

Final Analysis for Project 1

UMass Sustainability Initiative



CIS 362-01: Empirical Methods, 2020 Spring, Doctor Iren Valova

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Abstract:

Our team distributed a series of recycling surveys across the University of Massachusetts Dartmouth campus over the course of the spring 2020 semester. The goal of these surveys were to collect data regarding the recycling habits, frequency, and basic demographics of individuals at UMass Dartmouth. After analyzing the data, our team found that while most participants do make an effort to recycle, many of them either didn't know what the University's recycling rules were or that the rules existed at all. This unawareness points to a problem in how UMass Dartmouth presents its recycling programs. With thousands of Universities across the United States each with their own unique solutions to recycling, it may be time to look at others as examples to help improve our own recycling systems.

Introduction:

In recent years, with threats of global warming on the rise, recycling has become increasingly popular and important. Valuable, nonrenewable resources are being consumed at increasing rates, and when they are completely used up we will need a solution. Recycling can reduce the need for these nonrenewable resources, some of which are dangerous to the environment and people. By reusing resources the University can save money and the planet.

The University of Massachusetts Dartmouth has taken strides to reduce our campus' impact on the local and global environment. Currently the University provides recycling bins across campus with single-stream recycling rules attached. The Campus Sustainability and Residential Initiatives¹ includes projects, such as Slash the Trash, Be Cold Be Bold, Reduce the Juice, and Limit Your Minutes, that aim to reduce student material and energy usage. These initiatives also include events to clean-up and raise awareness, like Earth Day, Recycle Mania, and Earth Hour. The University has also performed waste audits in the past. A print audit in 2009 by the UMass Dartmouth Purchasing Department found that the campus consumes almost 13 million sheets of paper each year (MacCormack, 2009). Waste audits, or in this case a print audit, are valuable opportunities to measure the amount and composition of waste as well as provide valuable benchmarks for progress on recycling initiatives.

In order to accurately measure the recycling habits and frequency of individuals at UMass Dartmouth two focus groups were assembled. From the two focus groups our team gained valuable

¹ More information about the Campus Sustainability and Residential Initiatives can be found here <https://www.umassd.edu/campussustainability/>

insights about the University's inhabitants. For instance, we learned that an electronic survey distributed via QR codes was not only more efficient but also conserved paper compared to a printed counterpart. Our focus groups gave us initial assumptions to test, such as the lack of electronic recycling and the frequency of recycling overall. These variables helped us gauge the initial results of the survey and paint a large picture for the later parts of the survey.

HYPOTHESIS TESTING:

Hypothesis #1:

H0: The mean recycling frequency for upperclassmen is greater than or equal to the overall mean (3.9) of survey participants, where 5 denotes always, 4 denotes often, 3 denotes sometimes, 2 denotes rare, and 1 is never.

H1: The mean recycling frequency for upperclassmen is less than the overall mean (3.9) of survey participants.

The sample mean was 3.94 and the sample standard deviation was 1.01. From the data Z equals -0.0045. The probability of Z being less than -0.0045 results in a P-value of .5. If alpha equals 0.05 (1-0.95), alpha would be less than the P-value. Therefore, we can say with a confidence interval of 95% that we have failed to reject the null hypothesis.

The null hypothesis suggests that with the data that we have collected, upperclassmen recycle more frequently than the other people who inhabit UMass Dartmouth. While this includes professors and visitors to the campus this also includes underclassmen. If upperclassmen recycle more than the underclassmen then this shows that the current efforts to increase recycling are working at least somewhat. The longer students spend on campus, the more they recycle.

Hypothesis #2:

H0: The mean age for participants who knew recycling rules were present is greater than or equal to the overall average of the total population (20.99 years).

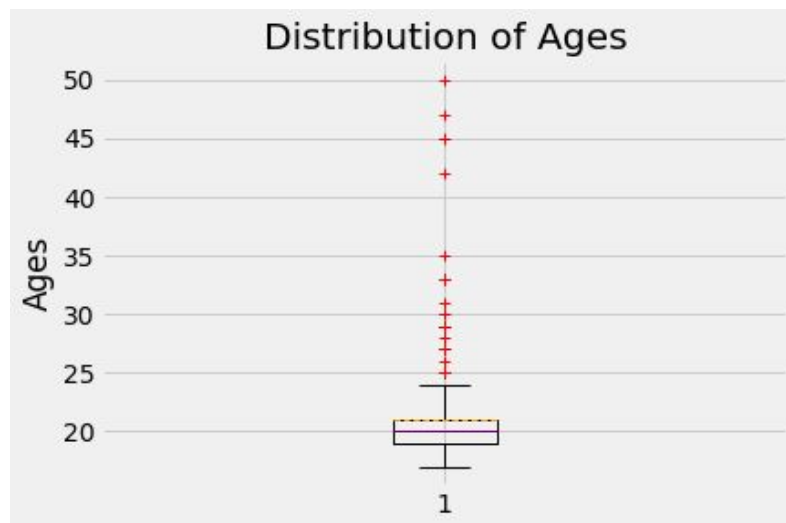
H1: The mean age for participants who knew recycling rules were present is less than the overall average of the total population (20.99 years).

The sample mean was 21.19 years old and the sample standard deviation was 5.82 years. From the data Z equals 0.3971. The probability of Z being less than 0.3971 results in a P-value of .65173. If alpha equals 0.05 (1-0.95), alpha would be less than the P-value. Therefore we can say with a confidence interval of 95% that we have failed to reject the null hypothesis.

The null hypothesis suggests that the older participants of the survey recycle more than the younger ones. This could be a result of many things, such as the population that was sampled for this survey or it could be representative of a larger issue. Perhaps the younger participants of the survey, freshman and sophomore students, have less access to convenient recycling options than older students and campus staff.

