MAJĀL
2023 VOLUME 2
UNDERGRADUATE JOURNAL

Recycling Assessment and Intervention on a University Campus in Qatar

Zoya Farooqui,[a] Masooma Zehra,[b] Jennifer Bruder[c]

[a] Carnegie Mellon University - Qatar, Alum
[b] Carnegie Mellon University - Qatar, Alum
[c] Carnegie Mellon University - Qatar, Associate Teaching Professor, Psychology; Associate Dean for Research

Plain Language Summary

This study employed mixed methods to understand and improve recycling behavior at Carnegie Mellon University's campus in Doha, Qatar. Waste audits from the university's general waste and recycling bins were recorded and contamination rates (i.e. sorting errors) in recycling bins were determined. A campus-wide survey assessed attitudes and reported behaviors related to recycling on campus. The survey was used to inform the content of a student-led intervention that included social influence and education. Overall, waste audits revealed poor recycling behavior and the survey revealed a lack of awareness and distrust of recycling policies at the university. The intervention did not lead to improvements in the amount of material recycled. These findings are discussed against the background of education, awareness, and social influence and provide several suggestions for future research.

Publication Category

Student-Faculty Collaboration

Academic Context

The Eco-Campus initiative was launched in 2019 at Carnegie Mellon University in Qatar (CMU-Q). It is a structured plan provided by the Federation for Environmental Education (and partnered with Earthna, Qatar Foundation) which drives schools and universities towards sustainability through initiatives aimed around UN Sustainable Development Goals. This research was initiated and conducted by CMU-Q's undergraduate students under faculty supervision to understand the present practices of the CMU-Q community towards waste generation and recycling, and to attempt to improve attitudes on campus through a targeted intervention (producing a measurable change).

Introduction

People from all cultures and spanning all geographical areas contribute to the production of waste. Not only is waste management an issue for human health, economy, and stability, but it is also a contributor to greenhouse gas emissions and therefore global warming. In 2016, solid waste contributed to about 1.6 billion tons of carbon dioxide greenhouse gas emissions. These emissions are generated from treatment and disposal, and open dumping of solid waste (Kaza et al., 2018). Furthermore, the amount of waste humans created is increasing, from an estimated 1.3 billion tons per year in 2012 (Hoornweg & Bhada-Tata, 2012), to 2.0 billion tons in 2016, and is expected to increase to 3.4 billion tons by 2050. The Middle East and North Africa generated 129 million tons of waste in 2016, however, the majority of this waste is generated by the wealthier GCC countries, including Qatar (Kaza et al., 2018). The amount of waste produced in this region is expected to double by 2050 in a business-as-usual scenario (Kaza et al., 2018). In 2018, only 8% of Qatar's waste was recycled, and plastic waste emerged as a serious concern (Mariyam et al., 2022).

Recycling is an important behavior because it enables the retrieval of secondary raw materials, which in turn, reduces greenhouse gas emissions (Bartelings & Sterner, 1999; Corsten et al., 2013). In response to the recycling needs, the state of Qatar set aims to recycle 15% of solid waste by the end of 2022[1], reflecting an urgent need for

[1] Note: the authors were unable to find information about the current recycling statistics in Qatar at the time of submission.

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service

improvements in the area of waste management (Qatar Second National Development Strategy, 2018-2022). However, as of 2023 only a few recycling facilities in the country were established and households and businesses, including universities, must organize (and in some cases pay for) these services on their own. It is assumed that the current circumstances limit the behaviors and attitudes of citizens and residents toward recycling.

Numerous studies have examined factors influencing recycling intentions and behaviors in Higher Education Institutions (HEIs) (see Sallaku et al., 2020 for review), and some researchers have conducted interventions to improve recycling behavior on the campuses of HEIs (reviewed below). Considering the need for understanding effective interventions in university settings, the present study aimed to audit waste, assess, and improve the recycling practices of university students in an undergraduate university in Qatar.

There are several reasons why university settings are considered important places to research pro-environmental behaviors. First, HEIs play a central role in training responsible future leaders for sustainable development due to the expertise of the community members and their perceived moral obligations to represent best practices and standards (as discussed by several researchers, for example, Armijo de Vega et al., 2008; Bailey et al., 2015; Cortese, 1992; Geng et al., 2013; Moqbel et al., 2020) and promoted by UNESCO (Leicht et al., 2018). Additionally, prior research suggests that universities often take the lead in local community action (Noeke, 2000; Tangwanichagapong et al., 2017; Velazquez et al., 2005). Further, pro-environmental behaviors, like recycling, are complex and influenced by situational and contextual factors, including social factors (Abrahamse & Steg, 2013; Becker et al., 2014; Kaiser et al., 2007; Taube et al., 2018). Therefore, understanding and improving the attitudes and behaviors toward recycling within a university in Qatar could be an important indicator for recycling readiness and act as a catalyst for this behavior in the country generally.

