Engineering Ethics

An *Interactive Qualifying Project*

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By

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Abstract

Ethics has been a controversial topic throughout the greater good of time, however more recently ethics seems to be playing more of a role in our everyday lives no matter the career or lifestyles of a person. With engineering being pushed to the limit everyday and new technological advances on the rise, we start seeing various direct and indirect impacts on people and the world. For example, the topics regarding engineering and its correlation to Climate Change or the use of Robotics and its impacts on industry. In this Research Paper, we will investigate how Engineering Ethics plays a role on a more relatable level. We will investigate the role Engineering Ethics plays on the students of Worcester Polytechnic Institute(WPI) and how WPI has an impact on students when it comes to teaching Ethics and motivating students about ethics through the actions of the Institute. Moreover, in this report we will examine what exactly WPI has done to practice sustainability and ethics, and what the school can do to be better.

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1. Introduction

1.1 Objectives

Listed below are the objectives that will be explored throughout this report:

1.1.1: To understand the WPI (Worcester Polytechnic Institute) communities current knowledge and understanding of the first canon of engineering ethics i.e., does WPI know what the first canon of engineering ethics is.

1.1.2: Determine the impact sustainability engineering ethics education has on WPI student's mindset.

1.1.3: Design an action plan to integrate sustainability engineering practices into Worcester Polytechnic Institute's education and campus.

1.2 Rationale

In order to understand why we are researching the impact of engineering ethics and sustainability at WPI, we must first understand the impact that engineering ethics plays on a students mind when they enter the professional workplace. Without a solid foundation of what ethics is and why it's important, some students might never realize the impact of what they do regardless of its use whether it's in the workplace or just in life in general. The idea of differentiation between right and wrong is such a complex subject that oftentimes is overlooked. WPI students will go on to lead diverse career paths in various aspects, but at the end of the day no matter the role that they are in, engineering ethics and ethics in general will have some sort of say in what they have to do. As an engineer, and with the fact that the majority of WPI students are studying engineering, we may see that there are situations in these aspiring engineers' lives that may create some sort of ethical question on whether or not their impact may negatively harm other people or even the environment. With technology today advancing at a rate that is so fast, we see an increased amount of pollution, climate change, and an impact on so many people from various walks of life around the world. Without understand the importance of ethics before practicing engineering,

Without understanding the importance of ethics before practicing engineering, we may see that the lack of knowledge or even regard for ethics can and will produce malpractice in the workplace and safe engineering can be on track to decline in the future. This could have a direct result on people and the environment, and the main cause for all of this would be the fact that engineers never thought in the first place that these may be some of the repercussions that the world and humanity will face for not valuing the ethical perspective of engineering.

WPI faculty and staff must acknowledge that they too have a huge impact on the students, as they serve as role models for many of these future engineers. It is the responsibility of the faculty and staff to acknowledge the importance of teaching engineering ethics to students and then actually commit to doing so. Many of the students may not understand the concept of ethics when it comes to their classes, not because they don't think it's important, but because no one told them to worry about that when learning about engineering. It should not only be a responsibility but also a requirement for faculty and staff to include this into their curriculums because teaching ethics to students not only guides the future engineers in terms of skills and knowledge, but also develops a great sense of character.

1.3 State of the Art

1.3.1 Understanding the Importance of Ethics in Engineering

As previously discussed in the rationale, ethics is important for engineers and the students of WPI as they are soon to be future engineers. Understanding why it's important to involve ethics into engineering and make it a common practice has a direct relationship with the actions people take, and whether or not they realize the impacts that they may have on themselves, other people, or even the world as a whole. Thinking about these aspects for making any decision as an engineer can result in a future of safe practices and lasting advancements, rather than temporary advancements that lead to the greater downfall in the long run. In this paper, we will be discussing what we have noticed so far, what is lacking, and what can be done in the future.

1.3.2 Analyzing and Understanding Current Action Plan of WPI

Before we do a deep dive into what WPI isn't doing and what they should be doing, let's first take a look at what they are doing already. It is important to acknowledge the current action plan and WPI and then perform an analysis after. WPI already has a sustainability plan that they described on their website. What is a sustainability plan? And what does it have to do with the impact on the students? The idea of seeing a Sustainability Plan at WPI develops the foundation of the importance of ethics in our school while combating one of the world's greatest ethical problems, global climate change. What is the point of teaching something, when at the end of the day it means nothing on the campus where it is being taught? Understanding how WPI is morally and ethically changing their practices to help solve one of the world's problems is important in terms of leading the future engineers of the school to success and ethical compliance.

When you navigate to WPI's Sustainability Website, you will find a lot of information regarding the efforts of sustainability here on campus. In fact we will notice that WPI has

actually made a report regarding sustainability each year since the 2018/2019 school year. When you read these reports you'll notice that the general format of each report, and every subsequent report, is a summary of what to expect, a definition on what sustainability is, and the involvement of sustainability in academics. In fact, you will see that in a separate report WPI mentions that students on campus can actually earn a minor in Sustainability Engineering. One thing that comes to my mind when noticing how sustainability is integrating into academics, courses and degrees. Why is this not mandatory for all students? Why is it more of a choice and an offering rather than a requirement. We have many requirements for a degree including humanities and electives, it seems like we could implement a sustainability course as a degree requirement. The reports also mention lectures and seminars that are held throughout the year to discuss sustainability. It is great to hear that these lectures and conferences are being held but what questions me is how come I've never heard about one of these lectures or seminars before reading the report. There are also pictures of the seminars being held and the attendance seems extremely low compared to the overall size of the WPI community. I think WPI could do a better job informing students about this as there may be more students who are wanting to participate (WPI Sustainability Page).