Summary of Results:

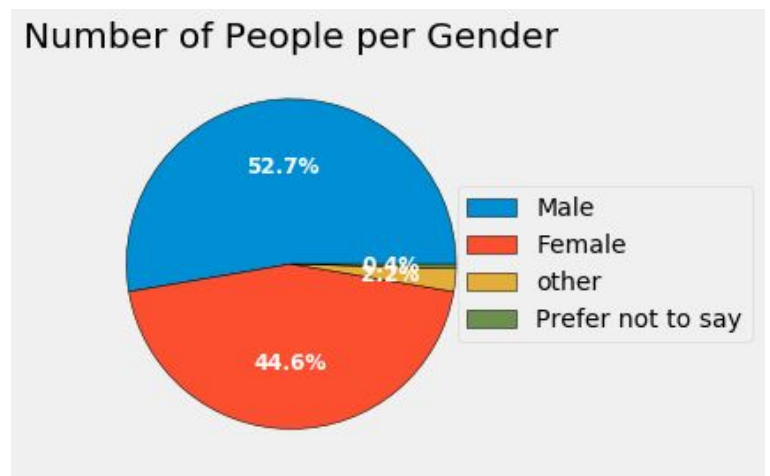
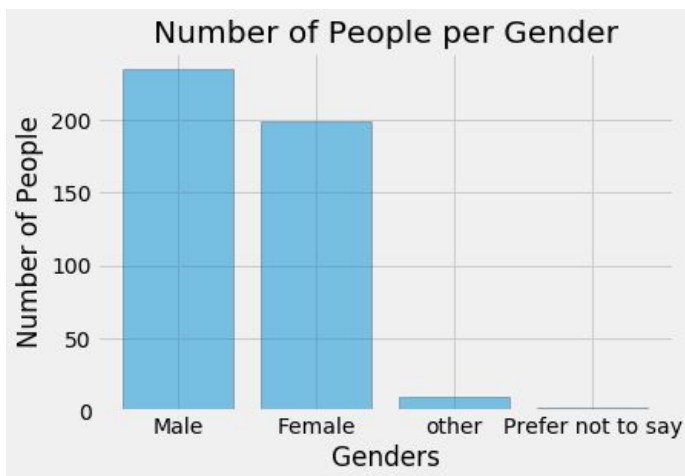
1. How old are you?



| <i>Mean</i> | <i>Median</i> | <i>Variance</i> | <i>Standard Deviation</i> | <i>Range</i> | <i>First Quartile</i> | <i>Third Quartile</i> | <i>Outliers</i> | <i>Skewness</i> | <i>Correlation</i> |
|--------------------------------|---------------|----------------------------|---------------------------|--------------|-----------------------|-----------------------|---|-----------------------|--------------------|
| 20.92 37668 16143 498 | 20 | 13.059343 98145815 6 | 3.61377143 458992 | 33 | 19 | 21 | 25, 26, 27, 28, 29, 30, 31, 33, 35, 42, 45, 47, 50 | 4.46330926 6343239 | 0.02224993 |

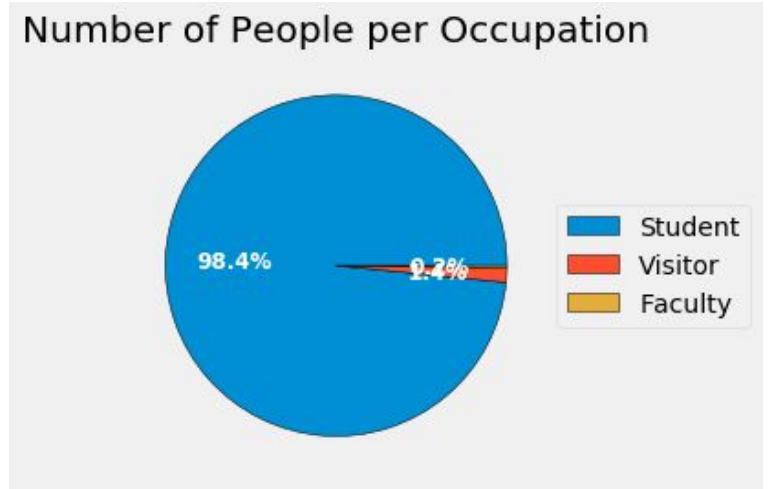
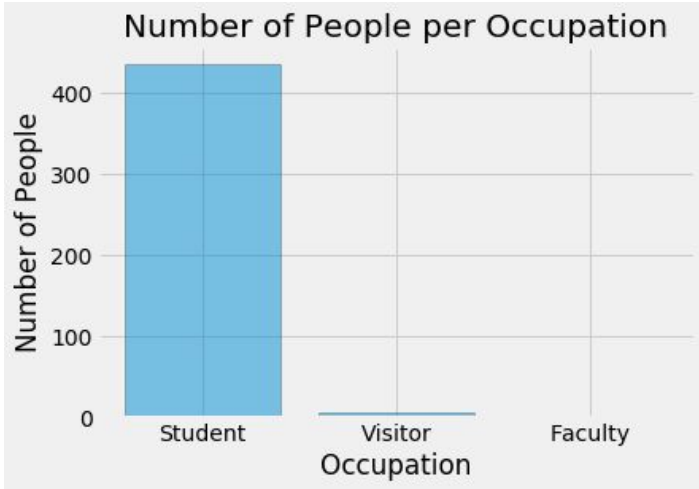
The boxplot and table are for the ages of the participants in the survey. The average age was about 20 years old. The max and min of participant's ages were 50 years old and 17 years old respectively, resulting in a range of 33. Despite the number of outliers and large range, the variance and standard deviation are relatively low with values of about 13.06 and 3.61 respectively. We can also see that with 50% of the data lying between 19 and 21 that the variability of the ages is quite low reaffirming the variance and standard deviation. With a large number of outliers in the data, the overall trend has skewed to the right with an approximate value of 4.46.