In a recent review, Grilli and Curtis (2021) identified five categories of effective intervention for improving pro-environmental behavior. The first category, education and awareness, addresses knowledge deficits by providing information (e.g. handouts, posters) to the target group. Generally, without adequate knowledge, such as the rules and expectations of the recycling programs, recycling will not improve (e.g. Passafaro & Livi, 2017). The second method, outreach and relationship building, provides education and awareness opportunities through community engagement events such as workshops and focus groups. This category is similar to the first category, education and awareness, but requires more resources and community involvement. Research shows it is most effective when used over a long period. Due to the time and resources required, this type of intervention has not been as extensively researched as the other strategies.

The third approach, social influence, utilizes close groups, such as peers or community members who work to establish a consensus within the community toward behavioral change. Social influence can include public oaths, behavior modeling, the use of block leaders, and providing feedback about a group's behavior. The most effective social influence approaches use face-to-face interactions to convey messages, for example through block leaders who are volunteers that belong to the target group's social network (also see Abrahamse and Steg, 2013). The power of social influence as a strategy for pro-environmental behavior leverages concepts from social norm research (e.g. Cialdini et al., 1990; Cialdini, 2003). In this context, behavior can be influenced by the environment and its perceived social norms. These norms may be descriptive. For example, individuals may recycle if they believe everyone else is recycling. Or the norms may be injunctive. For example, individuals may recycle because they believe that not recycling will be met with social disapproval.

The fourth category, nudges and behavioral insights, involves changing the target group environment in such a way that their choices become pro-environmental through design. This might involve making green choices more convenient, such as the user-friendly placement of recycling bins. Finally, the fifth category relates to providing some sort of incentive, monetary or otherwise, to the target group for engaging in pro-environmental behavior. Depending on the target population and the target behavior, all approaches alone or combined can be effective to induce behavioral change.

To date, few studies have explored long-term behavioral change in recycling as a result of interventions in HEIs; however, the existing research suggests that the strategies of social influence and education and awareness are key contributors to positive change. For example, Dupre and Meineri (2016) explored the effects of informed feedback on recycling behaviors in the common area of three cafeterias of a large French University. Daily waste audits of general and recycling bins in each cafeteria were analyzed. The authors found persuasion posters alone elicited little effect on recycling behavior and limited improvement was obtained when persuasion posters were combined with feedback about recycling behavior for one cafeteria. However, when recycling feedback was provided in the context of comparative social feedback from

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

competing cafeterias, the authors reported significant recycling improvement. These results suggest that comparative social feedback may improve recycling rates and are in line with some previous research in other settings (e.g. Nigbur et al., 2006; Schultz, 1999).

□n comparison, studies conducted in universities in South Korea (Kim et al., 2005) and Hong Kong (Cheung et al., 2018) found that feedback about recycling behavior (in the absence of social comparison) was sufficient to significantly increase the number of materials recycled as well as improve sorting errors, but these effects do not necessarily persist once feedback is removed. Similar results were reported by Manfredi et al. (2021) in an American sample when informational panels and educational facts were displayed with recycling bins. Other research suggests that electronic feedback can be useful in engaging people to recycle on campus (Mozo-Reyes et al., 2016). Notably, nudging recycling through the convenient placement of bins on campuses also positively impacts the amount of material recycled (Fritz et al., 2017; Katzev & Mishima, 1992; Largo-Wight et al., 2013; Ludwig et al., 1998; O'Connor et al., 2010), though the overall impact of placing bins in convenient locations is insufficient as a standalone strategy (Miller et al., 2016).

Currently, it remains unclear if these methods would work in all environments and cultures. □n their review, Grilli and Curtis (2021) found that the majority of (broadly defined) pro-environmental intervention studies were conducted in Europe and North America. Only a few comparative recycling interventions across international campuses have been conducted. For example, a study comparing British and □ndian students found that posters and information could improve food waste in both cultural contexts, but student attitudes that contributed to food waste reduction differed greatly across campuses (Davison et al., 2022). □n an online study comparing students from campuses in the UK and Kazakhstan, researchers found that social influence in both settings was more impactful than information alone (Lakshmi et al., 2022). The results of Lakshmi et al. (2022) are encouraging in the respect that students in Kazakhstan, a country with less developed recycling infrastructure, were highly motivated to recycle, and attributed this finding to several possibilities, most of which were related to the country's culture.

