Advancement of WPI's Sustainability Engagement and Education

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Interactive Qualifying Project Submitted to:

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Abstract

The purpose of this project was to identify and develop a solution that will address the lack of engagement in sustainability at WPI. Our research included assessing sustainability engagement initiatives at other universities, reading academic journals regarding student engagement, interviewing individuals from WPI and other universities, and conducting student surveys. We analyzed this information and determined that implementing more service-learning at WPI is the most impactful method of encouraging student engagement and changing the mindset of sustainability.

Executive Summary

Our IQP analyzed student engagement in sustainability at Worcester Polytechnic Institute (WPI). Through comparisons to other universities, we conclude that there are opportunities to improve WPI's student engagement in sustainability, including further development of service-learning initiatives at WPI. As the world demands more sustainable solutions, engineers must consider their impact on the environment at all stages of their personal and professional lives. Since most WPI students study engineering and other technical disciplines, WPI graduates have the potential to greatly influence sustainable considerations in problem solving.

Unfortunately, many undergraduate students at WPI are not involved in sustainability-related practices and do not have a fully developed knowledge of sustainability and their impact on the earth. To address this lack of awareness, we analyzed the feasibility of implementing a sustainability engineering major at WPI. Through the Sustainability Engineering major, we expected the curriculum to not only teach students about sustainability concepts, but also to increase awareness in sustainable topics for all students on campus.

After analyzing the initial results of the proposal to develop a Sustainability Engineering major, we learned that we could not sufficiently address awareness of sustainability through one simple solution. Several faculty and staff members that we interviewed did not express a significant interest in implementing a Sustainability Engineering major, since the demand for the major was not yet established. From this, we realized that simply teaching students about sustainable problem solving will not ensure that they will consider sustainable practices throughout their personal and professional lives. Student engagement in sustainability is a multidimensional concept that must be addressed with a change of mindset in each student. Therefore, we decided to redefine our project goal.

We recognize that while WPI may be able to increase the amount of sustainable material taught in courses, adding more requirements to an already-busy WPI student's curriculum will not address engagement in sustainability. Our new project direction focused on increasing sustainability engagement through a method of changing student mindsets. We found that the most impactful method of increasing sustainability engagement is through the implementation of more service-learning at WPI.

Service-learning has been known to increase student's civic engagement in their communities and positively affect learning more than the traditional lecture setting. Service-learning has also been academically linked to WPI's goals in Community Engagement, as defined in the 2012 Sustainability Plan.

Through our results, we conclude that WPI would be ready to implement service-learning into its pre-existing courses. Service-learning would likely not require any additional courses or faculty, and it aligns with WPI's sustainability goals, mission, and motto of "Theory and Practice." Our plan of implementation involves working with the Morgan Teaching & Learning Center at WPI to teach faculty how to implement service-learning opportunities in their classes. With the implementation of our project, we hope that service-learning will address engagement in sustainability through a change of mindset in WPI students.

Acknowledgments

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Chapter 1: Introduction

As climate change, overpopulation, and resource scarcity become more prevalent, awareness and knowledge of sustainability will become increasingly necessary. Humans, especially engineers, must consider their impact on the environment at all stages of their personal and professional lives. Sustainable practices can be seen at almost every institution. Universities are constantly developing sustainable initiatives, including green certified buildings, solar panel farms, and sustainability-inclusive academic curricula. However, some students are more engaged in these types of sustainable practices than others.

Student engagement is defined as the "participation in educationally effective practices, both inside and outside the classroom, which leads to a range of measurable outcomes [30]." Some universities in the United States have been successful in engaging their student body in sustainable practices. Meanwhile, many institutions, including Worcester Polytechnic Institute (WPI,) report that community engagement in sustainability is still a work in progress.

For example, from 2013 to 2016, WPI has participated in the nationwide Recyclemania competition to monitor their amount of recycled material in comparison to the amount of waste produced. In the 2015 Recyclemania event, WPI ranked in the lower 50th percentile of all participating institutions. The low scores for Recyclemania and comparable assessments have been hypothesized to be a result of a lack of awareness and a lack of personal responsibility in sustainability among students, faculty, and administration.

WPI's lack of student engagement in sustainability can also be seen in the AASHE STARS ratings. In spring 2015, WPI received a score of 15.15/20.00 in the Campus Engagement category, while other comparable universities received higher scores and sometimes perfect scores. Therefore, we have identified an opportunity for improvement in the sustainability engagement at WPI.

Elizabeth Tomaszewski, Associate Director of Sustainability at WPI, believes that a lack of communication and outreach to students could be contributing to the overall lack of awareness in sustainability. Therefore, student engagement in sustainable active practice, advocacy, and education at WPI are not meeting the expectations of future engineers. To address this problem, our IQP team aims to find and develop an implementation plan for better engaging students at WPI to be more interested in sustainability.

Project Goal

The purpose of our IQP was to identify and develop a solution that addresses the lack of engagement in sustainability at WPI. Our research was based on assessing sustainability engagement initiatives at other universities, reading academic journals that discuss student engagement, interviewing individuals from and outside WPI, and conducting student surveys. We analyzed this information and established the best method of engaging students in sustainability-related practices at WPI.

Chapter 2: Background

Introduction

In this section, we provide a background on sustainability engagement at Worcester Polytechnic Institute (WPI) and research into the connections between learning, advocacy, and active practices in sustainability. This chapter gives background information on the following topics:

- Defining Sustainability
- AASHE Ratings
- Engagement and Service-Learning
- Sustainability Education
- Sustainability Advocacy
- Sustainability Active Practice

2.1 Defining Sustainability

In 1987, the United Nations Commission on Environment and Development released a report called "Our Common Future." This report first defined the concept of "sustainable development." According to the report, sustainable development is defined as "development that meets the needs of the present without compromising the ability of the future to meet its needs [11]."

While "sustainable development" was defined in "Our Common Future," the definition of "sustainability" is not universal for all groups and individuals. Different definitions of sustainability have led to different guiding principles for institutions around the world [13]. The University of Vermont (UVM) acknowledges sustainability as "a big idea ...that looks different to different people and from different vantage points." UVM's definition follows the "sustainable development" definition from the United Nations Commission on Environment and Development [47], but the definitions vary at other colleges.

For example, Dr. Christopher Boone, Dean of the School of Sustainability at Arizona State University, said sustainability is "improving human well-being and ensuring social equity for present and future generations while safeguarding the planet's life-supporting ecosystems [4]." The University of Massachusetts Amherst models Sustainability after John Elkington's Triple Bottom Line: an awareness of and accountability for impacts on people, planet, and profit. The Triple Bottom Line has been restated as the Three E's of Sustainability: Equity, Environment, and Economics [49].

WPI has developed its own definition of sustainability. The WPI definition focuses on the combination of the following three guiding principles [79]:

- "Ecological stewardship embodies the principle that human activities must respect the need to preserve our natural world"
- "Economic security represents the understanding that all members of society deserve access to the means to support themselves and their families"
- "Social Justice represents our belief that respect for the dignity of every human being leads to the assurance of equitable rights and opportunities for everyone"

These guiding principles assert that environmental quality, economic opportunities, and social conditions must guide specific actions at WPI. Three actions relevant to our project are: "student learning, research, and scholarship," "the promotion of literacy and responsibility in sustainability throughout the entire WPI community," and "cooperative work with institutions and governments to advance sustainability in the Worcester community and beyond." A full list of the specific actions are listed on page five of the Sustainability Plan [79].

2.2 AASHE Ratings

The Association for the Advancement of Sustainability in Higher Education (AASHE) is a non-profit organization that provides the Sustainability Tracking Assessment and Rating System (STARS) program for use in measuring the sustainability performances of universities across the world. Liaisons from WPI and 754 other universities have self-reported criteria in five categories (Academics, Engagement, Operations, Planning, and Administration). These five categories allow administration to self-assess their own sustainability efforts in reference to other universities and provide suggestions for constant improvement in sustainability [45].

The STARS assessments for Academics and Engagement consider topics from degrees in sustainability related fields to guidelines for sustainable projects. Operations assessment addresses the efficiency of the institution with energy use and materials. The Planning and Administration evaluations focus on the quality of the individual implementation plans to improve campus sustainability [45].

2.2.1 The STARS Rating of WPI

STARS ratings are determined based on the cumulative STARS scores of the university. The overall STARS score is percentage-based and addresses a set of required assessment criteria for each of the five categories. Since the evaluations are self-reported, liaisons are able to mark evaluation criteria in any of the five categories as "Not Pursued" or "Not Applicable." A university will not be scored and rated based on "Not Applicable" criteria, but all "Not Pursued" criteria will result in a score of zero for that area [45]. Participating universities may receive a rating of Bronze, Silver, Gold, or Platinum. These ratings are determined by the minimum scores presented in Figure 2.1.

STARS Rating	Minimum Score Required
Bronze	25
Silver	45
Gold	65
Platinum	85

Figure 2.1: Scoring Criteria for STARS Ratings [45]

As of April 2015, WPI was ranked a Silver institution with an overall score of 56.9 on the STARS program [46]. Since there are 92 schools worldwide that have acquired Gold standard level and one that has achieved Platinum level [45], there is room for improvement for WPI in many of the areas addressed in the STARS program.

AASHE also highlights approximately ten institutions worldwide each year to detail their sustainability programs. Recognizing successful sustainability initiatives provides ideas and incentives to other universities for improving their own sustainability programs. AASHE creates a collaborative environment by providing president's letters and liaison contact information for each university [45].

2.2.1.1 Academics and Engagement Ratings

The STARS categories of Academics and Engagement assess how colleges educate future scholars, workers, and professionals, and engage these individuals through co-curricular activities. The Academics category is divided into two separate subcategories: Curriculum and Research.

AASHE assesses the Curriculum subcategory through an "evaluation of courses covering sustainability issues to help equip students to lead society to a sustainable future [6]." In order to document these courses, WPI developed an official "Sustainability Course Inventory" to detail and categorize every course that relates to sustainability [46]. The Research subcategory for Academics assesses the quality of "an institution's sustainability research [6]."

Table 2.1 below displays the Academics scores of WPI on the 2015 STARS assessment compared to the total possible scores awarded by AASHE. The scores shaded in green are areas where WPI receives a perfect score, and the scores shaded in red are areas where WPI has the opportunity to improve its STARS score.

Table 2.1: WPI Academics Scores

		WPI's Score	Total Possible Score
Academics	**Curriculum Total**	10	14
	Academic Courses	4.6	8
	Learning Outcomes	3	3
	Undergraduate Program	3	3
	Graduate Program	3	3
	Immersive Experience	2	2
	Sustainability Literacy Assessment	0	4
	Incentives for Developing Courses	0	2
	Campus as a Living Laboratory	4	4
	Research Total	14	18
	Academic Research	12	12
	Support for Research	2	4
	Access to Research	0	2

The Engagement category is divided into Campus Engagement and Public Engagement subsections. The Campus Engagement subsection "seeks to recognize institutions that provide their students with sustainability learning experiences outside the formal curriculum [6]." The STARS Technical Manual suggests that universities report numbers for student participation in sustainability-related clubs and provide opportunities to expand knowledge in sustainable topics. The Public Engagement subcategory seeks to recognize institutions that help catalyze sustainable communities through advocation of public policy, community partnerships, and service [6].

Table 2.2 below displays the STARS scores of Engagement for WPI against the total possible scores. The scores shaded in green are areas where WPI is awarded a perfect score, and the scores shaded in red are areas that need improvement.

Table 2.2: WPI Engagement Scores

		WPI's Score	Total Possible Score
Engagement	**Campus Engagement Total**	15	20
	Student Educators Program	2.8	4
	Student Orientation	1.4	2
	Student Life	2	2
	Outreach Material and Publications	2	2
	Outreach Campaign	4	4
	Employee Educators Program	3	3
	Employee Orientation	0	1
	Staff Professional Development	0	2
	Public Engagement Total	10.5	21
	Community Partnerships	3	3
	Inter-Campus Collaboration	2	2
	Continuing Education	0	5
	Community Service	3.5	5
	Community Stakeholder Engagement	2	2
	Participation in Public Policy	0	2
	Trademark Licensing	0	2

2.3 Engagement and Service-Learning

George D. Kuh, Director of the National Institute for Learning Outcomes Assessment, defines student engagement for universities as "participation in educationally effective practices, both inside and outside the classroom, which leads to a range of measurable outcomes [29]." Students can engage by enrolling in school sponsored clubs, developing initiatives, or participating in service activities.

Student engagement has been known to produce positive benefits such as increased "awareness of the world, better faculty relations, and higher knowledge-retention rates [7]." Sustainability-engaged students are also able to enhance and reform their institution's sustainability goals by assisting faculty and administration [12].

2.3.1 WPI's Sustainability Plan

Engagement is one of the four main sustainability goals of WPI. The WPI Sustainability Plan details the methods and measures of these four goals: Academics, Campus Operations, Research, and Community Engagement. Appendix B displays the objective/task charts of Academics and Community Engagement [79].

The 2012 WPI Sustainability Plan was written by WPI's Task Force on Sustainability. The Sustainability Plan provides leadership and coordination for enhancing the long-term sustainability of WPI. It also serves as a reference for the AASHE STARS liaison to assess the quality of WPI's sustainability goals [79].

The first goal of the Sustainability Plan identifies its academic goal in sustainability. WPI's goal is to allow all graduates to "leave campus with the understanding and abilities to develop sustainable solutions to the world's problems." WPI has made progress in implementing academic changes, from developing the "Sustainability Course Inventory" to redeveloping the curriculum to include new courses, projects, and majors [79].

The fourth goal of the Sustainability Plan, Community Engagement, addresses WPI's objectives and tasks in engaging the community in sustainability. Page 12 of the Sustainability Plan states that "community engagement that combines personal responsibility with civic engagement is critical to all three aspects of sustainability [79]." Addressing both personal responsibility and civic engagement will affect sustainability engagement at WPI.

2.3.2 Civic Engagement

According to the WPI Sustainability Plan, civic engagement and personal responsibility are the two major factors for engagement in sustainability [79]. Civic engagement in sustainability encourages the general public to participate in activities that increase sustainability at the community level. Professors Robert G. Bringle, Richard Games, and Reverend Edward A. Malloy from Indiana define civic engagement with four component focuses: Teaching, Community, Research, and Service [10]. Figure 2.2 below shows a Venn diagram of the component focuses of Civic Engagement.

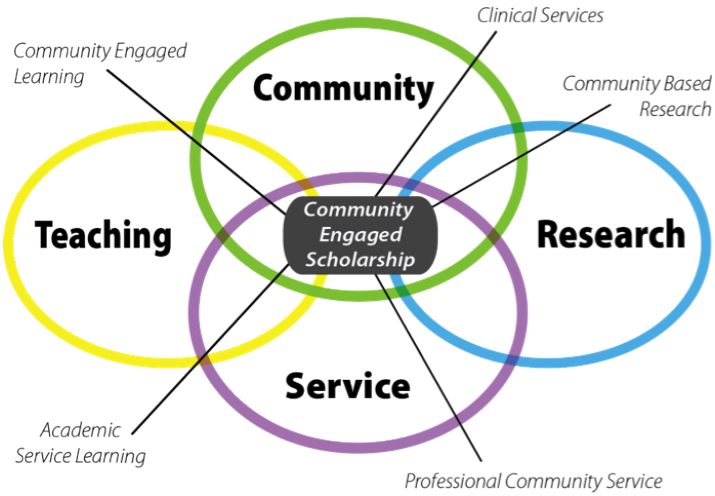

Figure 2.2: Venn Diagram for "Community Engaged Scholarship [56]"

2.3.3 Service-Learning

According to the developers of the Venn diagram for civic engagement, "Service learning provides the most important vehicle of community engagement because ... if one cannot measure and evaluate every aspect of civic engagement, then service learning is the most important critical indicator of a campus' civic engagement [10]."

Service-learning is a form of "experiential education [24]" that engages students in activities addressing human and community needs. Service-learning activities are designed to promote learning and development through a collaborative, cooperative, and problem-based education [41]. This type of education supports WPI's motto of "Theory and Practice [71]" because it allows students to apply knowledge by engaging in activities outside of the classroom.

Service-learning is different from volunteering and other service opportunities because it links service with course objectives and community interactions. Service-learning projects allow students to help the community as part of their degree program. Service-learning projects may include developing plans for enhancing local water systems or implementing local renewable energy sources to benefit the community [54].

Service-learning is a combination of academics and volunteerism that allows the student to learn critically while helping the campus and community. Student opportunities at WPI that most closely align with service-learning are the Major Qualifying Project, Interactive Qualifying Project, and Great Problems Seminar. While students at WPI have the opportunity to incorporate service-learning into these projects, it is not required [17, 83, 84].

2.3.4 Service-Learning Initiatives at Other Universities

In 2008, The University of Massachusetts Lowell (UMass Lowell) developed the Service Learning Integrated throughout the College of Engineering (SLICE) program. This program is the first engineering program to ever incorporate service-learning as the major focus [54].

The SLICE program received a three-year funding grant of one million dollars from the National Science Foundation to implement in UMass Lowell's Francis College of Engineering. SLICE integrated "service-learning projects into existing courses throughout the curriculum, so that every student in every engineering department is exposed to service-learning in every semester [52]." For example, in 2014, UMass Lowell's "Electronics II" course used learning topics of diodes and microelectronics to design a more power-efficient headlamp for people in remote regions of Peru [53].

The University of Vermont (UVM) implements a service-learning program that incorporates service-learning in 80 to 100 courses every year [60]. Some courses directly address sustainability issues on the UVM campus, including the *Campus Sustainability* class in the Environmental Studies department. This course engages students in sustainability analysis based on the annual STARS ratings for UVM [59].

Clark University in Worcester, MA also incorporates the "Sustainable Clark" service-learning program into their curriculum to drive their sustainable initiatives [15]. In addition to providing a central location to learn about sustainability projects, Clark also has a course dedicated to teaching students about sustainability. Clark's *The Sustainable University* course, explores "both the theory and practice of sustainability and sustainable development by examining the role of the university in promoting a sustainability transition [16]." The course allows students to work in team projects to directly influence the Clark University campus and the Worcester community as a whole.

2.4 Sustainability Curriculum

"With the pressure of rising population and declining resources, engineers will be called upon to design more eco-efficient systems and technologies [28]." Professional engineers will face challenges in the entire spectrum of sustainability [1] and will be required to evaluate and apply information from multiple disciplines, including economics, public policy, and environmental and social sciences [28].

In 2002, the United Nations identified the need to reform education to foster the concepts, skills, motivation, and commitment needed for sustainable development. The United Nations planned to link social, economic, political, and environmental concerns in education [28]. As a result, many universities have chosen to integrate sustainability principles into their curricula. Majors, minors, projects, and research opportunities have been implemented at WPI and other universities to develop societal values and knowledge in sustainability.

2.4.1 WPI's Approach to Sustainability in the Curriculum

The sustainability curriculum of WPI includes sustainability-related majors, courses, research opportunities, and project work. As of the 2015-2016 academic year, WPI offers undergraduate majors and minors in Environmental and Sustainability Studies (ESS) and Environmental Engineering (EVE). A graduate degree in EVE is also offered. Students who are not pursuing ESS or EVE as a major or minor have the opportunity to take sustainability-related electives and participate in sustainability-themed research and projects.

2.4.1.1 Environmental and Sustainability Studies

In 2014, WPI modified its Environmental Studies major to incorporate themes in sustainability, resulting in the Environmental and Sustainability Studies (ESS) program. The ESS program allows students to investigate the consequences of human life on environmental sustainability. As the mission statement describes in the excerpt below, the mission of the ESS major is to educate its graduates in human-environment interactions to meet the growing public demand for professionals with focuses in environmental sustainability.

> With a growing public demand for governments and the private sector to focus greater attention on the implications of human production and consumption for environmental sustainability, professionals educated in aspects of human-environment interactions will be in increasing demand. Through core courses, projects, and seminars focused on integration approaches to environmental issues, the environmental studies curriculum helps students to address contemporary environmental problems in creative ways that transcend disciplinary boundaries. This interdisciplinary approach also enables students to gain breadth and depth of knowledge in core disciplines such as biology, chemistry, philosophy, history and environmental law and policy.
>
> Graduates will have strong, marketable skills translatable into graduate school, law school, or a professional environmental position upon graduation [77].

Prior to developing the ESS program from the modified Environmental Studies program, no students graduated with an Environmental Studies degree in 2013 [74]. According to the 2014 and 2015 WPI Post-Graduate Reports, six students graduated with a Bachelor's degree in ESS between 2014 and 2015. Graduates with an ESS degree have double majored in chemistry and civil engineering and been employed at Yale University, Black and Veatch, and Bansfield Pet Hospital [75, 80].

2.4.1.2 Environmental Engineering

WPI offers both Bachelor's and Master's degrees in Environmental Engineering (EVE). According to the mission statement below, the undergraduate EVE program encourages students to experience the social science of engineering, health, and environmental preservation. It also prepares students to address environmental engineering problems with humanistic, economic, legal, and political considerations.

> Environmental engineers are challenged not only with mastering technical and scientific principles, but also understanding the broader context within which environmental solutions are implemented. The environmental engineering program encourages coursework in the humanistic and social aspects of engineering decisions, public health management, and environmental preservation. The projects program at WPI offers environmental engineering students a unique opportunity to explore the complex humanistic, economic, legal, and political issues surrounding environmental engineering problems.
>
> The Environmental Engineering degree program prepares students for careers in both the private and public sectors, consulting, industry, and advanced graduate study [77].

Between 2013 and 2015, 43 undergraduate and 36 graduate students have received degrees in Environmental Engineering [75]. Undergraduate students have double majored in chemical engineering and professional writing. EVE graduates have been employed at many different companies and federal agencies including Hannaford Supermarkets, General Electric, Tighe & Bond, and the New York State Department of Environmental Conservation [74, 75].

2.4.1.3 The Proposed Minor in Sustainability Engineering

Professor John Orr, Director of Sustainability and head of the Task Force on Sustainability at WPI, acts as the primary responsible party for all eight ongoing Community Engagement objectives in WPI's Sustainability Plan [79] The chart of objectives for Community Engagement in WPI's Sustainability Plan can be seen in Appendix B.

Professor Orr has developed and proposed a Sustainability Engineering minor for the 2017 academic year. With the minor, Professor Orr aims to benefit students who are interested in gaining knowledge and experience in sustainability as it relates to engineering. The minor requires six Sustainability Engineering-related courses (18 credit hours) and is designed to supplement the student's technical field of study. Professor Orr believes that the minor is more accommodating to students than a major because it avoids defining a Sustainability Engineering discipline and does not require new courses (interview summary in Appendix E.1). A draft for the minor can be found in Appendix F.

2.4.1.4 Sustainability Courses Offered

According to the 2015 WPI Sustainability Report, 76% of all departments at WPI offer at least one course that is relevant to sustainability [48]. Relevance in sustainability is categorized into Sustainability-Focused Courses and Sustainability-Inclusive Courses. The Association for the Advancement of Sustainability in Higher Education (AASHE) defines these two categories as follows [45]:

- Sustainability-Focused: "a course in which the primary and explicit focus is on sustainability and/or on understanding or solving one or more major sustainability challenge (e.g. the course contributes toward achieving principles outlined in the Earth Charter)."
- Sustainability-Inclusive: "A course that... is primarily focused on a topic other than sustainability, but incorporates a unit or module on sustainability or a sustainability challenge, includes one or more sustainability-focused activities, or integrates sustainability issues throughout the course."

The "WPI Sustainability Course Inventory" compiles all courses with relevance to sustainability into these two categories. For the 2015-2016 academic year, WPI offers 37 courses that focus on sustainability and 112 courses that include sustainability [78]. A full list of these courses, including sustainability classifications and course descriptions, is provided in Appendix G.

In addition to courses relevant to sustainability, WPI organizes three on-campus sustainability Project Centers where undergraduate students work together to complete Interactive Qualifying Projects (IQPs). The IQP is a "nine-credit-hour interdisciplinary requirement involving applied research that connects science or technology with social issues and human needs." The Energy Sustainability, Sustainable Food Systems, and Sustaining WPI Project Centers offer students opportunities to apply knowledge and skills toward solving sustainability problems at WPI [83]. WPI also allows students the opportunity to participate in the Worcester Community Project Center (WCPC) in downtown Worcester. The WCPC works with Worcester organizations to develop solutions to individual problems in the Worcester community. Students complete IQP projects with solutions that are "economically feasible, technically feasible, and socially acceptable," for the charitable, educational, and/or civic organizations in the city of Worcester [72].

WPI also offers the Great Problems Seminar (GPS) for first year students. GPS is a "two-course introduction to university-level research and project work that focuses on themes of current global importance [82]." Of the nine GPS courses offered as of the 2015-2016 academic year, five are focused in sustainability and one is inclusive. The six sustainability-relevant GPS courses are titled "Food Sustainability," "Livable Cities," "Biosphere, Atmosphere, and Human Fears," "Power the World," "The World's Water," and "Heal the World." Three GPS courses are not classified as being related to Sustainability in the WPI Sustainability Course Inventory: "Ignorance is not Bliss: Can Schools and Technology Help," "Recover, Reuse, and Recycle: Building a Lasting World," and "Culture, Technology, and Human Rights in the Developing World [78]."

2.4.2 Approaches to Sustainability in the Curricula of Other Universities

Other universities have developed and implemented sustainability-related programs. Programs may address sustainability concepts through different approaches, including technical skill, social study, and humanitarianism. These approaches are combined to develop a wide range of programs, including both undergraduate and graduate Art and Science degrees.

The first major in sustainability was developed in 2006 by Arizona State University. This major was a Bachelor of Science in Sustainability Studies [5]. Since then, other universities have differed in their approaches to develop their own sustainability majors.

Most sustainability degrees offered at other universities are Bachelor of Arts (B.A) or Master of Arts (M.A.) degrees. B.A. and M.A. degree programs in sustainability focus on teaching the concepts and methods of environmental economics, sociology, environmental policy, ethics, and design. Climate change, pollution, and impact on diversity are common undergraduate research topics [5, 19].

Some universities offer B.S. and M.S. degrees in sustainability. While Arts degree programs focus on the social science portion of sustainable solutions, Science degree programs focus more on the development of sustainable strategies using scientific concepts. These concepts may include hydrology, chemistry, and engineering [35].

