Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #48083

Engineering for One Planet Sustainable Engineering Leadership Microcredential through General Education Credits with Maritime Targets

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Background

This paper details the first stages of a pilot project to generate meaningful student experiences within the general education experiences of students at a maritime-focused institution. The primary goal of this effort is to create engineers who are trained to see their non-major courses as both meaningful and impactful for their careers while learning how to mentor others. This will be accomplished by collaboratively developing a series of courses offered outside of the engineering departments to look at engineering issues from a non-technical perspective. This paper focuses on the first series of courses: sustainability – both as an environmental principle and as a philosophy for social responsibility.

This course sequence will be developed in part by utilizing strategies from the Engineering for One Planet initiative to discuss how all engineers can bring sustainable principles into their work, such as how engineering decisions and actions can unintentionally or disproportionately cause negative environmental consequences for communities that have historically been marginalized or negatively impacted [1]. However, instead of solely attempting to address this from an engineering perspective, this work leans on the campus experts in these difficult conversations: the LAS faculty. Students can be presented with the technical aspects of a problem like coastal run-off or environmental regulations by an engineer and then be guided through the background context and implications by a historian or philosopher. This has the potential to improve the students' understanding of the material as students typically perform at a higher level when they find the material more interesting [2]. At the same time, this can limit the drain on already stretched instructors working with unmotivated students.

The literature frequently demonstrates that student interest has significant impact on their learning [3] [4] [5] [6] [7]. A student's perceived learning is directly related to student interest in the material, meaning instructional methods to get students involved can lead to higher outcomes [3]. Examples to increase this interest include utilizing contexts evoking prior individual interest and showing or enhancing utility value [4]. This can be especially true with underrepresented minority students as a connection to altruistic value and connections to ways to help one's community can supplement existing academic interests [5]. This effort seeks to highlight those connections to existing interests and provide context on how engineering can be used within local communities through analyzing sustainable concepts.

Students often feel their general education courses serve no purpose for them and are "demanding, dull, and unavoidable" [8]. One study from the University of Oklahoma's Psychology Department indicated only 7% of students surveyed (n=902) said they would take General Education courses over courses related to their major despite 70% (n=901) agreeing with the statement that "the main purpose of General Education courses is to help students become more well-rounded individuals and responsible citizens" [9]. This is a significant disconnect between educators believing these courses will make them better practitioners after graduation and students believing only their discipline-specific skills matter.

This was especially true at SUNY Maritime College because, until recently, our general education program required four specific courses that followed the traditional western hemisphere focus and included no electives. Colloquially, the students referred to them as "History of Dead White Guys 1 and 2" and "Literature of Dead White Guys 1 and 2". A change by the college's accrediting-body upended this system and allowed the campus to diversify its offerings. This was seen as an opportunity to develop courses that could appeal to the students' interests and equip them to be better engineers at the same time. The other departments were extremely receptive to these proposals as, among other benefits, it potentially means students in their classes would be more engaged with the material.

The faculty at SUNY Maritime College have historically chosen to silo themselves within their disciplines, seeing any curricular comments by other departments as an invasion of their space. This defensive reaction is believed to stem from the inherent dichotomy between the Deck and Engine officers on commercial vessels. As the core mission of the college is to generate those officers, that separation has permeated the faculty and student psyche for some time. There is also a legacy of in-fighting from when the school's enrollment plummeted to 1/3 of its current level. The effort this paper discusses was intentionally targeted towards interdisciplinary topics specifically to begin to address this siloing effect and encourage collaboration.

Like any new programmatic offering, this will take significant time to fully implement. The first cohort in the microcredential would start in AY 2024-25 and would finish a final capstone in for AY 2026-27. The results of initial interest, enrollment, and student surveys will be presented in this paper to measure the potential to develop and expand this effort. Discussions on future work to generate a maritime-focused microcredential with courses such as "Literature of the Sea" and "Sea Shanties and Work Songs" will also be addressed.