To the best of our knowledge, no recycling intervention studies have been conducted in the context of the Middle East, including Qatar. Unlike other countries, such as European countries, that participate in binding recycling targets (Waste Recycling in Europe, 2022), Qatar has not yet implemented a national recycling program and therefore the local mindset may be less tuned to recycling. □t may therefore be more difficult to succeed in improving recycling behavior in such an environment. □n this case, recycling intervention at HE□s, which seeks to increase environmental awareness and teach proper recycling practices, could have a strong impact within and outside the institution, as HE□s are known to play a formative role and demonstrate leadership in such initiatives.

Present Study

The present study explored recycling attitudes and behavior at Carnegie Mellon University's campus in Qatar (CMU-Q). CMU-Q's community is home to over 400 students and 100 faculty and staff. Student demographics reveal a multicultural spirit, where students hail from approximately 52 different nationalities. CMU-Q is a member of Qatar Foundation and is one of several HE□s in Doha's Education City. Qatar Foundation promotes sustainability in various ways, such as through "car-free days" where no cars are allowed on Education City premises, and provides several options for recycling around Education City, including recycling bins and facilities. As a member of Qatar Foundation, and in line with Carnegie Mellon's Sustainability Vision, CMU-Q's campus is also actively seeking ways to be aligned with sustainable goals, including through the promotion of reducing and recycling campus waste, and through a growing Eco-campus community, comprising a team of students, faculty, and staff working to make CMU-Q sustainable in education, research, and operations.

Despite these positive initiatives, casual observations by the Eco-Campus members of the campus recycling bins found poor recycling behavior, for example, visual observations revealed high contamination rates. Further, ad hoc discussions with community members highlighted sentiments of distrust in recycling processes. Therefore, this study was initiated and conducted as part of the Eco-Campus initiative to attempt to quantify recycling behavior through waste measurements and improve behaviors by directly querying and addressing community concerns.

The study had three general goals:

1) Establish baseline measurements of recycled waste and contamination rates of recycling bins on CMU-Q's campus through waste audits;

2) Survey community members to gain insight into behaviors, attitudes, and knowledge gaps toward recycling on CMU-Q's campus;

3) Use the findings of Goals 1 and 2 to design and conduct a recycling intervention combining two established categories of strategies, education/awareness and social influence, with the intent to improve recycling at CMU-Q.

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

Overall, the study aimed to understand recycling practices in CMU-Q's community and observe if an intervention designed to educate and engage with community members could improve recycling practices. The study was inspired by previous research related to university recycling interventions (Dupre & Meineri, 2016).

Therefore, we hypothesized that a successful intervention would improve the amount of material recycled on campus, decrease contamination rates and improve attitudes toward recycling (H1). □f the intervention was not successful, we would not expect to see an improvement in these measures (H2).

Methods

The study utilized an A-B-A design and was conducted over a three-week period (Figure 1) (preceded by three weeks of baseline waste data collection). □n Week 1 (Pre-intervention Week), a pre-survey was conducted to assess recycling attitudes campus wide. □n Week 2 (□ntervention Week), student volunteers led a three-day recycling and educational intervention in the university's cafeteria. □n Week 3 (Post-intervention Week), the survey was redistributed to gauge altered views and practices regarding recycling following the intervention. The amount of waste generated at CMU-Q was recorded during the three weeks of the study and three weeks prior to study initiation to evaluate the impact of the intervention.

