

## **Abstract**

In the 2017-2018 academic year, WPI recycled 23% of all disposables. To get an understanding of the WPI “community”, we sent a survey to students and faculty at WPI. We then examined the WPI recycling efforts in 2016 and 2017 using waste audit data collected from WPI’s annual waste audit in each respective year. The result of our findings indicated that less than half of the commonly used recyclable materials were properly recycled. Based on our previous findings, we interviewed students at WPI on their opinion on why people do not recycle. As a result of those interviews, we found that a majority of the students believed that carelessness was the main reason. Our research concluded that WPI students’ and faculty’s carelessness is the primary reason for such underwhelming recycling effort.

## **Introduction**

Sustainability is part of WPI’s mission statement; it says, “The achievement of sustainability must begin locally, but ultimate success requires a global vision. To that end, we pledge to engage with all of our communities: on campus, in Worcester, across the United States,

and around the globe.” WPI considers community cooperation and its utilization of technology as major contributing factors in reducing waste and recycling energy.

Recycling has been a weak area of WPI’s sustainability initiatives in comparison to other areas such as power and water usage. Power and water conservation has increased due to innovative ideas such as sensor lightings and waterless urinals. But recycling continues to show a declining trend over the years despite the efforts of the Sustainability Office. According to the WPI sustainability report from 2013 to 2017, the recycling rate during each of those years has been around the national average, 40%, but is in danger of falling below it. This can be seen by the decreasing recycling rate in the past years which will be discussed later on. We are interested in learning about WPI student’s perception about sustainability, specifically on recycling.

WPI students’ perception on recycling is an important issue because it may greatly affect the recycling rate at WPI. Recycling is an effort; it would not exist without participation from the WPI students. Learning about students’ perception of recycling will help narrow down the potential causes for WPI’s low recycling rate. Addressing the problem could potentially change the recycling culture here at WPI.

Each step in this report addresses different step of our methods. The initial step focuses on understanding what WPI students know. The second step is about understanding the expectations from the Sustainability Office. The third step is about gathering data about students’ and faculty’s perception on recycling. The fourth step will be our analysis of the raw waste data. And finally, the fifth and final step is the result of our previous steps.

To begin our investigation, we needed to evaluate how aware the WPI students are of the opportunities for sustainability on campus.

## Initial Step: Interviews

The initial step was to understand the WPI community’s stance on sustainability. We conducted brief informal interviews with 10 WPI students with the following questions:

*1.) “WPI has 149 sustainability courses to offer, have you heard about any of them? Has it crossed your mind to take or at least consider taking some of these courses?”*

2.) *“Are you aware of any sustainability (Go Green) initiatives that WPI has or will be taking? If so, what is your honest opinion about it? Does it affect you personally? Do you think it will change your environment?”*

3.) *“What do you know from the top of your head, about sustainability?”*

The purpose of these interviews was to gain an understanding of how much WPI students know about the sustainability projects taking place on campus. We wanted to learn about the students' general attitude towards sustainability.

Afterward, we learned that almost everyone knew that WPI offers sustainability courses. Since these classes are mostly electives, they have low priorities in course selection. The intensive curriculums at WPI limit the students' options to take any classes beyond their studies. Despite a lack of interest in sustainability projects, students are still well informed. Many students were able to identify projects such as zip cars, refillable water bottle stations, etc. But students were only able to identify big visible projects or ones that they pass by. However, a majority of the sustainable projects are still going unnoticed. For instance, not many students are aware of the annual sustainability audit. If a student does not see it, then to him/her, it never happened. Overall, the students we interviewed provided generic answers to their idea of sustainability, such as the use of technology to prevent and reduce negative feedback into our environment.

We concluded that despite being aware of the opportunities to be proactive in sustainability the students' do not regard sustainability as a high priority. The rigorous curriculum at WPI pushes the students to select courses and to participate in activities that would enhance their skills within their own field of study. This result in students being more knowledgeable in sustainability areas based around technology such as power conservation devices or energy efficient transportation. After learning how knowledgeable the students are towards the sustainability projects on campus, we decided to meet with the Director of Sustainability at the time, John Orr.

## **Second Step: Sustainability Office**

We came prepared with a set of questions about the power, recycling, transportation and activities around campus. The goal of the meeting was to gain a basic understanding of the state of WPI sustainability initiatives. WPI did well in preserving energies through getting LEED certified buildings. LEED, Leadership in Energy and Environmental Design, is a national-based rating system that judges how sustainable a building is. Next we were informed that the transportation methods such SNAP and zip cars are actually not sustainability friendly as we

initially thought. In fact they act as regular car which pollutes the air with carbon monoxide. The sustainability office is not in charge of SNAP or the zip cars so we moved on to the next sustainability area, recycling. We learned that WPI's recent recycling rate is close to the national average, although the national average is considered to be reasonably low. The Sustainability Office deployed many strategies to better the recycling behavior such as bigger bins, signs and placing recycling bins next to trash bins. To better understand the logistics of recycling and power, John Orr directed us to the WPI annual sustainability report for data on the sustainability activities taking place on campus.

In the report, we obtained the recycling rate at WPI from 2013-2017 and the amount of water, electricity and other energies used. The data obtained, specifically recycling, was still vague and difficult to comprehend. As a result, John referred us to the Assistant Director of Sustainability, Elizabeth (Liz) Tomaszewski who could provide us the raw data used to compute the data presented in the sustainability report.

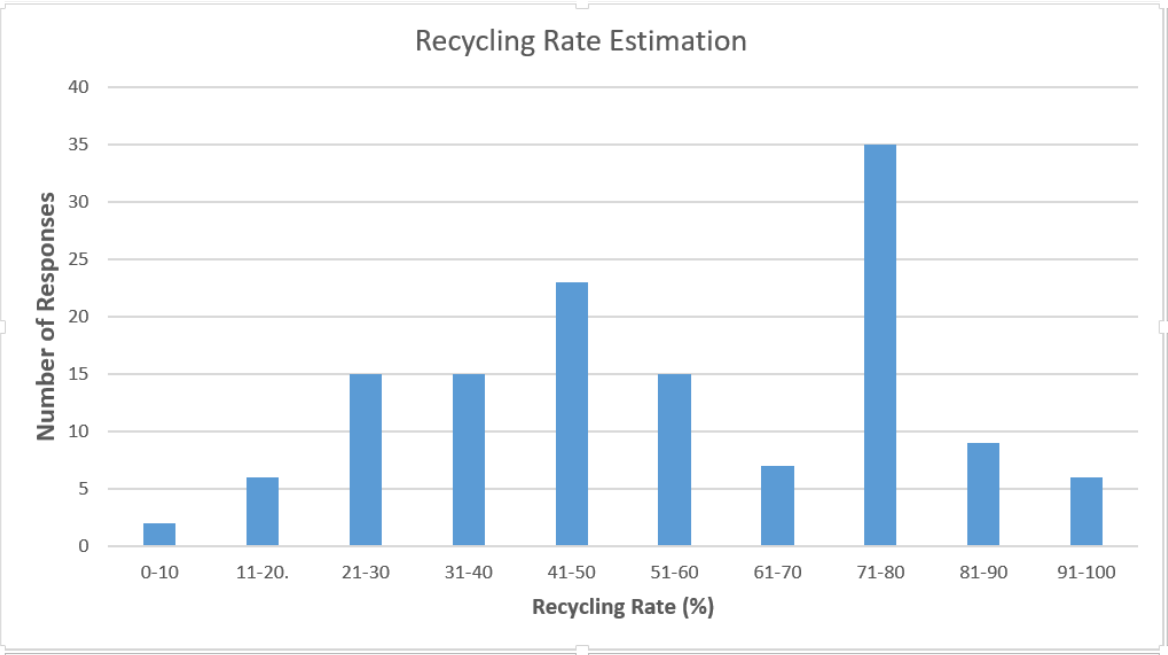
Coming into the meeting with Liz, we had many clarifying questions. Recycling rate was one of the important topics for discussion. In our survey, many students were unable to give a correct explanation on how the recycling rate is calculated (See Appendix E). Knowing how to calculate the recycling rate was important in determining whether recycling is a problem or not. Liz had high standards for the WPI recycling rate. She expressed disappointment at the current state of WPI's recycling rate, sitting below 30%, which does not measure up to the national average of about 40%. The number by itself was not the real issue; it was the lack of action from the students. During the meeting, we learned about the waste audit. The waste audit is an annual one-day event where people volunteer to sort through trash and recycling bags.

From our interviews and meetings, the one topic that stood out among others was recycling. Many power conservation technologies are visible across campus, but recycling is barely noticeable. There are signs and bins located everywhere, yet the numbers, in the sustainability report, indicated that we are doing worse than previous years. This phenomenon raised an interesting question: "What are students' and faculty's perception of recycling?" Acknowledging Liz's concern, we decided our next goal was to uncover the underlying behavior behind students' and faculty's attitude toward recycling. To move forward with our investigation, we received access to the raw data from the waste audit. We decided it was a question worth looking into. With the actual data in hand we decided to survey the WPI community in compare their perception on recycling versus the reality produced by the waste audit.