The University of New Hampshire, Rochester Institute of Technology, Villanova University, Rensselaer Polytechnic Institute, University of Massachusetts Amherst, and Arizona State University are universities that have developed B.S. and M.S. majors in sustainability [5, 35, 37, 50, 55, 61]. A chart of these universities and their sustainability program types is available below in Table 2.3.

Table 2.3: Model Universities and their Sustainability Program Type

Model University	**Program Type**
University of New Hampshire	Dual Degree in Sustainability
Rochester Institute of Technology	Master of Science in Sustainable Engineering
Villanova University	Master of Science in Sustainability Studies
Rensselaer Polytechnic Institute	Bachelor of Science in Sustainability Studies
Arizona State University	Bachelor of Science in Sustainability Studies
University of Massachusetts Amherst	Master of Science in Sustainability Science

In addition to majors, many universities offer minors in sustainability. These universities include the University of Massachusetts Dartmouth, George Washington University, and Notre Dame [51, 25, 31]. Other universities such as Harvard provide students with the opportunity to earn sustainability certificates [26].

2.4.3 ABET Accreditation

WPI has pursued and achieved accreditation by the Accreditation Board for Engineering and Technology (ABET) in each of its undergraduate engineering majors [73]. Proposals for any new academic program in engineering at WPI must also consider the requirements of ABET. As of the 2015-2016 academic year, ABET has never accredited a program in Sustainability Engineering [43].

ABET specializes in the accreditation process of engineering, science, computing, and engineering technology programs at the Associate, Bachelor, and Master levels. ABET accreditation ensures employers that graduates of the accredited degree program have received the appropriate background for work in their field [44].

Accreditation by ABET requires a two-step process. First, programs must conduct a readiness review and produce a self-study document. The applicant must conduct an evaluation of the program objectives and outcomes to assess the curriculum. The reviewer will evaluate the consistency between the program and the mission of the institution. The applicant must also submit a written testimony on the qualifications of relevant faculty. Finally, the applicant must provide a full curriculum and a description of its relevance to the program objectives. This curriculum must include a full plan of study, a flowchart of the course offerings, and a description of the senior project requirements.

After this document is approved, an ABET team will provide an on-site assessment of the applicant's program. The representative will ensure that the document contains the correct information and all classrooms, labs, and faculty are accounted for. After this evaluation, ABET will either deny or accredit the program.

2.5 Sustainability Advocacy

According to the Merriam-Webster dictionary, advocacy is "the act or process of supporting a cause or proposal [62]." Advocacy in support of a cause involves becoming educated on a topic, volunteering, gathering volunteers, and promoting the topic to others. Public support for a cause includes gathering knowledge on the topic and gathering followers to establish a volunteer effort. Sustainability advocation on campus allows like-minded individuals to collaborate and educate others to raise awareness of sustainability.

2.5.1 Sustainability Advocacy at WPI

WPI has three student-run organizations that advocate sustainability. The Green Team, Students for a Just and Stable Future, and the Eco-Reps attempt to raise awareness for sustainability on campus. Since these organizations are student-run and are not associated with WPI administration, they are not representative of the institution and do not contribute to the STARS ratings for advocacy.

2.5.1.1 WPI Green Team

The WPI Green Team is a social activism club consisting of undergraduate students and a faculty advisor, Elizabeth Tomaszewski. The Green Team is dedicated to increasing sustainability on the WPI campus. Each year, the Green Team focuses on initiatives to raise awareness and take action to help the environment. The Green Team organizes annual events including the E-Waste Drive, building energy audit, and waste audit. They also hold "sustainable product" fairs throughout the year, including the Sustainable Car Show and the Lighting Fair. The Green Team manages and maintains the Bike Share program beginning in D-term 2016 [66].

2.5.1.2 Students for a Just and Stable Future

Students for a Just and Stable Future (SJSF) is a student-run organization at WPI that is based off a regional group of the same name. SJSF advocates for policy change in climate sustainability by gathering student signatures to present to the WPI administration. Students also join in nationwide protests against companies and policies to educate its members and raise awareness [69].

2.5.1.3 Eco-Reps

WPI has also developed an Eco-Rep program for student and faculty volunteer representatives. The program was brought to WPI by Associate Director of Sustainability Elizabeth Tomaszewski and combines the efforts of WPI, Clark University, and the College of the Holy Cross. The program attempts to better engage students in sustainability through peer education [65].

Volunteers must submit an application for the position of Eco-Rep. Candidates are selected based on their experience, organizational skills, and leadership. Once selected, the Eco-Reps are assigned an academic building or residence hall. Each Eco-Rep receives four hours of training in communication and implementation of sustainability campaigns. They typically focus on energy usage, recycling, and waste reduction. [46].

2.5.2 Sustainability Advocacy at Other Universities

In 2012, The University of Vermont advocated a policy to ban the sale of disposable water bottles [58]. The policy was spearheaded by a student-run nonprofit group called the Vermont Student Environmental Program (VSTEP). VSTEP promoted the policy and reduced the amount of plastic waste on campus as well as improve the health of students by lowering sugary drink consumption [57]. Institutions around the world have acclaimed student-run organizations that advocate for sustainable causes.

At Hampshire College, faculty, staff and students come together to form the Hampshire Environmental Committee. This committee is "an advisory body and action committee" that engages the community in environmental and sustainability issues, reporting "to the [Hampshire College] President and the community at large [18]." The Hampshire Environmental Committee also heads the Hampshire College "Sustainability Revolving Fund (SURF)" program to help fund campus improvement projects to increase campus sustainability at Hampshire College. The funding allows students complete projects that reduce "fossil fuel energy costs, waste disposal costs, or water use costs [18]."

2.6 Sustainability Active Practice

Active participation in an area of study has been linked to an increased retention of knowledge. In *The Study of Knowledge Retention and Increased Learning Through the Use of Performance Based Tasks*, Northern Illinois University Professors Rahn and Moraga conducted a study on two groups of students in the same classroom. The students were split up into a control group and an experimental group and administered the same test. The control group was given a performance-based task that was irrelevant to the material covered in the test, and the experimental group was given a task that covered a portion of the exam material. The study concluded that students who participated in a relevant task generally scored better and more consistently on traditional tests than the control students who performed irrelevant tasks [33].

At WPI there are several ways a student can become involved with sustainability. Sustainability clubs and events are organized by student-run initiatives and WPI's Task Force on Sustainability. The Task Force is led by Professor John Orr, Director of Sustainability, and Jeff Solomon, Executive Vice President and Chief Financial Officer in the Office of Finance and Operations. The Task Force is an organization of students and faculty members that "provide leadership and coordination for WPI's campus-wide efforts in... enhancing the long-term sustainability of WPI's activities and the environment of which we are a part [70]." Student involvement in sustainable active practice can be measured with the percentage of student attendance.

2.6.1 Recyclemania

The WPI Green Team hosts the annual Recyclemania event for WPI. Recyclemania is an eight week recycling competition between participating universities in the United States and Canada. Recyclemania promotes waste reduction on college campuses by comparing recycling and waste production by weight. Universities are ranked based on the amount of total recycling that they produce divided by the amount of total waste they produce in the eight week time period. WPI has ranked in the lower 30th percentile of all participating universities in 2012 through 2015 [67].

2.6.2 Waste Audit

The Green Team also hosts an annual Waste Audit to assess the total weight of recycling and waste for specific buildings on campus. The Waste Audit helps quantify the amount of material that is being disposed in recycling and trash bins. The Waste Audit identifies improperly disposed material and compile a report of its findings.

The Waste Audit calculates the "Recycling Rate" of a building by dividing the total weight of correctly recycled items by the total weight of waste and recycling and converting to a percentage. The Recycling Rate is compared to the "Potential Recycling Rate," calculated by adding both correctly and incorrectly recycled items by the total weight of waste and recycling combined. The Recycling Rates the four assessed buildings are shown in Table 2.4 below.

Table 2.4: WPI Building Recycle Rates 2014 [76]

Building	Recycling Rate	Potential Recycling Rate
Rubin Campus Center	20%	35%
Gordon Library	4%	40%
Daniels Hall	24%	50%
Morgan Hall	23%	39%

All the tested buildings poor Recycling Rates, and have significantly lower Recycling Rates than Potential Recycling Rates. For example, Gordon Library has a 4% Recycling Rate compared to the 40% Potential Recycling Rate.

2.6.3 Sustainability Club Participation

According to Ryan Cooney, president of the WPI Green Team, there are generally around 25 - 30 active members in the Green Team a year. Participation in Green Team events is usually low among both Green Team members and the campus community. For example, some sustainable annual events, including the Spring E-Waste Drive, have few members of the community attend and few Green Team members sign up to run the event. Other sustainability clubs on campus, including the Eco-Reps and Students for a Just and Stable Future, report a similar low attendance.

Summary

This chapter provided a background for engagement in sustainability, including information on sustainability programs, initiatives, practices, and the current state of sustainability engagement at WPI. We identify the need for a solution to the lack of engagement in sustainability at WPI and identified service-learning as a potential solution. We want build upon WPI's existing initiatives and the initiatives at other universities. In order to accomplish this goal, our team will interview WPI faculty members, individuals from our select model schools, and research other supplementary information. Our process is documented in Chapter 3: Methodology.

Chapter 3: Methodology

Introduction

The initial goal of this IQP was to analyze the feasibility of adopting a Bachelor of Science degree in Sustainability Engineering at WPI. To accomplish this initial goal, we evaluated the sustainability programs of comparable universities across the United States and determined the value of adopting similar aspects of these programs into the curriculum at WPI.

WPI's mission states that "the role of the university is to simultaneously advance knowledge regarding our world while educating future leaders of the world [79]." Our idealized major in Sustainability Engineering would align with this technologically innovative mission of WPI. To accomplish this goal, the team practiced the following two objectives:

- Determine the Need for Sustainability Engineering Education at WPI
- Develop Suggested Curriculum for Sustainability Engineering Professionals

After proceeding with these two objectives, we determined that our original solution was not feasible for our previously defined goal. We redefined our project goal and continued with the following four objectives:

- Revise Project Direction and Goal
- Identify the Problem
- Assess Existing Initiatives for Sustainability Engagement at WPI
- Research Improvements for Campus Engagement

3.1 Determine the Need for Sustainability Engineering Education at WPI

To determine the benefit of a Sustainability Engineering major at WPI, we assessed the need for a science-based degree program in sustainability. We interviewed and surveyed individuals to understand the details and effectiveness of the Environmental Engineering Bachelor of Science major, the Environmental and Sustainability Studies Bachelor of Arts major and the proposed minor in Sustainability Engineering.

3.1.1 Speak with Select WPI Faculty

To understand the history of sustainability education at WPI, we spoke to faculty members at WPI who have developed its sustainability programs. The most relevant sustainability programs to our project are the Environmental and Sustainability Studies (ESS) Bachelor of Arts degree and the proposed Sustainability Engineering minor. We held meetings with the founding directors of these programs to learn their intentions for the programs and plans to advance the programs. We also discussed their opinions on pursuing a Sustainability Engineering major at WPI.

We first spoke to WPI Professor John Orr, Director of Sustainability and co-head of the Task Force on Sustainability. We discussed the Sustainability Engineering minor proposed by Professor Orr in detail. We requested information on the difference between a minor and a major in Sustainability Engineering and asked him to provide insight on the process of developing a new major at WPI.

We also spoke to Professor Robert Krueger, founding director of WPI's Environmental and Sustainability Studies (ESS) program. We discussed his intentions with developing the ESS major and the feasibility, benefit, and potential limitations of developing a new major in Sustainability Engineering.

3.1.2 Interview Individuals at Other Universities

To maximize the benefit of our proposed Sustainability Engineering major, we studied the sustainability programs of four comparable universities: Arizona State University (ASU), Rochester Institute of Technology (RIT), The University of Massachusetts Amherst (UMass Amherst), and The University of Vermont (UVM). These universities were selected because their sustainability degree programs are similar to the Sustainability Engineering program we intended to propose. We contacted the directors of these programs and scheduled interviews. Table 3.1 below shows the sustainability degrees and contacts for these universities.

Table 3.1: Table of Model Universities

University	Degree	Contact	Title
ASU	BA, BS, MA, MS, & Ph.D in Sustainability	Christopher Boone	Dean of the School of Sustainability
RIT	MS in Sustainable Engineering	Brian Thorn	Sustainable Engineering Program Director
UMass Amherst	MS in Sustainability Science	Darci Maresca	Program Manager of Environmental and Sustainability Program
UVM	MS in Leadership for Sustainability	Tom Wilson	Program Coordinator of the Community-University Partnership

We interviewed these contacts to gain information on their respective sustainability programs. We also requested insight on our project's scope, goals, and feasibility. A full set of interview questions for faculty at other universities is provided in Appendix C. The summaries of the interviews can be found in Appendix E.

3.1.3 Survey a Sample of WPI Students

In order to assess the need for a modified Sustainability Engineering curriculum, we had to first understand the opinions, interest, and knowledge of sustainability among students at WPI. This was done through a short survey (results in Appendix J).

We developed the survey by establishing the desired information we planned on gathering. From this, a set of questions was prepared. We submitted the questionnaire in an application to the Institutional Review Board at WPI. The surveys were centered around the following topics:

- General demographic information: identifying the background of students
- Interest and involvement in sustainability-related activities: analyzing the students' engagement in sustainability
- Relevance of sustainability education: identifying the opinions of students on the importance of sustainability in education

To ensure that our research in these areas was relevant to the widest possible audience on campus, we targeted undergraduate and graduate-level WPI students across all majors and concentrations. The survey was distributed through the Class of 2016, Class of 2017, Class of 2018, and Class of 2019 Facebook groups and through emails to faculty.

3.2 Develop Suggested Curriculum for Sustainability Engineering Professionals

In order to ensure our proposed major would benefit the students in their postgraduate careers, we prepared to develop a suggested curriculum. We researched the curricula of other universities and identified a list of required skills for professional sustainability engineers.

3.2.1 Research Curriculum of Other Universities

We researched other universities to find qualitative data on the goals and scope of each program. We focused on information from a set of model universities that have already adopted Bachelor of Science programs in Sustainability. The universities we researched and their program types can be seen in Table 2.3.

We researched the sustainability websites and course catalogs of each of these universities. This information was used to analyze the structure, content, and requirements for graduation of each program. From further studying the course catalogs, we analyzed the skill sets that are being provided to undergraduates in each sustainability program.

3.2.2 Research Postgraduate Careers and Desired Skills

To learn about postgraduate options for Sustainability Engineering majors, we researched potential career options for "sustainable engineers" or "sustainability project managers." These career options were researched through online job search websites including Glassdoor and Indeed. We read job postings in sustainability-related fields to determine the necessary qualifications for each job. From the information acquired in our research, we interpreted and compiled a list of required skills for Sustainability Engineering professionals.

3.3 Revise Project Direction and Goal

Due to our findings from the initial methods described above, we decided to change the focus of our project. We revisited the problem we were attempting to solve with our initial solution. We established that there is a lack of engagement in sustainability on the WPI campus. We determined an appropriate way to address sustainability in order to determine how we could make a larger impact. To accomplish this goal, the team completed the following three objectives:

- Identify New Direction
- Assess the Existing Initiatives for Sustainability Engagement at WPI
- Research Improvements for Campus Engagement

3.4 Identify New Direction

In order to fully establish our project's new direction, we needed to understand where our project could make the most impact. Therefore, we revisited the original problem and identified the areas where WPI has a significant opportunity to improve. We compared WPI's AASHE STARS ratings with those of similar universities. To identify similar universities, we developed a list of universities with high-rated engineering programs to ensure that we were assessing a population of students with similar technical mindsets. Our list of universities consisted of Arizona State Univrsity (ASU), Rochester Institute of Technology (RIT), The University of Massachusetts Amherst (UMass Amherst), The University of New Hampshire (UNH), and Villanova University (VU). The contacts and relevant degree information is available in Table 3.2 below.

Table 3.2: Model Universities

University	Degree	Contact	Title
ASU	BS in Sustainability Studies	Christopher Boone	Dean of the School of Sustainability
RIT	MS in Sustainable Engineering	Brian Thorn	Sustainable Engineering Program Director
UMass Amherst	MS in Sustainability Science	Linda S. Fortin	Head of Academic Programs for the Department of Environmental Conservation
UNH	Dual Degree in Sustainability	Tom Kelly	Sustainability Institute's Executive Director
VU	MS in Sustainable Engineering	William Lorenz	Sustainable Engineering Program Director

Interviews were scheduled for the contacts in Table 3.2. A list of questions for the contacts for the model universities can be seen in Appendix C.

To confirm that WPI's areas of opportunity for sustainability are not necessarily in academics and that there is more impact in addressing engagement in sustainability, we assessed the STARS ratings of Academics and Engagement for WPI. We then averaged the STARS ratings from 18 universities with top-ranked engineering programs and compared them to WPI's ratings. After this, we identified the areas where WPI was below average. We then assessed the feasibility of implementing solutions for these areas of opportunity.

3.5 Assess the Existing Initiatives for Sustainability Engagement at WPI

To determine the benefit of our proposed solution, we assessed WPI's initiatives to increase engagement in sustainability. We met with select faculty from WPI to request insight on the sustainability initiatives at WPI and how the initiatives were affected by the level of engagement.

We also attended the "How Sustainable is WPI?" Panel discussion that took place at WPI on April 6th, 2016. The panelists at the discussion consisted of the following personnel, displayed in Table 3.3 below.

Table 3.3: WPI Sustainability Faculty

Name	Title
Bill Spratt	Director of Facilities Operations
Mike Kearns	Shawmut Construction
Dan Sarachick	Director of Environmental Health and Safety
Joe Kraskouskas	Director of Dining Services
Terry Pellerin	Associate Director, Buildings and Events
Deborah Scott	Chief Information Officer
John Orr	Director of Sustainability

We also used this discussion to develop a list of staff that we believe may be interested in learning more about our recommendations and faculty that may be interested in implementing service-learning into their own courses.

3.6 Research Improvements for Campus Engagement

In addition to talking to WPI faculty, we also conducted research on the different methods of engaging students. We interviewed faculty members from other universities (outlined in Section 3.1.2), and read about programs at other comparable universities.

3.6.1 Survey Students from Other Universities

In order to compare the sustainability opportunities at other universities to WPI's current opportunities, we distributed a "Quick Survey" to students from other universities via Facebook and during the Massachusetts Sustainable Campuses Conference at Hampshire College on April 15, 2016.

The first step in developing the survey was to establish the desired information we planned on gathering. From this, a set of questions was prepared. We submitted this questionnaire in an application to the Institutional Review Board. The survey was centered around the following topics:

- General demographic information
- Opportunity at their institution to participate in sustainability-related activities
- Interest and involvement in sustainability-related activities
- Sustainability education and engagement at other universities

We distributed the survey to students through Facebook and by handing out cards with a link to the survey. A full set of questions for the "Quick Survey" is provided in Appendix I.

3.6.2 Gauge Faculty Interest

In order to determine faculty who would potentially be interested in implementing our proposed solutions, we scheduled meetings with Professor Elizabeth Stoddard and Professor Chrysanthe Demetry. Professor Stoddard was our first contact, since she is passionate about sustainability and student engagement. Professor Stoddard has worked with the "Rooftop Farm" IQP, a project center that utilizes service-learning principles.

After meeting with Professor Stoddard, she suggested that we talk to Professor Chrysanthe Demetry, Director of the Morgan Teaching and Learning Center at WPI. We spoke to Professor Demetry about how to best engage faculty for the implementation of our project idea.

Summary

The methods described above allowed us to quantify and identify the areas where the WPI community could improve its engagement in sustainability. From these methods, we were able to reach conclusions regarding the best ways for WPI can to better engage in sustainability. The results and findings of our methods are explained in more detail in the following section.

Chapter 4: Results

Introduction

In this chapter, we provide the results for our project as well as an analysis of the feasibility and implementability of our recommended solution. This chapter discusses the following topics:

- Sustainability in Engineering
- Development of a Sustainability Engineering Major
- Implementation of a Sustainability Engineering Major
- The Need for Improved Sustainability Engagement at WPI
- Method of Improving Sustainability Engagement: Service-Learning
- Is WPI Ready for Service-Learning?

4.1 Sustainability in Engineering

Our initial results established the need for sustainability in engineering education. The Journal of Cleaner Production article *Sustainability Engineering for the Future* states that engineers must "have the responsibility to address the entire spectrum of sustainability aspects, including the economic, environmental, social and multi-generational dimensions [1]." Therefore, we concluded that there is a need for sustainability education in the world, especially for engineering students and professionals. We reached this conclusion through the following insights:

- Academic Articles
- Existing Sustainability Courses at WPI
- Sustainability Engineering Majors at Other Universities

4.1.1 Academic Articles

To understand how others in academia view the importance of sustainability in engineering, we researched methods of engaging and teaching engineers how to practice sustainability in their field. Most articles identified that there is a need for more sustainability-minded engineers in their professional careers [9]. However, there is no concrete solution for the best way to teach sustainability in engineering programs [14].

The article *Sustainability Engineering as Diploma* references the lack of a concrete solution by stating "It is well recognized that sustainable solutions are not often going to be derived from traditional engineering solutions but will require innovative and new focuses which build on social, cultural and environmental strengths [38]." We understand that technological development affects the economy, environment, and society; therefore, allowing technological development and sustainability issues to interact with each other provides a way to solve real world problems in a sustainable way [20].

4.1.2 Existing Sustainability Courses at WPI

The following Table 4.1 displays the number of sustainability focused and inclusive courses in the WPI Sustainability Course Inventory. The full list of courses, including sustainability classifications and course descriptions, is provided in Appendix G.

Table 4.1: Undergraduate Sustainability Courses at WPI

Course Type	**Number of Courses**	**Percentage of Courses**
Sustainability Inclusive	91	12.1%
Sustainability Focused	29	3.9%
All Courses	750	100%

According to the data in Table 4.1, only 3.9% of all WPI courses are categorized as Sustainability Focused and only 12.1% mention sustainability [77, 78].

The 2015 WPI Fact Book contains tables of all undergraduate primary and secondary majors. These tables can be found in Appendix L. Figure 4.1 shows the percentage of undergraduate and graduate students enrolled in each department as their primary major.

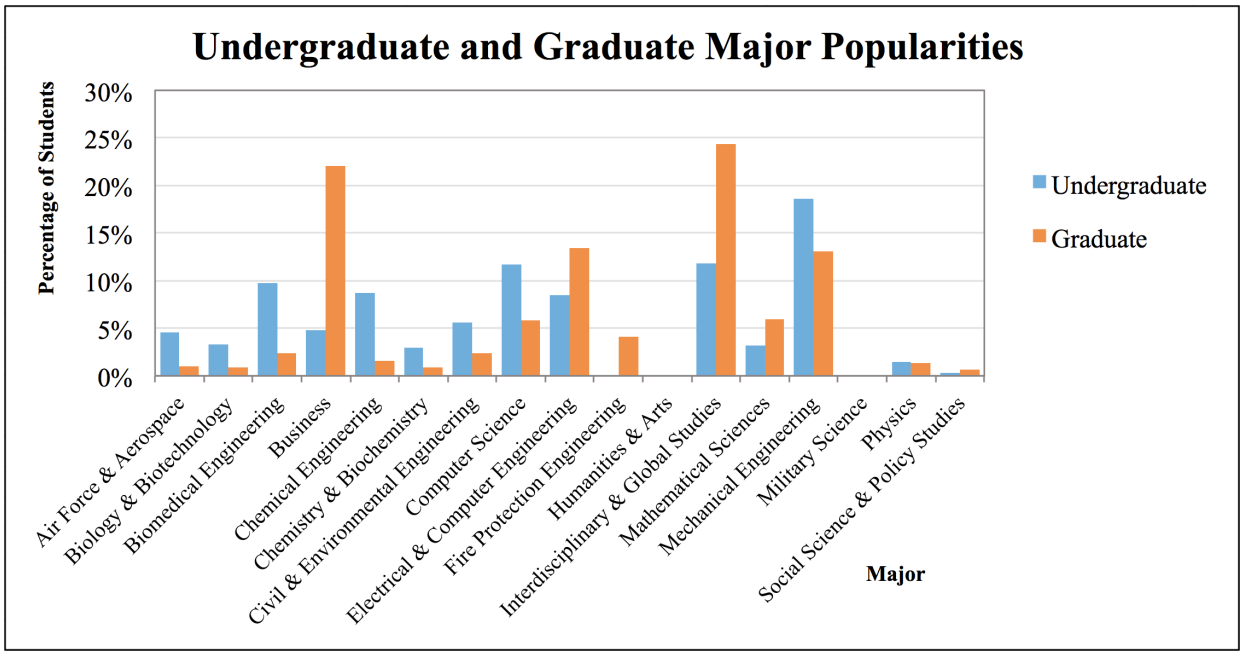

Figure 4.1: Undergraduate and Graduate Major Popularities [81]

According to the data in Figure 4.1, only 0.4% of undergraduate students major in Social Sciences or Humanities & Arts, as opposed to 55.7% of students who major in engineering and 22.8% that major in science. Conversely, the two most popular fields of study for graduate students at WPI are Interdisciplinary & Global Studies and Business.

Figure 4.2 below shows the number of sustainability-related courses available in each department.

