Data Analysis Report

Student Perceptions of Water Bottle Refilling and Reuse on Campus

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Background

Plastic waste has a massive environmental impact. Approximately 300 million tonnes of plastic waste is produced around the world each year, and Canadians produce around 3 million tonnes of plastic waste yearly (Environment and Climate Change Canada, 2020; UNEP, n.d.). It is estimated that only 9% of all plastic produced has been recycled (UNEP, n.d.). The remainder is either incinerated or continues to pollute our physical environment in landfills and oceans (UNEP, n.d.). The Government of Canada has created an action plan to reach zero plastic waste by 2030. This includes a proposed plastic ban targeted towards single-use plastics such as plastic checkout bags, straws, stir sticks, six-pack rings, cutlery, and food ware made from hard-to-recycle plastics (Environment and Climate Change Canada, 2020). Although plastic bottles are one of the biggest contributors to the problem (EPA, n.d.), they are not included in this ban.

However, to address this issue, some institutions have implemented their own plastic bans. According to research conducted in 2018, sixteen Canadian universities have banned the sale of single-use plastic bottles on campus (Jackson, 2018). However, there has been minimal research conducted on student water consumption and the impact of these bans (Berman & Johnson, 2015).

Students at Allegheny College were surveyed from Sept to Oct 2014 about their water consumption practices and beliefs (Choate et al., 2018). The researchers found that the main reason students were purchasing bottled water was due to concerns on the quality of water found on campus. Responses indicated that students found the water quality “Disgusting” and “Subpar” and believed that bottled water was cleaner and safer (Choate et al., 2018). The college took some steps to encourage sustainable water consumption, such as installing more filtered water fountains and bottle refill stations around campus, providing a metal-water-bottle to all first-year undergraduate students, and providing information about the safety of tap water and benefits of using a reusable water bottle (Choate et al., 2018).

The University of Vermont implemented policy changes surrounding the types of bottled beverages sold on campus in 2012 (Berman & Johnson, 2015). In August of 2012, all campus locations were required to provide a 30% healthy beverage ratio in compliance with the Alliance for a Healthier Generation’s beverage guidelines (Berman & Johnson, 2015). By 2013, they removed the sale of bottled water while maintaining this 30% ratio (Berman & Johnson, 2015). The researchers collected beverage shipment data under the assumption that the university was only buying beverages that students were purchasing. Results found that after the sale of bottled water was stopped, shipments of healthy beverages declined, and shipments of less healthy beverages increased, with more calories and added sugar increased significantly (Berman & Johnson, 2015). It was also found that there was no decrease in the number of plastic bottles purchased by students (Berman & Johnson, 2015).

Washington University in St. Louis implemented a bottled water ban in 2009 (D'Altrui, 2017). The university published a report in 2015 stating that since the ban went into effect, bottled beverages and fountain drink purchases have decreased while the student population on campus increased (D'Altrui, 2017). Bottled water went from 10% of purchases to 2%, while carbonated drink purchases decreased by 50% (D'Altrui, 2017). Alongside the bottled water ban, the university implemented other strategies to promote sustainable water consumption (D'Altrui, 2017). 108 water refill stations were installed across campus, and they had a team of "Green Ambassador" peer educators to educate students on water consumption and sustainability (D'Altrui, 2017). Results of these strategies included decreased recycling costs and student expenditure (D'Altrui, 2017).

Results on the effectiveness of bans on single-use plastic bottles are inconclusive due to conflicting findings from studies done at different universities.

Purpose

To further understand the culture and perceptions around bottle consumption on campus, survey responses were collected from over 800 residence students in the 2019/2020 academic year. This data demonstrated that McMaster residence students use a surprisingly large amount of plastic water bottles. Through our project, we aimed to investigate this problem by analyzing survey data and interpreting correlations between measured variables.

The primary goal was to determine why residence students continue to gravitate towards plastic water bottles. By analyzing survey responses, we gained data-driven insights into student motivations, patterns, and barriers to reusable bottle use. We used this knowledge to develop recommendations on initiatives the university and subsequent project groups can undertake to advance sustainable water consumption practices on campus.

Quantitative Data Analysis

The following three multiple-choice questions regarding single-use plastic bottles from the survey were analyzed (A breakdown of survey responses for each question is included in Appendix A).