## Third Step: Qualtrics Survey

We created a survey to understand students' and faculty's perceptions on recycling activities. In our survey, we asked students to estimate how active the WPI community is in taking action towards sustainability. In addition, we asked the students to provide us their estimates on what they believe the recycling rate is. We recorded the data and created a bar graph for each question showing the distributions of the responses (See Appendix B-E). The

average estimate about the recycling rate was much higher than the actual recycling rate which was about 23%. As shown in Figure 1 the distribution of answers from our survey ranges from as low as 5% to as high as 100%. It forms a weak normal distribution with an average of 58% which is 35% higher than the actual recycling rate.



Min:	5%
Max	100%
Average:	58%
Total Responses:	133

Figure 1: WPI Community Recycling Rate Estimations

### Fourth Step: Waste Audit

The waste audit is a day where we, as part of the WPI community, find out how well our recycling program is doing that current academic year. Liz and a sustainability organization, known as the Green Team, sponsor the audit every year. To better understand the function of an audit, we volunteered to help out. The process involves weighing incoming trash bags and recycling bags individually, sorting through those bags and organizing them to their designated

categories. The categories for sorting are usually trash, paper, plastics/cans/glass and food waste. After sorting, we would weigh the bags again. The waste audit gives the Sustainability Office an outlook on the recycling activities across the WPI campus. Usually volunteers sorted and weighed waste bags from at least three academic buildings.

Table 1 show where the waste audit data came from for the 2016 and 2017 academic years. In the latest audit, the Green Team did not collect data from all three buildings due to the lack of volunteers. This situation further increases Liz’s concern about student apathy towards sustainability. Not having enough volunteers to go through 3 buildings despite having us as additional assistance only strengthens the idea that students are uninterested in the sustainable efforts on campus.

**Table 1: Buildings that the waste audit took place in 2016 and 2017**

Campus Building	Year – 2016	Year – 2017
Gordon Library	x	x
Campus Center	x	x
Founders Hall		
Daniels Hall	x	

## Observations

During our volunteer hours, we found many items placed in the wrong bins. There were multiple items improperly placed in the trash bins such as clean paper, unemptied Dunkin Donuts cups, and a high amount of food waste from the Campus Center Kitchen and Dunkin Donuts. In the recycling bin, we found unclean plastic containers, food wraps, and even trash. There were six bins used for sorting. The categories for sorting in 2017 waste audit were paper, plastics, glass, trash, food waste, and clamshells containers. Many volunteers at the waste audit, including us, were not confident in our knowledge of what materials belong to what categories. So as we sorted through the bags, we would occasionally inquire Liz about the item in questions. Our confusion suggests that there is a possible human error in sorting which potentially could affect the recycling rate.

Our next step was to analyze the raw data obtained from Liz and recalculate how much each category makes up the total waste and recycling. This information would allow us to understand the reasoning behind the declining recycling rate.

## Waste Audit Result – 2016

The following charts represent the results of the 2016 Waste Audit. Table 2 shows that in the 2016 audit, the types of waste found in trash bins were 757.2 lbs. of trash and 83.6 lbs. were recyclables. In contrast, in the recycling bin it was discovered to have contained 292.8 lbs. of recyclables and 27.8 lbs. of trash.

Table 2: Results of the 2016 Waste Audit Post-sort Weights (in lbs.)

Type of Waste	Where the waste is disposed		Total
	Trash Bin	Recycling Bin	
Trash	757.2	27.8	785
Recyclables	83.6	292.8	376.4
Total	840.8	320.6	1161.4

At the waste audit we observed how the recycling rate is calculated and recorded. Recycling rate is the percentage of total weight of recyclables in the recycle bins/containers across campus over the total weight of waste produced.

Table 3 shows the percentage of total trash and total recyclables in each container. Using Table 2, the recycling rate is calculated by taking the amount of the recycling waste in the recycling bin, 320.6 lbs., and divide by the total amount of waste, 1161.4 lbs. It comes out to be 27.6%.

**Table 3: Results of the 2016 Waste Audit Post-sort Percentage**

Type of Waste	Where the waste is disposed		Total
	Trash Bin	Recycling Bin	
Trash	65.2	2.4	67.6
Recyclables	7.2	25.2	32.4
Total	72.4	27.6	100

## Waste Audit Result 2017

The following charts represent the results of the 2017 Waste Audit. Table 4 summarizes the latest 2017 waste audit. The types of waste found in trash bins were 1097.6 lbs. of trash and 95.2 lbs. were recyclables. In contrast, in the recycling bin it was discovered to have contained 290 lbs. of recyclables and 196.42 lbs. of trash. In addition, despite sorting through fewer buildings there were approximately 40% more total waste than in 2016.

**Table 4: Results of the 2017 Waste Audit Post-sort Weights (in lbs.)**



Type of Waste	Where the waste is disposed		Total
	Trash Bin	Recycling Bin	
Trash	1097.6	95.2	1192.8
Recyclables	196.42	290	486.42
Total	1294.02	385.2	1679.22

Table 5 Shows the percentage of total trash and total recyclables in each container, trash and recycle bin. From Table 4, the recycling rate is calculated by taking the amount of the recycling materials in the recycling bin, 385.2 lbs., and divide by the total amount of waste, 1679.22 lbs. It comes out to be 23%.

Table 5: Results of the 2017 Waste Audit Post-sort Percentage

Type of Waste	Where the waste is disposed		Total
	Trash Bin	Recycling Bin	
Trash	65.3	5.7	71
Recyclables	11.7	17.3	29
Total	77	23	100

## 2016 Waste Audit VS 2017 Waste Audit

The waste audit procedure in 2016 and 2017 was very similar. The only difference is that in 2016, volunteers and the Green Team under the leadership of Liz collected and sorted trash and recyclables from three academic buildings. While in 2017, the waste audit only took place in two academic buildings.

In the 2017 waste audit, the recycling rate is noticeably lower than the recycling rate from the 2016 waste audit, 23% vs. 27.6%. Based on Table 2 and Table 4, the amount of trash sorted in 2016 and 2017 were 1161.4 lbs. and 1679.22 lbs. The total amount of recycling materials in 2017 is 9.9% higher than in 2016. The amount of trash in the 2017 waste audit was surprisingly 40% more than in 2016. Despite only checking fewer buildings, there were more pounds of trash overall.

Looking at Table 3 and Table 5, the recycling rate for both 2016 and 2017 is 32.4% and 29% respectively. This means if everyone threw the waste in the correct bins 100% of the time, the recycling rate for the waste audit would be 32.4% in 2016. And in the 2017 waste audit, the theoretical max for the recycling rate would be 29%. The difference between theoretical and actual recycling rate is clear; WPI recycling effort is far from ideal.

## Fifth Step: WPI Perception and Reality of Recycling

Recycling signs and bins are visible across the WPI campus. Recalling from our past interview with Liz, we came to an agreement that good visibility does not correlate to long-term good recycling behaviors. From our survey, interviews, and observations from the waste audit, we came to realize that the perception of WPI's recycling effort is far from the reality.

### 2016

The following figures illustrate the assortments of beliefs on recycling activities at WPI, highlighting the overly optimistic perceptions of students and faculty versus the actual facts. Figure 2 compares perceptions vs. reality of the recycling rate at WPI. Faculty and Staff expect the recycling rate to be about 60%, Students expect the recycling rate to be 48%, but the actual recycling rate in 2016 is 30%. From the actual rate Faculty and Staff expects the rate to be 30% more, while Students expects the rate to be 18% more.