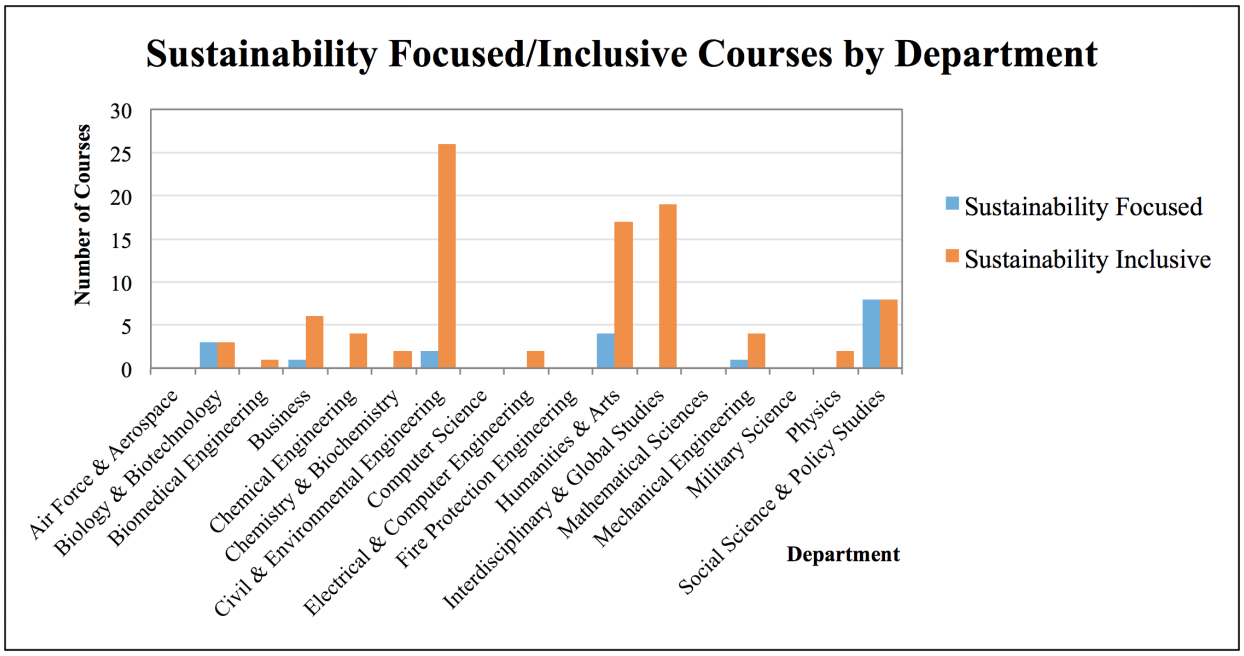

Figure 4.2: Sustainability Focused/Inclusive Courses by Department [78]

The majority of sustainability-related courses are available for Civil & Environmental Engineering, Humanities & Arts, and Interdisciplinary & Global Studies. The highest number of sustainability-focused courses are available in the Social Science & Policy Studies department. Therefore, students in these programs are more exposed to sustainability in their courses than students in other programs.

Comparing Figures 4.1 and 4.2, we conclude that the majority of sustainability-related courses offered at WPI are offered in less common departments for undergraduate students. This leaves a large portion of the WPI undergraduate population unreached by sustainability in academic courses.

4.1.3 Sustainability Engineering Majors at Other Universities

Teaching undergraduate engineering students about sustainability can be accomplished through the development and implementation of Sustainability Engineering as an undergraduate major. However, based on our research of other university programs, we conclude that most sustainability-based engineering courses are offered only at the graduate level.

Many other universities have seen the benefits of developing and implementing a Sustainability Engineering major. For example, Arizona State University, the Rochester Institute of Technology, and Villanova University have all successfully implemented Sustainability Engineering degrees [5, 37, 61]. Since these universities have had success with their programs, we initially concluded that a Sustainability Engineering major could be implemented at WPI at the undergraduate level to address the need for sustainability in engineering [68]. This would provide the opportunity for undergraduate students to learn sustainability concepts within their engineering discipline.

4.2 Development of a Sustainability Engineering Major

Upon deciding the "solution" to the need for sustainability in engineering, we determined the additional academic resources needed in order to implement a Sustainability Engineering major at WPI. We concluded that WPI would require the following additional materials in order to support the major:

- New Courses to Accommodate Required Skills
- Additional Faculty

4.2.1 New Courses to Accommodate Required Skills

To ensure that the courses at WPI would be able to give potential Sustainability Engineering majors the proper education, we developed a set of required skills for a Sustainability Engineering professional. These skills were determined through research of academic articles and course catalogs of comparable programs at other universities, including ASU's Bachelor of Science in Sustainability and RIT's Master of Science in Sustainability Engineering [5, 37]. The required skill set includes the Advanced Life Cycle Analysis and Sustainable Energy Systems.

4.2.1.1 Advanced Life Cycle Analysis

Life Cycle Analysis (LCA) is the study of a product or process from its creation to its destruction or repurpose. The life cycle of a product is analyzed to gauge its overall impact on the earth, including environmental and societal impacts [63]. As of the 2016-2017 academic year, WPI offers three courses that incorporate LCA into their syllabi. These courses are titled *Introduction to Environmental Studies* (ENV 1100), *Environmental Impacts of Engineering Decisions* (ES 2800), and *Civil Engineering Project Evaluation* (CE 3025)[78].

None of these courses exclusively teach LCA, even though our results have found that LCA is considered the key foundation for a Sustainability Engineering professional. In order to sufficiently teach LCA for a Sustainability Engineering major, WPI would need to develop a course exclusive to LCA. Other universities have developed their own courses exclusive to LCA. Both Rochester Institute of Technology (RIT) and Arizona State University (ASU) have courses titled *Applied Life Cycle Assessment*, which immerse students in LCA practices throughout the semester. This course exclusively teaches several advanced topics, including system boundary selection, functional unit selection, inventorying, impact assessment, and interpretation stages [2, 36].

4.2.1.2 Sustainable Energy Systems

Through more research on required skills for a Sustainability Engineering major, another common skill set was knowledge on sustainable energy systems. Based on the Sustainability Course Inventory, WPI has a course titled *Renewable Energy*, an "introduction to renewable energy, outlining the challenges in meeting the energy needs of humanity and exploring possible solutions [78]." This course is graduate-level and is not offered at the undergraduate level.

The journal articles *Engineering Education: Innovative Practices and Future Trends* and *Latest Trends on Engineering Education* emphasize that sustainability engineers must be knowledgeable in not only the technical aspect of power generation, but also must address power generation with political and social considerations [14, 42]. Since the *Renewable Energy* course focuses only on the technical side of renewable energy, a new course would need to be introduced to accommodate the need for an energy course that addresses both technical and societal implications. The *Sustainable Energy Systems* course at Rochester Institute of Technology (RIT) introduces students to alternative energy technologies and gives them an understanding of the economic, environmental, and social limitations of each of these technologies. The new course at WPI would need to be similar to the *Sustainability Energy Systems* course at RIT [36].

4.2.2 Additional Faculty

Another requirement for implementing a Sustainability Engineering major is the availability of qualified faculty members. These faculty members should have a depth of experience in teaching classes with skill development in the areas outlined above. Since implementing a Sustainability Engineering major at WPI would require incorporating new classes into the curriculum, WPI may need to hire additional faculty who are qualified and willing to teach these courses [9, 38].

Most faculty from other universities such as RIT have years of experience in completing publications related to sustainability in such topics such as life cycle optimization or sustainable design. [21] Therefore, our program would need to have multiple faculty members that are well respected in the sustainability field to accommodate the additional courses. Hiring additional faculty is costly, and would be more suited to more established departments than experimental departments. Therefore, we do not expect to convince WPI administration to accommodate the new Sustainability Engineering major for this requirement.

4.3 Implementation of a Sustainability Engineering Major

With the initial results in Sections 4.1 and 4.2, we concluded that the work required for the development of a Sustainability Engineering major at WPI may outweigh the meaningfulness of the final result. The implementation of a Sustainability Engineering major would likely be deterred by both the lack of resources and the following intrinsic problems:

- Undefined Discipline
- Unknown Student Demand

4.3.1 Undefined Discipline

Through the results of the methods described in Sections 3.1 and 3.2, we have concluded that Sustainability Engineering cannot be defined as one discipline. Sustainability is capable of being applied to a technical background, including a degree in science or engineering [23]. Since application of sustainability to technical fields first requires a technical background, it may not be feasible to implement an undergraduate degree in Sustainability Engineering.

If one single discipline for Sustainability Engineering cannot be defined, there are two possible solutions that are more feasible than an undergraduate Sustainability Engineering major: implementation of a graduate major or implementation of an undergraduate minor.

For the implementation of a graduate major in Sustainability Engineering, all graduate students would have a depth of prior knowledge in their technical field. The graduate students would be capable of building sustainable principles into their technical majors for work as sustainability engineers.

For the implementation of an undergraduate minor, the students would expand their knowledge of sustainability alongside their technical field. Since there is already a Sustainability Engineering minor being developed at WPI, undergraduate students are capable of minoring in Sustainability Engineering as soon as the 2015-2016 academic year.

4.3.2 Unknown Student Demand

Lack of interest from incoming undergraduate students is a significant limitation for a Sustainability Engineering major. Kristin Tichenor, Senior Vice President of the Enrollment Management Office at WPI, mentioned that Sustainability Engineering is "too new" of a field to know the need for an undergraduate degree (Meeting summary for Kristin Tichenor is available in Appendix E.6.)

To assess the potential undergraduate interest in a Sustainability Engineering major, we researched the interest in the Environmental and Sustainability Studies (ESS) major. In 2015, only 13 undergraduate students were registered for ESS as their primary or secondary major. These 13 students account for less than 0.3% of total students enrolled at WPI in 2015. From our discussion with Kristin Tichenor, we expect that a Sustainability Engineering undergraduate major may have similar low registration numbers.

4.4 Reaction to Initial Findings

After interviews with Professor Robert Krueger and Professor John Orr, our team concluded that further assessing the feasibility of a Sustainability Engineering major at WPI would not be worthwhile. Therefore, we began to reanalyze the scope of our project.

Our original goal was to address the lack of a Sustainability Engineering major at WPI by proposing the implementation of a Sustainability Engineering major as a solution. Considering our findings in Sections 4.1 through 4.3, we concluded that the lack of a Sustainability Engineering major at WPI was not a sufficient problem, and implementing a Sustainability Engineering major would most likely not be feasible. We also concluded that pursuing an implementation plan for a graduate Sustainability Engineering major may also be deterred by the same problems and would not have the impact on undergraduate students that we wanted. Therefore, we adjusted the project's direction using the methods discussed in Section 3.4.

4.5 The Need for Improved Sustainability Engagement at WPI

In order to promote sustainability among student and professional engineers, there must be an increased awareness and engagement in sustainability. We have concluded that there is an opportunity to increase engagement in sustainability among the WPI community from the results of:

- Visual Model of Sustainability Engagement
- How WPI Compares to Other Universities
- Student Survey Results
- Courses at WPI

4.5.1 Visual Model of Sustainability Engagement

From the academic research we conducted, we developed a visual model to define sustainability engagement. The contributing critera for Sustainability Engagement was found to be Active Practice, Learning, and Advocacy. The criteria were organized into the Venn diagram in Figure 4.3.

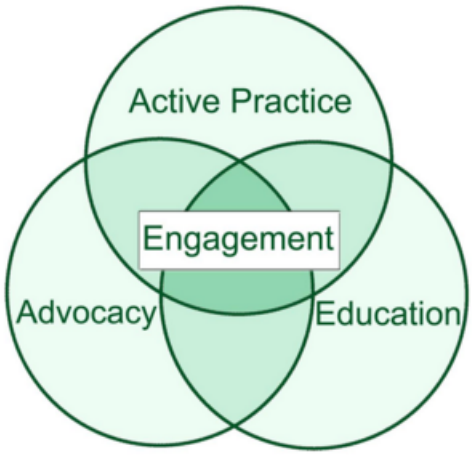

Figure 4.3: Model for Sustainability Engagement

The three criteria, Active Practice, Learning, and Advocacy, all contribute to the overall sustainability engagement of an individual or idea. Active Practice represents student outreach and participation in sustainability activities. Education represents teaching student sustainability concepts through the academic curriculum. Advocacy represents active support for sustainable causes. Engagement in sustainability requires all three criteria, and any solution for sustainability engagement must address all three.

4.5.2 How WPI Compares to Other Universities

In order to assess the sustainability engagement at WPI, we researched the quantitative data of the following reports in comparison to other universities.

- Recyclemania Scores
- AASHE STARS Score Reports

4.5.2.1 Recyclemania Scores

A significant indicator of the lack of active practice in sustainability among WPI students is WPI's poor recycling rates in comparison to other universities. Figure 4.4 shows the results for the 2014 Recyclemania competition at WPI and six other colleges.

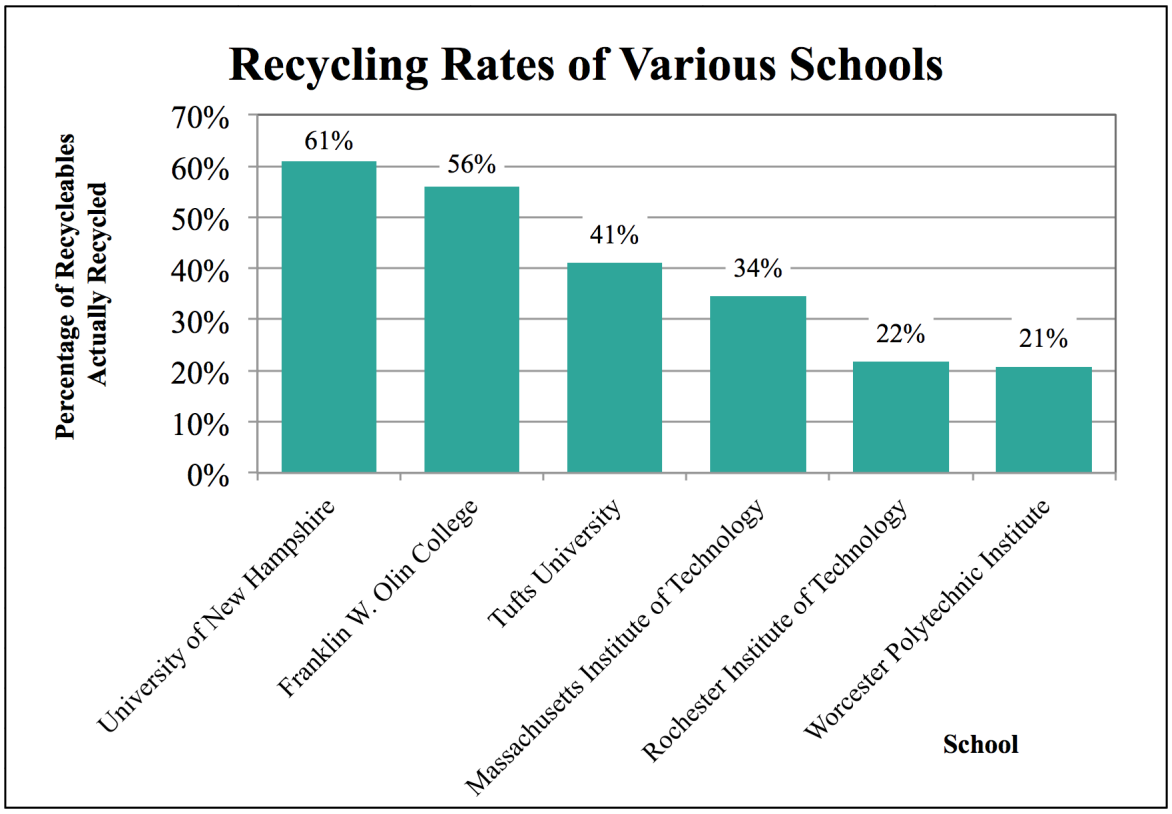

Figure 4.4: Recyclemania Recycling Rates [34]

The Recyclemania results show that WPI is not recycling at nearly as high a rate as comparable institutions. We hypothesize that the poor recycling rates could be caused by a lack of awareness of recycling rules, especially regarding single-stream recycling. However, we also hypothesize that members of the WPI community may be negligibly disposing of recyclable material. In either case, students that are more engaged in sustainability would seek an increased knowledge of recycling and take more of an initiative to recycle.

4.5.2.2 AASHE STARS Score Reports

To quantitatively assess the areas in sustainability where WPI needs improvement, we compared WPI to other universities with engineering programs. A table of the STARS scores of WPI compared to these other universities is attached in Appendix A.

WPI ranks above average by 8% for Curriculum and below average by 2% for Research, 13% for Campus Engagement, and 22% for Public Engagement. While WPI falls behind some top universities in their Academics assessment, they generally score higher than or similarly to most comparable universities. However, this data does reveal a significant lack of engagement in sustainability, as WPI scores lower than 15 of the 18 colleges on both Campus and Public Engagement. Therefore, we conclude that addressing engagement in sustainability will have more of an impact on WPI's STARS score than addressing academics, as originally intended.

Table 4.2 below gives the criteria for the areas of the Engagement category where WPI scores lower than average. We conclude that these areas are the most critical to address in engagement and have the most opportunity to be impactful.

Table 4.2: Engagement Areas of Opportunity

		WPI Score	Average	Criteria
Campus Engagement	1. Student Educators Program	70%	80%	Percentage of degree-seeking students reached by student educators (paid or volunteer) in sustainability
	2. Student Orientation	68%	92%	Percentage of new students provided an opportunity to participate in sustainability-related orientation programs
	3. Employee Orientation	0%	80%	Percentage of new employees provided an opportunity to participate in sustainability-related orientation programs
	4. Staff Professional Development	0%	79%	Professional development opportunities in sustainability are provided at least once per year
Public Engagement	5. Continuing Education	0%	49%	Institution offers "continuing education" courses in sustainability and at least one sustainability certificate program
	6. Participation in Public Policy	0%	89%	Institution advocates public policies that support campus sustainability or otherwise advance sustainability
	7. Trademark Licensing	0%	84%	Institution is a member of the Fair Labor Association (FLA) and/or Workers Rights Consortium (WRC)

Each of the opportunities in the Engagement category from Table 4.2 supports the three main focuses of sustainability engagement, determined from the visual model of sustainability engagement in Figure 4.3. Of these seven problem areas, three address student outreach for active practices (1, 2, and 3), two address whether WPI offers certain sustainability courses and programs in their education (4 and 5), and two address institutional advocacy (6 and 7).

4.5.3 Student Survey Results

In order to understand the general interest in and limitations of sustainability engagement, we surveyed students from WPI and other universities. We concluded that WPI students would likely engage more in sustainability if they were encouraged to adopt a sustainable mindset. We reached this conclusion from:

- WPI Student Survey Results
- Student Survey Results from Other Universities

4.5.3.1 WPI Student Survey Results

Our survey for WPI students received 103 responses from both undergraduate and graduate students. Since there are a total of 6,139 students enrolled at WPI, the confidence interval of each survey question is +/- 9.67%. The full results of this survey can be seen in Appendix J.

Figure 4.5 below displays the results for the question "Which of the following limits your participation in sustainable active practices? (Check all that apply.)"

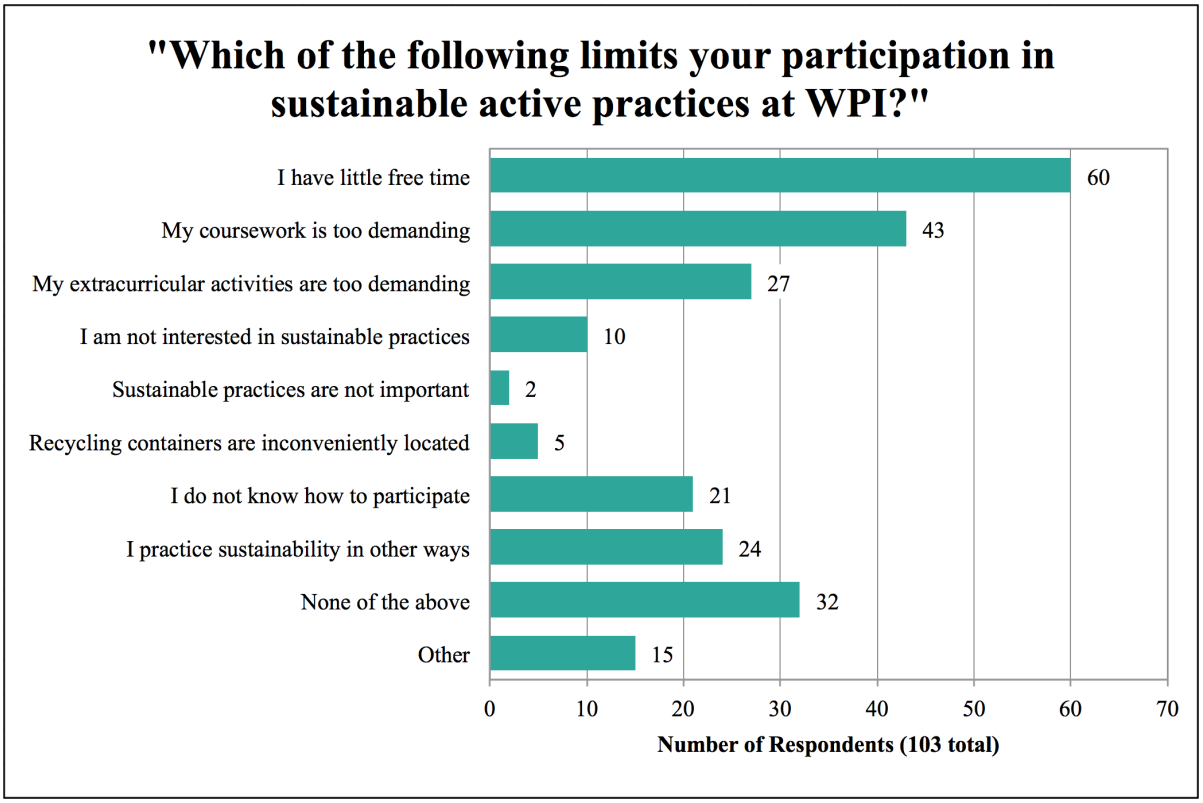

Figure 4.5: Data for Question 8 in the WPI Student Survey

The most significant limitations for the respondents were lack of free time and coursework that is too demanding, at 60% and 43%, respectively. Other common limitations were demanding extracurricular activities and lack of knowledge on how to participate. Very few respondents cited that they were not interested in sustainable practices, that sustainable practices were not important, or that they were not limited in practicing sustainability.

Write-in answers for the question "Which of the following limits your participation in sustainable active practices?" included concerns about "laziness," and the cost of participation. Two responses focused on the specific implementation of recycling and another two on the lack of composting. These responses indicate that students may want to participate in recycling or composting, but cannot due to poor implementation.

Figure 4.6 below displays the results from our survey question on how often students participate in active practices in sustainability.

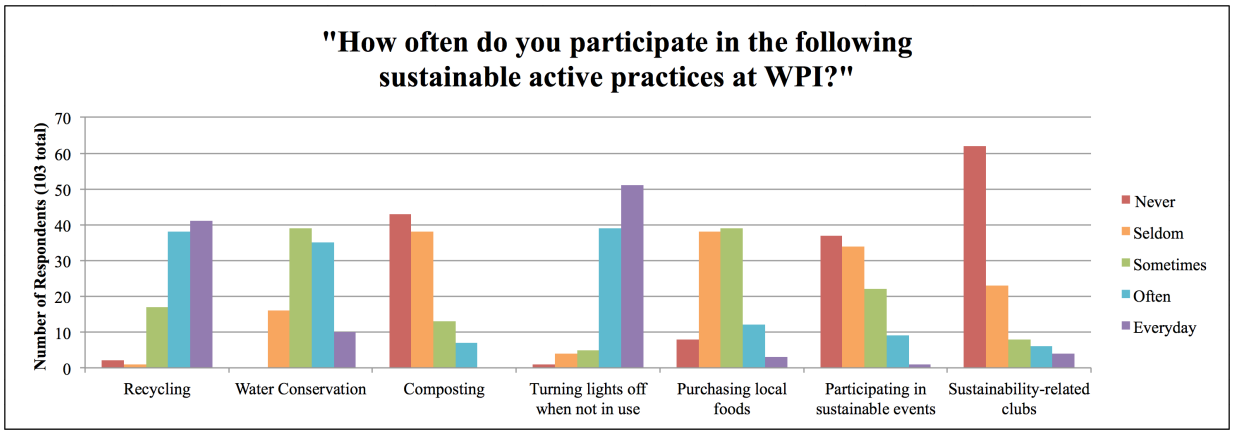

Figure 4.6: Data for Question 7 in the WPI Student Survey

The results that skew right show that students practice the activity more often, while results that skew left show that students practice the activity less often. According to this data, most students at WPI practice recycling and turning lights off often or every day, but practice composting, attend sustainable events, and participate in sustainability-related clubs seldom or never.

From Figures 4.5 and 4.6, we conclude that the sampled students are generally too busy to participate in time-consuming and unaccessible practices, but will not be limited in participating in quicker practices that require less effort.

The survey results for "How well do you think WPI students practice sustainability?" and "How well do you think WPI engages students in sustainability?" are displayed in the following Figures 4.7 and 4.8.

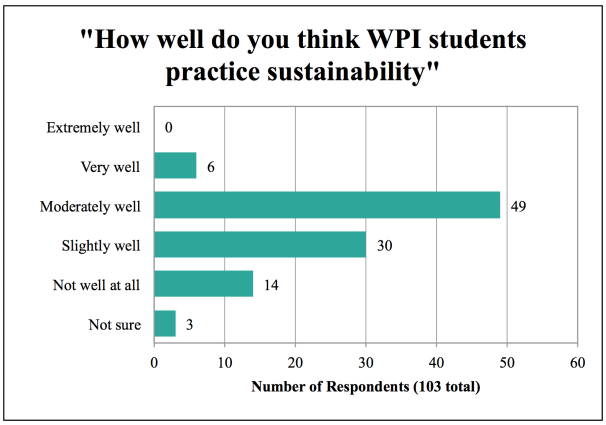

Figure 4.7: Data for Question 9 in the WPI Student Survey

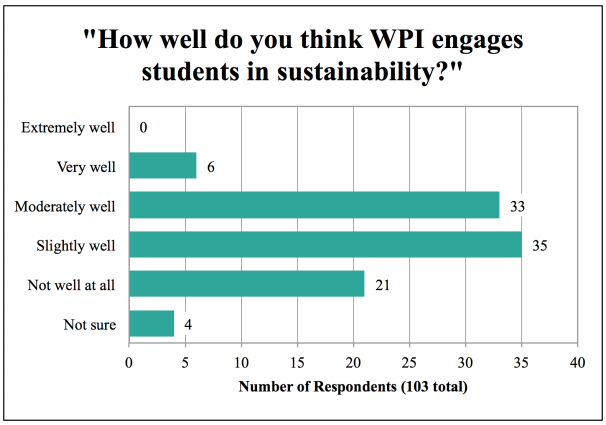

Figure 4.8: Data for Question 11 in the WPI Student Survey

These figures show results that are skewed toward "not well at all" for both sustainability practice and sustainability engagement. None of the 103 respondents selected "extremely well" for either question. As a general trend, the sample of students viewed sustainability practice more positively than sustainability engagement.

The following Figures 4.9 and 4.10 display the results for the questions how well WPI compares to other engineering colleges in terms of sustainable practices and sustainability engagement.