Another issue with all of the sustainability reports is that they all seem to be similar, with minor discrepancies on what is being done each year. There doesn't seem to be much improvement in sustainability, nor are there many suggestions on how sustainability can be improved. I will say there are improvements in certain categories each year and overall they do seem to be a downward trend in terms of energy consumption, but there's not enough information on how this is being done and what has been put in place to accommodate these improvements. When we look at WPIs Sustainability Plan as a whole, we learn that the

Sustainability Plan has been in place since 2014, and was revised to create a new sustainability plan in December 2019 and completed in fall of 2020. In the Sustainability Plan, WPI proposes a five-year action plan regarding sustainability including details such as various opportunities to invite input from the WPI community and the world to develop goals for sustainability (WPI Sustainability Page and Report).

1.3.3 Analyzing and Understanding Action Plans of other Institutions

After taking a look at WPI's Sustainability Plans, it can also be beneficial to look at other institutions and compare what we have done as WPI to that of other schools. We may observe that there are institutions that have done more than us and are ahead, or we may realize that there are institutions that have actually done little to nothing and that WPI may in fact be ahead. One thing that can be done later on, but addressed now to start a basis of conversation later, is to acknowledge whether it is a problem with colleges across the country when it comes to sustainability or if it's only a problem at certain schools. There may also be the assumption that all schools have been doing more when it comes to sustainability as opposed to other business units and the rest of the world. We will dive deeper into that question later but it is important to start thinking about these topics sooner rather than later.

First, let us take a look at Harvard University. With a big name and a high reputation a lot is expected of this university in general, and sustainability nonetheless. One of the major things that stood out as I read about Harvard University's sustainability plan is that the students have a direct involvement and a huge impact with sustainability on campus. Motivating students through extracurricular activities that involve sustainability and using that as a resource for the

greater good of the whole school makes it seem like it is more than just a club, and also provides the ability to create a lasting impact not only while the students are in school, but after they are out of school. Another thing that Harvard claims to be doing is that they have composting available in all dorms. Composting is a form of placing biodegradable materials in one container that can be recycled back to the earth (Hu, Composting 101). When you think about the amount of food waste and biodegradable waste, a lot of it seems to be going into trash cans, whereas Harvard gives the ability to compost and have it go back into the soil. Lastly, one of the most important factors to observe is that Harvard offers research funding to encourage sustainability on their campus. It is important to have money available to perform such activities otherwise the progress and the effectiveness of a solution may not be proactive. Harvard's ability to provide money towards sustainability is a great look (Harvard Sustainability Website).

Stanford University also provides various graphs and data directly on their website to highlight improvements. Stanford provides a lot of quantitative data to show what has been done which allows us to see proof through informative graphs to help us understand the impacts of certain solutions that Stanford has taken. Stanford also provides a lot of student engagement and encourages students to engage with their sustainability practices, however I will say that it doesn't seem as student-led as Harvard had their program. Another key aspect to Stanford's sustainability website is that they focus more on the results and what has already been accomplished, but they do not have much information on what they plan to do in the future. It's important to see progress, but no one is ever perfect and Stanford is by far definitely not fully sustainable to the point that they have no other improvements that they could be making. Thus, it would be nice to see more plans for the future to improve their sustainability rather than just end it there (Stanford Sustainability Website).

Smith College features a user-friendly sustainability website. Any information regarding sustainability is provided. For example, if you're trying to see how to get involved there is a tab for that, or if you want to see what academic courses are available for sustainability there's a separate tab for that. They are two different categories in terms of academics and extracurricular activities, however, they are still similar and it is nice to see that both are being represented on the sustainability page. Going into the academics, Smith features a lot of information regarding how students can get involved with sustainability by taking courses to develop majors, minors or even environmental concentrations. The ability to provide students this opportunity and highlighting it on their sustainability page can open doors for many students that maybe once thought that sustainability was more of an extracurricular activity, but now can realize that they can turn that passion into its own major (Smith Sustainability Website).

Princeton University sustainability website does an amazing job highlighting the upcoming events related to sustainability. It provides information on how you can get involved that could be low commitment and the website even provides sustainability related news. There are live updates of what has been done and what they plan to be doing on campus regarding sustainability, students can be aware of the progress that is being done and information related to sustainability on a more frequent basis rather than receiving a report once a year (Princeton Sustainability Website).

Next let's take a look at Middlebury College. Middleberry claims have gone carbon neutral in 2016. And their website explains how they went carbon neutral as well. Reading through, you will find that their journey began in 2001. It took them 15 years to go carbon neutral which means that they had a head start, but the more important thing is that the students have a realization of the importance of sustainability simply by the fact that they are a part of a

sustainable campus. Middlebury also talks about various constructions that have been implemented to help with their carbon footprint. For example, in late 2008 Middleberry claims to have built a biomass gasification plant which burns locally sourced wood chips and meets most of the heating and cooling needs on their campus while also co-generating 15 to 20% of electricity to stay carbon neutral. Middleberry claims that their carbon footprint dropped 40 to 50% from this addition to their campus(Middlebury Sustainability Page). That is impressive and reading about it has a lot of insight to the things that college campuses can do to follow in Middleberry's footsteps (Middlebury Sustainability Website).