1. How often do you purchase beverages in single-use plastic bottles (e.g. water, pop, etc)?
2. Do you store beverages in single-use plastic bottles in your residence room (e.g. in your fridge, a case of water bottles, etc)?

3. Would you support efforts to reduce the use of single-use plastic bottles in residence?

Responses revealed that 80% of residence students purchase single-use plastic bottles, with nearly 60% purchasing bottles once per week or more. Further, approximately 60% of respondents stated that they always or sometimes store single-use plastic bottles in their residence rooms. Lastly, 65% percent of respondents stated that they would support efforts to reduce the use of single-use plastic bottles in residences. An additional 33% of students mentioned that they may support such efforts, depending on how it was done.

Qualitative Data Analysis

The qualitative data analysis for our project was done using the responses from McMaster students that lived in residence in 2019 for the question “What would you do to reduce or eliminate the use of single-use plastic bottles in residence?”. Students submitted short answer responses with their feedback on what actions they would take to reduce their bottle consumption or what actions they think the university could take to reduce bottle consumption.

Methods

The process for the qualitative data analysis was split into three parts. Initially, each member of the group went through the data by themselves and looked at each response. Beside each response, each group member wrote three to four words that summarized the main point. Once this was done, the group met virtually to compile their initial analysis, and compare and discuss their findings. Next, each group member went through the data by themselves again and put one word beside each response that they felt best represented the point of the response. These words are known as “codes". Each member came up with a list of eight to ten codes that they would use to categorize the responses. Once each group member completed this, a meeting was held to discuss the codes each group member used, and if there were any similarities or differences. During this meeting, a final set of ten codes that would be used for the final coding process was agreed upon. Each member went through the data individually for the final time and used these codes to categorize each response. Afterwards, a meeting was held to compare the codes for each response and create a document with each response and the final code for it. This was done by discussing what code each member used and seeing if there were any differences in codes. If there was, each group member would explain their reasoning for the code they used, and a final agreement would be reached.

Results

Table I. Final codes and response examples for quantitative data analysis. This table displays the ten codes that were used for the final qualitative analysis of student’s responses from the 2019 Residence survey.

The table also includes key terms in responses that were used to identify which code would be used for the response, and examples of student responses to the survey.

Codes	Count	Refers to:	Example of responses from survey:
Reusable Bottle	85	Sale of reusable bottles, free reusable bottles, personal use of reusable bottles, reusable mugs, other reusable containers	“Give away free reusable bottles” and “bring my own reusable bottle”
More Fountains	52	More water fountains, distance to fountains, accessibility to fountains, water refills for bottles	“I would place more water fountains on campus. The building I live in, LP, doesn't have a single water fountain station forcing me to leave my building to get some water. It was an inconvenience, so I buy a case of water now.”
Filters	26	Filters for water on residence, personal filter for water	"Use a Brita filter instead of buying water bottles" and “filter water bottle stations in residence”
Reusable Program	25	Greenbox program, bring your own cup program, reusable bottle program for drinks (bottles provided by on-campus eateries and students return the bottles at their next visit)	“Option to refill beverages, or bring your own bottle” and "implement a refillable beverage container system similar to the green box program"
Plastic Ban	21	Banning plastic bottles, single use plastic etc.	“Prohibit the selling of single-use plastic bottles” and “Stop selling single use plastic, give alternatives"
Fountain Drinks	21	More drink options, refills for other drinks	“Introduce soft drink fountains to all eateries that allow for the use of reusable bottles” and “"have beverage filling stations as opposed to bottled drinks"
Incentives	18	Affordable reusable options, discounts for refills and bringing you own reusable cup/mug	“Provide a discount program for bringing your own drink container as well as selling them across campus” and "lower the price of drinks that are packaged in a green way"
Education	13	Encouragement to use reusable options, seminars on environmental impact of plastic and reusable bottles, posters on	“I would make a seminar, send emails, etc” and "Encourage the use of reusable water bottles by increasing awareness in the

		campus etc.	community by putting up posters."
Cleanliness	11	Trustworthiness, water quality, Hamilton water sanitation, hygiene	"Offer clean water in residence buildings as done in welcome week" and "clean tap water"
Recycling	7	Recycling programs, recyclable materials	"Create a bin for recycling plastic bottles only" and "we should do the recycling"
	279	n = 234 (Some respondents included multiple ideas)	