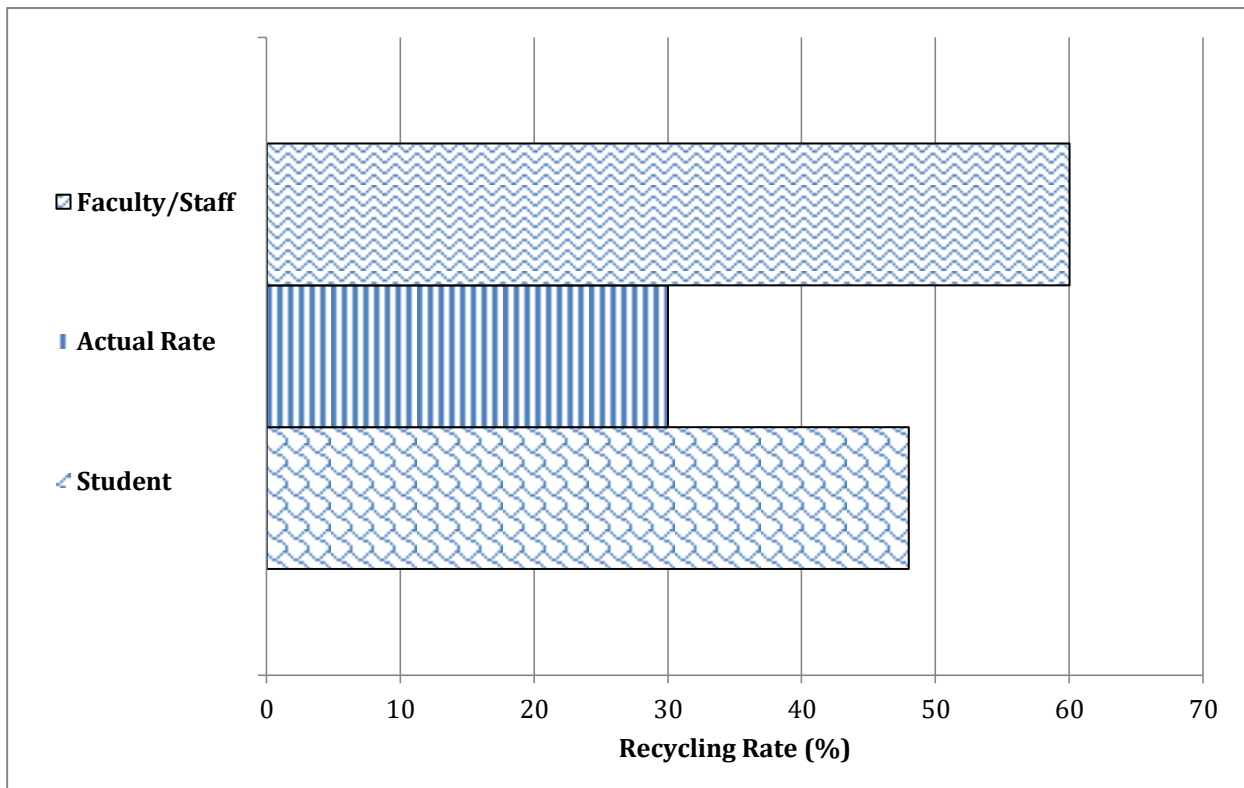


Figure 2: Perception vs. Reality of “What do you expect the WPI recycling rate to be?”

Figure 3 compares perceptions vs. reality of the percentage of recyclables in trash bin at WPI. Faculty and Staff expect 40% of the material in the trash bin to be recyclables, Students expect 33%, but the actual rate in 2016 is 10%. From the actual rate Faculty and Staff expects the rate to be 30% more, while Students expects the rate to be 23% more.

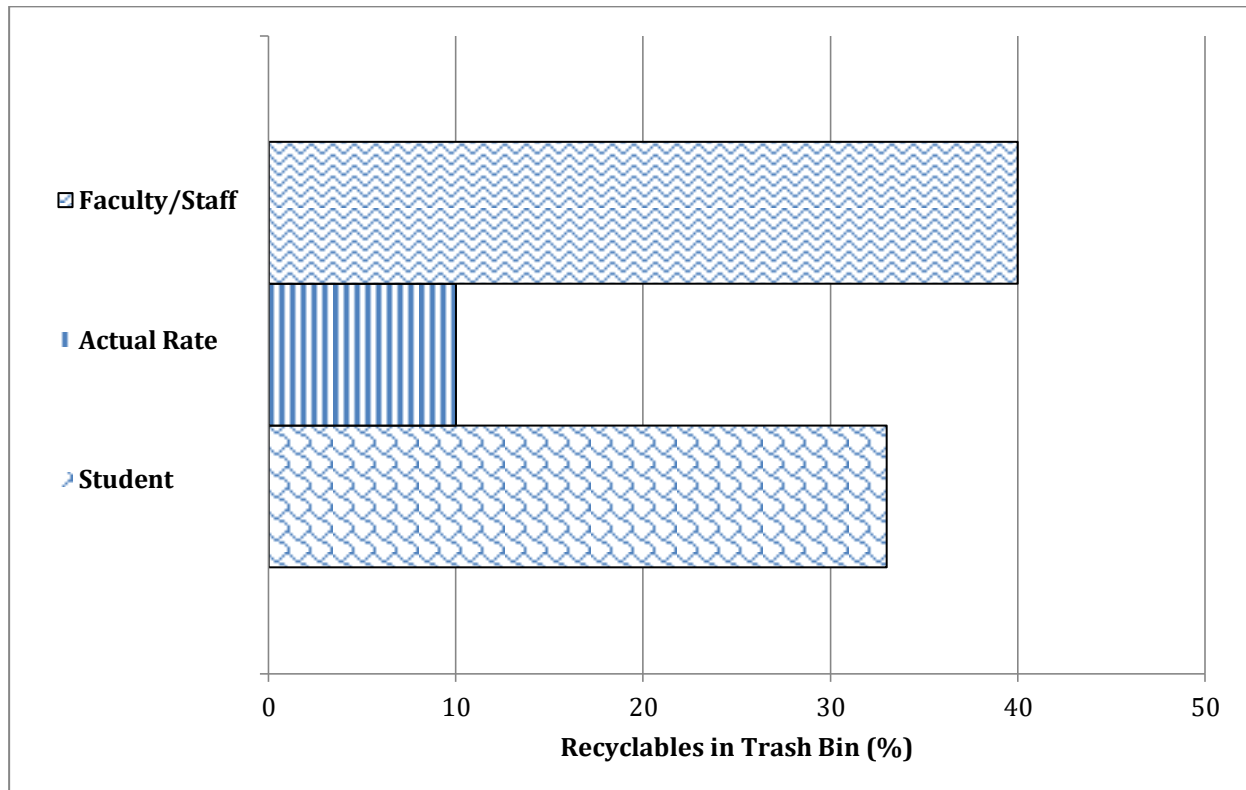


Figure 3: Perception vs. Reality of “What percentage of the trash bin is recyclables?”

Figure 4 compares perceptions vs. reality of the percentage of trash in recycling bin at WPI. Faculty and Staff expect 24% of the material in the recycling bin to be trash, Students expect 22%, but the actual rate in 2016 is 9%. From the actual rate Faculty and Staff expects the rate to be 15% more, while Students expects the rate to be 13% more.

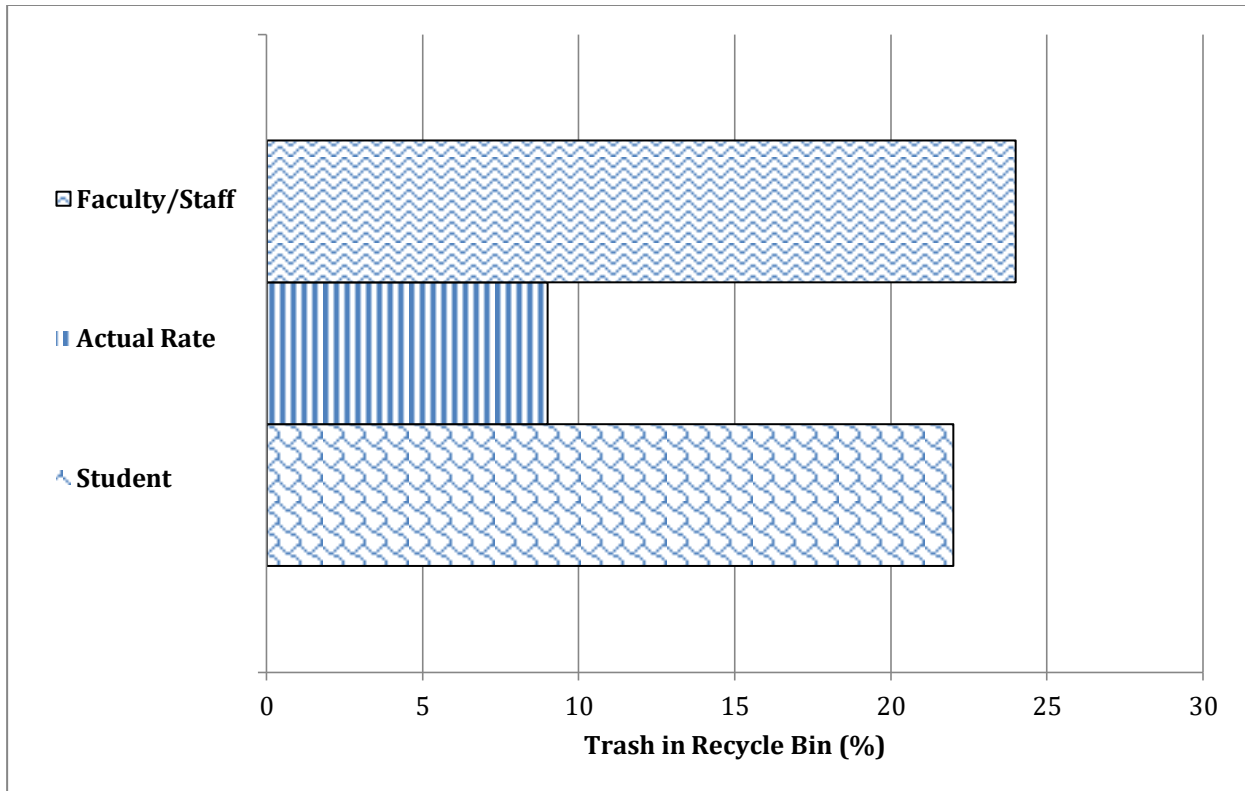


Figure 4: Perception vs. Reality of “What percentage of the recycle bin is trash?”