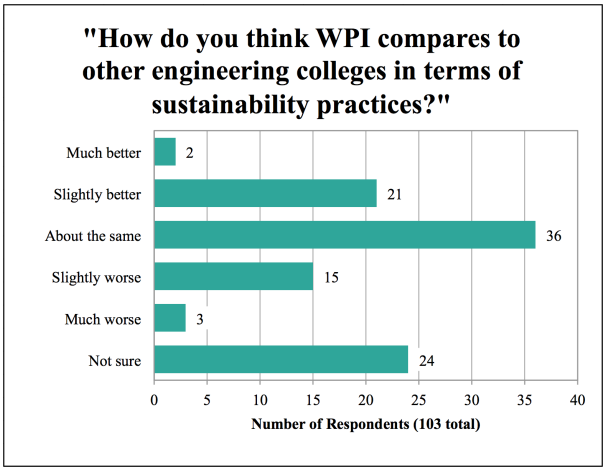

Figure 4.9: Data for Question 10 in the WPI Student Survey

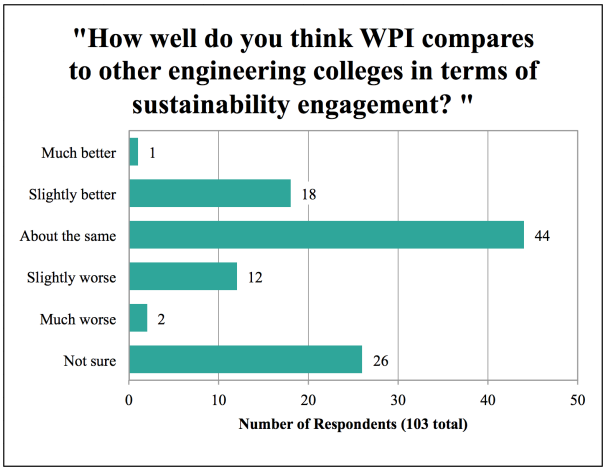

Figure 4.10: Data for Question 12 in the WPI Student Survey

In both figures, the responses are normally distributed through the graphs, aside from the "Not Sure" choice. Generally, this specific sample of WPI students believes that WPI is performing similarly to other engineering universities in both sustainable active practice and engagement. For both survey questions, approximately a quarter of surveyed students answered "Not Sure."

From these results, we can conclude that a majority of sampled students believe that WPI is performing equal to or better than comparable universities in terms of sustainable practice and engagement. This data contrasts with the comparisons in Section 4.5.2. This difference may signify a lack of awareness of sustainability at WPI and/or other universities.

The following Figure 4.11 shows the results for what options for sustainability engagement that the sample of WPI students would be interested in.

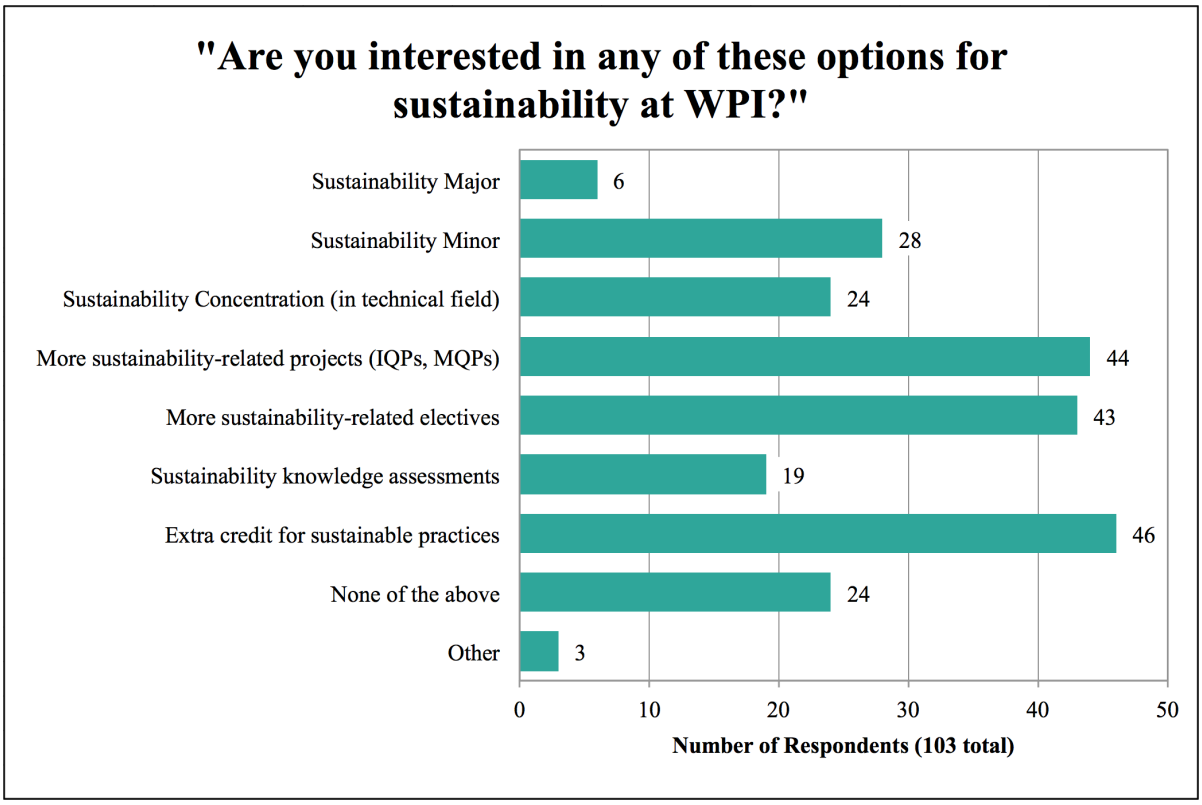

Figure 4.11: Data for Question 15 in the WPI Student Survey

According to the results in Figure 4.11, the majority of the sampled students were in favor of incorporating sustainability into their courses. The most popular method of incorporating sustainability into their courses was through extra credit for sustainable practices. The students also reported that they wanted more sustainability-related projects, including IQPs and MQPs.

4.5.3.2 Student Survey Results from Other Universities

Our "Quick Survey" received 31 responses from students at other universities. The full results of the Quick Survey can be seen in Appendix K.

Figure 4.12 below displays the results for how often students from other universities practice sustainability.

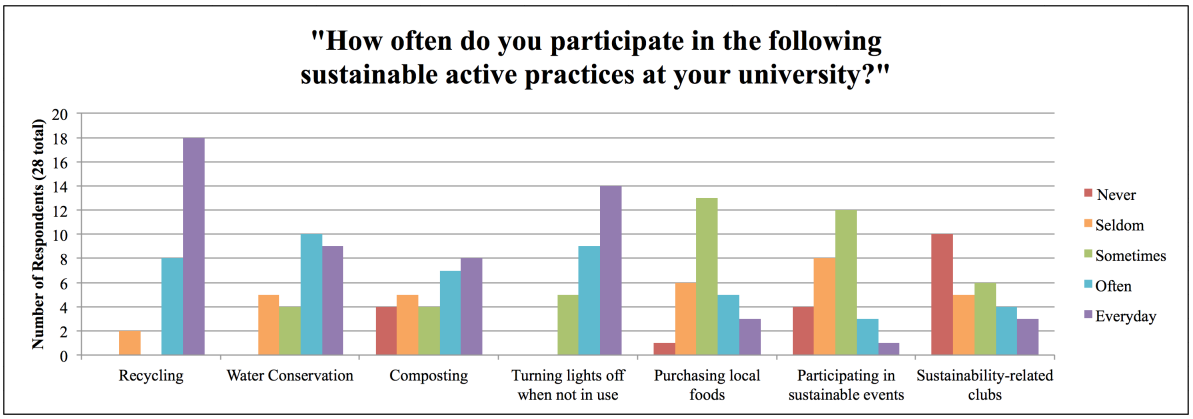

Figure 4.12: Data for Question 8 in the Conference Survey

The same question was asked to WPI students in the previous section (4.5.3.1). By comparing the results from the two surveys, we see several differences, especially in "participating in sustainable events," "recycling," and "composting." While the sample is skewed due to the difference in sample size, the sample of students from other universities is significantly more engaged in attending sustainable community events, practicing recycling, and composting.

Figure 4.13 below shows what limits the sample of students from other universities in terms of participation in sustainable practices.

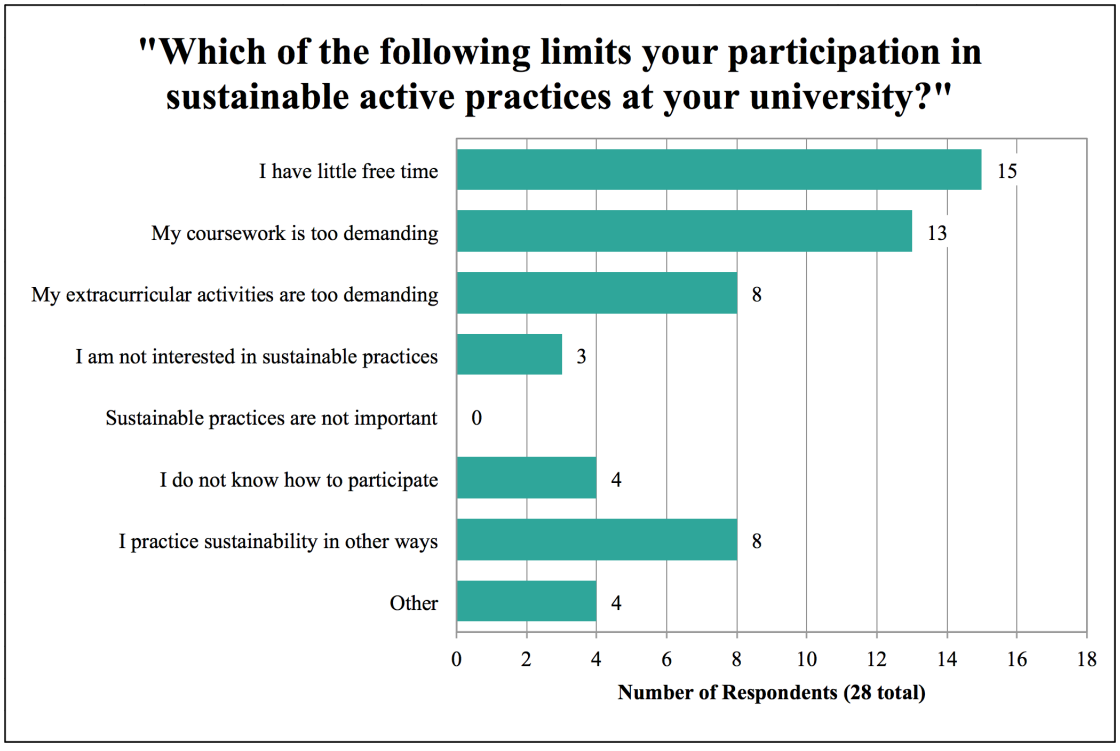

Figure 4.13: Data for Question 9 in the Conference Survey

Most sampled students report that they are not able to engage in sustainable practices due to little free time. From this, we conclude that the sampled students from other universities are facing similar limitations, but are able to overcome these limitations better to enhance their engagement in sustainability.

Figures 4.14 and 4.15 below display the results of the questions "How well do you think students from your university practice sustainability?" and "How well do you think your university engages students in sustainability?"

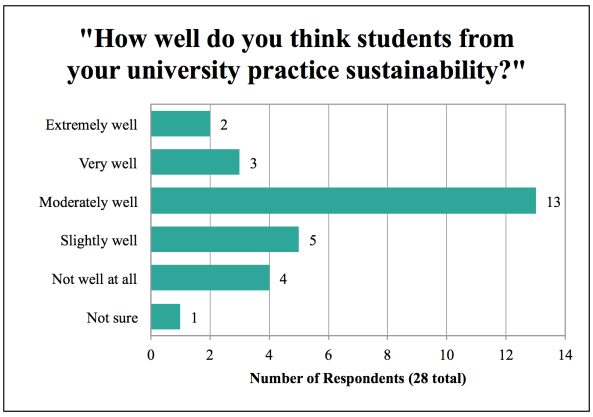

Figure 4.14: Data for Question 10 in the Conference Survey

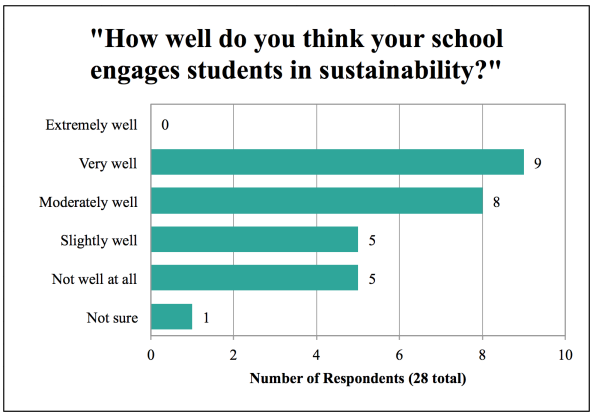

Figure 4.15: Data for Question 12 in the Conference Survey

The above two figures display the opinions on sustainability practice and engagement of the sampled students from other universities. In Figure 4.14, the responses are evenly distributed with a peak at "moderately well," as opposed to the results from WPI in Section 4.5.3.1. For Figure 4.15, the results show that a higher percentage of the student sample views sustainability engagement at their university more positively. From these analyses, we conclude that the students sampled from other universities believe their university practices and engages students in sustainability more than the sampled students from WPI.

4.6 Method for Improving Sustainability Engagement: Service-Learning

After considering the above findings from Sections 4.5, we conclude that there is low engagement in sustainability at WPI. Therefore, we revised the project statement of our IQP to include sustainability engagement at WPI and changed the direction of our project.

From our research, we determined that implementing service-learning into more courses at WPI would be the best way to engage students in sustainability. This solution is beneficial to WPI students because it:

- Links Education to Student Engagement
- Addresses Student Needs
- Aligns with WPI's Future Goals

4.6.1 Links Education to Student Engagement

Service-learning has been praised in academia and in practice as being one of the most influential factors in engaging students. Background Sections 2.3.1 and 2.3.2 identify two quotes that link service-learning to the community engagement goal in WPI's Sustainability Plan:

- "community engagement that combines personal responsibility with civic engagement is critical to all three aspects of sustainability [79]."
- "Service learning provides the most important vehicle of community engagement because ... if one cannot measure and evaluate every aspect of civic engagement, then service learning is the most important critical indicator of a campus' civic engagement [10]."

From these two quotes, we conclude that sustainability-related service-learning will address civic engagement at WPI, which has been identified as one of the two contributing factors to Community Engagement in Sustainability. Therefore, we conclude that implementing service-learning would be a worthwhile objective to include in the fourth goal of WPI's Sustainability Plan.

Examples of service-learning in practice can be seen firsthand at the University of Massachusetts Lowell (UMass Lowell). UMass Lowell's Service Learning Integrated throughout the College of Engineering (SLICE) program incorporates service-learning initiatives into pre-existing courses. Students in UMass Lowell's Francis College of Engineering are required to take at least one service-learning course each semester [13].

Student course evaluations for these service-learning courses have reported that service-learning helps them engage in their education more than traditional lecture-style learning methods. In addition, they have also reported that service-learning in their engineering courses has allowed them to become more civically engaged in their community [13].

Service-learning is also discussed in an academic article titled *How Service Learning Affects Students.* This article reported data from over 22,000 college undergraduates and determined that students who participated in service-learning initiatives were more engaged and interested in service after college. The sampled students reportedly graduated with "an increased sense of personal efficacy, an increased awareness of the world, an increased awareness of [their] personal values, and increased engagement in the classroom experience [8]."

The civic benefits of service-learning are further supported by a 1997 study at University of California, Los Angeles. In this study, the researchers collected data from 3,450 students from 42 different institutions that a form of service-learning. These respondents consisted of 2,309 service-learning participants and 1,141 non-participants. The results of the study showed that students that participated in service-learning reported having increased civic responsibility and were affected long after graduation. Their study concluded that participants of service-learning are more likely to engage in service after graduation and develop a long term commitment to civic involvement [39].

In addition to researching academic papers, the team attended a presentation by Bob Newton, Director for the Center of Environment & Ecological Design and Sustainability at Smith College. At the presentation, he discussed Smith College's efforts to engage students in community-based learning. Smith College has implemented a service-learning based Geoscience class into that analyzes the quality of permeable pavement compared to regular pavement. He concluded that service-learning benefits students the more than any other type of learning, since students engage more in their education and their community [40].

4.7 Is WPI Ready for Service-Learning?

After our findings from the section above, we then determined the feasibility of implementing service-learning into courses at WPI. We conclude that WPI would be ready to implement service-learning without the limitations of a Sustainability Engineering major (Section 4.2.) We reached our conclusion from the following findings:

- No New Courses are Required
- No Additional Faculty are Required
- Community Service Programs are Available at WPI

4.7.1 No New Courses are Required

We have concluded that the best way to implement service-learning at WPI is to introduce service-learning into pre-existing courses, especially at the introductory level in each discipline. This method will not require any new courses to be developed, which strengthens the chance of service-learning being implemented by faculty. The most feasible solution for WPI would be to follow the example of other universities that have incorporated service-learning in pre-existing courses, including UMass Lowell and Smith College.

4.7.2 No Additional Faculty are Required

In order to ensure that service-learning is implemented at WPI after the project is complete, we have determined that since service-learning would teach the same material in a nontraditional way, there would be no need for additional faculty. Instead, we have found that ensuring faculty are interested in sustainability-related service-learning is more important than hiring additional faculty. Therefore, the implementation of service-learning at WPI would involve teaching existing faculty new learning techniques. Several academic articles discuss the importance of faculty involvement in service-learning.

While student interest may be valuable, faculty are the only members of the institution that can incorporate service-learning into their courses [22]. This idea was also emphasized by Bill Spratt, Director of Facilities Operations at WPI, at the "How Sustainable is WPI?" panel discussion. Bill said that while student interest is important, each student is only enrolled at WPI for an average of four years and interest in sustainability initiatives can shift dramatically from year to year. Therefore, students need to collaborate with faculty who are part of the WPI community for a longer time. Involving faculty members in the implementation of service-learning at WPI will strengthen the chance of success.

Summary

This results chapter presents conclusions and an analysis of our findings from the methods described in Chapter 3. This chapter described our results of the feasibility of implementing both a Sustainability Engineering major and service-learning at WPI. From our findings, we conclude that the WPI community would benefit from service-learning to increase engagement in sustainability among students, faculty, and administration. Our team analyzed these results and developed the following recommendations as an implementation plan for increasing sustainability engagement at WPI.

Chapter 5: Recommendations

Introduction

This chapter outlines the recommendations our team developed based on the conclusions drawn from our results in Chapter 4. Our final recommendations are categorized into the sections outlined below:

- WPI Should Not Consider Implementing a Sustainability Engineering Major
- Approach Sustainability as a Mindset
- Implement Service-Learning at WPI
- Consider Further Development of Our Project

5.1 WPI Should Not Consider Implementing a Sustainability Engineering Major

Based on our results from Sections 4.1 through 4.3, our team has concluded that the implementation of a Sustainability Engineering major is not feasible at this time. This conclusion has been based on the lack of known benefit, including the undefined Sustainability Engineering discipline (Section 4.3.1) and the unknown demand for a Sustainability Engineering major (Section 4.3.2), and the known limitations, including the need for new courses (4.2.1) and additional faculty (4.2.2).

If the Sustainability Engineering minor proposed by Professor John Orr becomes successful and a level of interest is established for Sustainability Engineering, the Sustainability Engineering major should be reanalyzed. Dr. Thorn of the Rochester Institute of Technology (RIT) agreed with this approach, citing the success of RIT's Sustainability Engineering Master of Science and Master of Engineering degrees to a rise in student interest (Appendix E.9).

5.2 Approach Sustainability as a Mindset

We recommend that sustainability should be addressed as a mindset rather than a solution to a problem. Through our research, we have determined that engineers typically think in a problem/solution mindset, rather than determining opportunities. Therefore, technically-minded students like undergraduate engineers may not approach sustainability subconsciously and may become distracted with the limitations, like time management (Section 4.5.3.1.)

In order to consider the implementation of any sustainability initiative, one must assess the potential engagement from the perspective of individual student behavior. Students may be able to learn about technical topics in sustainability, but it is more impactful to learn to practice sustainability subconsciously. This type of sustainable mindset would not be addressed if we accepted our original project idea. Since the Sustainability Engineering major only aims to teach sustainable problem solving, it would likely not engage students or ensure that they consider sustainable actions in the future.

5.3 Implement Service-Learning at WPI

Through the results of Sections 4.5 through 4.7, we recommend that administration and faculty work toward implementing service-learning into the programs and curriculum at WPI. We recommend that WPI focus on implementing service-learning into the following:

- Community Service Organizations
- Morgan Teaching & Learning Center
- Degree Qualifying Projects
- Introductory-Level Courses

5.3.1 Community Service Organizations

The Mechanical Engineering course *Rehabilitation Engineering* (ME 3506) aligns with WPI's Assistive Technology Resource Center (ATRC) to develop designs for mobility aiding devices [27]. Students in ME 3506 attempt to solve community and social problems. This course is classified as "sustainability-inclusive" in WPI's Sustainability Course Inventory, indicating that sustainability is mentioned in the course but is not the focus [78].

The ATRC also collaborates with the student-led organization Engineering Projects in Community Services (EPICS) to "educate undergraduate engineers in the design process and give them real-world problem-solving skills, and help individuals and nonprofit organizations who may not have the access or necessary resources to hire a professional engineering team [27]." As of the 2015-2016 academic year, no course at WPI has collaborated with EPICS for community problem solving. Several universities, including Arizona State University and Purdue University, implement service-learning in undergraduate courses through their own EPICS programs [3, 32].

We recommend that the ATRC and EPICS organizations collaborate not only with the Mechanical Engineering department, but also similar departments including Electrical Engineering, Civil Engineering, and Robotics Engineering departments, to address community problems with interdisciplinary solutions. This will also allow service-learning to be incorporated into more courses and reach a larger number of students.

Two other on-campus community service programs already exhibit service-learning principles. The Establishing a Pipeline in College Success (EPICS, unrelated to Engineering Projects in Community Services) and STEM Saturday programs provide workshops for middle and high school students in the Worcester Metro and Worcester County areas. Under the Office of Multicultural Affairs, WPI students have the opportunity to join the programs as mentors and instructors. For the implementation of service-learning in courses at WPI, we recommend that faculty collaborate with these programs to adapt traditional learning methods to consider community diversity. We also recommend infusing sustainability-related topics into the collaborations, including sustainable practice initiatives and green STEM design.

5.3.2 Morgan Teaching & Learning Center

To ensure implementation of service-learning at WPI, our team recommends that faculty gain knowledge and interest in the details of service-learning as documented in this report. We believe that the Morgan Teaching and Learning Center may be an effective method of relaying this information to interested faculty.

The Morgan Teaching and Learning Center is a faculty-led development team that assists WPI faculty in strengthening their "instructional effectiveness and students learning by offering programs, services, and resources [64]." Professor Chrysanthe Demetry is the Director of the Morgan Teaching and Learning Center. During our interview with Professor Demetry, we requested insight on the best methods of communicating with professors to help implement service-learning at WPI (Appendix E.13)

To extend our outreach to faculty at WPI, we recommend that service-learning be documented in the Morgan Teaching and Learning Center, including definitions, visuals, and examples from other universities. We recommend that the Morgan Teaching and Learning Center pursues sustainability-related project-based education for professors so that they are able to implement service-learning into their own courses.

5.3.3 Degree Qualifying Projects

We also recommend that WPI encourage students to incorporate service-learning into their Interactive Qualifying Projects (IQPs) and Major Qualifying Projects (MQPs). While IQPs and MQPs can often include service-learning principles, students are not required to consider implementation of their project idea. If more IQPs and MQPs considered sustainability and implementation, students would impact community and social problems with interdisciplinary or field-focused sustainable solutions.

The best way to encourage students to complete service-learning based IQPs and MQPs is for advisors to present a problem or opportunity with a community service based application. Like in off-campus IQPs and MQPs, all projects should have the needs of a community or sponsor in mind. Encouraging students to consider sustainable solutions in their IQPs and MQPs would allow them to see the impact they can have on their community and world through research and technical skill.

5.3.4 Introductory-Level Courses

Since students already have the opportunity to incorporate service-learning into their junior- and senior-level projects, we recommend giving freshman- and sophomore-level students the opportunity to participate in service-learning as well. When students are exposed to service-learning early in their college career, there will be more of a chance to change their mindsets before learning advanced technical skills. Therefore, we recommend that WPI follow the lead of universities like the University of Massachusetts Lowell and Smith College for implementing community-based service-learning in introductory courses, such as chemistry labs and physics labs.

We also encourage the instructors of Great Problems Seminar (GPS) courses to address problems in global sustainability from a much smaller, more community-based perspective. We believe that first-year students would benefit from being exposed to service-learning and to see their impacts on the community while learning how to conduct and present a research project.

We believe that introducing sustainability-based service-learning in introductory courses and projects will also address WPI's Strategic Plan's goal of "Major and a Mission." Major and a Mission encourages students to "pursue a more intentional path at WPI and reflect on the connections between their academic coursework and co-curricular pursuits [68]." Service-learning at the introductory level would expose first- and second-year students to sustainability and civic engagment sooner, possibly impacting their "Major and a Mission" aspirations.

5.4 Consider Further Development of Our Project

To further develop our project and improve Sustainability at WPI, our team recommends considering sustainability engagement and its three focuses, described in Results Section 4.5.1. Further IQPs and student- or faculty-developed initiatives should also consider the idea of Sustainability as a mindset that requires a multidimensional approach.

The WPI Students Survey shows that 32 out of 108 sampled students responded that they do not know how to participate in sustainable practices. In Results Section 4.5.3.1, we concluded that many students are not aware of sustainability practices or engagement at WPI and/or other universities (Full WPI Student Survey results in Appendix J). Director of Sustainability John Orr and Associate Director of Sustainability Elizabeth Tomaszewski also mentioned there is no ideal method of communication between students, faculty, staff, and administration. Therefore, the Directors of Sustainability, Sustainable clubs, and other individuals find it difficult to promote, engage, or assess students in sustainable topics (See Appendices E.5 and E.7.)