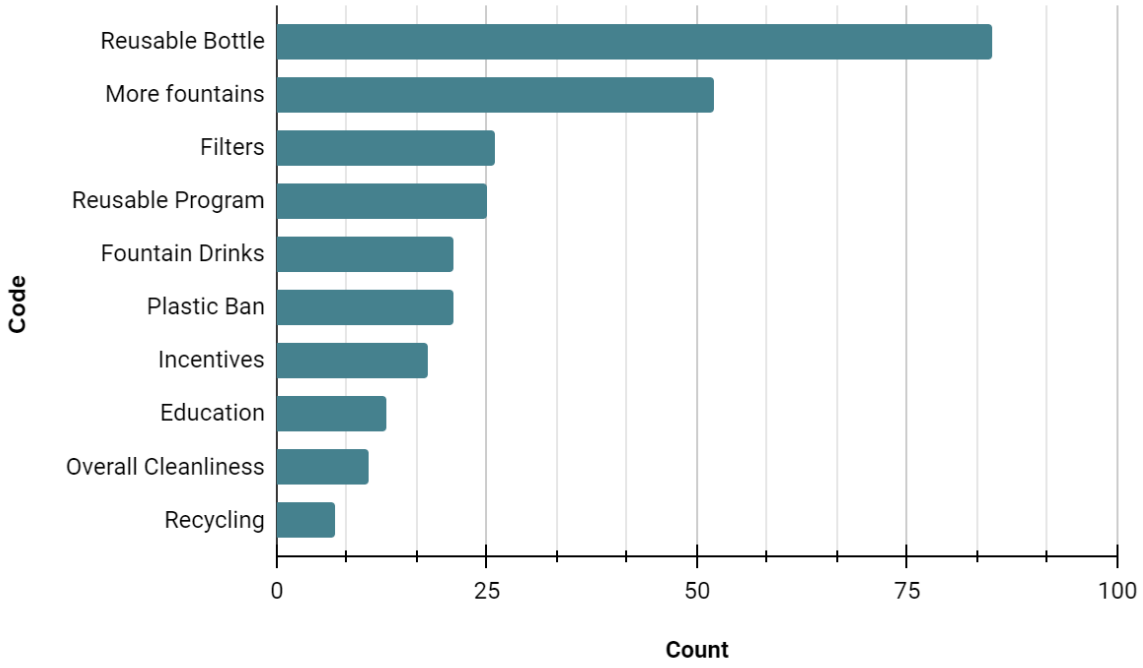

Figure I. Prevalence of Themes in Survey Responses. A bar graph representing the count of each code/theme in the survey responses, from most prevalent (top) to least prevalent (bottom).

Appendix B includes a table that shows the prevalence of each code as a fraction and percentage.

Overall Interpretation

In this section, we aim to answer the question “What story does the data tell us?”. We attempt to use the student responses to summarize their perceptions of single-use plastic water bottles, and barriers that prevent them from using reusable water bottles.

Reusable Bottle

Although there was not a particular theme that was present in the majority of responses, the most prevalent code was “Reusable Bottle”. There were three main ways reusable bottles were mentioned in the responses. The first two were: 1) students stating that they have their own reusable bottles which they regularly use. Or 2) it was mentioned as a general fact or suggestion for a practice that others should follow. This tells us that, overall, the student body recognizes that using reusable water bottles is the action that needs to be taken to achieve the goal of reducing or eliminating the use of single-use plastic bottles. Thus, perhaps they already understand the environmental benefits of using reusable water bottles. This leads us to two conclusions. First, perhaps this knowledge is not enough motivation to get everyone to use reusable water bottles. Second, it may not be a knowledge gap regarding the environmental impacts of single-use plastic that leads students to this behaviour.

The third way that students referred to reusable bottles in their responses was: 3) suggesting that inexpensive, quality water bottles should be sold on campus or that students should be provided with free, good quality water bottles. There are two factors at play here: affordability and quality. It is understandable that students do not wish to spend money on expensive water bottles. However, this is usually the case with bottles that are sold on campus and higher-quality bottles in general. Quality may be related to the longevity of water bottles as well as safety concerns associated with using reusable bottles. For example, one respondent mentioned that they like BPA-free water bottles in particular. Therefore, these two components may be important barriers in students using reusable bottles, and may also function as factors motivating students to use plastic bottles.