Similar to Figure 4, Figure 5 compares perceptions vs. reality of the percentage of trash in recycling bin at WPI. The only difference in Figure 5 is that the amount of cardboard is no longer part of the total material in the recycling bin and trash bin. In this calculation, the actual rate in 2016 is 40%. Compared to the 9% actual rate from Figure 4, the percentage of trash in the recycling bin has increased by 31%; it is an enormous difference. This analysis shows that cardboard is accounted for the majority of the total material in the recycling bin. Two important notes can be drawn from this: one, WPI produces too much waste but not enough recyclables materials, and two, WPI is not doing well in monitoring and controlling incorrect placement of waste. This is an interesting knowledge to keep in mind as we move further in our research.

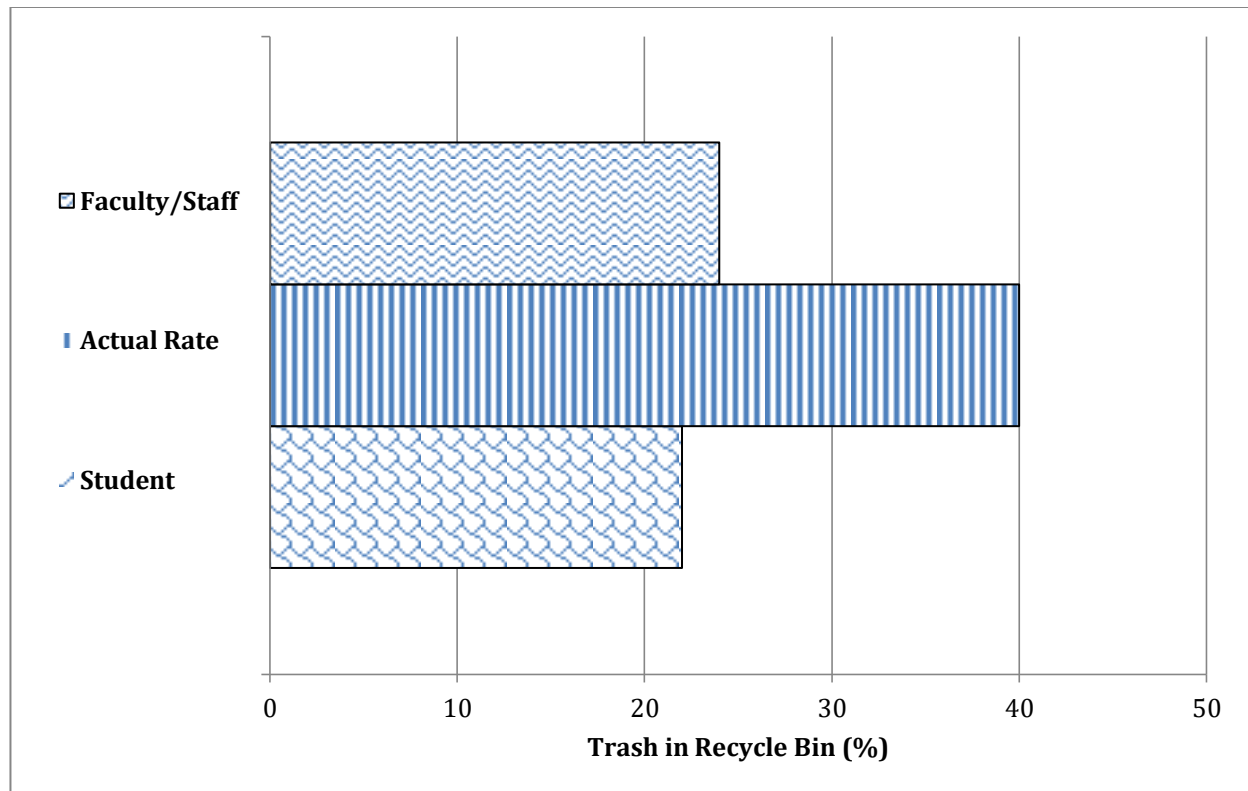


Figure 5: Perception vs. Reality of “What percentage of the recycle bin (without cardboard) is trash?”

Figure 6 compares perceptions vs. reality of percentage of bottles recycled at WPI. Faculty and Staff expect 57% of bottles are recycled, Students expect 50%, but the actual rate in 2016 is 42%. From the actual rate Faculty and Staff expects the rate to be 15% more, while Students expects the rate to be 8% more.

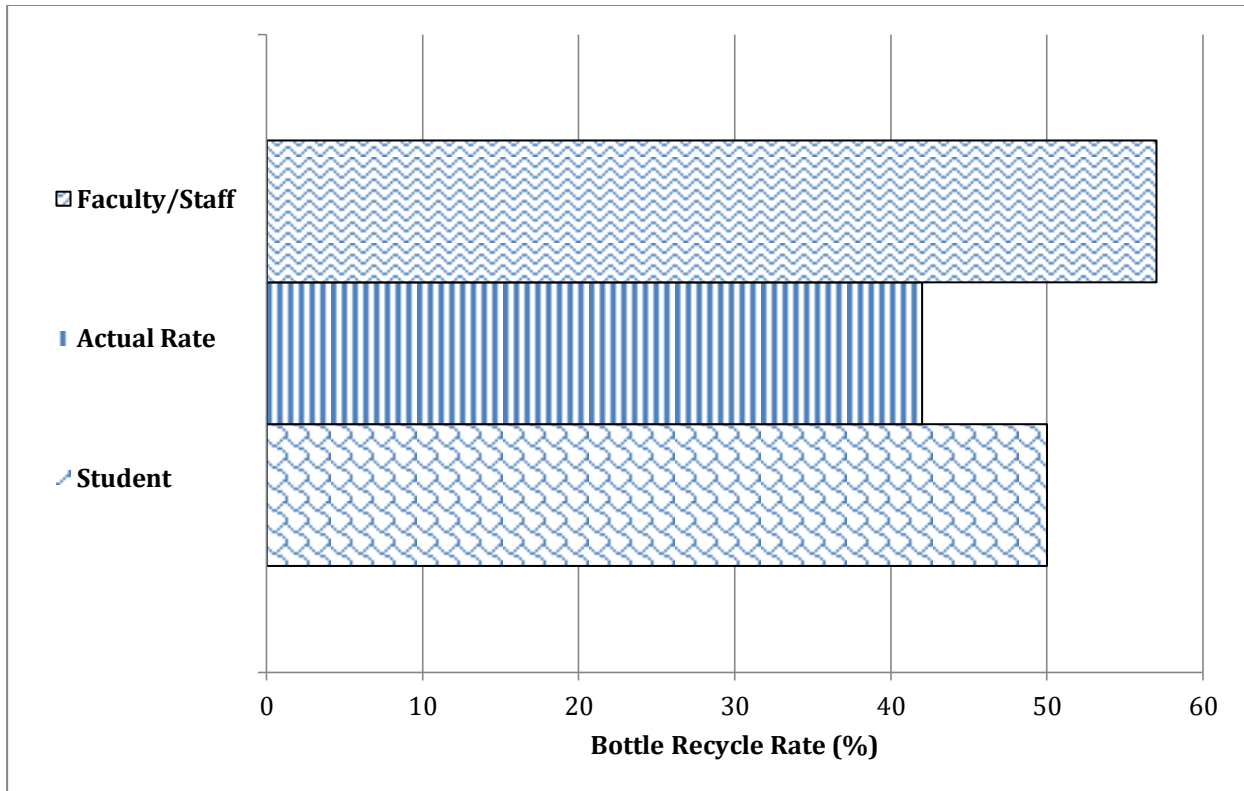


Figure 6: Perception vs. Reality of “What percentage of the bottles is recycled?”

## 2017

We will now compare WPI community perceptions to the waste audit data in most recent year. Figure 7 compares perceptions vs. reality of the recycling rate at WPI. Faculty and Staff expect the recycling rate to be about 60%, Students expect the recycling rate to be 48%, but the actual recycling rate in 2017 is 22.9%. From the actual rate Faculty and Staff expects the rate to be 30% more, while Students expects the rate to be 18% more.