2. What is your gender?



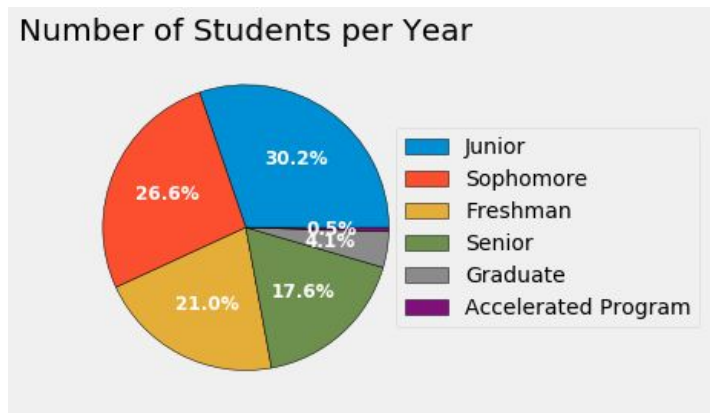
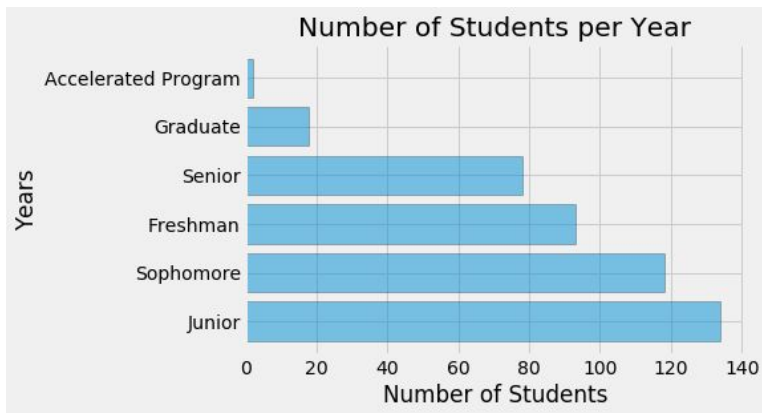
These two graphs represent the genders of participants. The bar graph (left) shows that a large majority of survey participants are either male or female, and mostly male. The pie chart (right) shows the numbers as percentages.

3. What occupation do you hold in the University?



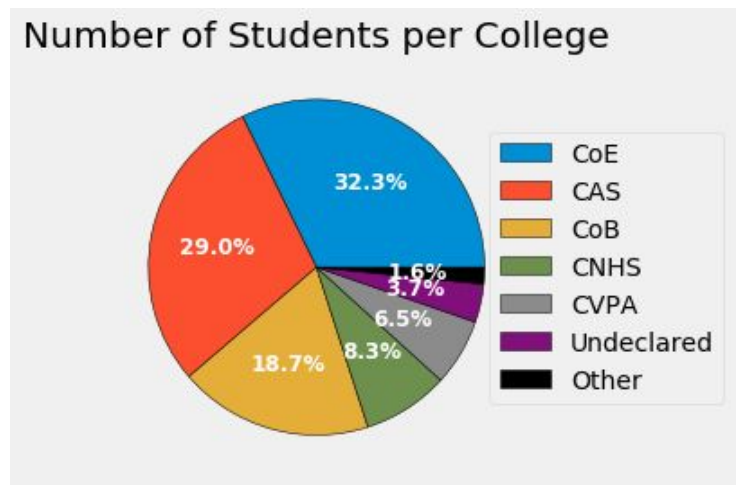
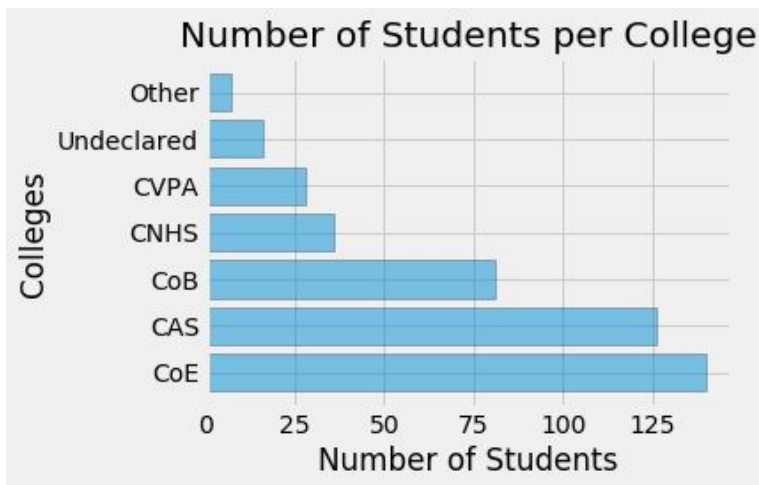
The question included the answers student, faculty, administration, staff, and visitors. In the survey based on the graph on the left, over 400 participants were students, a few were visitors and only one faculty. These numbers are expressed as percentages in the pie chart. Visitors are people who at one point have been to Umass Dartmouth for any particular reason.

4. What year are you?



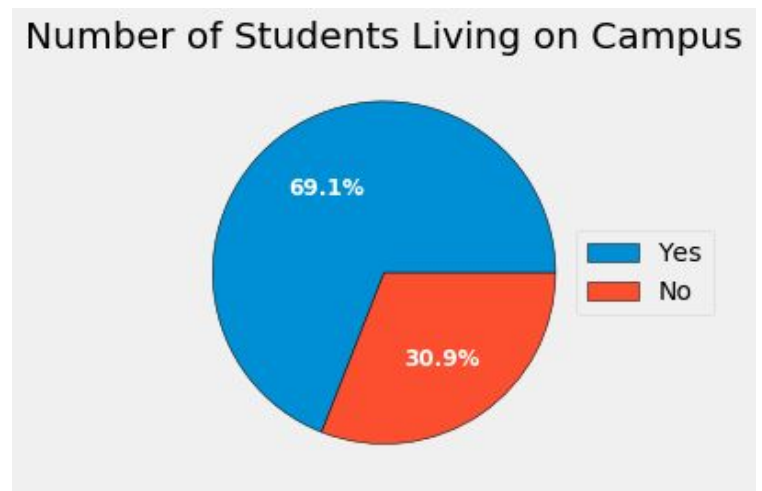
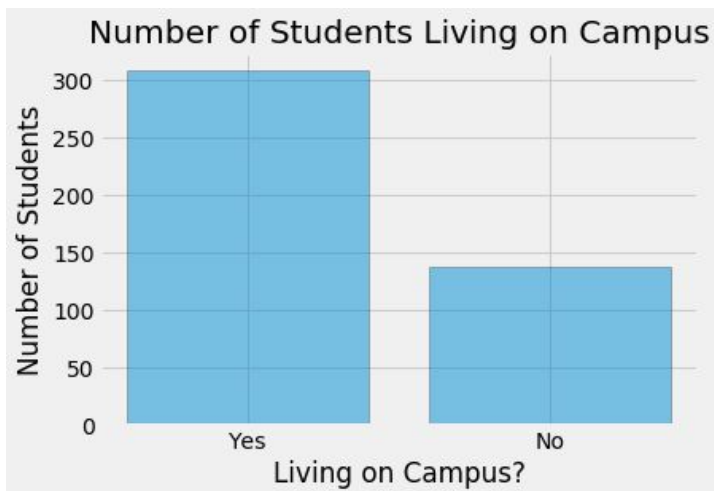
The pie chart (right) shows the percentages of participants based on what year they are currently in at the university, while the bar graph (left) shows the actual numbers of participants for said information. Juniors make up the biggest partition of the population, 30.2% or 134, while students in Graduate and Accelerated Programs only make up 4.1% and 0.5% respectively. The largest jump in the data is between the Senior population and the Graduate population pointing towards a significantly smaller population of Graduates than Undergraduates at UMass Dartmouth.