Waste Measurements

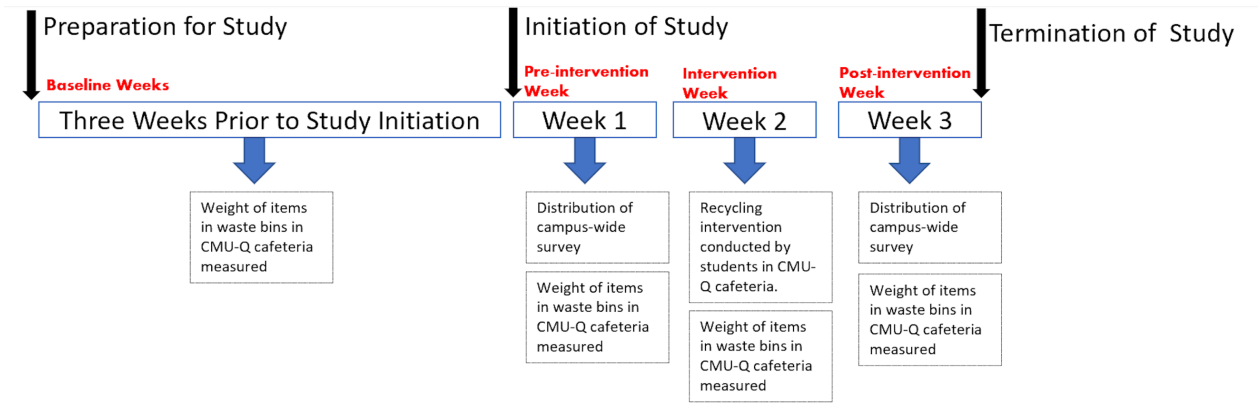
Prior to Week 1, the weight (in kilograms (kg)) of recyclable (metal, paper, plastic) and general waste discarded at CMU-Q was recorded for three typical weeks to establish a baseline of waste generation on campus (Figure 1). A typical week is defined as a five-day week with regular classes (i.e., no holidays and no hybrid remote classes). Recyclable waste was also sorted to determine the weight of contamination (i.e., incorrectly placed items) in recycling bins. Therefore, three measurements were recorded: total general waste, total recycled waste (including incorrectly sorted items), and total contamination (i.e. sorting errors) for each recycling bin. These measurements continued after the study's initiation (refer to Figure 1).

Survey

A survey was emailed to faculty, staff and student distribution lists as approved by CMU-Q's □nstitutional Review Board (Protocol #1885425) twice, before and after the student-led intervention (see Figure 1). Students under the age of 18 were excluded from the study. Participants could participate in the study at both time points, but this was not controlled for, as we wanted to ensure full anonymity of study participation due to the small nature of CMU-Q's campus.

The purpose of the survey was to assess specific aspects of CMU-Q's community's current recycling practices and confidence in the recycling policies in order to be able to address negative perceptions, erroneous beliefs, gaps in knowledge and poor behavior that community members may have in the study intervention phase, and to determine thereafter if the intervention may have had an effect on recycling behavior. Therefore, the survey targeted specific behaviors, attitudes, and knowledge toward recycling on campus. □t was adapted for CMU-Q's campus from previous literature on university populations (Bailey, et al. 2015; Manifredi et al. 2021). Altogether, the questionnaire was comprised of 20 questions with mixed response types and took no more than 5 minutes to complete. Only basic demographic data was collected (i.e. gender and university role: student/staff/faculty). Recycling behaviors were assessed by asking whether the participant recycled, the frequency of recycling, and the items they recycled. Participants were also asked about the likelihood that they would engage in particular behaviors, such as reusing recyclable items rather than disposing of them, as well as their motivations for recycling or not recycling. Of particular interest were the questions which asked about

F□GURE 1. Schematic representation of study timeline and methodology.



DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

TABLE 1. Total weights measured for each recycling bin (metal, paper, plastic) during the three-week study period. *All measurements are in kilograms (kg). Average weight refers to the weight recorded before controlling for error (contamination), averaged from that week's measurements. Error refers to the amount of contamination and is reported in kilograms and as a percent.*

	Pre-□ntervention Week Week 1			□ntervention Week Week 2			Post-□ntervention Week Week 3		
Weight Measurement	Average (SD)	Error (SD)	% Error (SD)	Average (SD)	Error (SD)	% Error (SD)	Average (SD)	Error (SD)	% Error (SD)
Metal Recycling (kg)	3.15 (3.00)	2.22 (1.68)	78.14 (11.15)	2.03 (1.04)	1.32 (0.14)	75.49 (27.62)	1.32 (1.64)	1.14 (1.44)	43.20 (49.92)
Paper Recycling (kg)	5.55 (4.81)	4.51 (4.65)	72.10 (16.43)	3.33 (1.45)	2.62 (1.13)	79.23 (8.79)	6.34 (7.67)	4.17 (5.59)	59.92 (21.57)
Plastic Recycling (kg)	3.54 (0.52)	3.01 (0.54)	84.55 (5.61)	4.00 (1.04)	3.04 (1.03)	75.09 (8.98)	4.08 (1.11)	2.81 (0.99)	69.93 (18.10)

the level of awareness of CMU-Q's recycling policies and whether they felt others on campus could use more information about how recycling works. The entire survey is available in Appendix 1.

□ntervention Location

CMU-Q's cafeteria was chosen as the target intervention location because it is a central campus location that must be passed to access classrooms and where the most waste is generated on campus. □t is also the most common place for students to interact, work, or take breaks. Staff and faculty are also found here during their lunch breaks.