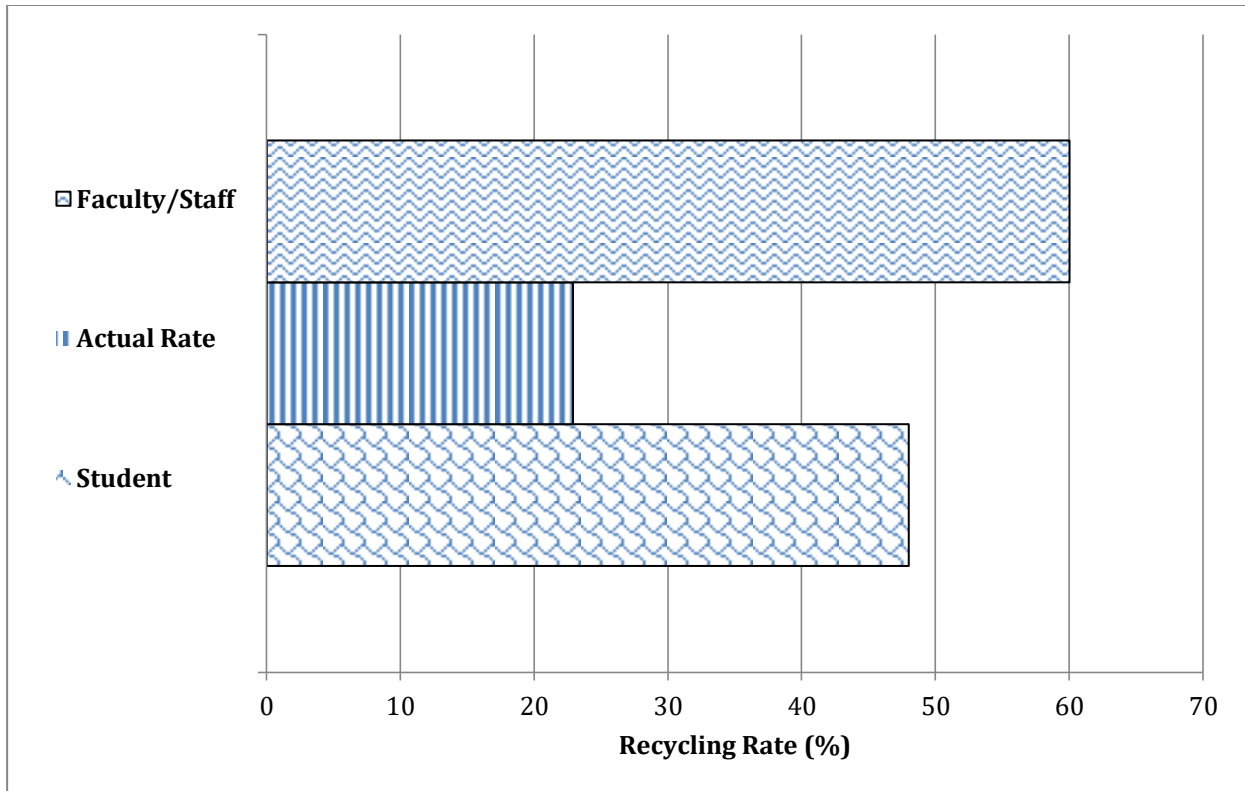


Figure 7: Perception vs. Reality of “What do you expect the WPI recycling rate to be?”

Figure 8 compares perceptions vs. reality of the percentage of recyclables in trash bin at WPI. Faculty and Staff expect about 40% of the trash bin is recyclables, Students expect it to be 33%, but the actual percentage in 2017 is 15%. From the actual rate Faculty and Staff expects the rate to be 25% more, while Students expects the rate to be 8% more.



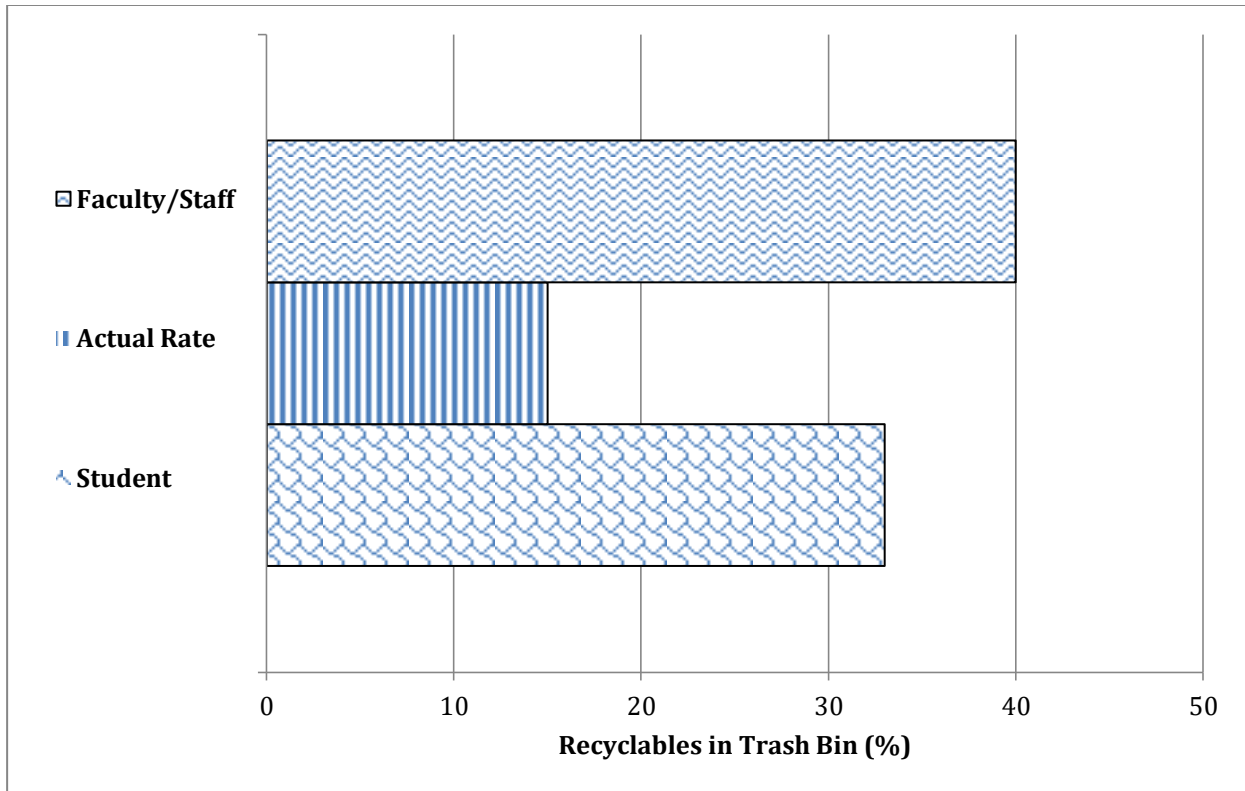


Figure 8: Perception vs. Reality of “What percentage of the trash bin is recyclables?”

Figure 9 compares perceptions vs. reality of the percentage of trash in recycling bin at WPI. Faculty and Staff expect about 24% of the recycle bin is trash, Students expect it to be 22%, but the actual percentage in 2017 is about 25%. From the actual rate Faculty and Staff expects the rate to be 1% more, while Students expects the rate to be 3% less. The perception of the faculty/staff and students are very close.