5. What is your major?



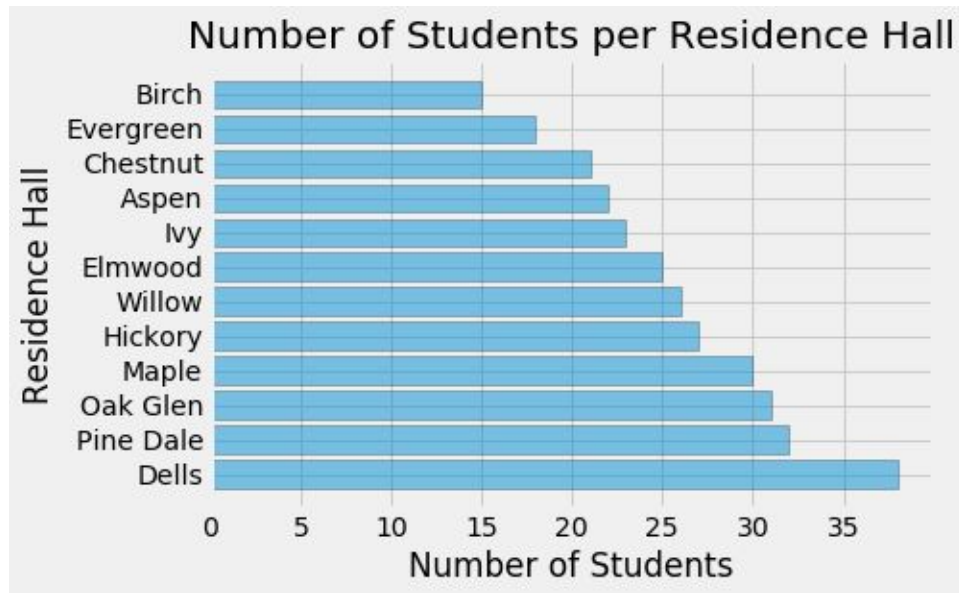
These graphs represent the number of students in each college at UMass Dartmouth. The colleges are (from most amount of students to least amount) college of engineering, college of arts and science, college of business, college of nursing and health science, college of visual and performing arts, undeclared, and other. Other refers to those who were visitors, professors, staff, or anyone else who does not officially attend the university. The most common answer was college of engineering.

6. Do you live on campus?



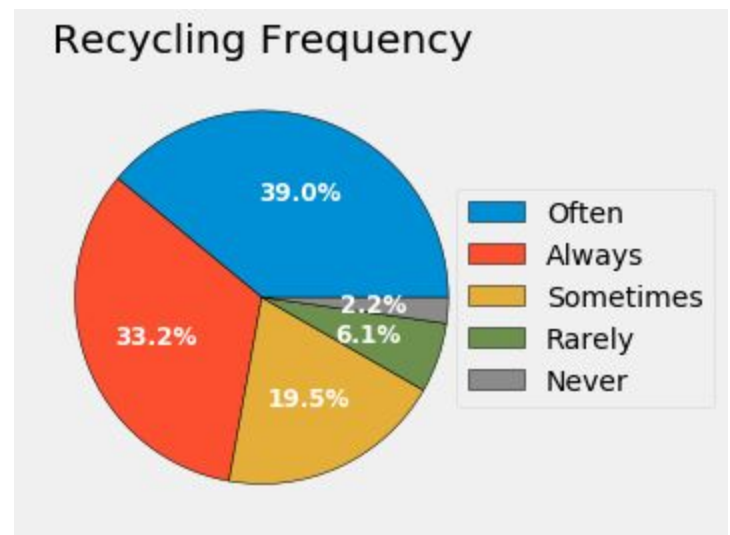
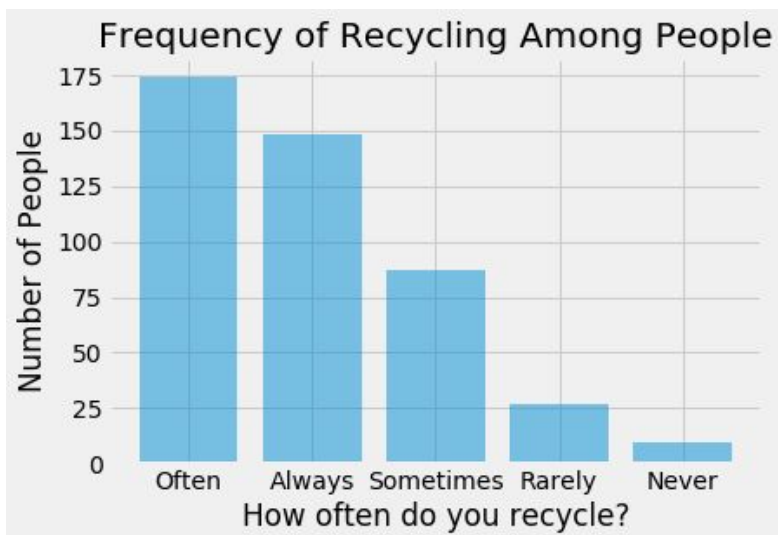
The graphs show the frequencies of those who said “yes” and “no” to the question. Most students said yes, meaning most students live on campus. Over 300 said yes which is represented as 69.1% in the pie chart. The people who live on campus we can confidently assume are students, the people who don’t live on campus we may think to be as visitors, faculty and staff, and commuters all live off campus.