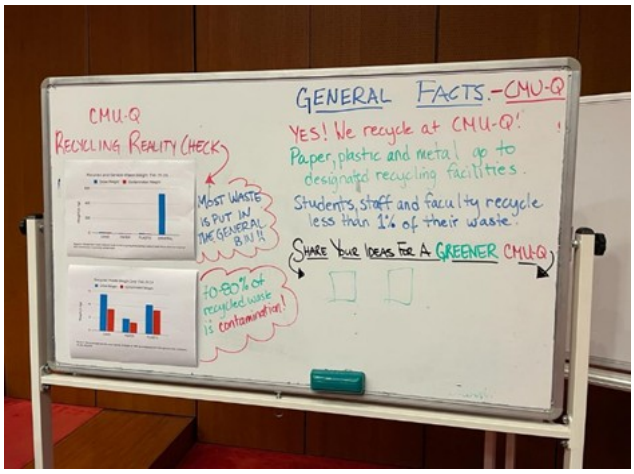
□ntervention Campaign

Three whiteboard posters were put next to the three sets of recycling and general bins in the CMU-Q cafeteria (Figure 2). These posters were designed using responses from the pre- intervention survey (week 1), tackling community misconceptions about the recycling capacity of CMU-Q. Additionally, they contained statistics about waste generation at the cafeteria during a typical week using waste measurement data. Whiteboards were used in the study to encourage community interaction as students could write comments. For three days of the □ntervention Week, student volunteers (N= 4 each day and consisted of different students each day) interacted with students and staff/faculty present in the cafeteria during the lunch break at CMU-Q. Student volunteers were from the Biological Sciences program at CMU-Q and received credit toward community service hours (8 hours required by their program). Prior to the intervention, volunteers were trained to use the whiteboard posters to interpret waste disposal statistics, relay information about current community practices, and answer questions relating to CMU-Q's recycling practices. Some volunteers stood near the waste bins, guiding people to sort and dispose of their waste in the correct bin, while others circulated through the cafeteria and explained to people about recycling practices on campus using the whiteboards.

Analysis

Data were analyzed using □BM SPSS Statistics (Version 26). Descriptive statistics are given for waste measurements and survey results. □ndependent t-tests and one-way Analysis of Variance (ANOVA) were used to investigate and compare waste baseline and intervention measurements.

F□GURE 2. □nteractive whiteboard used by student volunteers to explain recycling statistics in CMU-Q and to engage with the CMU-Q community about recycling practices and policies.



Results

Waste Audit: Baseline, □ntervention, Pre- and Post-□ntervention Weeks

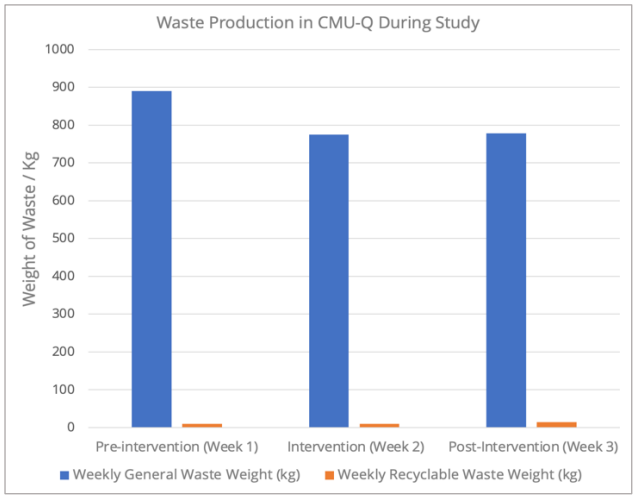
The baseline waste measurements show the production of 2070.74 kg of general waste and 34 kg of recyclable waste (after controlling for contamination) over the three-week baseline period prior to the study, resulting in an average

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

of 690.25 kg (SD=151.96) per week of general waste and 11.33 kg (SD=6.72) of recycled materials per week. The pre-intervention week's waste measurements did not significantly differ from the baseline as indicated by independent t-tests run over the measuring points for the base-line and pre-intervention weeks (*total general waste*: t(15) = 1.59, p = 0.13; *total recycled waste*: t(15) = 0.51, p = 0.62). Altogether, 889.97 kg of general waste and 10.06 kg of recyclable waste was measured in the pre-intervention week. As baseline and pre-intervention weeks had similar average waste production, it suggests the waste produced during pre-intervention week reflects a typical week.