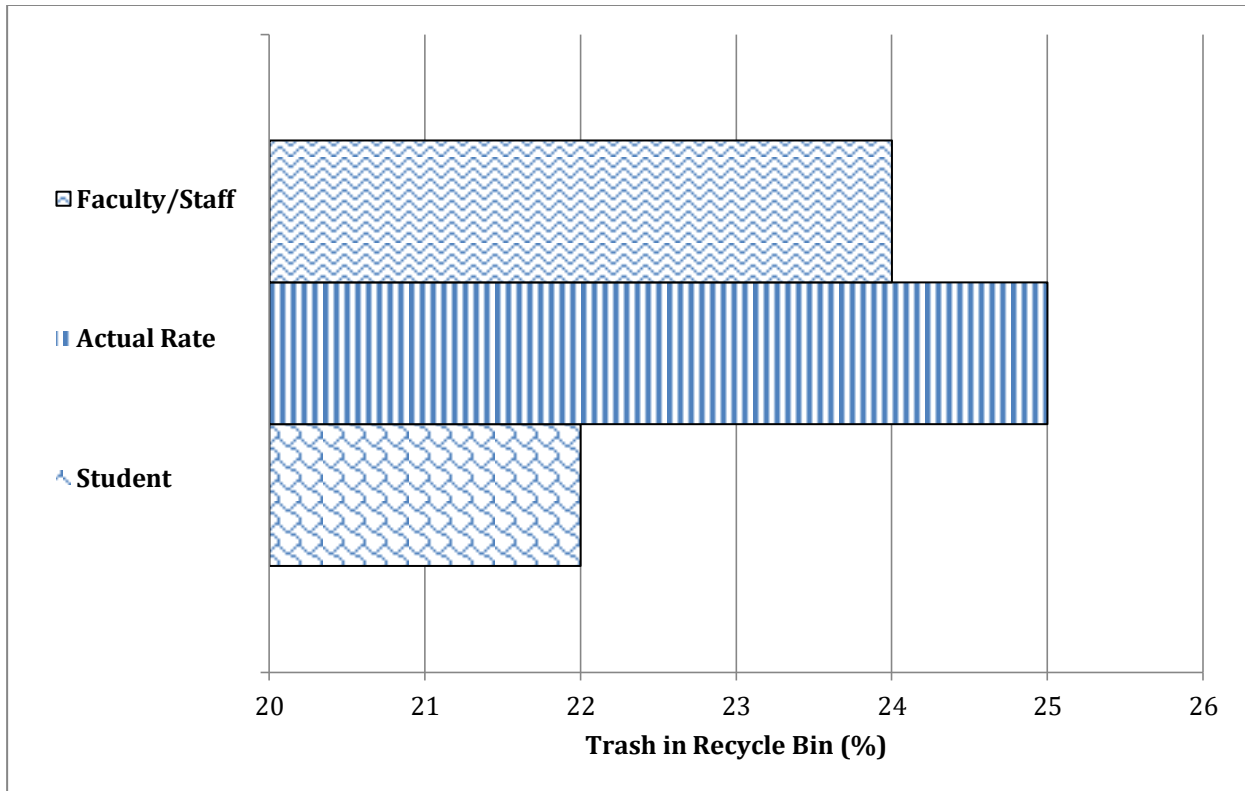


Figure 9: Perception vs. Reality of “What percentage of the recycle bin is trash?”

## Why The Recycling Rate is so low

One interesting discovery we made during our investigation was that a large portion of the recycling waste was cardboard; it inflated the recycling rate. Table 6 shows that the recycling rate for 2016 is 8%, which is less than the recycling with cardboard, 27.6%, by 19.6. Table 7 shows that the recycling rate for 2017 is 10.5%, which is also less than the recycling with cardboard, 23%, by 12.5. When we removed the cardboard out of the calculation, we noticed a drastic decrease in the recycling rate. This indicates that there is a high amount of waste produced at WPI, but we as the WPI community do not recycle enough or have enough material to recycle to close the huge gap between recyclables and waste ratio.

Table 6: Results of the 2016 Waste Audit Post-sort Percentage without Cardboard

Type of Waste	Where the waste is disposed		Total
	Trash Bin	Recycling Bin	
Trash	85	3	88
Recyclables	7	5	12
Total	92	8	100

Table 7: Results of the 2017 Waste Audit Post-sort Percentage without Cardboard

Type of Waste	Where the waste is disposed		Total
	Trash Bin	Recycling Bin	
Trash	76.5	6.6	83.1
Recyclables	13	3.9	16.9
Total	89.5	10.5	100

Looking at Table 6 and Table 7, the theoretical recycling rates, assuming everything goes in the correct bin, are 12% and 16.9 % respectively. In Table 6, of the total amount of waste, only 12% is recyclables. Of that total, 12%, only 5% is in the recycling bin, while the rest, 7% is in the trash bin. That means that people put the recyclables in the recycling bin  $(5/12) * 100 = 42\%$  of the time. According to Table 7, people put the recyclables in the recycling bin  $(3.9/16.9) * 100 = 23\%$  of the time. From Tables 6 and 7, it is interesting to note that there are more recyclables in

the trash bin than in the recycling bin. While these numbers only represented one day worth of waste, it is still worrying to see that people recycle correctly less than half of the time.

Now that we identified the meaning of the recycling rate, the next question becomes “What is causing the recycling rate to be so low on campus?” Using the Ken Wilber model as a basis, we conducted another series of informal interviews with WPI students on the rationale behind not recycling or not recycle as frequently as they should be.

The purpose of a Ken Wilber model is to deduce the actual cause of the low recycling effort. It aims to understand human sub-consciousness. The model is divided into four quadrants, interior-individual (intentional), the exterior-individual (behavioral), the interior-collective (culture), and the exterior-collective (social systems). The interior-individual refers to the sub-consciousness, the exterior-individual refers to the action of the individual's, the interior-collective refers to the collective belief of a group, and the exterior-collective refers to society<sup>1</sup>.

The responses we received were organized and placed in a Ken Wilber model as the template is shown in Figure 10.

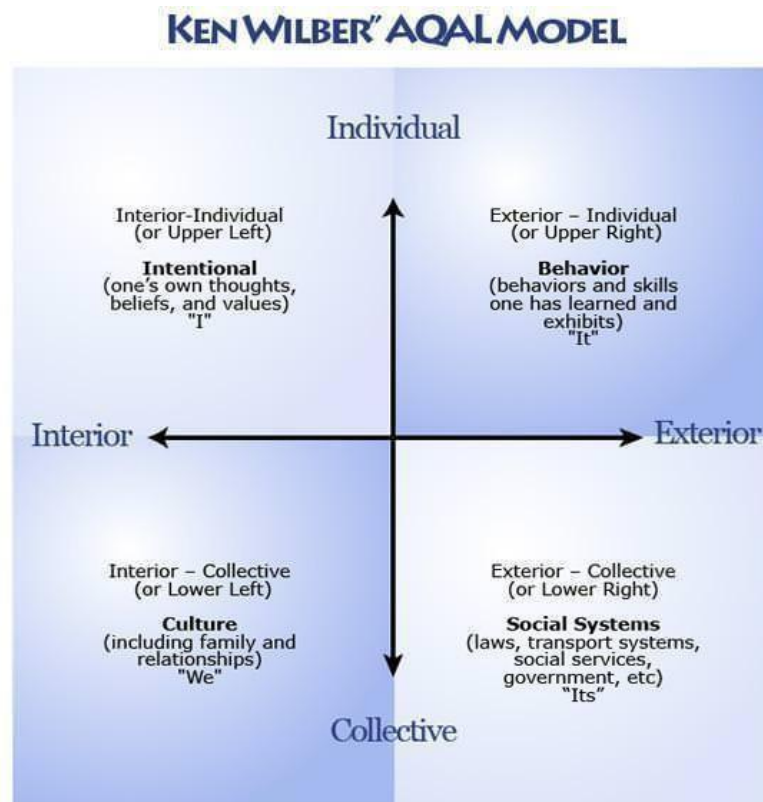


Figure 10: Ken Wilber Model Template<sup>2</sup>

<sup>1</sup> Brown, Tiffany. “Integral Theory: Understanding Your Business from a Truly Holistic Perspective.” *Holistic Marketing Concepts*, 21 Mar. 2013, tiffanyabrown.wordpress.com/2013/01/13/integral\_theory/

<sup>2</sup> Taken from [https://tiffanyabrown.wordpress.com/2013/01/13/integral\\_theory/](https://tiffanyabrown.wordpress.com/2013/01/13/integral_theory/)

The purpose of this model is to assist us in narrowing down the potential causes for the low recycling rate. We identified the causes for low recycling rate forming a new model of our own as shown in Table 8. The four categories in our model correspond to the same four quadrants of the original model. Carelessness is in quadrant I, intentional. Lack of Knowledge is in quadrant II, behavior. Family is quadrant III, culture. And Lack of Recycling Bins is in quadrant IV, social systems. Each quadrant focuses on a different aspect of human actions. Carelessness addresses the internal behavior. While carelessness can be learned, we felt that it is an unconscious action that stem from one’s own values. Lack of Knowledge exhibits the actions stemmed from learning. Family is the culture that influences human ability to act. Lack of Recycling Bins refers to the environment that rules our action.

Table 8: Wilber Model of the idea students believe that lead to having low recycling rate

<p><b>Carelessness</b></p> <ul style="list-style-type: none"> <li>• Rushing to class</li> <li>• Not noticing which bin is which</li> </ul>	<p><b>Lack of Education/Knowledge</b></p> <p>Does not have a clear idea of what can be thrown in the recycling bin</p>
<p><b>Family does not usually prioritize recycling</b></p> <p>Household doesn’t have recycling bin.</p>	<p><b>Lack of recycling bins around campus</b></p> <p>Students throw it in the trash bin since they can’t find a recycling bin nearby.</p>

Many of the responses categorized fell into the four quadrants of our model. Moving forward, we attempted to investigate all four reasons for not recycling. As we walked around the buildings such as the library and the campus center and we noticed there are a lot of recycling bins and they are always next to a trash bin. Therefore we concluded that lack of recycling bin is not a major cause for the low recycling rate. However, a few of the participants did admit that in the event that no recycling bin is nearby, the trash bin becomes the de facto place to get rid of their waste.