Our team believes that WPI needs a more effective communication gateway for sustainability between the administration, faculty, and students. A future IQP should attempt to develop a a better method of communication to help improve sustainability engagement within the campus community. We also recommend a future IQP team compile information for all sustainability programs and events on campus on one pamphlet or website. Finally, a future IQP team should develop an implementation plan for incorporating service-learning into more courses than intended with this IQP. For example, a future IQP could study a specific major and develop service-learning into that major's curriculum.

Summary

To improve WPI's engagement in sustainability-related practices, our team recommends the four considerations above. With these recommendations, we intend to address the opportunity to advance WPI's student engagement in sustainability. We recommend that all future initiatives and reports on student engagement address sustainability as a simple mindset rather than a problem or requirement. Finally, we recommend staff, faculty, student groups, and future IQPs work toward further developing service-learning to ensure WPI graduates are prepared and motivated to develop sustainable solutions.

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Appendix A:

Below is the full chart depicting the scores all 19 universities received on the different STARS rating criteria.

STARS Ratings from 19 Various Schools

	WPI	SU	UI	UTA	CU	PU	CM	TAM	UV	UCB	UR	UWS	BU	UCSB	NCSU	TU	UB	UMA	CSU	Average
Curriculum Total	67%	74%	56%	50%	66%	45%	47%	59%	49%	70%	49%	77%	48%	52%	57%	47%	59%	61%	92%	59%
Academic Courses	72%	62%	31%	36%	41%	30%	28%	83%	49%	98%	30%	77%	21%	42%	46%	22%	52%	44%	100%	51%
Learning Outcomes	70%	64%	33%	13%	55%	8%	11%	0%	11%	0%	19%	45%	19%	13%	26%	14%	26%	54%	62%	29%
Undergraduate Program	100%	100%	100%	100%	100%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	97%
Graduate Program	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Immersive Experience	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Sustainability Literacy Assessment	0%	39%	56%	2%	56%	21%	0%	0%	0%	11%	0%	63%	100%	0%	0%	12%	56%	0%	100%	27%
Incentives for Developing Courses	0%	100%	100%	100%	100%	100%	100%	0%	0%	100%	100%	100%	0%	100%	100%	100%	0%	100%	100%	74%
Campus as a Living Laboratory	100%	100%	80%	100%	100%	100%	100%	100%	100%	100%	100%	100%	70%	100%	100%	100%	100%	100%	100%	97%
Research Total	78%	100%	93%	49%	100%	75%	88%	22%	85%	92%	77%	80%	72%	81%	89%	87%	71%	86%	100%	80%
Academic Research	100%	100%	60%	57%	100%	79%	82%	100%	78%	88%	82%	70%	66%	80%	100%	79%	82%	96%	100%	84%
Support for Research	50%	100%	100%	50%	100%	50%	100%	0%	100%	100%	50%	100%	75%	75%	100%	100%	75%	100%	100%	80%
Access to Research	0%	100%	100%	0%	100%	100%	100%	0%	100%	100%	100%	100%	100%	100%	0%	100%	0%	0%	100%	68%
Campus Engagement Total	76%	88%	100%	88%	100%	73%	70%	100%	97%	100%	100%	100%	77%	77%	85%	73%	87%	92%	100%	89%
Student Educators Program	70%	42%	100%	100%	100%	100%	0%	100%	100%	100%	100%	100%	0%	100%	100%	26%	100%	100%	100%	81%
Student Orientation	68%	100%	100%	90%	100%	100%	100%	100%	75%	100%	100%	100%	100%	63%	100%	58%	100%	100%	100%	92%
Student Life	100%	100%	100%	88%	100%	75%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	98%
Outreach Materials and Publications	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Outreach Campaign	100%	100%	100%	100%	100%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	97%
Employee Educators Program	100%	100%	100%	100%	100%	100%	100%	100%	98%	100%	100%	100%	100%	1%	0%	55%	10%	49%	100%	80%
Employee Orientation	0%	100%	100%	100%	100%	1%	100%	100%	100%	100%	100%	100%	40%	3%	100%	82%	100%	100%	100%	80%
Staff Professional Development	0%	100%	100%	0%	100%	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	79%
Public Engagement Total	50%	88%	79%	68%	80%	40%	75%	49%	72%	92%	45%	74%	76%	93%	73%	67%	60%	83%	98%	72%
Community Partnerships	100%	100%	100%	67%	67%	67%	100%	100%	100%	100%	100%	67%	100%	100%	100%	100%	100%	100%	100%	93%
Inter-Campus Collaboration	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Continuing Education	0%	65%	87%	40%	100%	0%	30%	0%	20%	100%	0%	50%	83%	89%	53%	3%	14%	100%	100%	49%
Community Service	69%	64%	25%	84%	36%	8%	63%	67%	63%	100%	50%	43%	16%	61%	33%	77%	16%	28%	91%	52%
Community Stakeholder Engagement	100%	100%	100%	0%	100%	0%	100%	0%	100%	100%	100%	100%	100%	100%	100%	0%	100%	100%	100%	79%
Participation in Public Policy	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0%	100%	100%	100%	100%	100%	100%	100%	100%	89%
Trademark Licensing	0%	100%	100%	100%	100%	100%	100%	0%	100%	100%	0%	100%	100%	100%	100%	100%	100%	100%	100%	84%

Legend

Worcester Polytechnic Institute	WPI	Texas A&M	TAM	North Carolina State University	NCSU
Stanford University	SU	University of Virginia	UV	Tufts University	TU
University of Illinois at Urbana, Champaign	UI	University of Colorado Boulder	UCB	University at Buffalo	UB
University of Texas at Austin	UTA	University of Rochester	UR	University of Massachusetts Amherst	UMA
Columbia University	CU	University of Washington Seattle	UWS	Colorado State University	CSU
Princeton University	PU	Boston University	BU		
Carnegie Mellon	CM	University of California, Santa Barbara	UCSB		

Appendix B:

This is a chart of all the objectives and tasks addressed in the WPI Sustainability Plan

Sustainability Focused Academics Objective/Task Chart

Objective/Task	Measures for Progress	Target Begin/Complete	Responsible Parties
Objective: Increase visibility and financial support for the global project centers	• Amount of funds ($) received for global project centers • Monitoring of project centers' press and awards	FY14/ongoing	IGSD
Objective: Achieving social justice and meet basic human needs in sustainable global development through integration with academic programs	• Number of courses, projects, and research activities that address social justice and human needs	FY15/ongoing	Sustainability Studies program, Humanities/Arts Dept.
Task: Track the activities that address social justice and basic human needs in sustainable global development	• Number of courses, projects, and research activities with a component of human issues	FY15/ongoing	Sustainability Studies program, Humanities/Arts Dept.
Task: Track and coordinate sustainability content of IQPs, MQPs, GPS, and Humanities and Arts requirements	• Current and past data available on sustainability content	FY14/FY15 ongoing	Director of Sustainability, Undergraduate Studies, ISGD
Task: Formalize and highlight the significance of sustainability issues in the Great Problems Seminars, with consideration to the completion of the GPS by all students	• Evaluation of the status of GPS as a project to focus on sustainability issues • Marketing campaign to publicize sustainability and GPS established	FY14/ongoing	Associate Dean for the First Year
Task: Define the role of sustainability in the disciplines for all undergraduate and graduate academic majors	• Role of sustainability defined	FY14/FY15 ongoing	Director of Sustainability, department heads, program directors
Task: Assist students in incorporating sustainability into their majors	• Advising staff trained to advise on sustainability	FY14/FY15 ongoing	Academic Advising
Task: Define and document the sustainability component of each students education	• Definition developed • Current and past data available on sustainability in students' education	FY14/FY15 ongoing	Director of Sustainability
Task: Track and report faculty expertise and interest in sustainability	• Tracking mechanism established • Current and past data available on faculty expertise and interest in sustainability	FY14/FY15 ongoing	Director of Sustainability, Office of the Provost

Appendix C:

This is a transcript of the information and questions asked during interviews with faculty from other universities.

"The name, title and employer of the interviewee will be disclosed and used in the report"

1. What is his/her role at his/her school for the sustainability related programs?
2. What degrees are offered at his/her school that relate to sustainability?
3. What is the main goal of the sustainability programs at his/her school?
4. What percentage of students pursue a degree in sustainability at his/her school?
5. What percentage of students take classes in sustainability at his/her school?
6. What kind of jobs the students are getting after graduating with a sustainability related major?
7. What kind of skills are his/her school providing to students of sustainability programs?
8. What are the main materials included in his/her school's sustainability program?
9. What is the main reason that his/her school started offering a sustainability degree?
10. What is his/her opinion relating to the sustainability major for other schools?
11. What is his/her opinion on the Sustainability Engineering Major?
12. What are his/her suggestions for implementing a Sustainability Major or other sustainability program at a Tech School?
13. Can he/she provide any specific suggestions for WPI or if we should want to start offering a Sustainability Engineering Major or other new sustainability program?

Appendix D:

Below is a list of all the individuals we met with and interviewed. They are organized by school. For the interview summaries, please see appendix E.

Please note that any formal interactions with WPI faculty are denoted by the term "Meetings" and any formal interactions with faculty or staff of other universities or organizations are denoted by the term "Interviews." This differentiation is important because interactions parties external to WPI need to be approved by the Internal Review Board (IRB) of WPI.

Dr. Christopher Boone, Dean of the Sustainability School, Arizona State University: cgboone@asu.edu, (480)965-2236

Dr. Brian Thorn Director of Sustainable Engineering Graduate Programs at the Kate Gleason School of Engineering, Rochester Institute of Technology: bkteie@rit.edu, (585)475-6166

Draci Maresca, Program Manager of the Environmental and Sustainability Program, University of Massachusetts Amherst: dmaresca@umass.edu, (413)545-1680

Tom Wilson, Program Coordinator of the Community-University Partnership and service-learningProgram, University of Vermont: trwilson@uvm.edu, (802)656-3883

Chrysanthe Demetry, Director of the Morgan Teaching and Learning Center, Worcester Polytechnic Institute: cdemetry@wpi.edu, (508)831-5195

Laura Robinson Hanlan, Research and Instruction Librarian, Worcester Polytechnic Institute: lrob@wpi.edu, (508)831-5414

Robert Krueger, Director of Environmental and Sustainability Studies, Worcester Polytechnic Institute: krueger@wpi.edu, (508)831-5110

Fred Looft, Professor of Electrical and Computer Engineering, Worcester Polytechnic Institute: fjlooft@wpi.edu, (508)831-5369

John Orr, Directory of Sustainability, Worcester Polytechnic Institute: orr@wpi.edu, (508)831-5273

Elisabeth Stoddard, Assistant Teaching Professor of Social Science & Policy Sciences, Worcester Polytechnic Institute: eastoddard@wpi.edu, (508)831-5284

Kristen Tichenor, Senior Vice President of Enrollment, Worcester Polytechnic Institute: tichenor@wpi.edu, (508)831-5349

Liz Tomaszewski, Associate Director of Sustainability in the Office of Sustainability, Worcester Polytechnic Institute: ltomasz@wpi.edu, (508)831-5500

Appendix E:

E.1 Meeting with John Orr, March 18th 2016

Discussion Points:

- The Proposed Minor in Sustainability Engineering
- Suggestions

The Proposed Minor in Sustainability Engineering

Professor Orr stated that the reason for developing a Sustainability Engineering minor rather than a major was that it was more realistic. It is more feasible and requires less resources to start a new a curriculum from a minor, since students need only 2 units (18 credit hours) to fulfill the requirements of a minor.

Suggestions

Professor Orr suggested that the team study the disciplines of other majors such as Civil Engineering, Electrical Engineering and Robotics Engineering. Like Robotics Engineering, a Sustainability Engineering (SE) major could be designed with a combination of courses from appropriate departments. He also suggested that it is also better to study Sustainability in courses, or in other majors and minors, instead of studying only for the SE major.

Additionally, from the team's questions about the key information that should be included in an IQP report, he suggested the following topics to do further research:

1. What are other schools doing?
   (a) In an undergraduate level?
   (b) In a graduate level?
   (c) Do they have minors?
   (d) What courses do they offer in the program?
2. The ABET accreditation process
3. Reasons a student should major in Sustainable Engineering
   (a) What is the job potential as a Sustainability Engineer
   (b) What are potential employers
   (c) Are there masters programs? And what skills do they look for from undergraduates?

E.2 Meeting with Laura Robinson, March 18th 2016

Discussion Points:

- Debrief of project
- Recommendations for research

Debrief of project

At the beginning of the meeting, there was a brief discussion about the overall project idea and the tasks that the team had accomplished. After looking at the citation style, Laura commented that current citations were hard to read and suggested to use APA format with IEEE numbering.

Recommendations for research

Since our citations were mostly based on web research, Laura helped the team research databases for published academic papers, including:

- IEEExplore
- ASEE-Scopus
- Eric Database
- Google Scholars
- WPI Library Databases

For using keywords to research, Laura suggested to use a variety of synonyms for "Sustainability," in order to not limit our results by our terminology.

E.3 Meeting with Robert Krueger, March 24th 2016

Discussion Points:

- Professor Robert Krueger's background
- What prompted him to make the Environmental and Sustainability Studies major?
- Does he think the Sustainability Engineering major is worthwhile?
- Collaboration and collaborative learning
- Transdisciplinary education
- Course considerations
- How to make SE major meaningful

Professor Robert Krueger's Background

Professor Krueger's background is in Environmental Policy and Regulation, but he has also taken courses in science and engineering in college. He thinks that his interdisciplinary background gives him a better understanding of sustainability. Professor Krueger also works in Luxembourg as a guest professor every year, where he conducts research on urban studies, environmental justice, and regional and local planning for Luxembourg. He also worked with the Environmental Protection Agency to form advisory committees in environmental justice.

What prompted him to make the Environmental and Sustainability Studies major?

Professor Krueger and other colleagues decided to make the Environmental and Sustainability Studies (ESS) major because it was missing from WPI. We had an environmental policy program at the time, but it wasn't very popular. The ESS program used to be just environmental studies, but it developed into the environmental and sustainability studies later. He mentioned, that there are roughly 30 students per year who major in ESS. The graduates are split half and half between double majoring in ESS or choosing it as their primary major.

Does he think the Sustainability Engineering major is worthwhile?

He would support the Sustainability Engineering (SE) major, but he did not think we need it at WPI. Since the ESS major allows students to take up to 27 credit hours of engineering work, it would be very similar to the SE major. He thinks that instead of sustainability engineers working toward a problem, we need people to concentrate on sustainably solving problems.

Collaboration and collaborative learning

Professor Krueger wants projects, incuding Major Qualifying Projects, Interactive Qualifying Projects, and all other projects on campus to be collaborative between all students on campus. This includes collaboration between Humanities and Arts (HUA) majors and engineering majors as well, since nobody can do everything by themselves. Engineers need to work toward solutions that are functional in society, where HUA majors can step in and finish solving the full problem from a social vantage. He wants us to be able to incorporate this into the SE major, making collaboration a major skill that we need to address. He wants to develop a center for collaboration where all people are working together to develop a common goal of sustainability in the world. At this center, individuals from different disciplines would work together to develop more implementable and realizable projects. He thinks that this is currently a huge issue for many projects at WPI and that it is the reason why many projects on campus, which aim to improve sustainability on campus, do not get implemented.

Transdisciplinary education

Currently at WPI we have interdisciplinary majors and courses, which include double majors with a "4/3 interdisciplinary MQP." Professor Krueger does not think this can be done with SE because one major will always take priority over the other (most likely the technical one). We also have multidisciplinary individuals, where a person is majoring in two different disciplines. What we really need is transdisciplinary education, where different majors and disciplines are working together collaboratively towards a common goal of sustainability in the world.

Course considerations

Professor Krueger stated that courses at WPI including those in the SE major would need to be developed from scratch. If we were to take off-the-shelf courses, it would just be teaching the same courses to the same students and calling it sustainable. It wouldn't really change anything. These courses would need to be taught collaboratively- for example, a basic design course with some green design topics in class is less effective than a basic design course with a focus in green design.

Professors who teach those courses would not only need to be educated in their technical field, but also understand the transdisciplinary action behind the class. If a professor doesn't know, they can't expect the student to know. We also need to have course consistency, where one course leads into another like the fluids-statics-dynamics in engineering, but for sustainability.

How to make SE major meaningful?

We can do an SE major, but there's no guarantee that it will solve anything. We need to realize that just putting a group of courses together with a common theme won't change anything. We want to have an overarching theme that is the norm, not the exception. Our major can't just repackage what already exists, but it must incorporate the collaboration and transdisciplinary thinking that will show that sustainability education is really necessary. This SE major can be part of the collaborative learning theme that he wants, but it would not be limited to this.

E.4 Meeting with Professor Fred Looft, March 25th 2016

Discussion Points:

- The wrong approach
- What problem are you solving?
- General guidance
- Recommendations

The wrong approach

Professor Looft, Electrical and Computer Engineering Professor at WPI, said that sustainability engineering might not be the approach that we want to take with this project. He agreed with Professor Robert Krueger (Appendix E.3) in the fact that anybody can make a course load for a sustainability engineering major, but there's no guarantee that it is going to solve anything. In fact, he almost assured us that it won't solve any of the overall issues with sustainability. He told us that we were thinking too narrowly and to that sustainability engineering is the solution to the sustainability issues we face. It's only really a part of the whole.

What problem are you solving?

So what exactly is the problem? Sustainability education is only a single part of the whole picture. There are also active practices (recycling, turning off the lights, going solar, joining a sustainability club) and advocacy (environmental policy). To narrow it even more, we were also developing the education focus into the idea of "engineering" and "non-engineering". There's no guarantee that this is the best way to approach an overall problem of sustainability. So by limiting ourselves to this one focus, we're effectively shutting out a more substantial part of sustainability that we SHOULD focus on to make a greater impact.

General guidance

He thinks that we should address this from our research that we've done so far. It can be a part of our final paper- why exactly is a sustainability engineering major NOT the best solution? Instead of addressing feasibility, now we're addressing meaningfulness and effectiveness of the program that we're suggesting. Is there enough of our research so far to conclusively say that a sustainability engineering major is not sufficient to work toward solving this overall problem? Yes. Now what's a better way?

Recommendations

There are many different routes to choose from, and there's a lot of work that needs to be done in researching what we can do. We can look at the sustainability plans of other colleges to see what they're doing differently and how they're presenting sustainability to the students to make them more sustainability-conscious. With this information, we'll be able to refocus and present something totally new to WPI that may totally conflict with its Sustainability Plan.

So what about the surveys? It's not that they're totally lost- they still address the idea of education, which is a major part of our project. What we can reanalyze the data it to fall more in line with the sustainability engineering major being the representation of sustainability education for technically-minded students.

E.5 Meeting with Liz Tomaszewski, March 28th 2016

Discussion Points:

- Eco-Reps
- STARS Ratings
- Recycling
- Recyclemania
- Other Universities
- Student Communication
- Engagement
- Contacts

Eco-Reps

The Eco-Reps program was resurrected last year with the help of Greener U. The Eco-Reps program involves students who are trained for a few hours to learn to share knowledge and engagement in sustainability. She stated that WPI should be doing a lot better with this, but that we simply do not have the resources.

STARS Ratings

Our STARS ratings are low in some areas because we are doing well in some areas and poorly in others. There's simply a lack of engagement in the community, especially in recycling. STARS is a compilation of survey questions that addresses three needs- The Princeton Review, which offers a list of "green schools," The Sierra Club, which offers a list of "coolest schools," and the AASHE, which evaluates institutions based on everything from energy to financial aid.

We have been participating in the STARS assessment since it was a pilot program. AASHE works on the "honor system" since the results are self-reported, but the results are not allowed to be anonymously submitted and must be endorsed by the President of the University. Therefore, there is a much higher chance of the results being accurate.

Recycling

We introduced single-stream recycling to WPI which was intended to increase recycling, but it happened at an inconvenient time when we lost our Director of Sustainability. From there, we were supposed to develop a strategy, but it was not developed as it should have been. Engaging students in Recyclemania was also a problem, because students didn't know about it or did not participate. We did relatively well, but not the best.

Recyclemania

At other colleges, including Clark, students who participate in Recyclemania are given class credit. However, there's no incentive for students here. 5 or 6 years ago, we had a "precyclemania" event to prepare for our first participation in recyclemania. It was student driven, but it lost momentum and ended after only a few weeks because it was impossible to keep enough students interested and engaged. Students had to get up early, and it was cold in January. She wonders if incentives would have helped keep it running.

Other Universities
Liz works closely with Clark, who are very actively involved and engaged in sustainability. However, they also have a very different atmosphere on their campus. At WPI we are very focused on education and not so much on the social awareness factor.

She also works with Worcester State University, but it's hard to tell much about them because they're still trying to work out their campus image now that more students are living on campus than ever.

Student Communication
Reaching students is difficult because people want different methods of communication. We can't just find the perfect one. There's currently a graduate student group out of the school of business who are working with the Green Team. They are working on evaluating and modifying communication between all students.

There's also a new meeting series where all the clubs meet with student leaders of sustainability groups once per term and communicate what they want to do on campus.

We can communicate with students who are already engaged in sustainability, because there are aliases that exist with a lot of sustainability groups- GT, EWB, Habitat, GHA, EVE 1-4, EVE Studies, SJSF. That won't reach students that are not part of a sustainability group. We could try sending emails to s tudents@wpi.edu, but we would have to have someone in SGA approve the email.

Engagement
Students don't engage because they're too busy! There are a lot of students that aren't aware of any sustainability method other than waste recycling. At a student activities fair a few years ago, there was a student who said that they weren't interested in sustainability. (Greener U was there)

Greener U suggested that we find a method of communication that would change the way of thinking for students. There's going to be a student sustainability leaders roundtable on April 6 that we should go to. Working with student sustainability leaders is a step in the right direction, but it's a small step.

One solution might be a sustainability literacy assessment- the institute would assess literacy in sustainability. But there's still a problem with the lack of incentive here- what benefit do busy students get for participating? Other than credit, we may be able to provide students with resume material. We could possibly offer a sustainability certification for graduates.

Contacts
Liz also gave us a list of contact which she thought could benefit us in some way if we spoke to them about our project. Liz mentioned:

- Christine Girourd in Student Activities
- Suzanne LePage
- Engineering Ambassadors
  - Ryan Cooney and Meghan Trahan
- The Green Team
- Universities with sustainability

  - Become a member of a “green school list” to get input from schools that have had success in the problem that we have
- Greener U
- Synerge Worcester
- Liz again in the future- she is willing to answer any further questions that we have and she is interested in seeing our final report.

E.6 Meeting with Kristen Tichenor, March 29th 2016

Discussion Points:

- Feedback on demand for Sustainability Engineering Major
- Protocol for establishing a new program at WPI
- Recommendations

Feedback on demand for Sustainability Engineering Major

After discussing our project with Kristin Tichenor, we asked her for feedback on what she thought of the idea of a Sustainability Engineering Major. Kristin told us that she did not know what the demand was for a Sustainability Engineering Major was because it was "too new of a field." She said that it was such a new field of study and profession that there are no set career paths or degrees for it yet. The degrees that are out there all sort of have their own way of solving sustainability problems that consist of environmental, economic, and/or social impacts. But one thing Kristin did acknowledge at the end was that even though it is such a new field and there is not a lot of set information out there for the field, that it does not mean that there is no demand for sustainability engineers.

Protocol for establishing a new program at WPI

During the interview Kristin also mentioned to us that WPI had a particular protocol to establish a new program in the school. The program has to be approved by faculty through a faculty meeting. The undergraduate program Committee on Academic Operations (CAO) has to review the program before that can happen. She also told us that there has to be a few "faculty champions" which write the proposal for the program and put it through the CAO which could include the projected demand for the program as well as a landscape review of what other schools are doing.

After providing that context, Kristin mentioned that WPI does "love" announcing new programs because it does attract more students. Even though a lot of the courses could be some of the traditional courses which are already in place at WPI, the new name of a program could potentially attract more incoming students.

Recommendations

In the end, Kristin was not sure if the Sustainability Engineering Major would be needed at this point in time because it is such a relatively new field. So she decided to give us a few recommendations which have been listed below:

- Make sure whatever we bring complements and is different from the other sustainability- related programs we already have (Architectural Engineering, Environmental Engineering, Environmental and Sustainability Studies)
- Design an incentive program for students
  - The "eagle scout badge mindset" where a student is able to receive some sort of "badge" such as a certification as a reward for taking initiative in sustainability related activities. This thought came from the fact that WPI students are way too busy to try and pursue an interest in sustainability on top of the work they already have in their daily lives

Some of the initiatives she told us we could look into for the future as work to pursue in an incentive program included:

- The major in admission initiative program. Which does not actually exist yet but is in the works. Major in admission is a way to pursue an interest in an area in which we do not have at WPI. It can include a series of activities such co-curricular activities and engagement in programs such as the Grand Challenges initiative from the National Academy of Engineering
- Other programs like the Grand Challenges

E.7 Meeting with John Orr, March 30th 2016

Discussion Points:

- Beginning Discussion
- Suggestions
- Sustainability Career Fair?
- Summary

Beginning Discussion

First of all, Professor Orr mentioned that he would be retiring as an Electrical and Computer Engineering (ECE) professor and continue as just the Director of Sustainability. After discussion about WPI students being less engaged in sustainability active practice and a comparison to other universities, he commented that promoting civic engagement on campus would bring a lot of benefits.

Suggestions

Then he made a suggestion about bringing certification programs that students can be able to pursue accreditation from such as LEED. He mentioned that it would help the student's resume and attract the student's interest.

He suggested the team to look at the "WPI Strategic Plan" that was just recently announced by the president. Furthermore, he stated that organizing the perspectives on sustainability on campus and the literacy assessment for both faculties and students were also necessary things for further research on sustainability. Professor Orr also mentioned that there was some software related to sustainability for engineers, but no one had figured out where or how to use it.

Sustainability Career Fair?

Then the team and Professor Orr discussed the "Sustainability Career Fair" that is moving around Massachusetts. He said that he had suggested it to the Career Development Center (CDC). However, they found that sustainability companies need mostly technicians rather than engineers. Another discussion on it was that most students do not have the opportunity to go to those career fairs because of the high price. Professor Orr stated that the high price is to cover the cost of the event and therefore, reducing it seems to be impossible.