The last school worth taking a look into is Rensselaer Polytechnic Institute. Based off of RPI's website, their environmental services and sustainability plan is part of their facilities management website. Right off the bat, that tells us that RPI isn't doing much in sustainability and it became a sub-tab for Facilities. The website doesn't offer anything about sustainability practices and offers more information about routine services such as cleaning and emptying trash bins and cleaning restrooms and classrooms, like expected from a Facilities website, not a sustainability page. Besides that I am unable to even find a sustainability report from the campus, which makes me believe that RPI is doing little to nothing in terms of reducing their carbon footprint and encouraging sustainability on their campus (RPI Facilities Website).

1.4 Approach

Now that we know what other schools have been doing in terms of their sustainability practices and what WPI has been doing in regards to their sustainability practices, we can now compare the schools and really understand where WPI is compared to the other schools that we looked at and whether or not we are ahead of the game or behind the game and what improvements can be done in order to improve sustainability and ethics on our campus. From the research done as described in the State of the Art, there is a lot that can be learned from the other schools. Implementing their practices can greatly benefit our campus, and understanding how we are better in certain aspects compared to other campuses can also provide insight and recognition to WPI, so we do not stray away from those good practices.

Whether or not you're an Ivy League school, that should not be a basis on how ethics and morals play into a campus. The same expectations are set for WPI as are for Harvard. The key thing that WPI needs to learn from Harvard and implement into their sustainability practices is promoting a higher student involvement into sustainability. After all, the point of this paper is to understand whether WPI is doing a good job teaching ethics and morals to their students and effectively using sustainability as a way to solidify those practices. Harvard perfectly combines the two ideas and pretty much allows their students to run sustainability on their campus. It would be nice to see WPI do something similar where students are directly involved with the sustainability board on our campus and have a direct impact on the actions taken to reduce the carbon footprint on campus.

Now let's take a look into Stanford, we see a lot of good results, some results may even be better than WPI. However, the main thing to note here is that it's not about what has already been done, but what's more important is, what you have planned for the future. Acknowledging

that there is room for improvements proves to the whole student community as well as the WPI community that there are always improvements that can be made and providing information for future plans acknowledges that. WPI has a five-year action plan which in my opinion means more than what has been done in the past five years. With technology advancements today, there will always be room for improvement and motivating the students on that idea will only make that more of a fact.

Comparing Smith College's sustainably to that of WPI's, the main thing that WPI could learn from Smith College, or rather simple one, is to make the website more user friendly. The sustainability ideas/courses/anything else is more user-friendly. Smith does a good job communicating sustainability practices on their website and does a good job explaining to students what they can do to learn more about sustainability and even pursue a degree in it. WPI has sustainability related courses and ethics related courses, however it is not explicitly mentioned in the WPI website which can make it a little harder for some students to find. Smoothing out that process can encourage sustainability just a little bit more.

Princeton University does a good job of posting live updates on energy consumption data and also provides live news regarding sustainability. Allowing students to be actively involved with events and the news regarding sustainability keeps more students engaged and interested in sustainability practices on their campus, rather than reading a yearly report that is given out by the school as WPI also does. I think that in addition to the report it would be useful for WPI to create their own sort of news page to provide live updates to students across campus.

Middlebury College is a hard school for WPI to compare themselves to. The thing with Middleberry is that they are so far ahead of the game because they started so early that they were

able to actually reach a carbon neutral campus by 2016. That is impressive and WPI may be a couple years away from reaching that same goal, however, a lot of the same techniques used at Middlebury College can be implemented to WPI, only making the process of reaching the carbon neutral campus much easier. Instead of building more buildings on campus, maybe WPI can build one of those biomass gasification plants to reduce our carbon footprint by 40 to 50%.

Lastly, as RPI is one of our direct rivals, I'm proud to say that WPI is way ahead of RPI when it comes to sustainability and teaching ethics and sustainability on campus as it seems that RPI has done little to nothing to actually promote that within themselves or at least on their website. I hope RPI is doing more than what they claim to be on their website, but WPI is definitely way more involved in sustainability and there is not much that the school can learn from RPI in terms of improving sustainability practices. At the end of the day we are all on the same side of fighting Global Climate Change!

2. Methods

2.1 Create Survey questions while keeping focus questions in mind

In order to collect meaningful data that can be used for this report and provide valuable results in which we can draw conclusions, we must create survey questions to obtain feedback from the WPI community. However, to create those survey questions, we must also ask ourselves certain questions while formulating the survey questions. It is important to understand the significance of asking a question, and portraying the purpose of the question while asking the question itself. If that can be done, then attaining the results that we desire for this report will be far easier. So what are these focal questions to keep in mind while creating our survey questions? Well, they can be described as the following:

1. What is the Purpose of asking this question to students and faculty?

2. Will the respondent have an opportunity to gain insight into ethics and sustainability through this question?

3. Does this question relate to the objectives?

4. Does the format and type of this question maximize the potential value of the response?

Now that we know what the questions are, let's take a look into what each of them mean and why we should think about them while designing our survey questions to gather data.