Lack of education/knowledge was brought up a lot from the students we interviewed. According to some students, they throw material in the trash bin when there is uncertainty of whether or not the object is recyclable. Most of the voiced uncertainties refer to food/liquid stained objects, and paper cups. But these responses seem strange to us considering the many signs posted near the recycling bins to assist students in determining the type of trash they have. Signs are great to communicate an idea, but they tend to garner little to no attention from students and faculty. Giving attention to a sign requires the person to be active and requires the person to care about their actions, which bring us to our next point, Carelessness.

Carelessness seems to be the biggest reason for not recycling correctly. Many students have said that when they throw something away, sometimes they realized that they threw it in the wrong bin. The reason for such carelessness was that they did not pay attention to the bins. Instead, they viewed all bins as just trash bins. A few students have mentioned how the newer big bins make it slightly confusing since the recycling and trash bin is the same shape with colors that do not distinguish them as well as the standard black trash bin and blue trash bins. It results in a higher chance of tossing things in the wrong bin.

The possibility of the low recycling rate at WPI being a result of one's family is random and inconsistent. Family and culture is not quantifiable so it is difficult to establish a correlation to WPI's recycling rate. In addition, it is the hardest to solve because attacking someone's value can potentially create an even bigger problem.

After exploring each reason, we concluded that carelessness is potentially our biggest cause for the recycling rate at WPI. Addressing carelessness is the most optimal solution because if we create a system of recycling that is so easy and effortless, we could potentially improve WPI recycling behavior.

## **Future Work**

For future work, you can perform an experiment testing whether or not the different style of bins causes careless recycling. In this experiment, the independent variable is the bin styles and the dependent variables are amount trash and recyclables. The best experiment setting would have to be Campus Center and Library because they produce the most waste on campus. The idea of the experiment is that utilizing bins with different colors and/or shape could make them more distinctive from each other. This experiment would serve to determine whether the different style of bins can improve waste to bin identifications accuracy. If the experiment shows a relationship between the different style of bins and recycling accuracy, creating a trial period of the method can get us closer to improving WPI recycling behavior.

## Conclusions

Understanding a problem is the first step in solving it. In the beginning, we started a quest to understand WPI students' perception on sustainability. After noticing how poor our recycling efforts were, we pursued a burning question: What is students' and faculty's perception on recycling? The survey we designed led us to the next question: What is students' and faculty's attitude on recycling? We discovered that while recycling is a simple concept, not everyone does it correctly, if at all. From the waste audit dataset, we discovered that recycling is only a small percentage of the total waste so the recycling cannot be raised above a certain threshold. Assuming everything is in the correct bin, the threshold for 2016 and 2017 waste audit, based on our analysis given in Table 3 and 5, is 32.4% and 29%, respectively. Removing cardboard out of the calculation lowers the rate to 12% and 16.9%. Even if the recycle may not be as high as we want it to be, the most important thing is to recycle correctly and recycle as much as we can.

After carefully investigating each potential reason from our Ken Wilber Model, we found carelessness to be the primary factor in the recycling culture at WPI. It indicates WPI community does not pay attention to what they throw out, or where they throw it to. The lack of care for recycling is not surprising as it appears because the results of our initial interviews, survey and data support this, as stated previously. Addressing this carelessness factor could greatly change the recycling behavior here at WPI.

The waste audit data given to us by Liz is a small sample size and the analysis of those data can be taken with a grain of salt. Our student interview size is 10. Our survey size is 148. Our waste audit size is only 2. The concerns from the result of the interviews and the data coincide with the concerns that Liz voiced. While our sample is small, we believe our findings are valuable for future works in solving this recycling issue.

# Appendix

## Qualtrics Survey Questions and Answers

### A. Interview with Elizabeth Tomaszewski

#### **How is the recycling rate determined?**

- Divide recycle and food waste with annual amount of waste and recycling.
  - Food waster estimated by the kitchen waste that goes to the pig farmer
- Recycling rate is below 30%
  - Personally a sad and low number (opinion)
  - National average around 40%
- Challenge: take part in the audit. (typically nov. 15<sup>th</sup> but potentially can changed)
  - Google waste audit results to see WPI results.
- Needs disclosure policy to be sign to get data on recycling rate.

#### **If waste goes up with recycling does that change how the calculation is done?**

- New eco-friendly methods results in decreasing recycling rate numbers
  - Don't take numbers too seriously.
  - Ex. paperless evaluation forms = less paper recycled
- Need to divert food waste if too high
  - Already being sent to a pig farm.

#### **Why is there a sudden drop in recycling rate in 2012?**

- Unsure at the moment but will get back to us when disclosure form is signed.

#### **What is the 13%?**

- 28% recycled is a result from audit
- After sorted the 32% is determined is recyclable (when adding things that are recyclable but found in waste)
- The 13% is food waste in the whole waste

Meet with the student green team

President: kncorry@wpi.edu



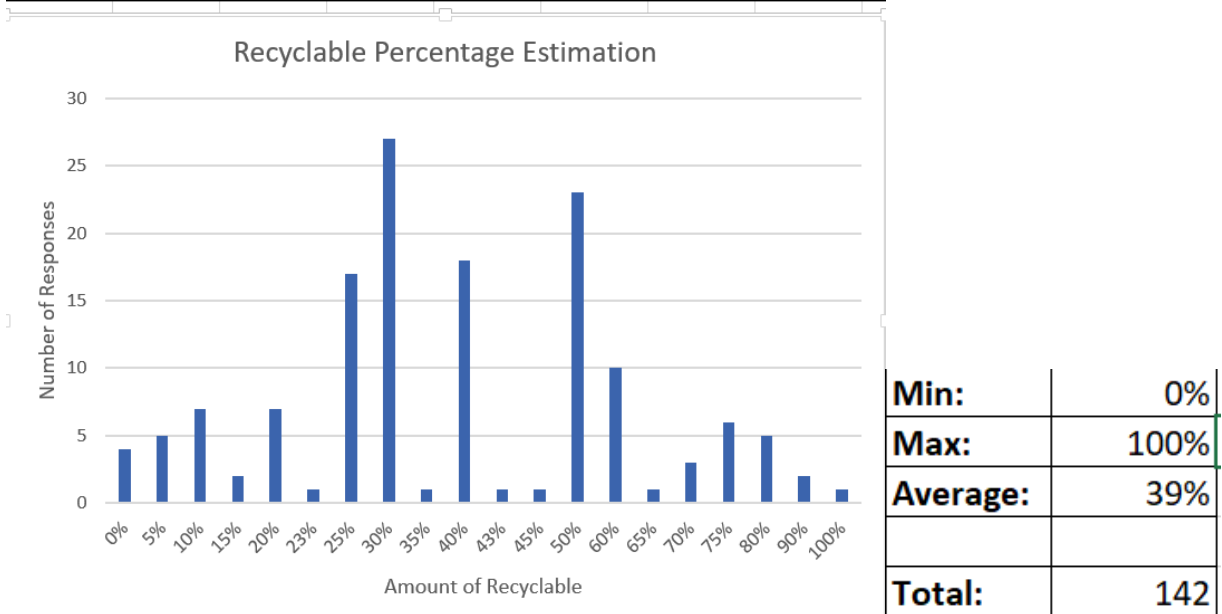
B.

1.) Which of the Following best Describes your status at WPI?					
Undergraduate	Graduate	Faculty/staff	Other		
28	1	116	3	Total:	148

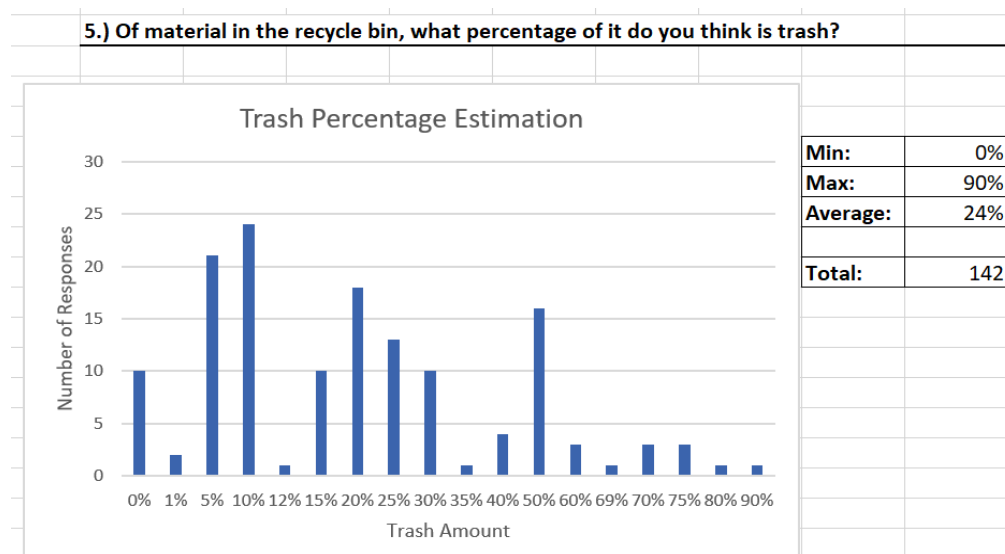
2.) Are you a part of any Sustainable Organization?