Structure

The microcredential sequence requires the completion of four Gen Ed electives followed by a capstone course. The Gen Ed courses are Environmental Literature, Sustainable Ethics by Design, History of the US Environmental Movement, and Economics of Sustainability. The capstone course will be Capstone in Engineering Leadership.

The Environmental Literature course will be scheduled to be offered to students in their second semester. It will be focused on satisfying Diversity: Equity, Inclusion, and Social Justice general education requirements required by our governing body. This course will utilize scientific analysis to review how different communities have been impacted by engineering decisions. This course will be co-taught by professors within both the Humanities and Science departments. The Science faculty will show data describing how human-driven decisions have led to effects like sea level rise, more intense heat waves, and childhood lead exposure that disproportionately impacted marginalized communities. The Humanities faculty will then work with students to read, analyze, and discuss texts written by members of these communities or written about these communities to gain a deeper understanding of the impacts. The goal of this course will be for students to see their future engineering work in a broader societal context.

The Sustainable Ethics by Design course will be offered during the sophomore year to satisfy a Humanities general education requirement. It will introduce philosophical lenses and their application to real-world scenarios. Case-study evaluations of engineering choices will be utilized to discuss situations where solutions are ambiguous. An example would be discussing the use of male-representing and female-representing crash test dummies. In short, female drivers are more 73% more likely to be injured and 17% more likely to be killed in an accident than a male driver, but male drivers were involved in 75% of fatal crashes. Cars could be designed to provide equal protection for female and male drivers, but this may result in an overall increase in fatalities than tailoring vehicles to male drivers. This is a real-world engineering design problem with significant moral and ethical implications that students could consider with philosophical perspectives. The goal of this course would be for students to see engineering decision making as nuanced and often without a single clear solution.

The History of the US Environmental Movement course will also be offered during the sophomore year, but on an alternating schedule with Sustainable Ethics by Design. It will satisfy a general education requirement for US History and Civic Engagement. This will review environmentalism in the United States with a significant focus on legislative issues and regulations that inform and dictate engineering practice. National regulations built from regional issues such as Three Mile Island's nuclear incident and the Love Canal superfund site will serve as discussion points for how modern engineering has been dictated by these historical events. The goal of this course would be for students to see how external pressures dictate engineering practice as well as consider how their future engineering work could lead to similar problems.

The Economics of Sustainability course will be offered in the first semester of the junior year and will satisfy a Social Sciences general education requirement similar to micro- or macroeconomics. It will introduce these business concepts as tools to evaluate engineering decisions regarding sustainability. This will include issues such as climate change, energy policy, and recycling/reuse of materials. A critical examination of the business case for sustainability alongside firm policy will form the conclusion of the course. The goal of this course will be for students to begin to reconcile the aspirations of engineering sustainability with the realities of financial decision making outside of an academic environment.

The Capstone in Engineering Leadership course will be offered annually to satisfy an engineering or technical elective within the engineering degree programs. This course will introduce principles of management and guidance of engineering design teams. Students will be able to apply these skills through mentoring student design teams in the first-year design experience at the college or through mentoring pre-college engineering design teams at a local Career and Technical Education (CTE) school. While mentoring the teams, the capstone students will introduce sustainable concepts to the teams and lead them into ways to incorporate these concepts into their designs.

Implementation

While several groups on campus expressed initial interest in the idea, external funding was necessary as seed money to provide breathing room for faculty to develop these new courses. To emphasize our commitment to the program and to ensure the other faculty felt this would be a collaborative effort, the School of Engineering sought out and secured funding through the

ASEE-EOP MGP, a Mini-Grant Program offered in collaboration between ASEE and the Engineering One Planet initiative with the Lemelson Foundation.

These courses were initially developed during Summer and Fall 2024 with the first course – Environmental Literature – offered in Spring 2025. The Sustainable Ethics by Design course is being offered in Fall 2025 with the History of the US Environmental Movement going to the campus curriculum committee so it can be offered in Spring 2026. The Economics of Sustainability course will be developed over the next calendar year as this is the weakest area for campus.

The Capstone in Engineering Leadership course will be offered on a trial basis in Fall 2025 in conjunction with the instructor for the first-year experience course.