The first question, what is the purpose of asking this question to students and faculty? This question may seem generic and simple, however many researchers in the process of thought may in fact forget about the purpose of the research as a whole when asking a question, which can often lead to irrelevant data and off-topic conversations. To maximize my time and my response time without wasting any time, it is important for me as a researcher to ask myself whether or not the question has a purpose. Will I gain any information, such as quotes, opinions,

and quantitative data that can actually help my report, or will I just gain information that will be deleted later on?

The second question asks whether or not the respondent will have an opportunity to gain insight into ethics and sustainability through this question. Part of my job when asking questions related to ethics, it's a see whether or not I can get the respondent to understand the value of ethics and sustainability through my conversation with them. Sometimes being asked a question can open doors for another person on whether or not they lack knowledge on a certain topic, and more importantly whether or not they should know more about a certain topic. When it comes to ethics and sustainability I think most would agree that lacking knowledge is not a good thing.

Another important question that we must ask ourselves is whether or not the objective is being met through the question. In the beginning of this paper you will see our main three objectives that we are trying to understand. To accurately understand those objectives, we should use our survey questions as a tool to help answer them. Getting insight into the objective questions even though they might not be responsible for the objective itself can prove to be a useful tool.

Lastly, we want to understand whether the format of the question and the type of question we are asking will maximize his potential value in response. This may seem like an odd question to ask yourself, however, oftentimes the respondent may not provide as useful feedback from a question based on how it is being asked. For example, if we asked the multiple-choice question where the obvious answer was clearly listed while the other three answers or choices could easily be crossed out, we are giving the opportunity for the respondent to choose the correct answer, when in reality if we asked them the question face-to-face, they would not know the answer. Understanding when to ask a certain type of question can provide much more accurate results in

terms of what the respondent knows about a certain topic, leading us to draw more accurate conclusions from the survey.

2.2 Compare the similarities and differences between WPI sustainability plan and each of the other schools

This Part of the methods involves comparing the similarities and differences between the WPI sustainability plan with the other schools. In fact, this section has already been completed and been described in the approach section of the paper. It is still important to highlight the fact that this will be a big method when analyzing the sustainability plan and ethics at WPI, although it has been already described it is still important to mention in the method section of the paper.

Comparing The similarities and differences between WPI and her schools provides us the opportunity to establish a baseline in terms of where WPI is at with ethics and engineering and as we saw in the approach, it can easily be understood that WPI is definitely not at the top nor the bottom when it comes to ethics and sustainability. Establishing that baseline gives us an idea on what to focus on when it comes to improving the school and what to give credit to WPI in terms of what has already been done. The fact that we now have this realization it will be much easier to critique and formulate ideas based off of the comparisons we made with other schools to create the action plan that was mentioned in the objectives.

2.3 Research reliable documents and articles, while using this [guide]

When it comes to any research paper, one of the key things to focus on while researching is to make sure that the information and data you collect from these documents and articles are beneficial to your paper but also to make sure that they are reliable and trustworthy. It may seem like an easy task, however in order to really understand what I am doing when researching, I

found this guide to help me research, providing me with the information to draw conclusions from the documents and articles I read.

If you take a look at this guide you will see the various steps needed when researching and following those steps has made the process of writing this paper much easier. As described from the website, the first step involves developing a topic, and using that topic you can develop research questions and find the relevant background information based on your topic. Then you can locate the information necessary and evaluate/analyze the information. At the end of analyzing that information, you can be able to communicate that information as I am doing with this paper. Lastly, as obvious as it may seem, but nevertheless important is to cite those sources (Elmira College Research Guide)!

2.4 Interview students directly to obtain a better understanding of their knowledge in Engineering ethics

Once we have solid research questions and survey questions prepared to collect data, our next step is to collect the data itself. The first method in order to collect the data is by interviewing students directly. With this method the idea is that we schedule one on one meeting times with students across campus, and ask them questions face-to-face to gather information, as described in Section 2.1. This can often be a challenging process especially in today's world with COVID-19 and the limitations of direct contact with other people because of social distancing. Another challenge of the process is finding availability for a time that works for both students to conduct the interview. Especially given that the students of WPI are most likely busy at most times due to the requirements of their other classes as well as extracurricular activities.

2.5 Collect primary data from the survey questions

The other method that I plan to collect data with, is by one creating an online survey that I can reach out to students with to fill out and collect data. This provides students the opportunity to answer questions on their own time without having to schedule a time to meet up with the interviewer, providing a lot of flexibility. I personally like the idea of survey questions because it allows me, with the use of modern day technology, to reach out to a much broader audience and be able to collect a lot more data in a shorter time span improving my efficiency in completing the tasks required for this project.

However, as mentioned before there are downsides to this method of conducting interviews. One downside is that this may not provide as much engagement from the respondent creating less meaningful responses and the possibility of gathering data that has to be disregarded due to lack of valuable information.

During the time of collecting this data, I did in fact collect it along with the rest of my IQP team during B term in 2021. So a lot of the data may seem similar from our two reports, because they were the same.