3.) If so what is the name of the organization?

4.) Of the materials in the trash bin, what percentage do you think is recyclable?

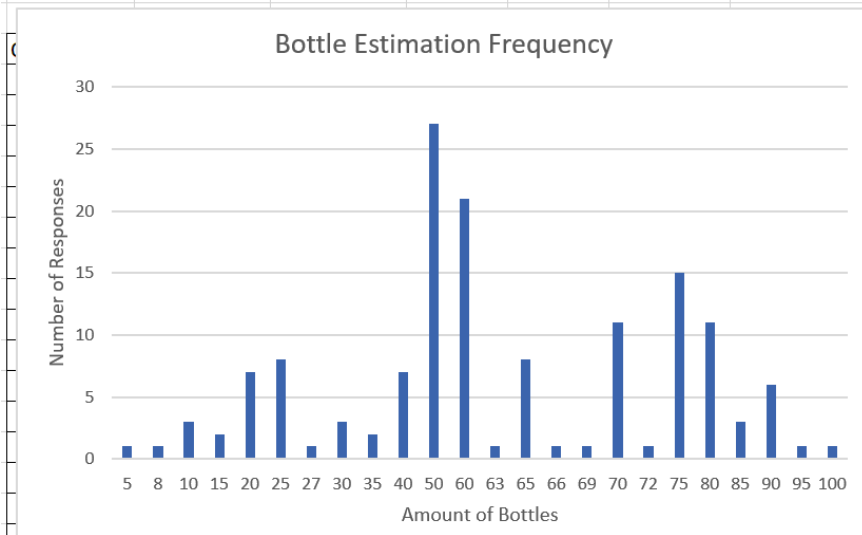


C.



D.

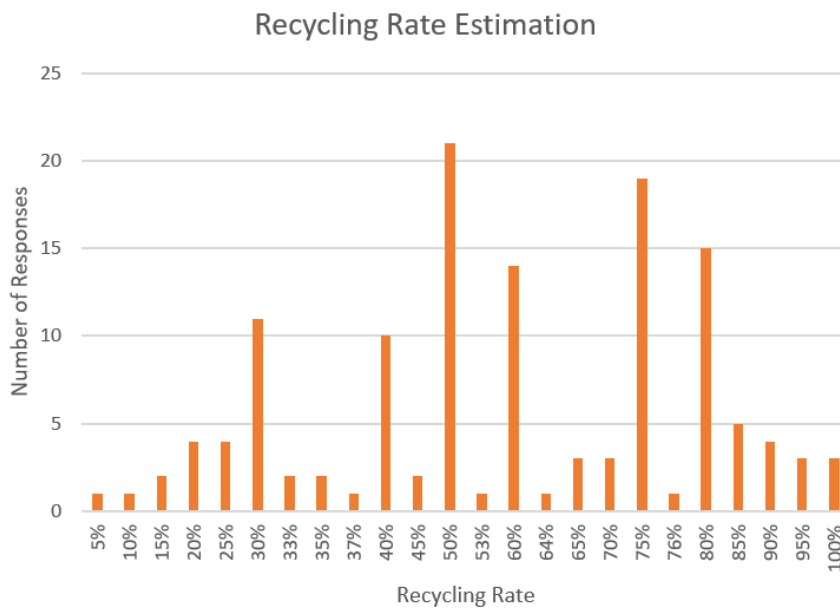
6.) Out of 100 recyclable bottles consumed on campus, how many do you think are recycled?



Min:	5
Max:	100
Average:	56.26
Total Responses	143

E.

7.) What do you expect the WPI recycling rate to be?



Min:	5%
Max:	100%
Average:	58%
Total Responses:	133

F. The official WPI recycling rate is approximately 30%. How do you think this number is calculated?

Total recycled volume divided by the total waste volume.

At this point, I do not know, but I am helping on November 15th to sort the campus trash/recycle. I have a feeling I will learn then!

The amount of material recycled versus the amount that goes to a landfill.

From the annual trash event where people go through the garbage.

What is removed by staff and disposed of with companies that charge for their service. We calculate by the cost.

Sampling of trash from various areas on campus; counting items that are recycled vs. not within those samples

It must take place in the measuring and designated recycle bins and sorting the trash bins?

ratio of weight of materials sent for recycling to the total weight of all discards

Semi-annual sorting party.

Not sure

Checking the trash and recycling bins

I suspect it is calculated by volume, as that is probably the easiest to estimate via the number of containers hauled away by rubbish removal companies.

measured from trash/ recycling bins

audits of trash and recycle containers

Weighing the amount of recycled material versus the amount of trashed material.

By taking the pounds of recyclables and dividing it by total pounds of waste.

idk

Bottles, cans, paper

Total weight of trash and recycle divided by the recycling once it's removed.

I would guess from the ratio of tonnes of recyclables collected on campus to tonnes of general waste collected.

audits

Waste audit

recycled amount/total waste

?

weight?

Through the waste audit

Spot checks of recycling and trash containers to determine percent for a small-N, which is then used to estimate across campus.

weight of material recycled and estimate of total material used

Please explain what "recycling rate" means? Rate means a speed to me.

No idea

During trash sorting by green team and other departments in charge of waste management and hauling

Don't know

I would assume it is calculated by weight. Weight of Trash compared to weight of recycling.

I am surprised. I thought know the City of Worcester's rate is higher

Trash "audits" - staff volunteers going through the trash and recycling bins to see what's in them.

The amount of recycled waste vs. the amount of trash.

Volume of recyclables sold vs volume of incoming recycling?

No idea. Percentage of total mass?

Amount of material in recyclable bins as a percentage of the total waste generated.

I don't know.

Student run Green Team sampling and other events

Don't know

?

An evaluation into the trash that is collected

Trash audit

Don't know

I assume from the recycling audit that is done on a regular basis.

I assume that the Sustainability team checks trash from different areas on campus and counts the number of recyclables in the trash, and does the same for trash in the recycling.

Not sure - but that is very disappointing.

Sales minus number recycled

It was a random guess, knowing that some people are great at recycling, but majority of people throw things away out of convenience and lack of knowledge.

?

Using the annual trash survey

Liz Tomaszewski leads a group of students every year in a trash audit. I'm assuming they evaluate dozens of bags of trash and come up with a recycled-to-trash formula.

I do not know how that number is calculated.

I don't know

based on the weight of recycling vs trash

Weighing recycle bin materials and trash. Modified by waste audits.

i don't know

No idea

annual survey of what is in the trash and recycling

Not sure, clearly there is a lot of waste on campus but I am surprised the recycle rate is not higher

don't know.

No idea.

Going thru trash bags and sorting what could have been recycled.

Going through garbage and recycling containers.

I'm not sure.

Based on the sorting and checking buildings. Also by the amounts collected and recycled for the whole campus.

This is calculated by the amount of recycling that is given to our vendor?

$\text{recycling weight}/(\text{trash weight}+\text{recycling weight})$

trash checks; custodial input; trash/recycle vendor removal charges

trash to recycle ratio

by weight of all trash/recycling pick up

Monitoring of certain trash/recycle bins on campus

No idea.

?

No idea

Don't know

Recycled over total times 100%

I have no idea! I wish I knew.

I do not know.

I have no idea, but I would sample some bins daily and count the misplaced items.

annual surveys

Unsure

by comparing weights of recyclables vs trash

by sample counts

Estimated rates of consumption in proportion to volume of recyclables collected by commercial waste removal company. Does this figure include green or compost waste?

Taking some trash sample.

I have no idea

I assume at some point someone picked through the trash by hand

How much recyclables people consume are actually recycled.

It's probably calculated by estimating the weight of recycling and trash, and estimating the percentage of the recycled material that should actually be recycled, and the percentage of trash that is recyclable.

Amount of recycled materials found on average within trash cans

Comparison between the mass of garbage and mass of recycling

Based on recyclable items sold on campus versus the amount found in recycling

The amount of estimated recyclable goods is compared with the amount of objects actually recycled

Looking through the trash

With a dollop of fairy dust.

Amount of recycling in recycling bin compared to recyclables in the trash and recycling bin

$(\text{total recycled})/(\text{total recyclable}) * 100$

Its probably based on what facilities recycle.

Trash recycled / Trash total

Estimated material consumed vs trash and recycling in tons being taken away.

That is probably an interesting calculation to say the least. I honestly have no idea how you could make that work without liberal assumptions.

Looking through the trash and self reporting

Distributed mass of recyclable material v. Total mass of recycled material

From the amount of recyclables in the recycle bin vs the trash

dont know