Finally, there was a smaller number of students that mentioned the attractiveness of reusable water bottles as a motivating factor. Therefore, it may be important for students to have water bottles that they *like* to use. For example, some responses mentioned that residence or McMaster University-themed bottles would be a good motivator.

More Fountains

The second most common theme found in survey responses was students mentioning the need for more water fountains on campus, particularly in their residences. It was often suggested that each residence floor (or at minimum the main floor or each residence) should be equipped with a designated bottle refill station. Students complained that in order to fill their water bottles, they have to travel outside their residence to other buildings on campus. Many students also expressed an aversion to tap water, whether that be from kitchen or bathroom sinks. This was either due to issues with cleanliness (surrounding area or water itself perceived to be ‘dirty’) or difficult access (small sinks size, kitchen sink filled with dishes). The result is that buying cases of plastic water bottles offered students 1) more convenient and quick access to water as well as 2) access to water

perceived to be ‘cleaner’. This tells us that lack of easy access to a preferred water source makes it more difficult for students to use reusable water bottles.

Filters/Cleanliness

The third most common theme we came across was the concept of filtration. Firstly, students often mentioned this in conjunction with the idea of water fountains. This tells us that perhaps students prefer the filtered water fountains that are already on campus over other sources of water. Secondly, students also frequently mentioned using personal ‘brita’ filters. Overall, we know that students value water that has been ‘filtered’. This may be due to personal habit (e.g. students drinking filtered water from a fridge at home) or a preference in taste that filtration changes. On the other hand, it may also be that students have a belief that direct tap water or ‘unfiltered’ water is not clean or drinkable. This is further supported by the fact that many responses mentioned the theme of “Cleanliness”. A number of students seem to believe that the residence tap water, or water in the City of Hamilton in general, is ‘dirty’. Students also disliked that the residence sinks themselves are dirty. Overall, there is a clear factor of mistrust in water quality. This may be due to changes in taste or appearance of water, as some respondents mentioned. It may also be influenced by information they hear from friends and family or the media about local water quality.

Reusable Program/Fountain Drinks

The theme ‘Reusable Program' occurred as frequently as ‘filters’. Here, students described a program similar to the eco-container program, where one would be able to fill various beverages in their personal reusable containers. This idea is similar to the next common theme of ‘Fountain Drinks’. Students expressed a desire to have fountain drink machines for other types of beverages that they commonly buy in plastic bottles. This tells us that for many students, the majority of their single-use plastic bottle waste comes from non-water drinks such as pop, juice, and energy drinks. Therefore, if students have alternative ways of getting those drinks, they may reduce their usage of single-use plastic bottles. Although these are great options to reduce the usage of plastic bottles, it is important to be careful in the implementation of such programs. This is because we do not want to make it easier for students to access unhealthier beverages if water isn’t available at the same convenience. From this, an important take-away is it that perhaps we need to promote healthier food and drink consumption within first-year residence students.

Incentives

Another common theme found in some responses is that financial incentives can motivate students to reduce their usage of single-use plastic bottles. Some ideas suggested in responses were: a discount for students to use reusable bottles to fill drinks (part of reusable program); reducing costs of reusable water bottles; reducing costs of beverages packaged in eco-friendly materials; and increasing costs of drinks in plastic bottles.

Plastic Ban

Some students suggested that McMaster could 'ban' or stop the sale of beverages in single-use plastic bottles on campus. Others suggested a similar idea, where drinks in plastic bottles could be replaced with drinks packaged in alternative materials. This tells us that some students do support a plastic bottle ban on campus and it could be a viable option. However, it is important to be careful that a plastic ban should not reduce beverage options for students or make access to water more difficult.

Education

Some students expressed that encouraging the use of reusable bottles or education about the topic may motivate others to reduce their usage of single-use plastic bottles. Perhaps education campaigns could be regarding the environmental impact of plastic bottles as compared to reusable bottles. Another important topic of education may be teaching students about the water quality of tap water on campus. Some important questions to address may be, "What is already filtered out in our tap water?"; "What chemicals/toxins are actually harmful in our drinking water?"; "What do campus water filters filter out?"; "What do Brita filters filter out?"; "Why does water taste/appearance vary and when is it harmful?". Addressing these issues may make students less opposed to refilling water from the water sources that already exist around them.