2.6 Analyze and draw conclusions from the survey questions and interviews

Once all the data has been collected, our next step will be to begin dissecting the information collected. We have so much information now, although it is important to realize that not all the information may actually be valuable as mentioned before, and some of the primary data that serves no meaning such as blank responses may as well just not be referenced in the paper.

We will also have a lot of valuable data. And with a school of bright students they may raise points that require a higher level of thought to understand their thoughts and draw conclusions from those points. It is important to acknowledge that we are not only trying to understand what students know but what we can learn from the students. Observing this information allows us to develop questions based on their responses, and ask whether or not the objectives for this project lineup with the concerns of the students at WPI. It is important for us to do a thorough breakdown of the student data because most of our results will be driven from what other students on campus have to say.

2.7 Meet weekly to discuss research findings

This method was used when I actually had a team to work with during B-term of 2021. During this term, the team and I would meet at least once a week to discuss our progress on our research findings, as well as updating our team with the work done to reach our end goal of completing our Interactive Qualifying Project. Proper communication within the team was necessary in order to maximize the efficiency of our time. Also, four brains can learn a lot more about an issue regarding ethics and sustainability than one can! Due to complications of working along with my team due to taking the semester off during C and D term, I was unable to complete my Interactive Qualifying Project with the rest of my team causing them to finish without me. However, I am grateful for the information and knowledge I have learned alongside the team, and it has definitely provided me the ability to make much more progress in terms of reaching my end goal of gaining new knowledge from this project. I truly think that I would've learned a lot less if I had not had my team during the B term of 2021.

2.8 Frequently communicate with the Advisor and use feedback appropriately

Lastly, it was important for me to communicate with my advisor, Professor Brown, in order to understand that the progress I was making was satisfying the expectations of the project. Also, Professor Brown provided a lot of valuable feedback when it came to the project as a whole and has given me many opportunities to further my understanding of engineering ethics and sustainability at WPI by bringing up meaningful questions and encouraging me to dig deeper into some of my research. Frequent communication also assured my professor that I am putting in my fair share of work in completing this project. Also, using this method of frequent communication with my advisor has allowed me to make substantial progress as a student and completing my degree requirements for my Interactive Qualifying Project.

3. Results

3.1 Survey Questions

After finalizing and sending out our survey to various group chats as well as friends in order to collect our data, we were able to notice the following things. Please note that in this section we will only be serving the direct results and we will provide an analysis on the results in the discussion section of the paper.

One of the first things to acknowledge is where students are coming from when we collect data and what class they are in. From our data, it is evident that the majority of students were seniors, with 41.7% of them being seniors. That means that our distribution could have been better by favoring and collecting data from other classes especially the freshman class as they would have been a valuable tool in collecting data. However, we were limited by the number of people we knew and our team knew less freshman students, in fact no freshman students were able to complete our survey. We did get representation from the juniors and sophomores as well as graduate students (Figure 1).

Another key discrepancy from our survey results was that the majority of students were robotics engineers, with 50% of them being robotics engineers, this served as a major discrepancy (Figure 2).

It was also noticed that the first canon of engineering ethics was actually answered correctly by 66.7% of our recipients. Now this is an odd number as that means that the majority of students were able to acknowledge or know what the first can of ethics is. It is important to keep in mind here that the survey questions thus far discussed were all served as multiple-choice response questions (Figure 3).

We then start asking questions with written responses. As shown in the appendix, we asked the question whether students were aware of any engineering ethics course, and if so whether or not they have taken any of the engineering ethics courses. After analyzing those results it was concluded that 80% of the students that answered the survey knew of engineering ethics courses at WPI, whereas only 20% did not know about any engineering ethics course at WPI. Also 40% of the respondents have taken an engineering ethics course at WPI. This means that half of the respondents that had said yes have also taken a course. Think back here to the correlation with the majority of the response being robotic students, there could have been variation in results because of this and we will talk more about this in the discussion (Figure 4).

Our next question was whether or not students at WPI knew any environmental related actions that WPI has taken to make the campus more sustainable. If so, we then asked whether or not they knew what those actions were. Most did not know that there were actions being taken, however some did mention the toilets in the Recreation Center for being recognized to save water among other items such as timers in the hallway lights and sensors to turn lights on (Figure 5).

We then asked students the big question, whether or not they believe that engineering ethics should be implemented in their courses, and if so how do we include engineering ethics to WPI courses. This is a deep question as we are asking students whether or not they have the solution to our big problem. However, we might not know if their solution is correct. It introduces us to a bigger audience and allows us to analyze a richer input of data. Most students believe that teaching engineering ethics in their course is important and it should be implemented in the courses. One notable argument, however, was that each course has its own focus so it

might not necessarily have any benefit to include ethics in a course where the course might have nothing to do with ethics in the first place. And that is a reasonable argument (Figure 6).

That brings us to the end of our survey questions that we received data for. We will look into a broader and deeper analysis into what these results actually mean in the discussion section of the paper.

3.2 Interviews

This would have been beneficial to our final report as performing interviews is crucial in terms of obtaining the data needed and getting feedback from students one on one. Not only that, it creates a sort of connection between the interviewer and the respondent as the questions may be able to be responded to on a personal level which may not have the same effect through a computer screen.