7. If you do live on campus, where do you live?



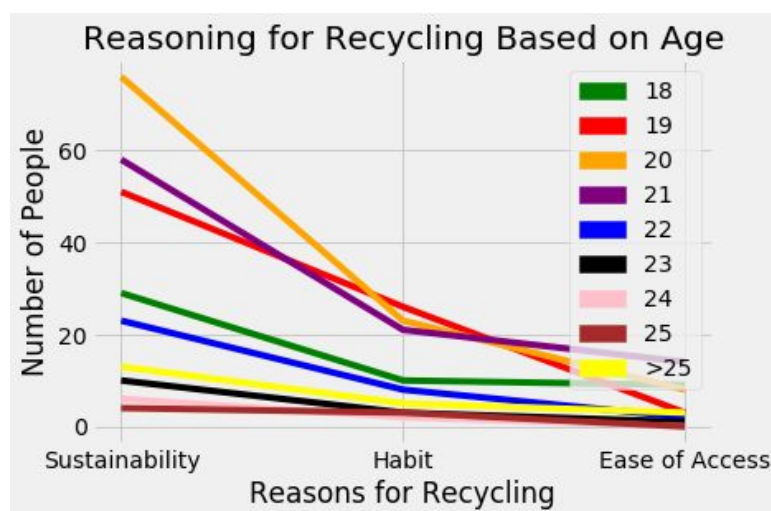
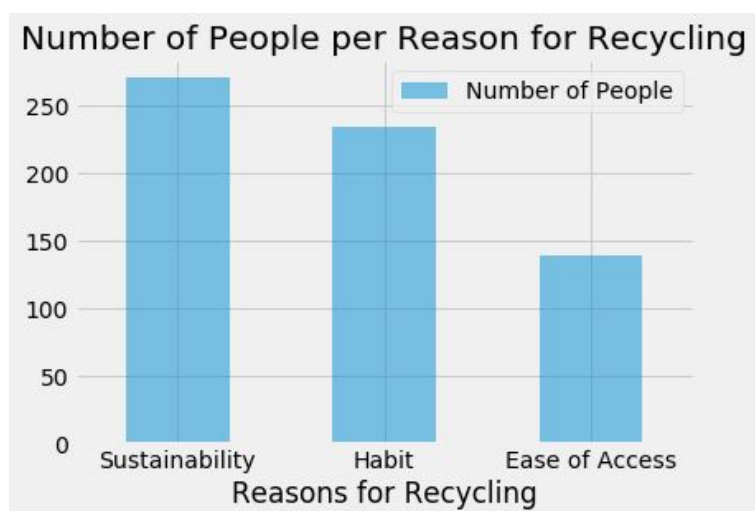
For those who are students enrolled at the university and living on campus, this graph represents the number of students who live in each residence hall. The Dells being the most common answer, with the number of students being over 35. The residence hall with the least amount was Birch, which had about 15 survey participants living there.

8. How often do you recycle?



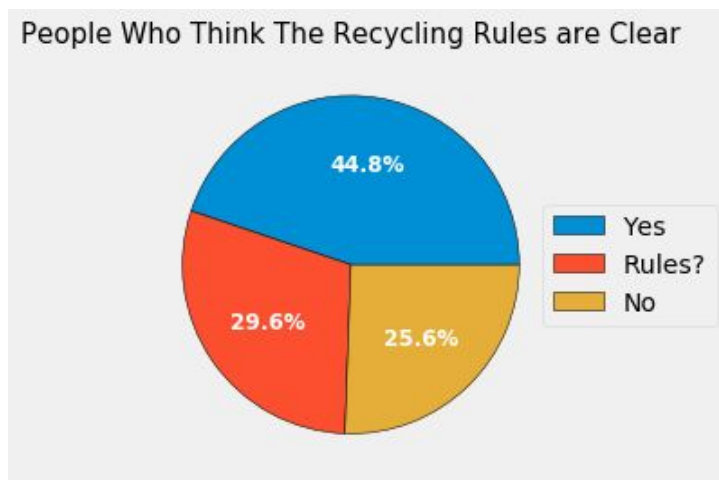
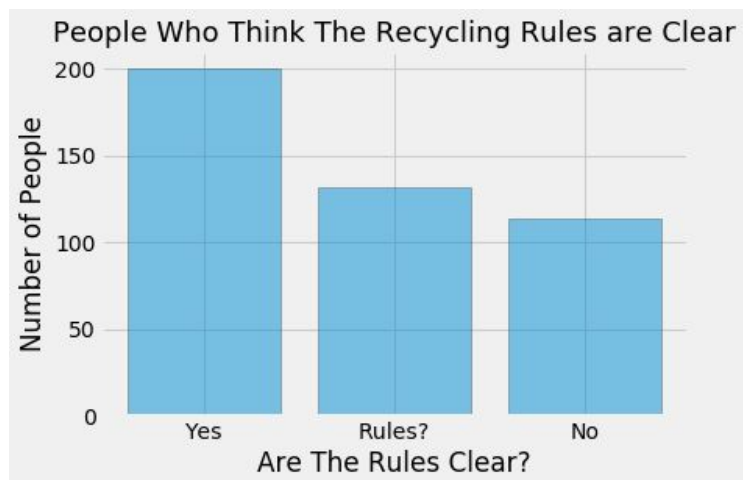
The bar graph (left) shows the number of students who picked each answer from the question. About 175 participants answered they recycle often, and less than 25 of the participants answered they never recycle. The pie chart (right) shows how often the survey participants recycle as percentages. Out of these percentages, often and always makes up over a third of the answers, 39% and 33.2% respectively. While participants who answered rarely or never make up under one tenth, 6.1% and 2.2%. As we can see most participants, for whatever reason, make at least some effort to recycle. This trend is promising, however as there are people who still never or rarely recycle there are still improvements to be made.