Recycling

A few students expressed that recycling is a good solution for this problem. However, recycling does not reduce or eliminate the usage of single-use plastic bottles, but rather helps control the impact they have on the environment. Therefore, some students that answered with this may have misinterpreted the survey question. On the other hand, a few students expressed that instead of trying to reduce plastic bottle usage, the university should focus on creating systems that allow for appropriate waste management in residence buildings.

Summary of Barriers and Motivations to Reusable Water Bottle Use Among Students

Based on student responses, we identified the following barriers and motivators to reusable water bottle use.

Barriers	Motivations
• Affordability of water bottles • Quality of Water Bottles (Longevity, safety concerns) • Distant water bottle refill stations	• Access to 1) affordable, 2) high quality, 3) attractive water bottles • Designated water refill stations in residence

• Water quality preferences (filters, taste) • Preferred beverages only available in plastic bottles (Health concerns*) • Perceptions of Cleanliness	• Water filters: either personal or on water refill stations/ Perceptions of Cleanliness • Fountain Drinks + Reusable Program (Health concerns*) • Financial Incentives • Education and Promotion (environmental impacts, water safety, health)

*Health Concerns refers to ensuring students are encouraged to consume healthy beverages such as water, instead of sugary drinks. This is discussed in more detail above, under *Reusable Program/Fountain Drinks*.

Observations and Interpretations From Survey Data Split by Residence

In this section, we use our current knowledge of campus and building infrastructure to make some observations and interpretations about student behaviour regarding usage of reusable bottles. Due to some gaps in our knowledge about how many water fountains were available in buildings at the time of the survey, this is a preliminary analysis. Our interpretations are not final conclusions, but rather mere speculation that can be supported or rejected after seeking further research.

In general, when comparing factors between residences, it was identified that presence of LLCs, age of residences, and proximity to eateries did not appear to change student perceptions between residences. However, these are the pieces of data and trends that stood out the most.

To begin, Edwards Hall is one of the two oldest residence buildings on campus (the other being Wallingford Hall), as it was built in 1930. Our team found it interesting that this residence had the highest percentage of students suggesting improvements to the overall cleanliness, with students mentioning “dirty water,” “tastes weird,” “bathroom water,” and “sewage leak”. When discussing possible reasoning for these results, we considered whether this could have stemmed from a lack of trust in the infrastructure and water quality in older buildings. Similarly, Edwards Hall also had the second-highest percentage of students asking for the installation of more filters (15% of respondents).

Some of the newer residences, Mary Keyes (2003) and Les Prince (2006) had the lowest percentage of students asking for the installation of more fountains, which may suggest that these residences are more equipped with the infrastructure to help students in refilling their reusable bottles and incorporating sustainable practices into their lives.

It is also interesting that the newest residence, PGCLL, was the one with the highest percentage of students suggesting more filters. From our knowledge, at the time that residents moved in,

PGCLL had quite a few water refill stations, which added to our team's uncertainty about the reasoning behind this outcome. However, this may be due to the fact that the building was still partially under construction at the time. Therefore, these factors could have led to an overall lack of trust in the quality of water being offered.

The final significant observation our team made was that Mary Keyes also had the highest percentage of students asking for a reusable Green Box or Eco Container program for drinks, which is relevant considering that these students have more accessibility to food locations (Bistro & Convenience store), which they can purchase from the bottom floor of the residence and easily/conveniently take it back to their own common spaces/room.

Recommendations for Next Steps

Overall, we found 10 relevant themes in student responses. We believe that these responses revealed two important underlying themes: convenience and trust. It appears that students are largely motivated by convenience, and trust in the safety and quality of water. Therefore, we think it will be valuable to look into the following questions to determine how these factors influence student decisions, and whether changes to these factors can translate to a change in student behaviour.