Initial Findings

The results to date of the project are promising on several fronts: cross-campus collaboration, faculty development, student interest, and follow-on support. Baseline data has been collected regarding student responses to 5 Likert questions and 3 free response questions but is unavailable as of the final paper deadline due to data management issues converting handwritten responses. This data will be compiled and posted online by the ASEE Annual Conference in June 2025. As SUNY Maritime College's academic year finishes late, a comparison of entry and exit survey data cannot be completed by the original submission of the paper, however it will be posted online by the ASEE Annual Conference in June 2025. This data will be posted publicly at the following link: ASEE 2025 Paper Data (https://bit.ly/3Z0bQyi).

The Likert questions with responses ranging from Strongly Agree to Strongly Disagree are:

1. I am familiar with the concept of "sustainability"
2. I could apply sustainability to solutions to environmental issues like climate change
3. I can talk about how environmental issues affect groups of people differently
4. I expect to apply principles of sustainability in my job after graduating from SUNY Maritime College
5. I can describe how an environmental issue affects my community

The free response questions are

1. How, in your own words, do societal factors, like race, class, and gender affect group identity?
2. How, in your own words, do factors like race, class, and gender continue to shape power dynamics?
3. How, in your own words, do social justice actions affect power dynamics shaped by race, class, and gender?

As mentioned, SUNY Maritime College faculty are extremely isolationist and protective. It was anticipated that these conversations would be rebuffed quickly. However, many of the faculty in different departments were eager to be involved. A common refrain was "this is worth doing". The largest concern for the faculty was compensation rather than protection of their own

programs. Several other programs have expressed interest in similar initiatives with the Marine Environmental Science major looking to create their own microcredential utilizing the same four General Education courses along with their own capstone.

To ensure the program itself is sustainable, the faculty working on the General Education courses were encouraged to develop an option towards an upper-division elective within their own discipline. For example, the History of the US Environmental Movement course is solely focused on US perspectives. The instructor for the course is working to develop a second course that considers a global perspective. This allows faculty to effectively double dip, generating two courses that will count towards their tenure and promotion metrics, one of which is in their major.

Student interest in the program is initially strong. The initial course offering is fully enrolled with 24 students and the number of engineers in the class generally reflects our student body (30.4% of class, 34.3% of student body). Unsurprisingly, there is an overrepresentation of Marine Environmental Science students in the class. Self-reported data on student perceptions of sustainability before and after the class will be included in the full paper.

Follow-on support for the program has begun to be secured. Grants are being pursued for additional course development and implementation; however, a grant has been secured through the Office of Naval Research for a three-year trial offering of the Capstone course that will include a local maritime Career and Technical Education (CTE) high school as the mentees.

Future Work

The program will be assessed by reviewing student responses to the self-reported data from the students in the initial class and enrollment in the follow-on courses scheduled for the Fall semester. Questions on self-reflections will include assessments of their views on sustainability, their views on how sustainability works within their future careers, and whether they are more or less likely to continue within their major. This information will be used to evaluate whether the course is effective and determine whether it can be successfully implemented as a tool towards student retention.

If the program is successful and it appears to be useful for retention, other microcredentials are planned, including a focus on the local metro area, on the maritime industry, and on social responsibility as an applied DEISJ sequence. Initial curricula here have been sketched out with four Gen Ed courses in each focus area drawn from History, Humanities, DEISJ, and the Arts. As an example, the maritime industry microcredential will include Literature of the Sea (Humanities), Sea Shanties and Work Songs (the Arts), US Maritime History (History), and Oceanic Migrations (DEISJ).

When the Capstone course is fully developed and students from the first-year engineering course are the mentees, the performance of the first-year design teams can also be evaluated to assess the effectiveness of the student mentors.

Conclusion

This paper has outlined the initial stages of a microcredential providing exposure to sustainability principles for engineering students through their General Education courses. This effort has received significant internal and external support and has shown promising results. Continued efforts in this area are expected to generate engineers more cognizant of external factors in their engineering and increase student satisfaction with their General Education courses.

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