implementation, especially as it pertains to course content and instructional approaches. To begin to better understand and expand CEJ education at MIT, ESI has launched The Climate Justice Instructional Toolkit to provide adaptable modules and other resources for teaching and learning CEJ. This is one part of a multi-pronged, long-term strategy for integrating CEJ content across disciplines both at MIT and within other institutions of higher education.

10 Additional References

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11 Appendix

Sample One-Pager on integrating Environmental and Climate Justice Content within courses offered by the Civil and Environmental Engineering Department

How is CEJ relevant to civil engineers?
Civil engineers design and implement infrastructure and systems that impact the environment and communities that access the built infrastructure and affected environment. Thus, it is critical for CEE students to understand the environmental and equity implications of their work and how the burdens and benefits of the infrastructure are unevenly distributed across different communities.

In what areas can CEJ content be integrated into civil and environmental engineering curriculum for students? What includes critical CEJ-related knowledge that should be learnt by CEE students?

1. Infrastructure design and construction: Exposure to sustainability principles for construction and design of large infrastructure projects
2. Access to infrastructure: Equip students to incorporate issues of environmental justice in infrastructure projects while keeping in mind issues of access for marginalized groups (eg: sustainable water management systems for clean and safe water for all communities; sustainable transportation that is mindful of access, affordability, and travel needs of underrepresented groups; avenues for clean and affordable energy for all, etc)
3. Just processes and participatory design: CEE students must be familiar with the need and processes to engage communities through public participation in order to identify and address environmental justice concerns related to their infrastructure projects
4. Environmental impact assessment: Potentially mandatory course/topic to help CEE students identify the potential impacts of their projects on communities, along with tools to mitigate issues of injustice or inequity that might emerge for marginalized groups as a result of their projects
5. Hazardous environments: CEE students must be mindful of issues related to waste management and hazard disposals, including those who are being impacted negatively and how the same can be minimized and sustainable systems that prioritize CEJ can be developed
6. Land use and environmental law: CEE need to be familiar with CEJ concerns of land development, zoning, and environmental law and how their work and actions can influence and be influenced by the same
7. Disaster resilience: Historically marginalized groups are typically most affected by natural and man-made disasters -- thus, CEE students can learn about the design and

management of disaster-resilient infrastructure and systems that prioritize the needs of all communities

What avenues exist for integrating CEJ content in existing courses?
Depending on the course of interest, professors can integrate CEJ content in their curriculum by bringing in guest speakers, case studies and datasets highlighting environmental inequities, and impact evaluation tools of CEE projects.