Summary

In conclusion, Professor Orr suggested the team make "the report useful for someone." He mentioned that the team should present ways to implement the solution instead of just presenting several recommended solutions. He suggested that we look at the Bike Share IQP and mentioned how they are trying to implement it now to help us understand what he meant by making "the report useful for someone."

E.8 Interview with Dr. Christopher Boone, April 5th 2016

Discussion Points:

- Arizona State University Programs
- ASU Sustainability Student Skillset
- Why a sustainability program?
- Final comment

Arizona State University Programs

After a brief about our project project, Dr. Boone explained the sustainability programs at Arizona State University (ASU). ASU provides a sustainability major as a Bachelor of Science(BS), Master of Science (MS), Bachelor of Arts (BA), Masters of Arts (MA), and PHD programs. Dr. Boone further explained that with some overlap among BS and BA programs, BS program focuses more on social science and technology while BA program focuses on more writing requirements.

ASU also provide minor in Sustainability with two main concentrations: Certificate in Energy and Certificate in Food Sustainability. Dr. Boone mentioned that they could have seen significant amount of student's interest in food sustainability. Furthermore, in ASU there are altogether 62000 seats in sustainability classes. Dr. Boone said that, those classes are already familiar topics for the students.

ASU Sustainability Student Skillset

The skill set that ASU is training to its students are:

- Consistent thinking
- Confidences
- Strategic competency
- Collaborative competency

Why a sustainability program?

The main reason that ASU starts providing Sustainability major was a part of President's vision to build innovative university. ASU's President see sustainability as design science, outcome oriented science, social need, environmental need and economic need. The discipline of the major was structured by faculty from different departments in one room. Dr. Boone said that this major brought together the whole university.

Final comment

As a last comment, he said that he would welcome any university that creates a sustainability major because it is becoming one that the world is needing.

E.9 Interview with Dr. Brian Thorn, April 6th 2016

Discussion Points:

- Programs at RIT
- Sustainability Engineering Program Beginnings
- Skills
- Comments
- Recommendations

Programs at RIT

After a brief discussion about the our project, Dr. Brian Thorn explained what programs of study relative to sustainability are available at RIT. The programs are listed below with a little bit of information which Dr. Thorn provided us with:

- Master of Science (MS) in Sustainability Engineering (SE)
  - This program culminates in a thesis
  - Technical undergraduate background required (engineering/science undergraduate degree)
- Master of Engineering (ME) in Sustainability Engineering
  - This program requires a final project
  - Technical undergraduate background required (engineering/science undergraduate degree)
- Master of Science in Sustainable Systems
  - Program takes wider background of students (undergraduate degree in the liberal arts, engineering, sciences, etc.)
  - This program involves more research and less problem solving than the Sustainability Engineering programs at RIT

Sustainability Engineering Program Beginnings

When asked about the main driving force behind the SE masters programs, Dr. Thorn responded with "students." He then restated that students had been the driving force behind the program starting up. He mentioned that years back, a group of students had repeatedly requested for courses such as the ones in the SE masters programs now. Then more and more students throughout the years kept requesting for courses, which showed interest and the faculty decided to create a minor in sustainability engineering. After more time, with continued interest in the program, faculty decided it was appropriate to create the SE masters programs.

He ended the thought telling us that the faculty also received support from the dean which helped get the program jumpstart.

Skills

When we asked Dr. Thorn about the skills that his program develops in his students, he told us about the core courses that his students take in RIT's Sustainability Engineering programs. There is one course on the fundamentals of sustainability which covers topics of environmental issues, social issues, and policy implications. Dr. Thorn also told us that the fundamentals of sustainability course provides the ability to conduct life cycle assessments. There is also another course that Dr. Thorn told us about which is product development. This course allows students to analyze a product from concept to design to retirement. The course also provides skills in energy auditing. One thing he emphasized was that the Sustainability Engineering programs at RIT include lots of team project work and he thought that being able to work in a team was a very important skill to attain. Dr. Thorn mentioned that afterwards, the students can decide to branch off and specialize into any facet of the program which he said he did not have enough time to explain fully.

Recommendations

Dr. Thorn recommended that we take "baby steps" as the program at RIT did where it started with a couple engineering courses that were designed for a group of interested individuals. Then the courses eventually turned into a minor once enough student interest was there and then eventually the Sustainability Engineering MS and ME programs were created. The way he summed it up was to first "bite" off a smaller scope project, and "then go into" a larger scope project.

E.10 Interview with Darci Maresca, April 7th 2016

Discussion Points:

- Darci's role at UMass-Amherst
- New Sustainability Program
- MS3 Program at UMass
- Project Opportunities in Sustainability
- MS3 Program Beginning
- Suggestions for WPI

Darci's role at UMass-Amherst

After a brief discussion about our project, Darci explained what her role is at the University of Massachusetts - Amherst (UMass Amherst) Sustainability programs. She works under the School of Urban Sustainability, primarily with program, faculty, students and research. Moreover, she coordinates between the department of environmental conservation, department of geo-science and department of culture. Those three departments focus on environmental sustainability science. There were also other entities on campus that focus on sustainability.

New Sustainability Program

She also stated that on April 13, 2016, the university administration was going to approve the creation of the new School of Urban Sustainability. It would become the center of UMass Amherst for student education, training, innovation and research.

MS3 Program at UMass

Then the discussion went to UMass Amherst's Master of Science in Sustainability Science. Darci stated that it was one of the "huge" programs in the country that provides advanced education in sustainability. Students under this program want to explore sustainability under different topics. Therefore, the program has four specializations (Environmental Quality, Sustainable Agriculture and Food System, Water Sustainability, and Climate Change and Urban Sustainability) that students mainly focus on.

Furthermore, students can also pursue the area of interest apart from those four traditional specializations. The other important aspect of the program is that all of their students complete a practicum that is a 150 hour internship. Darci also stated that most employers have demonstrated the need of sustainability knowledge in every organization. Students go into the occupation field as sustainability managers or sustainability coordinators.

Most of the employers were higher education institutions. They hired the graduates from MS3 Program as their sustainability coordinator. In addition to the practicum, a lot of their graduate level training involved service-learningprojects and campus activities. Therefore, graduates could add examples on how they incorporate sustainability in higher education. Another sector that looks to hire sustainability professionals is the government. At the state level, there were positions like sustainability managers, sustainability advisors, etc. Another job that students get is in the local food system.

Project Opportunities in Sustainability

In the teaching way of UMass Amherst, there are many interactions between leadership, campus activities, and curriculum. Darci gave the eco-rep program as an example. A lot of graduate students in MS3 programs were mentors to undergraduate students for sustainability projects. Darci provided three examples of campus projects. The first one was the Permaculture Project that got the White House award. The student who thought of the project was a part of the MS3 program. The second campus project example Darci gave was the Sustainable Clothing that created a green clothing line on campus. The last one was the project of a few MS3 students working on waste on campus at UMass Amherst.

MS3 Program Beginning

The MS3 program was started in 2011 mainly by the graduate program director. To launch the program, he had to go through a multi-year process of creating a new program. The first class only had 4 or 5 students. The current class size is around 20-25. For the next year, the class has received 80 applicants, including international students. Darci stated that there is a demand for a sustainability program and that they will try to open up more seats for it.

Suggestions for WPI

Darci suggested the team looks at "Interdisciplinary Environmental Education: element of field identity and field curriculum design" by Shirley Vincent from National Council of Science and Environment. Darci thinks that a degree program is more marketable than a certificate or minor. She sees tremendous linkage between sustainability and engineering. She commented that if WPI had the opportunity to link sustainability with engineering, the program would be wildly popular and students could be very successful in the job market.

E.11 Interview with Tom Wilson, April 14th 2016

Discussion Points:

- Tom Wilson
- Service-Learning at UVM

Tom Wilson

After a brief description about the project, Tom explained that the service-learning program at UVM started a long time ago. He said that he might not have a lot of insight on the start time of the project. However, that he is a good contact for the current program, current partnership, has knowledge on how they set up service-learning projects, and connecting faculty and partners.

Service-Learning at UVM

The discussion started with how the current service-learningprogram was running. Tom said that typically there are 70 to 80 available service learning-based courses each year. However, they have closer to 100 courses this year. Those courses are not evenly spread through the different fields of study. The number varies by the school/college or by department. UVM's School of the Arts and Sciences is the largest school at UVM with half of the total undergraduate students enrolled in it. However, it has the least number of service-learningcourses. Tom said that some departments and colleges have really built service-learninginto their curriculum. service-learningis implemented in many different courses and course levels from introductory level courses to capstone level courses. The examples are College of Environment and Natural Resources, Department of Community Development and Applied Economics, College of Education and the Department of Civil and Environmental Engineering. Then the discussion went into how often they communicate with outside organizations to solve the community problems. Tom explained that it varied according to the type of project and the type of provision. Among the several ways of incorporating service-learningwith community partners, one is direct communication with the organizations for projects. However, what they usually do is have faculty utilize their connections for their service-learningclasses. Tom said according to their research, service-learninghas similar benefits regardless of discipline. However, there are certain subject areas that are more used to doing field work. Moreover, UVM has the oldest service-learningoffice in the country. It was founded in 1971. The office reformed a few throughout the history. In 2003, the office changed its to Community- university Partnership and Service Learning. The idea was to get primary gateway from community to UVM. As the last thing, Tom mentioned that UVM has sustainability requirements for all students.

E.12 Meeting with Elisabeth Stoddard, April 18th 2016

Discussion Points:

- Rooftop farm in Boston
- Great Problems Seminar (GPS)
- Major & Mission
- Further people to contact

Rooftop farm in Boston

Professor Stoddard advises the annual IQP working with a rooftop farmer in downtown Boston. Previous projects included development of snail production for increasing the economic sustainability of the farm and developing solutions for carbon free delivery of produce throughout the city. The IQPs mentioned above were essentially given to the students. The farmer had clear problems and ideas of ways to solve them, and the students developed specific solutions and then expanded the scope to allow those solutions to be applied to other, larger scale problems.

Great Problems Seminar (GPS)

The Professor went over the GPS process and tendencies of students in great detail. During the first of the two terms, the students are shown the general problems, in this case, the usage, conservation, and supply of water globally. As the students begin to understand the general trends of this field, they also narrow the scope of the problem to allow them to find a problem that is solvable in the next term. Generally, by the end of the first term, students have a well defined problem. In the second term, students research the specific problem, and develop potential solutions.

The professor emphasised the main differences between this project, and the IQP process. In general, GPS projects start with a very broad problem and narrow it to an achievable one. The IQPs however, generally start with a specific problem and expand its impacts to grander scales. The important distinction here is the change in scope. GPSs start with a larger scope and narrow while IQPs start with a narrower scope and expand. In addition, the GPS is also a first year course designed to teach students many things in addition to the single topic at hand. This includes communication skills, research skills, how to write with sources, and general group dynamics.

Major & Mission

With the new Strategic Plan from President Leshin, WPI is trying to emphasize the "Major & Mission" mentality. Basically, students come to WPI with a mission in mind. This mission then aligns with their major, projects, and extracurricular activities. Professor Stoddard suggested relating our service-learning approach to this new way of talking about an individual's college career. Perhaps there is a way to relate our idea of service-learningto the GPS and the new strategic plan.

Another important realization is the idea that students need to see tangible results. If a student puts weeks of time and effort into a project, and the project succeeds and leads to a real change, then the students is more driven to learn more and will retain more of the information later. Having tangible results is necessary for the success of any project with individuals who have an engineering mindset.

In addition to unifying service-learning with the WPI strategic plan, Professor Stoddard also suggested making some kind of guidelines for adding service-learning to an course. Many faculty members are interested in increasing sustainability and many more are interested with increasing student's retention and effort. Developing a set of guidelines with concrete examples of courses with service-learning components will help faculty incorporate service-learning into their own courses.

Further people to contact

In addition to advice on the project, Professor Stoddard also gave us a list of faculty to contact. The most important person on the list is Chrys Demetry, Director of the Morgan Teaching and Learning Center and Associate Professor of Mechanical Engineering. Professor Demetry helps coordinate many courses and also manages many faculty community learning grants. Professor Stoddard also said that Professor Demetry is one of the faculty members most likely to benefit from and use our solution. Professor Demetry might also be able to help us acquire a grant for this project, which would help it get a long way to being fully implemented.

E.13 Meeting with Chrysanthe Demetry, April 25th 2016

Discussion Points:

- Professor Demetry's Background in Service Learning
- Major and a Mission
- Advice
- Last Thoughts

Professor Demetry's Background in Service Learning

After a brief discussion about our project, Professor Demetry gave us a little bit of information about her and her connection to service-learning at WPI. She mentioned how service-learning has been in WPI's curriculum for over the past 40 years in Interactive Qualifying Projects (IQPs) specifically. That includes both on campus and off campus sites as well. Professor Demetry mentioned how she is not the most "informed" person on service learning, because she has not read up on it much or done much research on it, but that she is informed on the power of service learning. She told us about the program CAMP REACH that she developed, which is actually a program geared to introduce girls to the concept of engineering design in a social context, which is a service-learningprogram because they solve real world community problems of the surrounding community. Her direct quote about service-learning was that it "can contextualize and motivate learning."

Major and a Mission

We asked Professor Demetry about the strategic plan and how the Major and a Mission plan that is in store could fit into it. She responded by saying that there could be room for that in there, but that there would be challenges with it because the Major and a Mission is very personal. The Major and a Mission initiative has students develop their own individualized mission so it is very tough to implement it in that perspective. Also, Professor Demetry found that implementing service-learning into seven week courses seems like a very tough obstacle to overcome because she did not think it was enough time to solve a good project that involves service learning.

One last note on the subject, was that she thought that there is a lot of potential including local problems as a context in learning which could classify as service learning.

Advice

When we asked about advice when presenting the idea of service-learning to faculty who may be interested in implementing the system, she advised us to give concrete examples. She mentioned that they are extremely helpful and that presenting a range of what we believe to be service-learning, especially in a graph with resource links, would probably be best for the understanding of service-learning.

Last Thoughts

Professor Demetry also talked about a few other concerns she had with implementing service-learning in a curriculum. One of the key things she said was that finding community partners to work with "takes a ton of time." And that faculty will find that the most troubling.

A few other things she mentioned were:

- Present to professors who teach and are always trying new ways to teach
- service-learning could be successful in first and sophomore year courses here at WPI
- "Faculty are inspired by example." So again, to present concrete examples on ways this has been implemented before "both here on WPI's learning example and everywhere also as well"
- Try to target maybe one professor in each program at first

Appendix F:

Below is the draft for the Sustainability Engineering Minor proposed by Professor John Orr, Director of Sustainability at WPI.

Proposed Minor in Sustainability Engineering

Description

This Minor is intended for students who are interested in gaining knowledge and experience in the principles and practices of engineering design for sustainability, and of the critical role of engineering decisions on the sustainability of the resulting designs. Every engineering discipline impacts the environmental and social sustainability of the planet, and knowledge of the principles of sustainability in engineering design will contribute substantially to professional practice.

While this minor is intended primarily for engineering students, it is open to all students. Students may elect to pursue sustainability within the context of their Major, or to use this Minor to significantly broaden their knowledge and skills. For example, an ME student with interests in renewable power generation could construct a Minor program that adds knowledge in electrical power systems to an ME concentration in mechanical power.

Requirements

Candidates for the Sustainability Engineering Minor must meet the following requirements:

1. Complete and obtain approval for the Application for the Minor in Sustainability Engineering available from the Registrar or the Office of Sustainability.
2. Complete two units of work for the minor, one unit of which may be double counted with other degree requirements. The two units must meet the following requirements:
   - I. Must include ES 2800, Environmental Impacts of Engineering Decisions.
   - II. May include at most 1/3 U of relevant 1000-level work, such ENV 1100 or relevant GPS credit.
   - III. Must include between 1/3 and 2/3 U of relevant Humanities or SSPS work selected from the following list:
     - ENV 2201, Planning for Sustainable Communities
     - ENV 2400, Environmental Problems and Human Behavior
     - ENV 2600, Environmental Problems in the Developing World
     - GOV 2311, Environmental Policy and Law
     - GOV 2312, International Environmental Policy
     - GOV 2319, Global Environmental Politics
     - HI 2401, U.S. Environmental History
     - HI 3317, Topics in Environmental History
     - PY 2717, Philosophy and the Environment
   - IV. Must include at least 1 U of engineering work from the following list:
     - AREN 3003, Principles of HVAC Design for Buildings
     - AREN 3025, Building Energy Simulation
     - CE 3059, Environmental Engineering
     - CE 3070, Urban and Environmental Planning
     - CE 3074, Environmental Analysis

- ECE 3500, Introduction to Contemporary Electric Power Systems
- ES 2001, Introduction to Materials Science
- ME 5105, Renewable Energy

3. To accommodate new sustainability-related courses and independent study and project activities, up to two thirds units may be substituted for the activities listed in items III and IV with the approval of the Sustainability Engineering Minor program review committee. This committee may be contacted through the registrar or the director of sustainability.
4. See the WPI Undergraduate Catalog for additional rules for all minors, in particular that the MQP cannot be used in satisfying any Minor and that at most 1 unit may be double counted with another degree requirement.

Guidance for Students

Possible focus areas (not exhaustive):

The following focus areas and sample programs may be helpful in selecting the activities that compose the two units of credit for the minor, but they are not meant be restrictive in any way.

- Architectural Engineering
- Manufacturing Engineering
- Environmental Engineering
- Power and Energy Engineering
- Materials
- Fuels

Example Programs

For a Civil Engineering student (double counted courses are in bold)

- ES 2800, Environmental Impacts of Engineering Decisions
- GPS Course, Powering the World
- ENV 2201, Planning for Sustainable Communities
- **AREN 3003, Principles of HVAC Design for Buildings**
- **CE 3059, Environmental Engineering**
- **CE 3070, Urban and Environmental Planning**

For a Mechanical Engineering student

- **ES 2800, Environmental Impacts of Engineering Decisions**
- **ECE 3500, Introduction to Contemporary Electric Power Systems**
- HI 2401, Environmental History
- AREN 3003, Principles of HVAC Design for Buildings
- **ME 5105 Renewable Energy**
- ENV 2201, Planning for Sustainable Communities

Additional course to meet background requirements:

- ECE 2010, Introduction to ECE

Application for **Minor in Sustainability Engineering**

Student name _____

ID number _____ **Email Address** _____ @wpi.edu

Academic Advisor _____ **Major** _____

The Sustainability Engineering Minor consists of 2 units of work distributed as follows with no more than 1 unit of work overlapping other degree requirements.

Requirement/Option	Course #	Units	Term	Grade	X if double counted
Required 1/3 U of ES 2800	ES 2800	1/3			
Optional 1/3 U of 1000 level work from List A					
Required 1/3 U of HU/A or SSPS from list B					
Optional additional 1/3 U of HU/A or SSPS, from list B					
Required 1/3 U from list C					
Required 1/3 U from list C					
Required 1/3 U from list C					
Optional 1/3 U from list C					
Approved substitute activity, if any					
Total Units		**2**			

Focus of this Minor (such as renewable energy, appropriate technology, clean fuels, etc.):

_____

Required Signatures

Approval of substitution for any of the requirements

The following activity_____

is approved for substitution of _____

Sustainability Minor Review Committee _____

Date _____

Approval of the Minor Plan of Study:

Sustainability Minor Review Committee _____

Date _____

The student is responsible for completing this form and obtaining the required signatures in advance of application for graduation.

List A, 1000 level Courses

- Relevant GPS activity
- ENV 1100, Introduction to Environmental Studies

List B, HU/A and SSPS Courses

- ENV 2201, Planning for Sustainable Communities
- ENV 2400, Environmental Problems and Human Behavior
- ENV 2600, Environmental Problems in the Developing World
- GOV 2311, Environmental Policy and Law
- GOV 2312, International Environmental Policy
- GOV 2319, Global Environmental Politics
- HI 2401, U.S. Environmental History
- HI 3317, Topics in Environmental History
- PY 2717, Philosophy and the Environment

List C, Engineering Courses

- AREN 3003, Principles of HVAC Design for Buildings
- AREN 3025, Building Energy Simulation
- CE 3059, Environmental Engineering
- CE 3070, Urban and Environmental Planning
- CE 3074, Environmental Analysis
- ECE 3500, Introduction to Contemporary Electric Power Systems
- ES 2001, Introduction to Materials Science
- ME 5105, Renewable Energy

JAO 2/4/16

Appendix G:

This is a transcription of the WPI Sustainability Course Inventory 2015-2016. The example formatting is shown below:

Undergrad/Grad, **Subject**, CN####, **Course Title**, Focused/Inclusive

Courses:

Undergrad, **Biology/Biotechnology**, BB 1002, **Environmental Biology**, Focused

Undergrad, **Biology/Biotechnology**, BB 1045, **Biodiversity**, Inclusive

Undergrad, **Biology/Biotechnology**, BB 2040, **Principles of Ecology**, Inclusive

Undergrad, **Biology/Biotechnology**, BB 2904, **Ecology, Environment, & Animal Behavior**, Inclusive

Undergrad, **Biology/Biotechnology**, BB 4150, **Environmental Change**, Focused

Undergrad, **Biomedical Engineering**, BME 4300, **MQP Capstone Design**, Inclusive

Undergrad, **Entrepreneurship**, ETR 290X, **Social Entrepreneurship**, Inclusive

Undergrad, **Organizational Behavior and Change**, OBC, **Leadership, Ethics, & Social Entrepreneurship**, Inclusive

Undergrad, **Chemical Engineering**, CHE 3702, **Energy Challenges in the 21st Century**, Focused

Undergrad, **Chemical Engineering**, CHE 3920, **Air Quality Management**, Inclusive

Undergrad, **Chemical Engineering**, CHE 4402, **Unit Operations in Chemical Engineering II**, Inclusive

Undergrad, **Chemical Engineering**, CHE 4404, **Chemical Plant Design Project**, Inclusive

Undergrad, **Chemical Engineering/Civil Engineering**, CHE/CE 4063, **Transport & Transformations in the Environment**, Inclusive

Undergrad, **Chemistry & Biochemistry**, CH 3410, **Principles of Inorganic Chemistry**, Inclusive

Undergrad, **Architectural Engineering**, AREN 2023, **Introduction to Architectural Engineering**, Inclusive

Undergrad, **Architectural Engineering**, AREN 3001, **Architectural Graphics and Communication**, Inclusive

Undergrad, **Architectural Engineering**, AREN 3002, **Architectural Design**, Inclusive

Undergrad, **Architectural Engineering**, AREN 3003, **Principles of HVAC Design**, Inclusive

Undergrad, **Architectural Engineering**, AREN 3005, **Lighting Systems**, Inclusive

Undergrad, **Architectural Engineering**, AREN 3006, **Advanced HVAC Systems**, Inclusive

Undergrad, **Architectural Engineering**, AREM 3025, **Building Energy Simulation**, Inclusive

Undergrad, **Architectural Engineering**, AREN 3026, **Building Envelope Design**, Inclusive

Undergrad, **Civil & Environmental Engineering**, CE 3022, **Legal Aspects in Design and Construction**, Inclusive

Undergrad, **Civil & Environmental Engineering**, CE 3025, **Project Evaluation**, Inclusive

Undergrad, **Civil & Environmental Engineering**, CE 3026, **Materials of Construction**, Inclusive

undergrad, **Civil & Environmental Engineering**, CE 3059, **Environmental Engineering**, Inclusive

Undergrad, **Civil & Environmental Engineering**, CE 3060, **Water Treatment**, Inclusive

Undergrad, **Civil & Environmental Engineering**, CE 3061, **Waste-Water Treatment**, Inclusive

Undergrad, **Civil & Environmental Engineering**, CE 3062, **Hydraulics**, Inclusive

Undergrad, **Civil & Environmental Engineering**, CE 3070, **Urban & Environmental Planning**, Focused

Undergrad, **Civil & Environmental Engineering**, CE 3074, **Environmental Analysis**, Inclusive

Undergrad, **Civil & Environmental Engineering**, CE 4060, **Environmental Engineering Laboratory**, Inclusive

Undergrad, **Civil & Environmental Engineering**, CE 4061, **Hydrology**, Inclusive

Undergrad, **Civil & Environmental Engineering**, CE 4071, **Land Use Development & Controls**, Inclusive

Undergrad, **Civil & Environmental Engineering**, CE 4600, **Hazardous and Industrial Waste Management**, Inclusive

Undergrad, **Geosciences**, GE 2341, **Geology**, Inclusive

Undergrad, **Electrical and Computer Engineering**, ECE 2019, **Sensors, Circuits, & Systems**, Inclusive

Undergrad, **Electrical and Computer Engineering**, EVE 3500, **Introduction to Contemporary Electrical Power Systems**, Inclusive

Undergrad, **English**, EN 2237, **Literature and the Environment**, Inclusive

Undergrad, **History**, HI 2332, **History of Modern American Science and Technology**, Inclusive

Undergrad, **History**, HI 2401, **U.S. Environmental History**, Inclusive

Undergrad, **History**, HI 2403, **Global Environmental History**, Inclusive

Undergrad, **History**, HI 3317, **Topics in Environmental History**, Inclusive

Undergrad, **History**, HI 3335, **Topics in History of Non-Western Science and Technology**, Inclusive

Undergrad, **History**, HI 3343, **Topics in Asian History of Religion in China**, Inclusive

Undergrad, **Humanities**, HU 3900, **Inquiry Seminar: Developing Teaching Game**, Inclusive

Undergrad, **Humanities**, HU 3900, **Inquiry Seminar: Developing Teaching Game**, Inclusive

Undergrad, **Humanities**, HU 3900, **Inquiry Seminar: Human Animal Studies**, Inclusive

Undergrad, **Humanities**, HU 3900, **Inquiry Seminar: Environmental Philosophy**, Inclusive

Undergrad, **Humanities**, HU 3900, **Inquiry Seminar: Technical Resource and Population Bomb**, Inclusive

Undergrad, **Humanities**, HU 3900, **Inquiry Seminar: World History**, Inclusive

Undergrad, **Humanities**, HU 3900, **Inquiry Seminar: DDT, Silent Spray and American Environment**, Inclusive

Undergrad, **Humanities**, HU 3900, **Inquiry Seminar: Environmental History of the Airplane**, Inclusive

Undergrad, **Humanities**, HU 3900, **Inquiry Seminar: Waterways History**, Inclusive