With that being said I was unfortunately not able to perform any interviews with students due to the IQP being in the summer and not having many connections on campus to perform interviews. It was one of the setbacks with doing the IQP in summer, however I still feel it is necessary to acknowledge the interviews in the results section of the paper as it provides insight as to what were some of the expectations for the report, and how it could be an improvement if I had the opportunity to obtain the results. Acknowledging the importance of conducting interviews also provides the realization that the report could have been stronger with interview results. Rather than leaving the section blank I felt it necessary to point out to whoever may read this, to understand the values of conducting interviews.

3.3 WPI's Current Position Regarding Sustainability

As mentioned before, WPI has two sources of information that can provide details on the sustainability plan. When you go on the Sustainability Plan page on WPI you will see that you can find an overview page which has a condensed report of what to expect in the sustainability plan, as well as a full detailed report which goes in depth on what the sustainability plan entails. As part of this, we will do an in-depth analysis of what we can find in both of these documents so that we can later on discuss the impacts of the current sustainability plan and what else can be added to the sustainability plan based on what we have learned from other schools as mentioned in the approach (WPI Sustainability Page).

Let's take a look at the overview of the sustainability plan first as it provides us the key details of what to expect. The plan states that over the course of five years, from 2020 to 2025, WPI will incorporate changes to create a sustainable ecosystem. In the Vision section of the plan WPI highlights that they focus on incorporating the three broad goals of sustainability which are environmental stewardship, economic security, and social justice. WPI hopes to make a culture out of sustainability by using the campus as a laboratory and with this create an innovation hub that can be used across the world to address global challenges when it comes to sustainability. With those being the three major ways to make the campus more sustainable, we did not see any specific details on changes to the campus regarding how we can be more sustainable. Here they are more focused on ways of communicating sustainability within campus, beyond campus and with the world, but I do not see anything regarding physical changes to the campus to promote sustainability (WPI Sustainability Plan Overview). Maybe we will see that in the more detailed sustainability plan which we will talk about next.

The detailed sustainability plan also emphasizes the three objectives that I mentioned earlier in the overview. They are "to advance sustainability within our campus as a living and learning laboratory, to advance sustainability locally by expanding our efforts beyond our campus and developing the local community and region as a hub for sustainability innovation, and to advance sustainability globally by reaching out beyond our campus to develop our academic initiatives that impact communities worldwide"(WPI Sustainability Plan 2020-2025, 6). It seems that this is the major course of action that WPI wants to fulfill in the next five years. Moving further into the document and report, I can now start seeing details regarding the objectives between operations and facilities at WPI. To summarize, WPI hopes to reduce environmental impacts by reducing energy, water and waste and other resources, however they do not mention specific ways that they can do this. Instead they say by considering creative ideas(WPI Sustainability Plan 2020-2025, 17). There is no indication of what the ideas might be, but just that they would consider any of them. WPI also focuses on research contributions and scholarship to advance the studies of sustainability, but we again do not see any specific research or scholarships that will be provided to directly address sustainability. It seems to me as though there is no actual protocol or steps but more just an idea of what we can expect or what we are thinking of doing over the next five years. There are no actions or objectives directly related to sustainability improvement in this report which makes me believe that the sustainability plan still needs work and is more of a recognition that we are thinking of doing things, however there is no indication on what we will actually do.

4. Discussion

Now that we have all of our results stated from the survey questions to the analysis on WPI's Sustainability Plan, let us now analyze what this all actually means. We didn't want to dive too deep into the meeting and the analysis of this in the Results as a discussion will provide that broader understanding.

Starting with the survey questions let's discuss the class in which most of our responses were from. Based on the results it is evident that 41% of our respondents were seniors. This means that seniors would have swayed the data based on their understanding of the school which would most likely be more than what a freshman would know. This is because freshmen are still getting used to school and learning how everything works, however seniors already know much about how the school works and have heard more about the school over the greater number of years that they've been here. Now this can be a good thing and a bad thing. This is a good thing because of the fact that it provides us reasonable data as a student that has been here longer and been exposed to more things around campus may have a better picture of what WPI is actually trying to do. However, when a freshmen answers these questions they may have not even experienced even half of what the academics offer to understand what sustainability and ethics even really means to their curriculum. That leads us to the bad thing, although freshmen may not notice, it should still be important for them to understand the value of ethics, and shouldn't it be an important lesson that they learn among all their other freshman year classes when they first enter the school? The fact that we did not have any freshman listed in the results can give us a bigger picture of how many people have a true understanding of ethics and sustainability of the school related to the amount of time that they spent at the school.

Moving on, we also noticed that the majority of students that answered the survey were Robotics Engineers, with a stunning 50% of them being robotics engineers, the data may have bias towards the one major and their curriculum. One thing I will note here, is that I myself am a Robotics Engineer and speaking from a Robotics Engineer's perspective, which I think can relate to the many other Robotics Engineers that took this survey, is that the Robotics curriculum requires us to take an ethics class as part of our degree requirements, therefore most of the respondents that were RBE's should all say that they are aware of your ethics related courses at WPI and it shouldn't matter to them if it should be mandatory because it already is! However, I also have a second major which is Mechanical Engineering, and then that major I have no degree requirement that requires me to take an ethics related course, which means that if it wasn't for the robotics engineering curriculum, I most likely would not have taken an ethics class here at WPI.