Table 1 shows the average amount of correctly recycled materials recorded over the three-week study period. Average contamination in all the recycling bins was high ranging from 43.2% to 84.5%. One-way ANOVAs on all waste measurements (recycling weight and contamination) conducted over the pre-intervention week, intervention week, and post-intervention week revealed no effect of the intervention on recycling behaviors and waste generation (*F*s(2, 9) = [F values range from] 0.08-1.67, all ns). Additionally, Figure 3 shows relative weights of general vs recyclable waste produced during the study and reveals poor recycling habits as depicted by low weight of recyclable material compared to large amounts of general waste.

FIGURE 3. Weekly general and recyclable waste production in CMU-Q during study duration. *Figure shows relative production of general vs recyclable waste during the study period. Contamination has been controlled in recyclable waste weight.*



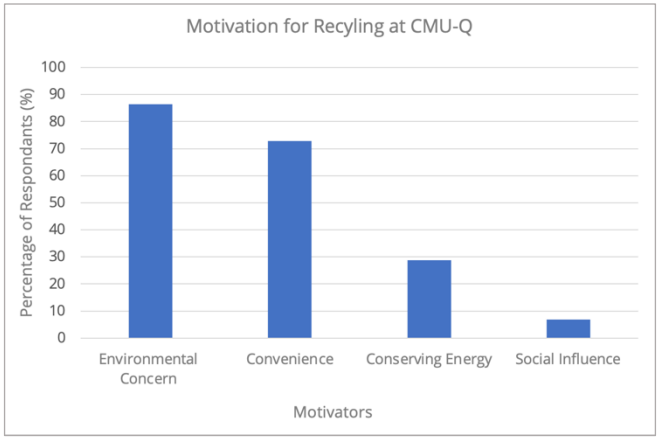
Survey Results

Participant answers in the pre- and post-tests to the questions "*Do you recycle at CMU-Q?*" and "*How often do you recycle at CMU-Q?*" were compared using independent t-tests to determine if reported recycling behavior improved over the course of the study. There were no significant differences in the response attitudes to the survey administered in the pre-intervention and post-intervention weeks, therefore the results of the pre- and post- survey were merged together to gain an overall understanding of campus attitudes toward recycling. Altogether, 77 members of the CMU-Q community participated (students: n = 38; staff: n = 25; faculty: n = 14; 60% female). As there were 432 students, 100 staff, and 60 faculty at CMU-Q in 2022, the response rate reflects 9.5% of the student population and 35% of the staff/faculty population. The survey results were analyzed to understand the beliefs, challenges, and barriers to recycling faced by the CMU-Q community.

Recycling Motivation on CMU-Q's Campus

Overall, 59 participants indicated they recycle at CMU-Q and 15 indicated they did not recycle. From the participants who recycled, 71.2% of respondents recycled on campus on at least a weekly (32.2%) if not a daily basis (39%). Therefore, it can be assumed that most survey participants opted for survey participation due to pro-environmental intentions. This is evident in Figure 4 where the highest percentage of respondents (86.4%) chose environmental concern as their reason for recycling. Only 6.8% of respondents indicated they recycle because they see others doing so, suggesting social influence is not a strong recycling motivator at CMU-Q.

FIGURE 4. Recycling waste motivators at CMU-Q depicted from survey responses. *The figure shows different motivations for those that recycle at CMU-Q determined from the 59 respondents who stated they recycle.*



Of the 15 respondents who stated they did not recycle, 9 indicated that they did not believe the waste was recycled; 7 claimed to not understand recycling; 6 indicated it was inconvenient and time-consuming (note: respondents could choose multiple options). These results suggest that lack of awareness and understanding of recycling policies demotivate people from recycling.

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

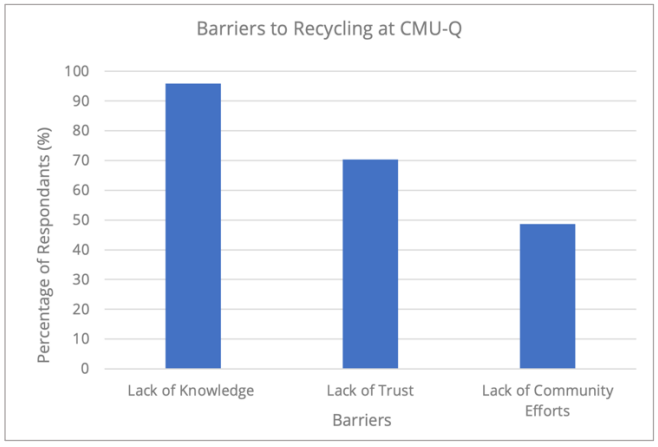
Barriers to Recycling Practices at CMU-Q