Undergrad, **Humanities**, HU 3900, **Inquiry Seminar: Environmental American Literature**, Inclusive

Undergrad, **Humanities**, HU 224X, **Global Justice & Development**, Inclusive

Undergrad, **International and Global Studies**, INTL 2910, **Topics in Global Studies**, Inclusive

Undergrad, **Philosophy**, PY 2711, **Philosophical Theories of Knowledge**, Inclusive

Undergrad, **Philosophy**, PY 2712, **Social and Political Philosophy**, Inclusive

Undergrad, **Philosophy**, PY 2717, **Philosophy and the Environment**, Focused

Undergrad, **Philosophy**, PY 2719, **Philosophy of Science**, Inclusive

Undergrad, **Philosophy**, PY 2731, **Introductory Ethics**, Inclusive

Undergrad, **Philosophy**, PY3711, **Topics in Philosophy: Capitalism and Critics**, Inclusive

Undergrad, **Philosophy**, PY 3712, **Philosophy of Religion**, Inclusive

Undergrad, **Philosophy**, PY 3731, **Ethical Questions of Our Time**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Albania**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Bar Harbor**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Capetown**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Costa Rica**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, China**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Hong Kong**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Morocco**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Denmark**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Australia**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, India**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, New Zealand**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Boston**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Nambia**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Nantucket**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Bamgkok**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Puerto Rico**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Santa Fe**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Venice**, Inclusive

Undergrad, **Interdisciplinary**, ID 2050, **Social Science Research, Worcester**, Inclusive

Undergrad, **Interactive Medial and Game Development**, IMGD 2000, **Social Issues in Interactive Media & Games**, Inclusive

Undergrad, **Interactive Media and Game Development**, IMGD 4600, **Serious Games**, Inclusive

Undergrad, **Mechanical Engineering**, ME 4821, **Plastics**, Inclusive

Undergrad, **Mechanical Engineering**, ME 4860, **Food Engineering**, Inclusive

Undergrad, **Engineering Science**, ES 2800, **Environmental Impacts of Engineering Decisions**, Focused

Undergrad, **First Year**, FY 1100, **GPS: Food Sustainability**, Focused

Undergrad, **First Year**, FY 1100, **GPS: Livable Cities**, Focused

Undergrad, **First Year**, FY 1100, **GPS: Biosphere, Atmosphere, and Human Fears**, Focused

Undergrad, **First Year**, FY 1100, **GPS: Power the World I**, Focused

Undergrad, **First Year**, FY 1100, **GPS: The Worlds Water I**, Focused

Undergrad, **First Year**, FY 1100, **GPS: Heal the World I**, Focused

Undergrad, **First Year**, FY 1101, **GPS: Food Sustainability II**, Focused

Undergrad, **First Year**, FY 1101, **GPS: Livable Cities II**, Focused

Undergrad, **First Year**, FY 1100, **GPS: Biosphere, Atmosphere, and Human Fears II**, Focused

Undergrad, **First Year**, FY 1100, **GPS: Power the World II**, Focused

Undergrad, **First Year**, FY 1100, **GPS: The World's Water II**, Focused

Undergrad, **First Year**, FY 1100, **GPS: Heal the World II**, Focused

Undergrad, **Economics**, ECON 1110, **Introductory Microeconomics**, Inclusive

Undergrad, **Economics**, ECON 2117, **Environmental Economics**, Focused

Undergrad, **Economics**, ECON 212X, **Public Economics**, Inclusive

Undergrad, **Environmental Studies**, ENV 1100, **Introduction to Environmental Studies**, Focused

Undergrad, **Environmental Studies**, ENV 1500, **Introduction to Geographical Information Systems**, Inclusive

Undergrad, **Environmental Studies**, ENV 2210, **Planning for Sustainable Communities**, Focused

Undergrad, **Environmental Studies**, ENV 2400, **Environmental Problems and Human Behavior**, Focused

Undergrad, **Environmental Studies**, ENV 2600, **Environmental Problems in the Developed World**, Focused

Undergrad, **Environmental Studies**, ENV 4400, **Senior Seminar in Environmental Studies**, Focused

Undergrad, **Environmental Studies**, 200X, **Climate Change: Vulnerability and Mitigation**, Inclusive

Undergrad, **Environmental Studies**, ENV 230X, **Environmental Governance, Technology, and Innovation**, Focused

Undergrad, **Environmental Studies**, ENV 250X, **Growth, Development, & Environmental Justice in China**, Focused

Undergrad, **Environmental Studies**, ENV 280X, **Environmental & Risk Communication**, Focused

Undergrad, **Political Science, Government & Law**, GOV 2302, **Science-Technology Policy**, Inclusive

Undergrad, **Political Science, Government & Law**, GOV 2311, **Environmental Policy and Law**, Inclusive

Undergrad, **Political Science, Government & Law**, GOV 2312, **International Environmental Policy**, Focused

Undergrad, **Political Science, Government & Law**, GOV 2319, **Global Environmental Politics**, Focused

Undergrad, **Society/Technology Studies**, STS 120X, **Fundamentals of Global Health**, Inclusive

Undergrad, **System Dynamics**, SD 1510, **Introduction to Systems Dynamics Modeling**, Inclusive

Grad, **Biology/Biotechnology**, BB 515, **Environmental Change: Problems and Approach**, Focused

Grad, **Biology/Biotechnology**, BB 542, **Ecological Simulation Modeling**, Inclusive

Grad, **Biology/Biotechnology**, BB 577, **Advanced Ecology & Evolutionary Bioscience**, Inclusive

Grad, **Business**, BUS 500, **Business Law, Ethics & Social Responsibilities**, Inclusive

Grad, **Business**, BUS 598, **Social Responsibility and Organizational Strategies**, Inclusive

Grad, **Business**, BUS 598, **Introduction to Sustainability Management**, Focused

Grad, **Operations & Industrial Engineering**, OIE 541, **Operations Risk Management**, Inclusive

Grad, **Operations & Industrial Engineering**, OIE 555, **Lean Process Design**, Inclusive

Grad, **Chemical Engineering**, CHE 531, **Fuel Cell Technology**, Inclusive

Grad, **Chemical Engineering**, CHE 580, **Cameroon Energy Project**, Inclusive

Grad, **Chemistry & Biochemistry**, CH 555, **Advanced Topics**, Inclusive

Grad, **Civil & Environmental Engineering**, CE 515, **Smart Structures**, Inclusive

Grad, **Civil & Environmental Engineering**, CE 542, **Geohydrology**, Inclusive

Grad, **Civil & Environmental Engineering**, CE 562, **Biosystems in Environmental Engineering**, Inclusive

Grad, **Civil & Environmental Engineering**, CE 565, **Surface Water Quality Modeling**, Inclusive

Grad, **Civil & Environmental Engineering**, CE 566, **Ground Water Flow & Control**, Inclusive

Grad, **Civil & Environmental Engineering**, CE 567, **Hazardous Waste: Containment, Treatment and Prevention**, Inclusive

Grad, **Civil & Environmental Engineering**, CE 571, **Water Chemistry**, Inclusive

Grad, **Civil & Environmental Engineering**, CH 574, **Water Resources Management**, Inclusive

Grad, **Civil & Environmental Engineering**, CE 587, **Building Information Modeling**, Inclusive

Grad, **Civil & Environmental Engineering**, CE 590, **Senior Project: Water Security**, Inclusive

Grad, **Civil & Environmental Engineering**, CE 590, **Sustainable Infrastructure**, Focused

Grad, **Materials Science & Engineering**, MTE 5847, **Materials for Electrochemical Energy Systems**, Inclusive

Grad, **Mechanical Engineering**, ME 5105, **Renewable Energy**, Focused

Grad, **Mechanical Engineering**, ME 5847, **Electrochemical Energy Systems**, Inclusive

Grad, **Nuclear Science and Engineering**, NSE 530, **Health Physics**, Inclusive

Grad, **Nuclear Science and Engineering**, NSE 550, **Reactor Design, Operations, and Safety**,

Grad, **Physics**, MPE 574, **Physics for Citizen Leaders**, Inclusive

Grad, **Social Science**, SS 590, **Energy and Environmental Dynamics**, Focused

Grad, **System Dynamics**, SD 561, **Energy and Environmental Dynamics**, Focused

Appendix H:

The following is a transcript of the online survey given to WPI students.

"This survey is completely anonymous and the identity of the surveyee will not be recorded by any means"

1. What is your student status at WPI
   (a) Undergraduate
   (b) Graduate
2. What is your gender?
   (a) Male
   (b) Female
   (c) Other
   (d) Prefer not to answer
3. What is/are your major(s)? (Check all that apply)
   (a) Mechanical Engineering
   (b) Biology and Biotechnology
   (c) Biomedical Engineering
   (d) Robotics Engineering
   (e) Electircal & Computer Engineering
   (f) Civil and Environmental Engineering
   (g) Computer Science
   (h) Other (Place to insert major)
4. What is/are your minor(s)?
   (a) Specify your minor (Place to insert minor)
   (b) I do not plan to minor in any subject
5. What is your planned year of graduation?
   (a) 2016
   (b) 2017
   (c) 2018
   (d) 2019
   (e) 2020
6. What is your interest level in practicing sustainability?
   (a) Extremely interested
   (b) Very interested
   (c) Moderately interested
   (d) Slightly interested
   (e) Not interested at all
7. How often do you participate in the following sustainable active practices
   (a) Recycling
      i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday
   (b) Water Conservation
      i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday
   (c) Composting
      i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday

(d) Turning lights off when not in use

i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday

(e) Purchasing local foods

i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday

(f) Participating in sustainable events (Earth Day, Meatless Mondays, etc.)

i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday

(g) Sustainability-related clubs

i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday

8. Which of the following limits your participation in sustainable active practices? (Check all that apply)
   (a) I have little free time
   (b) My coursework is too demanding
   (c) My extracurricular activities are too demanding
   (d) I am not interested in sustainable practices
   (e) Sustainable practices are not important
   (f) Recycling containers are inconveniently located
   (g) I do no know how to participate
   (h) I practice sustainability in other ways
   (i) None of the above
   (j) Other (Place to insert other option)
9. How well do you think WPI students practice sustainability?
   (a) Extremely well
   (b) Very well
   (c) Moderately well
   (d) Slightly well
   (e) Not well at all
   (f) Not sure
10. How do you think WPI compares to other engineering colleges in terms of sustainable practices?
   (a) Much better
   (b) Slightly better
   (c) About the same
   (d) Slightly worse
   (e) Much worse
   (f) Not sure
11. How well do you think WPI engages students in sustainability?
   (a) Extremely well
   (b) Very well
   (c) Moderately well
   (d) Slightly well
   (e) Not well at all
   (f) Not sure
12. How do you think WPI compares to other engineering colleges in terms of sustainable engagement?
   (a) Much better
   (b) Slightly better
   (c) About the same
   (d) Slightly worse
   (e) Much worse

(f) Not sure

13. Indicate your agreement with the following statements:
    (a) Knowledge of sustainability is becoming more and more important
        i. Strongly agree; ii. Agree; iii. Neither agree nor disagree; iv. Disagree; v. Strongly disagree
    (b) Colleges and universities should have courses related to sustainability
        i. Strongly agree; ii. Agree; iii. Neither agree nor disagree; iv. Disagree; v. Strongly disagree
    (c) There is a demand for individuals with education in sustainability and sustainable practices
        i. Strongly agree; ii. Agree; iii. Neither agree nor disagree; iv. Disagree; v. Strongly disagree
    (d) WPI offers an adequate sustainability education
        i. Strongly agree; ii. Agree; iii. Neither agree nor disagree; iv. Disagree; v. Strongly disagree
    (e) Engineers should have basic knowledge of sustainability
        i. Strongly agree; ii. Agree; iii. Neither agree nor disagree; iv. Disagree; v. Strongly disagree
    (f) There are many jobs in sustainability fields for engineers
        i. Strongly agree; ii. Agree; iii. Neither agree nor disagree; iv. Disagree; v. Strongly disagree
    (g) Being actively engaged on campus enhances my learning
        i. Strongly agree; ii. Agree; iii. Neither agree nor disagree; iv. Disagree; v. Strongly disagree
14. What topics are relevant to sustainability in technical fields? (Check all that apply)
    (a) Social Science
    (b) Statistics
    (c) Business
    (d) Agriculture
    (e) Environmental Science
    (f) Environmental Policy
    (g) Design
    (h) Other (Place to insert other option)
15. Are you interested in any of these options for sustainability (Check all that apply)
    (a) Sustainability Major
    (b) Sustainability Minor
    (c) Sustainability Concentration (in technical field)
    (d) More sustainability-related projects (IQPs, MQPs)
    (e) More sustainability-related electives
    (f) Sustainability knowledge assessments
    (g) Extra credit for sustainable practices
    (h) None of the above
    (i) Other (Place to insert other option)

Appendix I:

The following is a transcript of questions asked of students attending the Sustainability Conference, Hampshire College, April 15th 2016.

"This survey is completely anonymous and the identity of the surveyee will not be recorded by any means."

1. Which University are you attending?
   (a) Hampshire College
   (b) UMass Amherst
   (c) Smith College
   (d) Mount Holyoke College
   (e) Amherst College
   (f) Other (Place to insert other option)
2. What is/are your major(s)?
   (a) (Place to mark major)
3. What is/are your minor(s)?
   (a) I do not plan to minor in any subject
   (b) Enter minor(s) (Place to mark minor)
4. Which of the following are offered by your university? (Check all that apply)
   (a) Sustainability Major
   (b) Sustainability Minor
   (c) Sustainability Electives
   (d) Sustainability Projects/Research Opportunities
   (e) Sustainability Concentrations
   (f) My university does not offer ways to study sustainability
   (g) Other (Place to enter other options)
5. What is your interest level in studying sustainability?
   (a) Extremely interested
   (b) Very interested
   (c) Moderately interested
   (d) Slightly interested
   (e) Not interested at all
6. In which ways are you studying sustainability at your university? (Check all that apply)
   (a) Sustainability Major
   (b) Sustainability Minor
   (c) Sustainability Electives
   (d) Sustainability Projects/Research Opportunities
   (e) Sustainability Concentrations
   (f) I am not studying sustainability at my university
   (g) Other (Place to enter other option)
7. What is your interest level in practicing sustainability?
   (a) Extremely interested
   (b) Very interested
   (c) Moderately interested

(d) Slightly interested
(e) Not interested at all

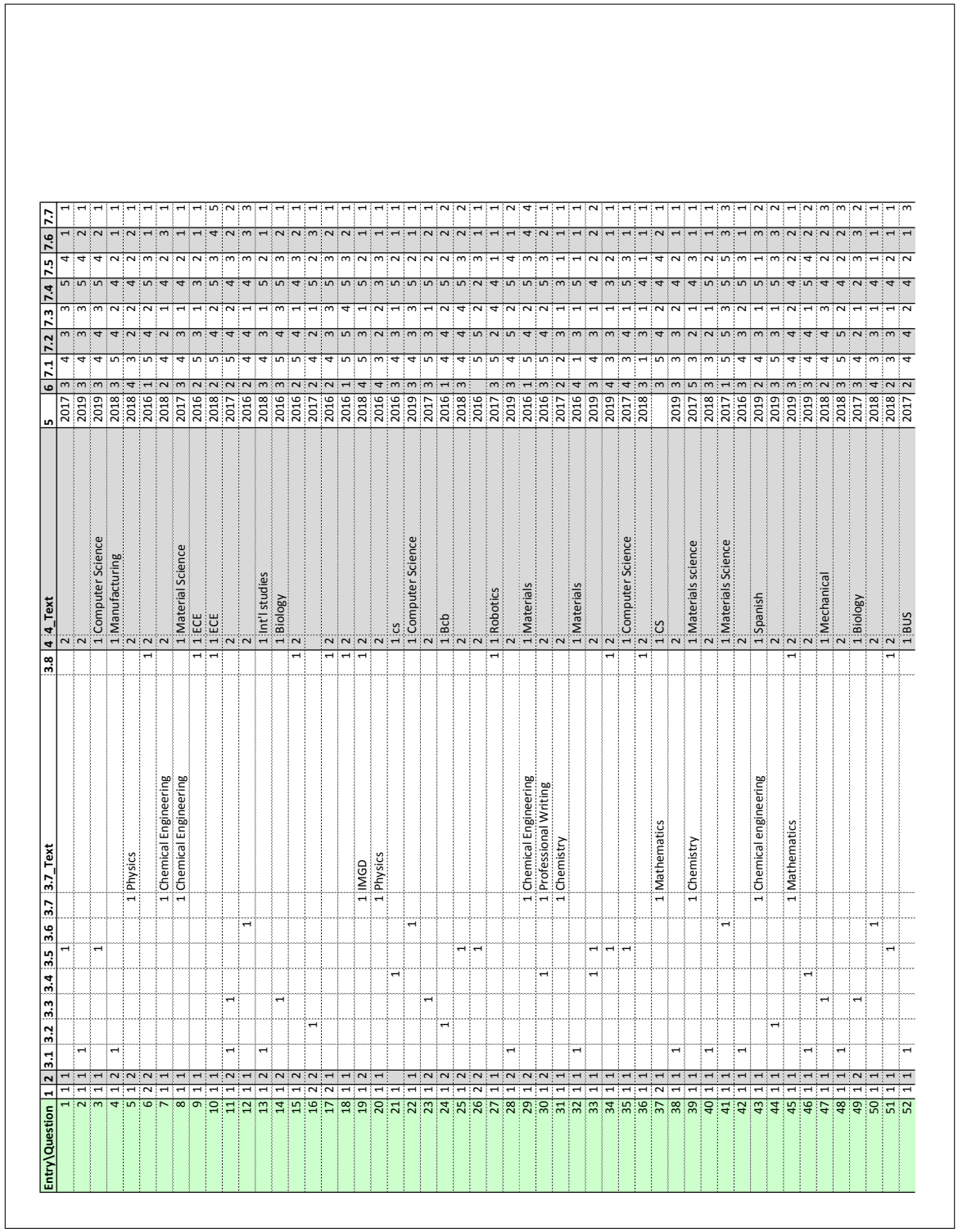
8. How often do you participate in the following sustainable active practices?
   (a) Recycling
      i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday
   (b) Water Conservation
      i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday
   (c) Composting
      i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday
   (d) Turning lights off when not in use
      i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday
   (e) Purchasing local foods
      i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday
   (f) Participating in sustainable events (Earth Day, Meatless Mondays, etc.)
      i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday
   (g) Sustainability-related clubs
      i. Never; ii. Seldom; iii. Sometimes; iv. Often; v. Everyday
9. Which of the following limits your participation in sustainable active practices? (Check all that apply)
   (a) I have little free time
   (b) My coursework is too demanding
   (c) My extracurricular activities are too demanding
   (d) I am not interested in sustainable practices
   (e) Sustainable practices are not important
   (f) I do not know how to participate
   (g) I practice sustainability in other ways
   (h) Other (Place to enter other option)
10. How well do you think students from your university practice sustainability?
   (a) Extremely well
   (b) Very well
   (c) Moderately well
   (d) Slightly well
   (e) Not well at all
   (f) Not sure
11. How do you think your university compares to other universities in terms of sustainable practices?
   (a) Much better
   (b) Slightly better
   (c) About the same
   (d) Slightly worse
   (e) Much worse
   (f) Not sure
12. How well do you think your school engages students in sustainability?
   (a) Extremely well
   (b) Very well
   (c) Moderately well
   (d) Slightly well
   (e) Not well at all

(f) Not sure

13. How do you think your school compares to other universities in terms of sustainability engagement?
    (a) Much better
    (b) Slightly better
    (c) About the same
    (d) Slightly worse
    (e) Much worse
    (f) Not sure
14. Indicate your agreement with the following statements:
    (a) Knowledge of sustainability is becoming more and more important
        i. Strongly agree; ii. Agree; iii. Neither agree nor disagree; iv. Disagree; v. Strongly disagree
    (b) Colleges and universities should have courses related to sustainability
        i. Strongly agree; ii. Agree; iii. Neither agree nor disagree; iv. Disagree; v. Strongly disagree
    (c) There is a demand for individuals with education in sustainability and sustainable practices
        i. Strongly agree; ii. Agree; iii. Neither agree nor disagree; iv. Disagree; v. Strongly disagree
    (d) There are many jobs in sustainability fields for engineers
        i. Strongly agree; ii. Agree; iii. Neither agree nor disagree; iv. Disagree; v. Strongly disagree
    (e) Being actively engaged on campus enhances my learning
        i. Strongly agree; ii. Agree; iii. Neither agree nor disagree; iv. Disagree; v. Strongly disagree
15. Which of the following sustainability disciplines are you interested in? (Check all that apply)
    (a) Social Science
    (b) Statistics
    (c) Business
    (d) Agriculture
    (e) Environmental Science
    (f) Environmental Policy
    (g) Design
    (h) Other (Place to insert other option)
16. Do you have any suggestions for raising student awareness in sustainability at Worcester Polytechnic Institute?
    (a) (Place to enter suggestions)

Appendix J:

Below is the data from the survey of WPI students. The question number and answer number correspond to the questions and possible answers in the actual survey depicted in Appendix H.



Entry\Question	1	2	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.7_Text	3.8	4	4_Text	5	6	7.1	7.2	7.3	7.4	7.5	7.6	7.7
1	1	1					1					2		2017	3	4	3	3	5	4	1	1
2	1	1	1									2		2019	3	4	3	3	5	4	2	1
3	1	1					1					1	Computer Science	2019	3	4	4	3	5	4	2	1
4	1	2		1								1	Manufacturing	2018	3	5	4	2	4	2	1	1
5	1	2							1	Physics		2		2018	4	3	2	2	4	2	2	1
6	2	2									1	2		2016	1	5	4	2	5	3	1	1
7	1	1							1	Chemical Engineering		2		2018	2	4	2	1	4	2	3	1
8	1	1							1	Chemical Engineering		1	Material Science	2017	3	4	3	1	4	2	1	1
9	1	1									1	1	ECE	2016	2	5	3	1	3	2	1	1
10	1	1									1	1	ECE	2018	2	5	4	2	5	3	4	5
11	1	2	1			1						2		2017	2	5	4	2	4	3	2	2
12	1	1						1				2		2016	2	4	4	1	4	3	3	3
13	1	2	1									1	Int'l studies	2018	3	4	3	1	5	2	1	1
14	1	2				1						1	Biology	2016	3	5	4	1	5	3	2	1
15	1	2									1	2		2016	2	5	4	1	4	3	2	1
16	2	2			1									2017	2	4	2	1	5	2	3	1
17	2	1									1	2		2016	2	4	3	3	5	3	2	1
18	1	1									1	2		2016	1	5	5	4	5	3	2	1
19	1	2									1	2		2018	4	5	3	1	5	2	1	1
20	1	1							1	IMGD		2		2016	4	5	3	2	3	3	1	1
21	1								1	Physics				2016	3	4	4	3	5	2	1	1
22	1	1				1						1	cs	2016	3	4	3	1	5	2	1	1
23	1	2						1				1	Computer Science	2019	3	4	3	3	5	2	1	1
24	1	2			1							2		2017	3	5	3	1	5	2	2	1
25	1	2					1					1	Bcb	2016	1	4	4	2	5	2	2	2
26	2	2					1					2		2018	3	4	4	2	5	3	2	2
27	1	1										2		2016		5	5	2	2	3	1	1
28	1	2		1							1	1	Robotics	2017	3	5	2	4	4	1	1	1
29	1	2							1	Chemical Engineering		2		2019	3	4	5	2	5	4	1	2
30	1	2				1				Professional Writing		1	Materials	2016	1	5	4	2	5	3	4	4
31	1	1							1	Chemistry		2		2016	3	5	4	2	5	3	2	1
32	1	1	1									1	Materials	2017	2	2	2	1	3	1	1	1
33	1	1				1	1					2		2016	4	1	3	1	5	1	1	1
34	1	1					1							2019	3	4	3	1	4	2	2	2
35	1	1					1				1	2		2019	4	3	3	1	3	2	2	1
36	1	1										1	Computer Science	2017	4	3	4	1	5	3	1	1
37	2	1							1	Mathematics		2		2018	3	1	3	1	4	1	1	1
38	1	1	1								1	1	CS	2018	3	5	4	2	4	4	2	1
39	1	1										2		2019	3	3	3	2	4	2	1	1
40	1	1		1					1	Chemistry		1	Materials science	2017	5	3	2	1	4	3	1	1
41	1	1										2		2018	3	3	2	1	5	2	1	1
42	1	1	1					1				1	Materials Science	2017	1	5	5	3	5	5	3	3
43	1	1							1	Chemical engineering		2		2016	3	4	3	2	5	3	1	1
44	1	1			1							1	Spanish	2019	2	4	3	1	5	1	3	2
45	1	1							1	Mathematics		2		2019	3	5	3	1	5	3	3	2
46	1	1	1			1					1	2		2019	3	4	4	2	4	2	2	1
47	1	1										2		2019	3	4	4	1	5	4	2	2
48	1	1	1									1	Mechanical	2018	2	4	4	3	4	2	2	3
49	1	2										2		2018	3	5	5	2	4	2	2	3
50	1	1				1						1	Biology	2017	3	4	2	1	2	3	3	2
51	1	1						1				2		2018	4	3	3	1	4	2	1	1
52	1	1	1								1	2		2018	2	3	3	1	4	2	1	1
												1	BUS	2017	2	4	4	2	4	2	1	3