- Are students aware of the newly installed filtered water spouts in residence kitchens?
- After the installation of the water spouts, how often do students purchase plastic bottles? Has this number changed since the 2019/2020 academic year?
- With the presence of filtered spouts, do students still desire additional water fountains in residence buildings? What are their perceptions regarding water quality, cleanliness and safety at present?
- How often do students store plastic bottles in their residence rooms? Has this number changed since the 2019/2020 academic year?
- The 2019/2020 survey addressed single-use plastic bottles in general, as opposed to plastic bottles. However, we think it is important to understand how much of student purchase/storing of single-use plastic bottles consists of water bottles?
- How often do students consume water, as compared to other beverages? This is an important question to investigate as perhaps student behaviour regarding plastic bottle usage is related to beverage preferences. This is also a potential health concern.
- Would students reduce their usage of plastic water bottles if there were more water fountains in residence?
- Would education and transparency about the way tap water (in residence, McMaster, or Hamilton in general) is already filtered impact student perceptions? For example, posters

in kitchens listing the types of contaminants our water is safe from, how it is monitored, etcetera.

- Investigate student interest in fountain drink/bring-your-own-bottle program for on-campus eateries.

Other Suggestions for Future Residence Surveys

The 2019/2020 survey responses varied in that students answered the open-ended question with different perspectives (e.g. responses regarding individual actions students could take or responses regarding actions that the community/university should take). We also noted that the relevant questions were questions 56-59. Students had to answer multiple questions prior to this, potentially reducing quality and accuracy in responses due to fatigue. Therefore, we think it would be beneficial to include these questions earlier on in the residence survey if possible. As well, we suggest re-wording questions to refer to plastic water bottles instead of single-use plastic bottles in general. We also worked with our Community Project Champions, Monica Palkowski and Liana Bontempo, to create the following questions for the 2021/2022 residence survey:

1. How often do you purchase water in single-use plastic bottles?

   [Multiple choice: Daily, Weekly, Monthly, Never/Almost Never]

2. Where do you purchase your bottled water most frequently?

   [Multiple choice: On-campus Locations (ex. La Piazza, Union Market, Centro, vending machines), Online (ex. Amazon), Grocery Stores]

3. How often do you drink water from a reusable water bottle?

   [Multiple choice: Daily, Weekly, Monthly, Never/Almost Never]

4. If bottled water wasn't available for purchase anywhere on campus, what would you be most likely to do?

   [Multiple Choice: Buy bottled pop/juice, Fill a bottle at a sink, Fill a bottle at a refill station, Avoid getting a beverage all together}

5. What would encourage you to choose refillable over single-use plastic all of the time?" [If you already choose to reuse all of the time, please respond with what you think would encourage others]

   [Open box answer]

6. What actions do you think McMaster University should take to reduce or eliminate the use of single-use plastic bottles in residence?

   [open-ended text box]

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Appendix A

Breakdown of responses from quantitative multiple-choice answers.

Q56- How often do you purchase beverages in single-use plastic bottles (e.g. water, pop, etc)?

Response	**Percentage**	**Count**
More than once a day	7.32%	64
Once a day	13.73%	120
A few times per week	26.54%	232
Once per week	12.36%	108
A few times per month	12.59%	110
Once per month	7.8%	68
Never/almost never	19.68%	172
Total Respondents		874

Q57- Do you store beverages in single-use plastic bottles in your residence room (e.g. in your fridge, a case of water bottles, etc)?

Response	**Percentage**	**Count**
Yes, always	20.37%	178
Yes, Sometimes	37.99%	332
Never	41.65%	364
Total Respondents		874

Q58- Would you support efforts to reduce the use of single-use plastic bottles in residence?

Response	**Percentage**	**Count**
Yes	64.99%	568
Maybe- it depends how it was done	32.72%	286

No	2.29%	20
Total Respondents		874

Appendix B

Table II. Count, fraction, and percentage of each code. "Count" is the total number of times a particular code appeared in all the survey responses. "Fraction" represents the proportion of responses that mentioned a particular code (count/total # of responses). "Percentage" represents the percentage of responses that mentioned the code. *Note: The codes are not mutually exclusive. That is, one response can have multiple codes associated with it.*

Code	Count	Fraction	Percentage (%)
More Fountains	52	52/234	22.2222222
Fountain drinks	21	21/234	8.974258974
Recycling	7	7/234	2.991452991
Filters	26	26/234	11.1111111
Plastic ban	21	21/234	8.974258974
Incentives	18	18/234	7.692307602
Cleanliness	11	11/234	4.700854701
Education	13	13/234	5.555555556
Reusable program	25	25/234	10.68376068
Reusable bottle	85	85/234	36.32478632