9. Why do you recycle?



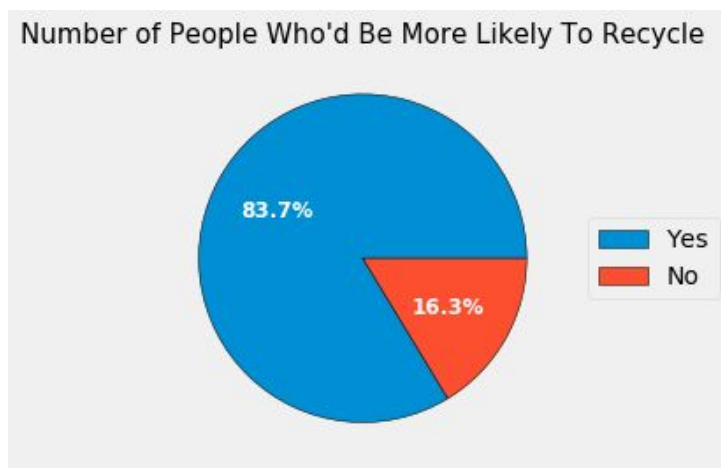
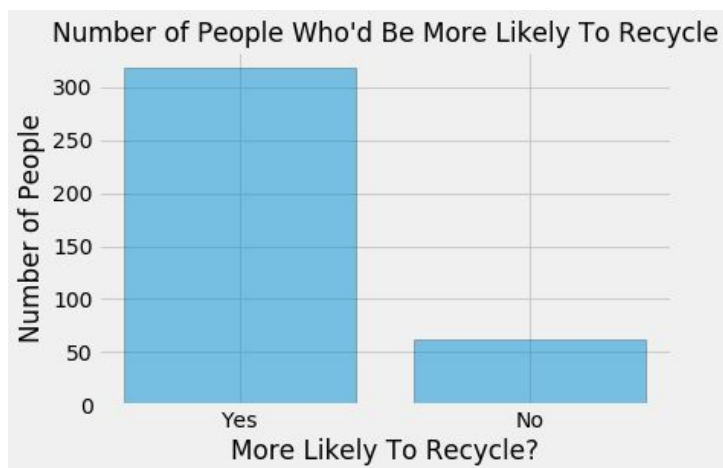
The bar graph (left) represents the reasons why participants recycle. Over half the participants checked off that they recycle for the purpose of sustainability, and many surveyees answered with habit. Many people in our sample are concerned about sustainability and have created a habit of recycling, which could be related to their concern for sustainability. Based on the line graph (right), it is also clear that sustainability was the largest choice for college age students, ages 18-22. Surveyees could also pick multiple answers for their reasoning.

10. Are the recycling rules on campus clearly presented?



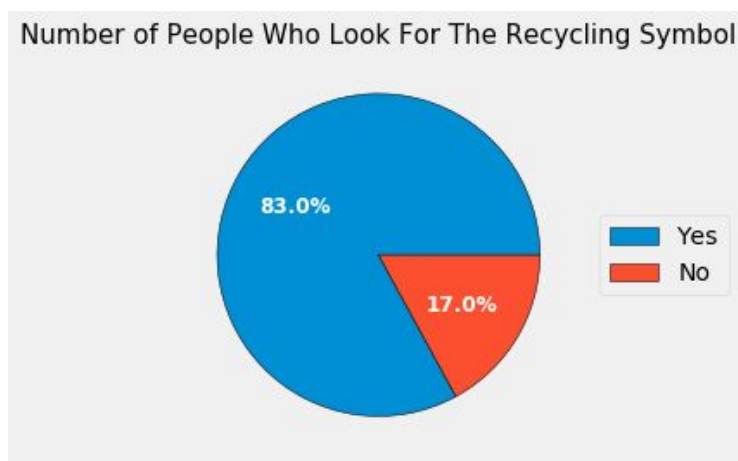
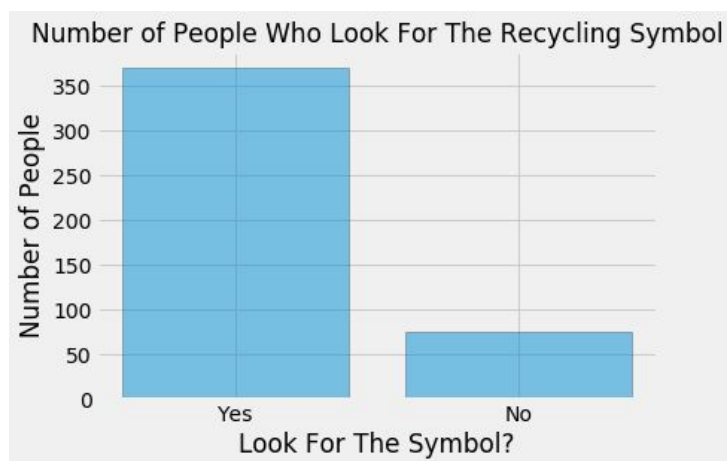
The bar graph on the left represents the quantity of participants who replied with “yes”, “I didn’t know there were any recycling rules!” (denoted as “Rules?”), and “no” to the question. Although the majority of surveyees replied with yes, this is misleading because the people who didn’t know there were rules would also think rules aren’t clear, and would agree with those who replied “no”. Based on these answers, 200 participants don’t think the recycling rules are clear, and 200 participants do think the rules are clear. These quantities are represented as percentages in the pie chart in the table on the right.