Entry\Question	1	2	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.7_Text	3.8	4	4_Text	5	6	7.1	7.2	7.3	7.4	7.5	7.6	7.7
53	1	1			1							2		2018	3	3	2	2	5	3	2	2
54	1	1							1	BCB		2		2017	2	4	4	1	4	3	3	1
55	1	1		1								2		2017	2	5	4	2	5	2	2	2
56	1	1							1	Aerospace Engineering and Physics		2		2018	3	5	3	4	4	2	1	1
57	1	1									1	1	IMGD/Spanish	2018	3	4	3	1	5	2	2	1
58	1	1				1						2		2019	3	5	3	1	5	3	3	2
59	1	1		1								1	Music	2017	2	5	3	2	5	4	4	1
60	1	1						1				2		2017	2	4	3	1	5	3	2	2
61	1	1									1	2		2019	3	5	4	2	5	5	3	1
62	1	2	1									2		2019	2	4	4	2	5	2	2	1
63	1	1									1	2		2017	4	3	3	1	5	2	1	1
64	1	1									1	1	IMGD	2018	2	5	4	3	4	3	2	1
65	1	1				1						2		2019	3	3	4	1	2	3	3	1
66	1	1									1	1	PSY	2018	3	3	3	1	4	4	2	2
67	1	1							1	Mathematical Sciences	1	2		2017	3	4	4	2	4	3	3	2
68	1	1				1					1	2		2016	3	3	3	2	5	2	1	1
69	1	2						1				1	Sustainability engineering	2016	1	5	4	2	5	4	5	5
70	1	1									1	2		2019	3	4	3	2	4	1	1	1
71	2	2									1			2017	3	4	3	2	4	3	3	1
72	1	1	1									2		2018	2	4	4	3	4	3	3	2
73	2	1	1											2018	1	4	2	4	1	3	1	1
74	1	1	1									2		2017	3	5	5	1	4	4	2	1
75	1	2							1	Biochemistry & Professional Writing		2		2017	4	5	2	1	5	3	1	1
76	1	2							1	Environmental Engineering		1	Sustainability Engineering	2017	1	5	5	1	5	3	2	4
77	1	1	1									2		2017	4	3	3	1	4	2	2	2
78	1	1	1									1	Aerospace	2019	4	5	4	2	3	3	1	1
79	1	1	1									2		2017	2	5	4	1	5	4	1	1
80	1	1							1	Biochemistry		2		2018	4	3	2	1	4	2	1	1
81	1	1									1	1	Economics	2018	2	5	3	1	5	2	2	2
82	1	1							1	Chemical Engineering		2		2017	3	4	2	2	4	2	2	2
83	1	1						1				2		2018	1	5	5	2	5	2	3	4
84	1	2		1								1	Economics	2016	2	3	3	2	4	2	2	2
85	2	1							1	Operations Analytics and Management		2		2017	1	4	2	2	5	5	4	3
86	2	1				1	1							2016	2	4	3	1	5	3	2	1
87	1	1	1			1						2		2018	3	4	3	3	4	2	2	1
88	1	1	1									2		2018	1	5	2	2	4	3	2	1
89	1	1		1										2019	1	5	4	2	5	3	4	1
90	1	2						1				2		2017	3	5	4	1	2	1	1	1
91	1	1					1					2		2016	2	4	3	3	4	3	3	2
92	1	1						1				1	Business	2017	2	4	4	4	4	2	1	1
93	1	2							1	Chemical Engineering		1	Spanish, Materials Science	2019	2	5	3	2	5	3	3	4
94	1	2							1	EV		2		2019	2	4	4	1	5	2	4	1
95	1	1			1							1	International Studies	2017	3	4	5	2	5	4	3	3
96	1	1	1									2		2018	1	5	3	2	5	3	3	4
97	1	2						1				2		2017	1	5	4	3	5	2	3	3
98	1	2	1						1	Social Science		2		2016	1	5	4	1	5	4	3	5
99	1	2		1								1	Social science	2017	3	5	4	4	4	4	1	1
100	1	1				1					1	1	History	2018	1	4	3	3	4	4	3	2
101	1	2	1									1	Electrical and COmputer Engineering	2018	1	4	3	1	4	3	4	4
102	1	1					1					2		2016	2	5	2	3	5	2	4	2
103	1	2						1				1	sustainability Engineering	2016	1	5	5	2	5	3	4	5

N	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	8.10	8.10_Test	9	10	11	12	13.1	13.2	13.3	13.4	13.5	13.6	13.7	13.8
1	1	1							1			3	6	4	3	1	1	3	3	3	1	3	2
2	1	1	1						1			4	3	4	3								
3	1	1										4	3	4	2	1	2	3	3	2	1	2	3
4	1			1			1					3	6	3	6	2	2	2	2	3	2	3	1
5								1	1			5	4	5	4	2	2	2	4	4	3	2	2
6	1											3	3	3	3	1	1	3	3	3	2	3	1
7	1	1							1			4	6	5	6	2	2	2	3	3	2	3	3
8				1					1			3	6	4	6	2	4	2	3	3	2	4	2
9	1											5	3	4	3	1	3	4	4	3	1	4	3
10								1	1			3	2	4	3	1	2	1	3	4	1	2	2
11	1											3	6	3	6	1	1	3	3	2	1	3	1
12	1	1										3	3	3	3	1	1	1	4	3	1	2	2
13	1	1	1									5	6	5	6	1	2	2	3	3	2	3	3
14	1	1										4	4	5	3	1	3	3	2	3	2	3	2
15	1	1	1				1					2	6	6	6	1	1	1	2	1	1	1	1
16	1								1			3	3		3	2	2	3	3	3	2	3	2
17	1	1	1					1				5	3	4	3	2	2	1	3	2	1	1	2
18						1						3	2	2	2	1	1	2	3	3	2	3	2
19	1	1	1									6	6	5	6	2	2	3	3	2	2	1	1
20				1			1					3	3	5	6	4	3	3	2	2	2	2	4
21		1						1				3	6	3	6	2	4	4	4	3	3	4	4
22						1						3	6	3	6	1	2	1	3	3	1	3	3
23	1	1							1			3	2	3	3	1	3	2	3	2	2	2	2
24			1					1	1			4	4	5	4	1	2	1	3	4	1	1	2
25									1			3	6	6	6	2	3	2	2	3	1	2	2
26										1	recycling containers filled with dirty plastic and non-recyclable trash	3	6	3	6	2	5	4	3	3	2	3	3
27	1									1	I do not have luxury/resource	3	4	5	6	3	4	4	3	3	1	4	3
28										1	I have not heard of events	5	6	4	6	1	2	2	3	3	1	1	1
29	1	1	1					1				4	4	4	4	1	1	2	3	3	1	2	1
30	1		1									3	3	2	2	2	3	2	2	4	2	3	3
31	1	1	1						1			5	6	5	6	1	3	4	3	3	1	4	1
32	1	1		1								5	3	5	3	2	2	2	3	5	3	2	1
33						1						4	3	5	3	2	2	3	3	3	2	3	2
34								1				2	2	3	3	3	4	2	3	3	2	3	2
35	1			1								3	3	3	3	3	4	2	3	2	4	3	1
36	1	1	1					1	1			4	2		3								
37								1	1			4	4	4	4	2	2	2	3	3	1	2	1
38	1							1				3	4	3	2	2	2	3	3	2	2	3	3
39				1				1				6	6	6	6	4	5	5	3	3	5	5	2
40	1								1			4	5	5	5	2	2	2	4	4	2	4	3
41	1		1				1					3	2	3	3	1	1	1	2	1	1	1	2
42					1							3	6	4	6	2	2	4	3	2	2	4	3
43		1							1	1	There is no place for compost	4	5	5	4	1	1	1	2	2	1	3	2
44		1	1									3	2	3	2	2	2	3	3	3	1	2	1
45	1							1	1			4	4	5	6	2	3	4	3	3	2	3	2
46		1						1				3	3	3	3	2	3	2	3	4	1	2	1
47		1					1					3	2	4	3	1	1	1	2	2	1	3	2
48	1	1	1									3	3	4	3	1	2	3	3	3	1	2	2
49	1		1						1			3	3	3	3	2	3	4	2	2	3	3	1
50										1	I'm lazy			4	2	2	2	2	2	2	2	2	2
51	1	1						1	1			4	4	4	6	1	2	4	3	2	1	3	2
52	1	1	1									3	6	4	6	2	2	2	2	3	1	2	2

N	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	8.10	8.10_Test	9	10	11	12	13.1	13.2	13.3	13.4	13.5	13.6	13.7	13.8
53							1					3	3	3	3	2	2	2	3	3	2	2	1
54	1							1				4	3	4	3	1	1	1	3	3	2	3	2
55	1	1								1	Expense	3	6	3	6	3	2	3	3	3	2	3	2
56	1	1	1				1					4	3	4	2	2	2	3	3	2	2	4	2
57							1			1		4			3	2	3	3	4	4	2	3	3
58										1	It is not my number 1 priority	3	2	3	3	2	2	1	1	2	1	1	1
59							1		1			4	2	4	3	1	1	1	3	2	1	1	1
60										1	Motivation to go to events	2	2	4	2	2	2	2	3	3	2	3	3
61												4	4	4	3	1	1	1	4	4	2	3	2
62							1					4	2	3	2	2	2	2	3	2	1	2	1
63	1			1	1		1	1				5	3	5	3	4	5	5	3	4	2	5	5
64	1	1	1						1			4	3	4	3	2	2	2	3	3	2	2	2
65		1	1					1				3	6	6	6	2	3	3	4	5	3	2	1
66				1								4	2	2	2	2	2	3	2	1	2	2	1
67	1								1			2	3	3	3	1	1	1	2	2	1	1	1
68				1			1	1				4	2	4	3	2	2	2	4	2	2	3	3
69	1	1										5	3	5	4	1	1	1	4	2	1	2	1
70								1				3	3	3	3	2	2	2	2	2	2	3	1
71	1	1	1									3	3	3	3	2	2	2	3	2	2	3	3
72	1	1	1									3	2	3	2	2	2	2	2	2	1	2	1
73	1											5	3	4	3	1	1	1	1	1	1	1	1
74	1	1	1									3	6	4	6	2	4	3	4	4	2	2	2
75	1			1			1		1			3	1	2	2	4	2	2	3	1	2	4	1
76	1	1	1							1	Purchasing unrecycleable materials, composting not available, hard to get local food.	4	4	3	3	2	1	3	4	2	1	2	2
77	1	1	1						1			3	6	4	6								
78						1						2	2	4	3	2	2	2	3	3	2	2	3
79	1											4	5	4	4	2	4	3	4	4	2	3	2
80										1	Too lazy	5	3	4	3	1	3	3	4	4	2	3	4
81	1						1					2	1	3	1	1	2	2	1	3	1	2	1
82						1						3	3	3	2	2	2	3	4	3	2	3	3
83									1			3	2	4	3	1	2	2	4	3	1	1	2
84	1											4	6	3	6	2	1	2	4	3	2	2	2
85									1			3	2	2	2	1	1	1	3	2	1	3	2
86								1				6	3	4	3	2	3	2	3	2	2	3	1
87	1							1	1	1	Sustainable options are sometimes cost prohibative	3	3	3	3	2	2	2	3	3	1	2	2
88							1		1			5	4	5	4	2	3	2	4	3	2	2	2
89	1	1										3	6	4	6	1	1	1	3	2	1	2	1
90		1										4	3		3	2	3	1	3	2	2	1	2
91	1											4	3	5	4	1	1	1	4	4	1	2	1
92	1	1					1					4	2	5	5	1	1	3	4	4	1	3	2
93	1		1						1			3	3	3	3	1	2	2	2	1	1	1	1
94	1	1					1					5	6	4	4	1	2	2	3	2	1	3	2
95	1	1	1				1		1			3	3	3	3	2	3	2	4	3	1	2	3
96	1											3	3	3	2	1	1	2	2	2	1	2	1
97		1										3	3	3	2	1	1	2	2	2	1	3	2
98										1	Composting is not promoted at WPI	3	4	2	2	1	1	1	4	2	1	1	1
99	1		1				1		1			3	4	5	4	1	3	3	4	4	1	2	3
100		1						1	1			4	3	4	3	1	1	1	3	2	1	3	1
101	1	1	1				1		1			5	4	5	4	1	1	2	3	2	1	3	1
102	1	1						1		1		4	2	3	2	2	3	1	5	3	1	5	3
103	1	1					1	1		1	lack of knowlegde	3	2	4	3	1	1	1	4	2	1	1	1

N	14.1	14.2	14.3	14.4	14.5	14.6	14.7	14.8	14.8_TEXT	15.	15.2	15.3	15.4	15.5	15.6	15.7	15.8	15.9	15.9_Text
1	1			1	1	1	1						1			1			
2																			
3				1	1							1			1				
4			1	1	1	1	1										1		
5	1			1	1	1	1									1			
6	1	1	1	1	1	1							1	1		1			
7	1	1			1	1											1		
8	1		1		1	1										1	1		
9																			
10	1		1	1	1	1	1				1	1				1			
11	1	1	1	1	1	1	1				1	1	1		1				
12	1	1	1	1	1	1	1			1	1	1	1	1	1	1			
13				1	1											1			
14	1			1	1	1								1		1			
15		1	1	1	1	1						1	1						
16					1	1					1			1					
17			1	1	1	1	1										1		
18	1	1	1	1	1	1	1					1	1	1					
19	1	1	1	1	1	1	1							1	1	1			
20	1	1	1	1	1	1	1										1		
21	1			1	1		1										1		
22					1								1						
23	1				1	1	1				1		1			1			
24	1		1	1	1	1	1										1		
25	1	1	1	1	1									1	1	1			
26			1	1	1	1	1	1									1	1	Seminars from guest lecturers/professors
27	1	1	1	1	1	1											1		
28	1	1	1	1	1	1	1	1	RBE			1		1		1			
29	1			1	1	1	1				1	1	1	1		1			
30			1	1	1	1	1									1			
31	1		1	1	1	1	1				1	1	1	1					
32																	1		
33	1			1	1	1	1						1	1					
34	1		1	1	1	1											1		
35	1	1		1	1	1											1		
36	1	1	1	1	1	1	1						1			1			
37	1	1	1		1	1	1										1		
38	1	1			1	1											1		
39				1	1	1											1		
40				1	1	1										1			
41				1	1	1						1	1	1					
42	1	1	1	1		1											1		
43	1	1	1	1	1	1	1					1	1						
44	1			1	1	1										1			
45	1		1		1	1	1									1			
46	1			1	1								1	1		1			
47	1			1	1	1							1	1	1	1			
48	1	1	1		1	1					1					1			
49		1		1	1	1					1	1	1						
50	1	1	1	1	1	1											1		
51	1	1	1	1	1	1							1	1		1			
52	1	1	1	1	1	1	1										1		

N	14.1	14.2	14.3	14.4	14.5	14.6	14.7	14.8	14.8_TEXT	15.	15.2	15.3	15.4	15.5	15.6	15.7	15.8	15.9	15.9_Text
53	1	1		1	1	1					1				1	1			
54			1	1	1	1							1			1			
55			1	1	1	1	1										1		
56	1		1	1	1	1											1		
57		1	1	1	1	1								1	1	1			
58		1	1	1	1	1	1							1					
59	1	1	1	1	1	1	1						1	1					
60	1		1	1	1	1	1				1		1	1		1			
61	1	1	1	1	1	1	1							1					
62	1	1	1	1	1	1	1									1			
63				1	1	1												1	Ease of use with recycling
64	1			1		1	1					1	1	1		1			
65		1		1	1	1										1			
66	1	1	1	1	1												1		
67	1	1	1	1	1	1	1						1	1	1	1			
68	1	1	1	1	1	1	1					1		1	1	1			
69	1	1	1	1	1	1	1			1	1	1	1	1	1	1			
70	1	1	1	1	1	1	1							1					
71	1			1	1	1								1		1			
72	1		1	1	1		1												
73	1		1	1	1	1													
74	1	1	1	1	1	1	1									1			
75	1		1	1	1	1	1								1	1			
76	1	1	1	1	1	1	1	1	Everything	1	1		1	1		1		1	
77				1	1	1					1			1					
78		1		1	1		1										1		
79					1	1													
80			1	1	1	1	1						1						
81	1	1	1	1	1	1	1						1	1					
82		1	1		1	1	1					1	1	1					
83	1	1	1	1	1	1	1				1	1	1	1	1	1			
84	1			1	1	1					1		1						
85	1	1	1	1	1	1	1				1	1	1	1	1	1			
86	1	1	1	1	1	1											1		
87		1	1		1	1													
88	1			1	1	1	1						1	1		1			
89	1	1	1	1	1	1	1				1	1	1	1	1	1			
90	1			1	1	1											1		
91	1			1	1	1					1		1	1					
92	1	1	1	1	1	1	1			1	1	1	1	1	1	1			
93	1				1	1					1								
94			1	1	1	1	1							1					
95	1		1			1	1				1	1	1	1					
96	1	1	1		1	1	1						1	1					
97	1	1	1	1	1	1	1				1	1	1						
98	1	1	1	1	1	1	1			1	1		1		1	1			
99	1	1	1	1	1	1	1				1		1						
100	1	1	1	1	1	1	1	1	Systems/Engineering Management		1		1	1		1			
101	1	1	1	1	1	1	1				1	1	1	1	1	1			
102		1		1	1	1							1	1		1			
103	1	1	1	1	1	1	1			1	1	1	1	1	1	1			

Appendix K:

Below is the data from the quick survey handed out a the sustainability conference attended by our team. The question number and answer number correspond to the survey depicted in Appendix I.

Number\Question	1	1_Text	2	3	3_Text
1	6	Saint Michael's College	Environmental Science	2	Biology
2	6	University of Maryland Baltimore County	Information Systems	2	Computer Science
3	6	VTC	Civil	1	
4	6	Champlain College	Business Administration	2	Psychology, International Business, Entreprenuer
5	6	University of Connecticut	Paychology	2	Cognitive Science, Linguistics
6	6		stats	1	
7	6	St. Thomas University	Science, Technology, and Society	2	Sociology
8	6	University of Connecticut	Applied Mathematics; Chemistry	1	
9	6	Rhode Island College	Criminal Justice	2	Business
10	6	Framingham state university	Sociology	1	
11	6	University of Vermont	Wildlife and Fisheries Biology	2	Forestry
12	6	Johnson and wales	Sports entertainment events management	1	
13	6	Earlham College	Chemistry and economics	1	
14	1		Operation and information management	2	Information Technology
15	6	Simmons College	Business Management/ Marketing	2	Information Technology
16	1		Computer Science	1	
17	6	Linfield College	International Relations	2	Mathematics
18	6		Nursing	1	
19	6	University of Vermont	Wildlife biology	2	Studio art
20	5		Visual art		
21	5		child development; theatre	2	spanish
22	5		Scenographt	1	
23	5		postcolonial studies		
24	6	Western New England University	Electrical Engineering	2	Sustainability
25	6	Westfield State University	Environmental Science, Regional Planning	2	Environmental Planning
26	6	Westfield State University	Geography and Regional Planning	2	Business Management
27	6	Michigan Technological University	Wildlife Ecology and Management	1	
28	6	Westfield State University	Environmental Science	2	GIS

4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.7_Text	5	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.7_Text	7
1	1	1	1	1				1	1			1					1
		1	1					2						1			1
1	1	1	1					3			1						3
1	1		1	1				2			1	1					2
		1	1					3						1			2
1	1							4						1			4
					1			3						1			1
1	1	1	1	1				2						1			3
					1			3						1			3
			1					2						1			2
		1	1	1				2						1			2
	1		1					5						1			5
						1	Sustainability Office	4						1			4
1			1					3						1			3
	1	1	1	1				2		1	1	1					1
1	1	1	1	1				3						1			3
			1					5						1			5
					1			4						1			4
1	1	1	1	1				2			1	1					1
				1				4						1			4
		1	1	1				5			1	1					3
1	1	1	1	1				4						1			2
		1	1	1				4							1	Postcolonial studies and decolonization projects	4
					1	1		2		1	1				1	Senior design project center around power electronics and renewable energy.	1
		1						4			1						4
		1						3			1	1					3
1	1	1	1	1				2	1				1				2
		1	1					2			1	1					3

8.1	8.2	8.3	8.4	8.5	8.6	8.7	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.8_Text	10	11	12	13	14.1	14.2	14.3	14.4	14.5
5	4	5	5	4	4	5	1	1								3	1	2	2	1	1	1	1	2
5	5	3	4	2	1	1								1	Laziness	3	4	2	2	1	1	1	1	1
5	5	4	5	4	1	3	1		1				1			3	2	3	2	1	1	2	1	2
5	5	5	5	3	3	3	1	1	1							3	2	2	2	2	1	1	1	2
5	4	2	5	3	3	4	1									3	2	3	2	1	1	2	3	2
5	3	4	4	3	2	2	1	1		1		1				1	1	2	1	1	3	3	2	2
4	4	4	5	4	3	1								1	School cafeteria doesn't compost	5	5	5	6	1	1	2	3	2
4	3	3	4	5	3	5	1	1					1			3	2	2	2	2	2	2	3	3
4	3	1	4	3	2	1	1	1		1			1			4	3	4	4	2	2	3	2	2
5	5	2	5	3	3	3			1							3	1	3	1	1	1	1	2	1
5	3	5	5	3	3	4										3	1	3	1	1	1	1	1	1
2	2	1	3	3	2	1			1							5	4	4	4	2	3	3	2	3
4	4	4	4	4	1	1						1				4	3	3	3	2	2	3	3	3
5	4	4	4	3	3	2							1			3	2	2	2	2	2	2	2	3
5	5	3	5	3	4	4		1					1			3	3	4	3	1	1	1	1	1
5	5	5	5	3	3	2							1			2	2	2	2	1	2	1	2	2
2	2	2	4	3	2	1	1	1		1						6	6	6	6	3	3	3	3	3
5	2	2	3	4	3	2						1				2	3	4	4	2	1	2	2	2
5	4	5	5	5	3	4	1									1	1	2	1	1	1	1	1	1
5	4	4	4	3	3	1	1	1								3	1	3	1	1	1	1	1	1
4	4	5	3	2	5	3		1	1				1			2	1	3	2	1	1	2	1	2
5	5	5	5	5	3	1	1	1	1							3	1	2	2	1	1	1	1	1
4	4	3	3	2	1	1	1	1	1				1	1	Underpaid workers	4	6	4	3	3	3	3	3	3
5	5	4	5	3	4	5	1	1						1	General lack of available activies	4	4	5	5	1	1	2	1	1
5	2	1	5	1	2	1						1				5	5	5	4	2	2	2	4	2
4	4	2	3	2	2	3			1							5	5	5	5	2	2	2	2	2
5	5	5	5	2	2	3	1									3	2	3	2	2	1	2	2	2
4	2	1	4	2	2	2	1	1								4	4	5	4	1	1	1	1	2

15.1	15.2	15.3	15.4	15.5	15.6	15.7	15.8	15.9	15.9_Text	16
			1	1		1				
1	1		1	1	1	1	1			
				1	1	1	1			
		1				1				
1				1	1					
	1									
1				1						
	1		1	1						
		1								
1			1	1		1	1			
				1						
				1						
1		1								
		1					1			
1		1		1			1			
				1		1				
1										
			1							
			1	1		1	1			Reduce the sale of bottled drinks, strongly suggest that students bring ther own bottles/mugs to refill
	1		1				1			
				1			1			
1							1			Increase minimum wage of works
						1	1			Increased signage
				1						
		1	1				1			
				1	1					
1	1					1				

Appendix L:

Below are two tables from the WPI 2015 Fact Book, showing the distribution of primary and secondary majors among all undergrads.

Full-Time Degree-Seeking Undergraduate Enrollment by Major & Class[1], Fall 2015

Department & Major	Freshmen	Sophomores	Juniors	Seniors	Total
Biology/ Biotechnology	**25**	**23**	**36**	**52**	**136**
Biomedical Engineering	**115**	**103**	**76**	**103**	**397**
Chemical Engineering	**70**	**102**	**80**	**104**	**356**
Chemistry and Biochemistry	**19**	**30**	**33**	**40**	**122**
Biochemistry	10	23	19	30	82
Chemistry	9	7	14	10	40
Civil & Environmental Eng	**52**	**54**	**56**	**69**	**231**
Architectural Engineering	16	11	15	16	58
Civil Engineering	36	43	41	53	173
Computer Science	**120**	**126**	**114**	**116**	**476**
Electrical & Computer Eng	**57**	**83**	**85**	**119**	**344**
Humanities and Arts	**1**			**1**	**2**
Interdisciplinary Programs	**129**	**101**	**108**	**143**	**481**
Bioinformatics & Computat Bio	6	4	1	4	15
Environmental Engineering	23	13	20	22	78
Interactive Media & Game Dev	21	22	23	38	104
International Studies			2		2
Liberal Arts & Engineering		1			1
Robotics Engineering	79	61	62	79	281
Management	**22**	**49**	**55**	**69**	**195**
Industrial Engineering	13	21	23	26	83
Management	3	6	1	3	13
Management Engineering	6	18	22	25	71
Management Information Systems		4	9	15	28
Mathematical Sciences	**27**	**23**	**38**	**41**	**129**
Actuarial Mathematics	10	12	15	19	56
Mathematical Sciences	17	11	23	22	73
Mechanical Engineering	**214**	**250**	**191**	**293**	**948**
Aerospace Engineering	59	40	41	47	187
Mechanical Engineering	155	210	150	246	761
Non-Department	**159**	**29**	**4**		**192**
Engineering - To Be Declared	128	18	3		149
Science (Freshmen Only)	6	3			9
Undecided	25	8	1		34
Physics	**18**	**16**	**7**	**21**	**62**
Engineering Physics	5				5
Physics	13	16	7	21	57
Social Science/Policy Studies	**7**	**2**	**2**	**3**	**14**
Economic Science	2				2
Environ & Sustain Studies	4	1	1	2	8
Psychological Science		1	1	1	3
Society, Technology & Policy	1				1
Grand Total	**1,035**	**991**	**885**	**1,174**	**4,085**

[1] Standing as determined by accumulated credits

Declared Second Majors of Full-Time Degree-Seeking Undergraduates, Fall 2015

Department & Major	
Biology/Biotechnology	**5**
Biomedical Engineering	**9**
Chemical Engineering	**3**
Chemistry and Biochemistry	**14**
Biochemistry	7
Chemistry	7
Civil & Environmental Eng	**4**
Architectural Engineering	2
Civil Engineering	2
Computer Science	**84**
Electrical & Computer Eng	**39**
Humanities and Arts	**29**
Humanities and Arts	10
Professional Writing	19
Interdisciplinary Programs	**70**
Bioinformatics & Computat Bio	3
Environmental Engineering	2
Interactive Media & Game Dev	17
International Studies	7
Robotics Engineering	41
Management	**15**
Industrial Engineering	2
Management	3
Management Engineering	2
Management Information Systems	8
Mathematical Sciences	**31**
Actuarial Mathematics	2
Mathematical Sciences	29
Mechanical Engineering	**40**
Aerospace Engineering	2
Mechanical Engineering	38
Physics	**7**
Physics	7
Social Science/Policy Studies	**16**
Economic Science	3
Environ & Sustain Studies	5
Psychological Sciences	4
Society, Technology & Policy	4
Total	**366**