Next, we were able to see that a majority of our respondents were able to correctly answer the first canon of engineering ethics. Although I never conducted interviews, I took the liberty to call a couple of my friends and ask them the question whether or not they knew what the first canon of ethics was, and to recite it word for word and all five of them were not able to answer it correctly. And honestly it is not something that you can guess. "Engineers shall hold Paramount the safety, health and welfare of the public in the performance of their professional duties" (IEEE Code of Ethics) is not a easy answer to say when asked in person, however I can see how it seems like the obvious choice in a multiple-choice survey. Which is why I would consider having this question as a written response rather than a multiple choice if I was to redo it.

Now moving onto our next questions which were all written responses, we were able to notice that 80% of students knew engineering ethics courses from the survey. This is actually a good number, however there may be a slight variation if for example, not all of the respondents were RBE, and we had more freshmen answering the survey. As an upperclassman you get to search through the courses offered to WPI much longer and most courses do not change over the years and seeing an engineering related course that has to deal with ethics may not be uncommon when you have to sign up for classes four years in a row. It is also interesting that 40% of the respondents have taken an engineering ethics course at WPI, which also provides us insight that of the 80% of students that knew about an engineering ethics course half of them actually took an engineering ethics course. That is a good number, however what could've been potential reasons for the other 40% to not take an engineering course? Could it have been due to not fitting into the degree requirements at WPI, or maybe they never saw the value in the course. Now we also asked students whether or not they were aware of any environmentally related actions that WPI has taken to make the campus more sustainable. Most did not know of any such means, which is understandable as WPI has never been one to mention these sorts of things, however a few attentive respondents mentioned certain things such as the toilets in the rec center that were used for saving water as well as other items such as sensor lights that turn on in the library. However, these are all small advances yet meaningful, but what I would like to see are more big changes to hopefully create a net zero campus like Middlebury college. They created a whole biomass gasification plant which dropped their carbon footprint 40 to 50%. Incorporating some change like that not only would stand out to the student body of WPI, but would create a much more sustainable campus.

Now, we also asked students whether or not they believe that engineering ethics should be implemented in their courses and asked them how they could see us as a campus doing that. This is a deep question and a hard question to answer and most of our respondents did not know the answer to that question, or would leave that part blank. However, it was nice to see that the majority of respondents believe that teaching engineering ethics in their courses is important and should be implemented in the courses. It almost seems like the obvious answer, when you asking anyone do you think that ethics is important, most people would say yes, however, since it is not enforced in our degree requirements and the idea of classes costing students money may be a downside for students as either they aren't required to take class that requires ethics and they wanted to, but at the end of the day it would be more money for them and would not give them the educational value for their degree requirements as it would to develop an engineer. One notable argument also was that not every class should necessarily benefit from an ethics course or ethics topic in the course because some courses may not have anything to do with ethics in the first place. Now when we think about some certain classes such as Calculus I, for example, math is a supplement to an engineer in the first place and teaching ethics in a math class may not really have anything to do with the class itself. At the end of the day all they are doing is solving a bunch of equations and writing down numbers. It would be hard to incorporate ethics with a class such as that, and I can understand why some students may see that engineering ethics should not be incorporated in all classes because it would be almost off-topic. So maybe it would not be a good idea to incorporate ethics in every class, however it should be important to incorporate ethics in every major.

If I was still with my team, or in a regular school year, one change that I would've made to this IQP would be to have conducted actual interviews. This would have given me a lot more

insight to my results and provided much better feedback for the report, however since I had these setbacks just with timing and constraints of the IQP Ethic I was unable to conduct these interviews therefore my report will be slightly weaker than what it could've been.

Now let's discuss our findings with WPI's current position regarding sustainability and what we read and noticed from the sustainability plan. It was obviously evident that WPI wants to do something regarding sustainability, otherwise they would have never made a report in the first place or a five-year plan regarding sustainability. However, what was concerning to me was that there was not any action plan stated in the sustainability plan and it makes me almost question whether or not WPI has an actual plan yet. The primary reason this is so concerning is because they called to report a sustainability plan, however there is no plan that I can evidently see. WPI keeps talking about visions and ideas of communicating with other schools and within the community, but what is the point of communicating when there's not much to communicate about in the first place. We need results to communicate and WPI is not offering any sort of action plan to obtain these results to communicate to the greater community. WPI wants to be a working lab which I think is a great idea and if we test sustainability on this campus we can involve students, professors and so many more to create a much more sustainable campus however there was no actual idea presented on how to do that. One of the other things that was concerning was that in the action plan that WPI claims to have, they want to reduce environmental impacts and reduce energy and water and waste and resources by considering creative ideas. Basically what that means is WPI has no idea how to do that but they will consider those ideas if they ever come by. Does that sound like an action plan? Or does that sound as a letter saying that we are open to being more sustainable. It would be nice to see WPI taking more initiative like Middlebury college and performing some endeavor to build something

that actually promotes sustainability. We recently just built unity hall, what if the space was used

to build a similar gasification plan and allowed our campus to go carbon neutral?