11. If not, if the recycling rules were clearer would you be more likely to recycle?



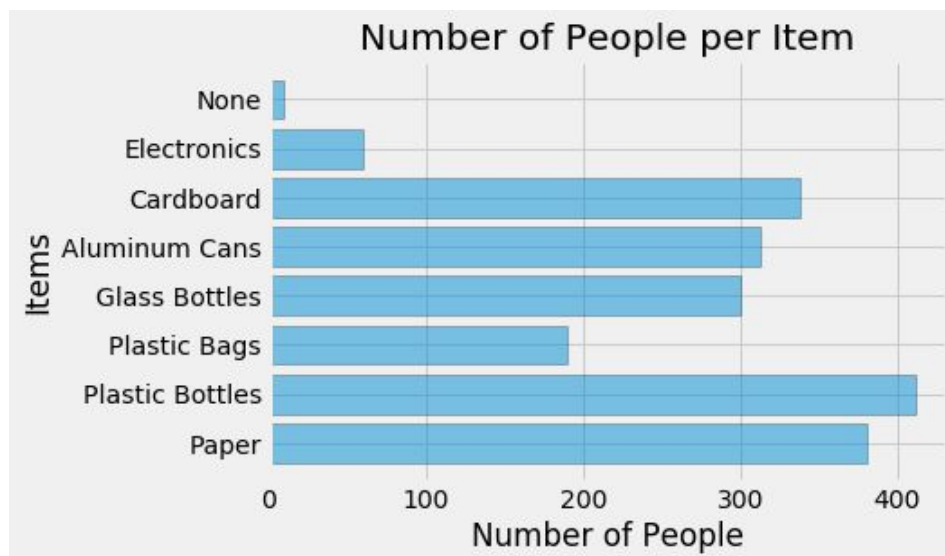
These two graphs show the same information just in different forms. How many of the participants are willing to change their habits if they are presented with more information. An overwhelming majority of participants, 83%, said they would recycle more if they were provided with more information. For the remaining 17% of participants they most likely are the type of individuals who would most recycle no matter what you fix/change.

12. Do you look for the recycle symbol before recycling?



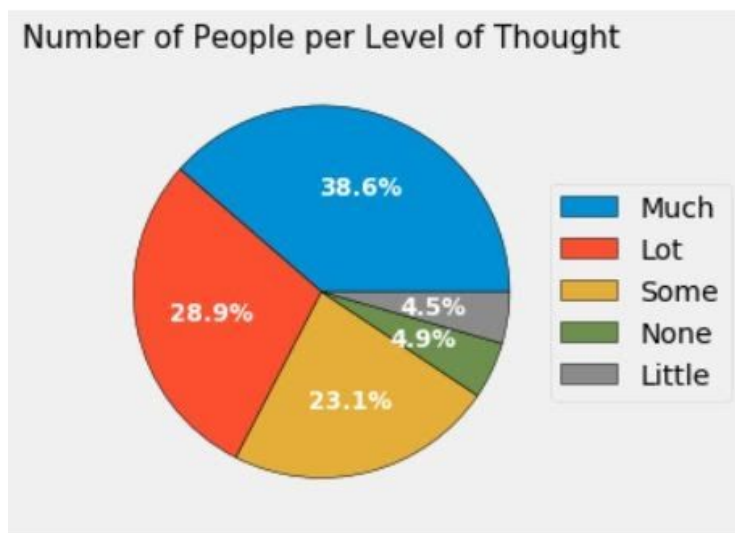
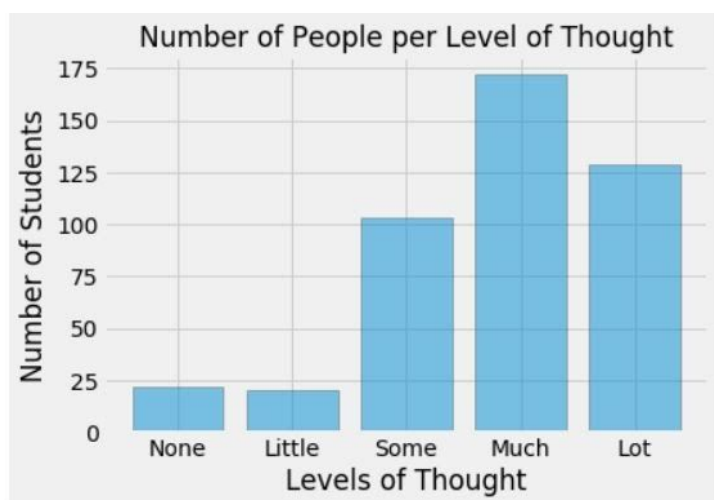
Universally the recycling symbol helps determine whether or not an item is recyclable. It is the widely known identifier to recycle. The frequency of students knowing what the symbol means and looking for it are two different labels. For the 83% that denote that they do look for the symbol it makes a better argument that the efficiency and frequency of recycling would tend to be a little higher. Those that fall under the other 17% may be not searching for they already think they know what is and is not recyclable or are just lazy.

13. What items do you usually recycle?



This horizontal bar graph above shows which items students recycle. Students could pick multiple answers for this question. Only a few students don't recycle any of the items listed. Paper and plastic bottles are the most recycled objects, with well over 300 participants checking off these objects. Approximately 200 recycle plastic bags, which is against the rules because plastic bags can ruin single-stream recycling processes and machines. Electronics was the least recycled item by over 100 answers. In general most people recycle in some way based on our questions.

14. Did the survey overall make you think about your own personal recycling methods and habits?



In this question those surveyed were asked if taking the survey made them consider their own habits, and each answer's bar represents the quantity of people who picked each answer. Over half of those surveyed said the survey made them at least somewhat reflect on their recycling habits and over a fourth, 28.9%, of those surveyed said that the survey made them think a lot about their recycling habits. These results point towards our survey having some impact, in the sense that it got most participants thinking about what, why and how often they recycle.

Summary:

The mean age for participants was 20.92, and 52% of our surveyees were men. Our participants were mostly students, and were from each college, but most were in a major from the college of engineering. 70% of the students who partook in the survey lived on campus. From our results we found

that 150 people recycle “often” and 175 recycle “always”. This is approximately 72% of the people we surveyed. We discovered that a majority of those who aren't aware of the recycling rules or find them confusing claimed they'd be more willing to recycle if the rules were clearer.