Survey responses also offered insight into perceived barriers towards recycling at CMU-Q as illustrated in Figure 5. Both lack of knowledge and lack of trust in CMU-Q's policies emerged as the greatest barriers preventing adoption of recycling practices by CMU-Q's community. Nearly all survey respondents (95.9%) indicated a desire for increased awareness about the university's recycling policies and only one third (29.7%) of survey respondents were confident that waste in recyclable material bins was recycled. Additionally, only half (51.4%) of the participants felt encouraged by CMU-Q's community efforts to recycle. Similarly, an even lower proportion of participants (25.7%) felt motivated by Qatar Foundation's sustainability efforts, like 'car-free day' in Education City, to recycle. In summary, lack of knowledge, trust and impactful community efforts are all barriers to recycling at CMU-Q.

Effect of Convenience on Recycling Practices

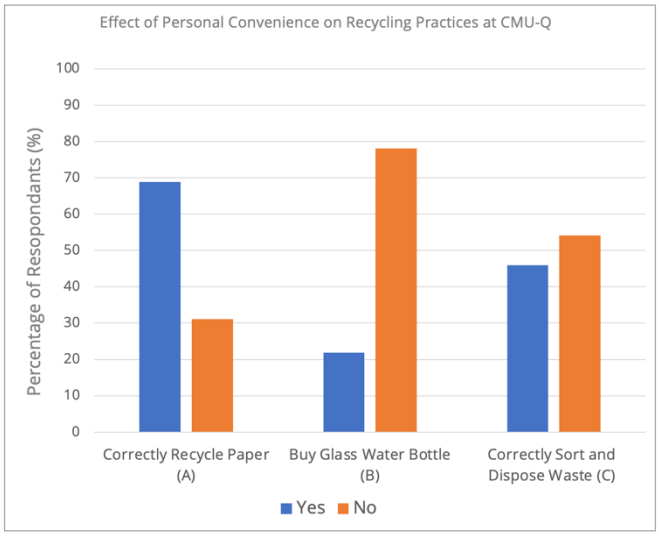
Participants were further asked questions to understand the role personal convenience and cost might play in their recycling behavior. First, they were asked about their willingness to take a few extra steps to recycle paper rather than use the general waste bin. One third, (31.1%) of respondents indicated they would choose the closer, general waste bin rather than take additional steps. Second, when asked if they would buy water in a "bit more" expensive glass bottle over a cheaper plastic bottle, 78.1%

FIGURE 5. Perceived barriers to recycling waste at CMU-Q depicted from survey responses. *The figure above shows barriers that prevent adoption of recycling practices determined from the 73 survey respondents. Participants could choose multiple motivations for recycling.*



of respondents replied that they would buy the plastic bottle. Finally, when asked if participants would take the time to separate and correctly dispose of waste containing different materials (paper, plastic, and metal) into their respective bins, 54.1% of participants declared they would not separate the waste. These findings are interesting because of many of these respondents indicated they recycle at CMU-Q, yet perhaps only under certain circumstances. Thus, this finding may highlight personal convenience and cost may strongly influence recycling practices of CMU-Q's community (Figure 6).

FIGURE 6. Effect of personal convenience on recycling practices at CMU-Q determined from survey responses. *The figure above shows the percentage of respondents (n = 73) who would A) take extra steps to reach a paper recycling bin; B) spend more money to buy a glass water bottle instead of plastic; C) would correctly sort waste containing three different materials and dispose of each part in its correct bin.*



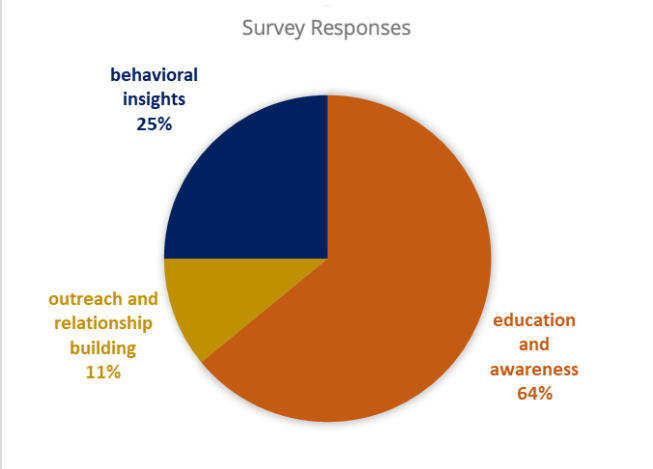
Suggestions for Improving Recycling Practices at CMU-Q