5. Conclusion

  To conclude this report, I think it is important to say that WPI still has a lot to do when it comes to sustainability. They are in no means at the top among other universities when it comes to creating a sustainability plan, however they are also not at the bottom. We are seeing that there are many other schools that have done far less than WPI, but at the same time we are seeing that there are other schools that have done a lot more than WPI. With that being said it is reasonable to say that WPI is average when it comes to sustainability. However I would not consider WPI an average school, WPI is known for being an exceptional school with a rigorous academic program and a great student body. It should be in WPI's best interest to excel in all categories and not just academics. WPI has started to create a push towards a more sustainable campus, however without more effort, I can see not much being accomplished by 2025 in terms of sustainability. Please keep in mind that this sustainability plan was created in 2020 and we are already in 2022. With us almost being half way towards the end of our sustainability journey or at least the first phase of it, WPI still has a lot to prove. In terms of the students, academics could definitely use a greater push to involve engineering ethics into the degree requirements and academic plan of every student which will allow us to create well-rounded engineers that will leave to the workforce and be able to make meaningful decisions responsibly and ethically. It has been a pleasure researching about ethics at Worcester Polytechnic Institute for this Interactive Qualifying Project, and I certainly have learned a lot about what ethics means to me and how I want to incorporate ethics into my role as a future engineer and I have also learned a lot of what ethics means to WPI and how WPI can improve upon their current standing with sustainability and ethics as well as how they compare to other schools.

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7. Appendices

7.1 Survey Questions and Results

What's your class year

12 responses

Figure 1

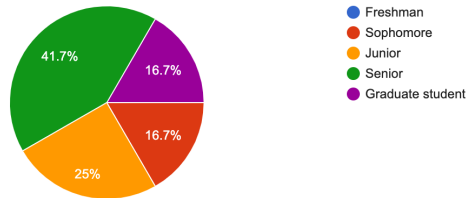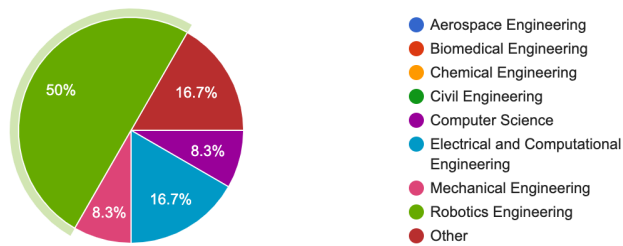What's your major?

12 responses

Figure 2

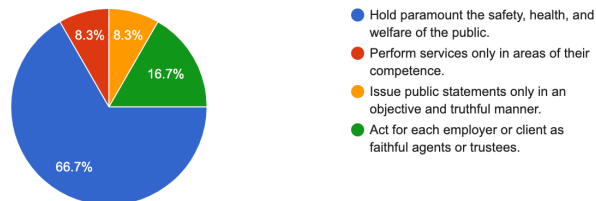What is the first canon of engineering ethics?

12 responses

Figure 3

Do you know any engineering ethics related course? If yes, have you even taken or taught any of the engineering ethics courses?
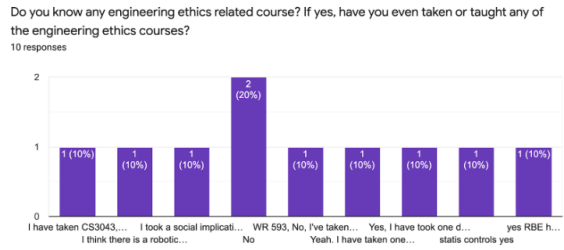10 responses

Figure 4

Are you aware of any environmental-related actions that WPI takes to make the campus more sustainable? If yes, what are the actions that WPI take to make the campus more sustainable?
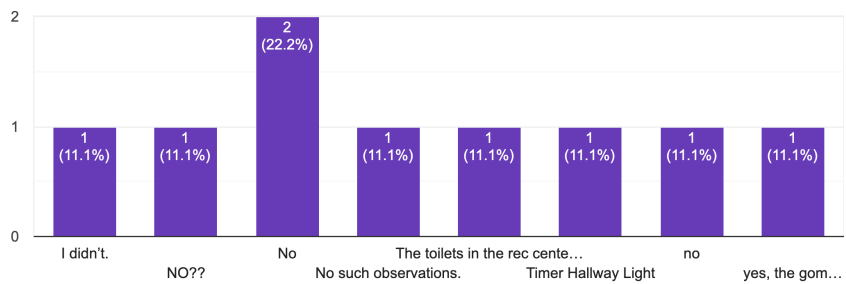9 responses

- 80% yes
- 20% No
- Only 40% have took one

Figure 5

Do you think engineering ethics should be implemented in your course? How do we include engineering ethics to WPI courses?
9 responses

Yes. Include ethical criteria (safety feature, testing, environmental, ...) in the class project evaluation.

case study/ projects

Yeah. We could mimic some situations and teach students engineering ethics

Yes social implications?

Yes. Teach it as teaching the course.

Not necessarily, each course has its own focus. Professors and experienced engineers should can talk about their experience when they are challenged in terms of ethics, what choice did they make and what is the final turnout.

Yes, I think we should watch documentaries or readings for the topics will be helpful

I'm not sure if teaching ethics would help.

Figure 6