Based on our findings we found that the average Umass Dartmouth student recycles sometimes or often, but more likely often. We can be 97% confident that our average falls somewhere between the range of 4.04 and 3.84, where 5 denotes always, 4 denotes often, 3 denotes sometimes, 2 denotes rarely, and 1 denotes never. Although we could be more precise by using a smaller confidence percentage, we can see that those on the Umass Dartmouth campus recycle to some degree, and may do it often. For the participant's age we are 87% confident that the average age for a survey participant is contained in the interval 21.31 to 20.68. These intervals were calculated with a sample size population of 446.

Conclusion:

Our findings from the survey were insightful to the habits and opinions of the students who represent the majority of the Umass Dartmouth campus. Recycling seems to have become somewhat of a habit for people who come to the campus. By using both random sampling and stratified random sampling we were able to get results from a diverse group of people who we feel can accurately reflect the thoughts, actions, and habits of the entire Umass Dartmouth community. Participants in general recycle for sustainability purposes and out of habit. The university can use this as an opportunity to present more ways for students to recycle more materials, as well as inform those who are concerned for sustainability and how they can be more effective in the recycling process at Umass.

An astounding 83.7% of those who were unaware of recycling rules claimed they would be more willing to follow the recycling rules if they were presented in a clearer way. Even though the single-stream recycling rules for the Campus are posted on all recycling bins and dumpsters. Perhaps these students think there are more rules to recycling than the ones presented on the bins and dumpsters. This follows as objects such as plastic bags, styrofoam, and electronics aren't recyclable with single-stream recycling. If the University of Massachusetts Dartmouth is committed to becoming a zero waste campus by 2025, then the University needs to commit to a more comprehensive recycling program.

Recommendations:

While single-stream recycling is the most prevalent method of recycling, dual-stream recycling is far more effective at maximizing recyclable material. (Ferrante, 2020) By separating paper and cardboard and glass, metal, and plastic the amount actually of recyclable material is substantially increased. Universities, such as Harvard, Stanford, Boston University, and Tufts, have already adopted dual-stream recycling. Even though the surveys the team distributed don't pertain to dual-stream recycling, the team still thinks that the University should consider new and different ideas that push the envelope.

According to the Campus Sustainability and Residential Initiatives the UMass Dartmouth campus "aim to have zero waste by 2025". This a great goal to set that will help to push society toward a more sustainable future; however, the University needs to think bigger about what it considers waste. Technology is abundant at Universities, which is why UMass Dartmouth has an electronic-waste recycling program for the University's equipment. But, students don't have access to that program, which is why the University should consider the product stewardship recycling programs. Specifically the University should implement the free Call2Recycle® battery and cell phone collection program (Smith, C). This program would handle the majority of student e-waste and help the University reach its zero waste goal.

References:

- MacCormack, J. (2009). Chancellor's Letter: Responsibility & Renewal. Retrieved from [https://www.umassp.edu/sites/umassp.edu/files/content/resources/budget-office/sustainability/UMD Climate Action Plan2.pdf](https://www.umassp.edu/sites/umassp.edu/files/content/resources/budget-office/sustainability/UMD%20Climate%20Action%20Plan2.pdf)
- Ferrante, D. (2020, January 22). The Road to Zero Waste Universities: It's More Than Just Recycling. Retrieved from <https://www.bevi.co/blog/environmental-sustainability/zero-waste-universities/>
- Smith, C. (n.d.). Reducing Campus E-Waste Through Product Stewardship Recycling Programs. Retrieved from <https://www.call2recycle.org/reducing-campus-e-waste-through-product-stewardship-recycling-programs/>
- GitHub Link:** <https://github.com/aalmeida9/362Project1>

Appendix A: Focus Group 1 Recycling Survey:

Y.O.G: _____ Age: _____ Major: _____ Residency/ Commuter: _____

UMass Sustainability Initiative

Survey Section:

How often would you say you recycle? (*Mark Only One*)

☐ Always(+90%) ☐ Often(+75%) ☐ Sometimes(+50%)

☐ Rarely(+25%) ☐ Never(+0%)

If so, why do you recycle? (*Mark All That Apply*)

☐ Sustainability ☐ Ease of Access ☐ Habit

Are regulated recycling rules on campus clearly presented? (*Mark Only One*)

☐ Yes ☐ No ☐ Didn't know there were recycling rules

If not, would you be more likely to recycle if the rules were clearer? (*Mark Only One*)

☐ Yes ☐ No

Do you tend to recycle items with the recycling symbol on them more often? (*Mark Only One*)

☐ Yes ☐ No



What items do you usually recycle? (*Mark All That Apply, If none leave all blank*)

- ☐ Paper
 ☐ Cardboard
 ☐ Plastic Bottles
☐ Plastic Bags
 ☐ Glass Bottles
 ☐ Aluminum Cans
☐ Electronics
 Other: _____

Questions Regarding Survey:

Were the questions clear and/or easy to understand? (*Circle One*)

- 1 2 3 4 5
 Not Clear ☐ ☐ ☐ ☐ ☐ Crystal Clear

Did the survey overall make you think about your own personal recycling methods and habits?
(*Circle One*)

- 1 2 3 4 5
 Not at all ☐ ☐ ☐ ☐ ☐ Very Much

Is answering online more or less convenient for you? (*Circle One*)

- 1 2 3 4 5
 Less Convenient ☐ ☐ ☐ ☐ ☐ More Convenient

Would you say the questions were biased or unbiased? (*Circle One*)

- 1 2 3 4 5
 Biased ☐ ☐ ☐ ☐ ☐ Unbiased

What did you like or dislike about the survey?

What is the best way to reach you for the prize draw? (Email, Phone, etc.)

Appendix B: Phase 2 Survey:

The original Focus Group 2, Phase 2, survey was based on the Focus Group 1 survey; however, the Focus Group 2 survey was more targeted at measuring recycling habits and demographic information. Since the Focus Group 2 survey was a google form our group simply added questions and responses based on user feedback from Focus Group 2 in order to create the final Phase 2 Survey. The final Phase 2 Survey can be found [here](#), or at <https://tinyurl.com/sl3ef3a>