At the end of our survey, participants were asked to give their suggestions for improving recycling behavior at CMU-Q (see all comments in Appendix 2). These responses were independently coded by two volunteers. Their coding was in agreement with ~90% of all cases, misalignments were discussed with the research team and re-coded according to the consensus. Though the comments are only suggestions from the community, they were found to align with 3 of the best practices mentioned in Grilli & Curtis (2021): (Category 1) Education and awareness: any comments suggesting awareness of existing resources, recycling policies, campaigns, events, communities at the university, education on recycling and its importance, accessibility and visibility of recycling resources; (Category 2) Outreach and relationship building: comments recommending sustainability initiatives, events or tasks organized by the university to improve recycling; (Category 4) Nudges and behavioral insights: comments advocating for novel initiatives that change the default system and require a "nudge" to revert back to the original, such as changes to the design and number of bins.

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

Out of 52 responses, the majority (64%, n=41) suggested the need for more education and awareness. This was followed by recommendations for nudges and behavioral insights (25%, n=16). Finally, a few comments addressed outreach and relationship building (11%, n=7) (Figure 7. Appendix 2). These results can be used to drive future interventions and strongly suggest the community is aware of their need for additional education and awareness to successfully change recycling behavior.

FIGURE 7. Percentage of survey comments corresponding to Grilli & Curtis (2021) categories. *Figure shows the percentage of survey responses regarding suggestions to recycling practices at CMU-Q, mapped to categories mentioned by Grilli & Curtis (2021).*



Discussion

Higher Education Institutions (HEIs) can play a central role in training responsible future leaders for sustainable development, not only through education but by setting high moral standards and establishing best practices (e.g., Armijo de Vega et al., 2008; Bailey et al., 2015; Cortese, 1992; Geng et al., 2013; Moqbel et al., 2020). Thereby, universities and their communities can take the lead in local community action (Noeke, 2000; Tangwanichagapong et al., 2017; Velazquez et al., 2005).

Changing human behavior is challenging and different strategies for promoting pro-environmental behaviors, such as recycling, have been found to be effective (Grilli & Curtis, 2021). These strategies include education and awareness, outreach and relationship building, social influence, nudging and behavioral insights, and incentives. Interventions to improve recycling on university campuses have focused primarily on education and awareness (Dupré & Meineri, 2016; Manfredi et al., 2021; Mozo-Reyes et al., 2016), utilizing social influence through comparative feedback or providing feedback about campus recycling behavior (Dupré & Meineri, 2016; Kim et al., 2005), and through nudging and behavioral insights (Fritz et al., 2017; Katzev & Mishima, 1992; Largo-Wight et al., 2013; Ludwig et al., 1998; Miller et al., 2016; O'Connor et al., 2010). The research conducted to date suggests that all of these interventions can be effective at improving recycling behavior but the overall impact varies across settings and is not necessarily sufficient to promote good behavior once the intervention is removed.

In line with previous research, this study aimed to audit recycling waste and contamination rates in recycling bins, assess the self-reported behaviors, attitudes, and knowledge gaps toward recycling behavior of a university community in Qatar via a survey, and conduct an intervention to improve recycling behavior. The baseline audit of CMU-Q's recycling waste revealed very poor recycling behavior. Almost none of CMU-Q's waste reached the recycling bins. The majority of the waste was placed in the general waste bins and the waste in recycling bins revealed high degrees of contamination (i.e., sorting errors), suggesting that the recycling bins are either used as general waste bins or people do not know how to sort their waste.

In response to survey questions, CMU-Q community members who participated in the survey indicated deficits in awareness, as well as distrust towards campus recycling practices. Those respondents who recycled were motivated primarily by environmental reasons. Virtually all respondents felt inadequately informed about the university's recycling program, and subsequently, numerous requests for increased education and awareness were made.

Based on the survey results and leaning on previous research (Dupré & Meineri, 2016), an intervention that combined education and awareness and social influence was designed. Over a one-week period, information about CMU-Q's recycling policies and graphical feedback about campus recycling behavior was displayed next to recycling bins on whiteboards in the cafeteria. During this setup, student volunteers engaged with community members on three days during the peak lunch hour to personally relay this information and encourage recycling. The waste in the general waste bin and in recycling bins was measured during the intervention and for one week after the intervention and then compared to the baseline week. Despite these efforts, the waste audits and post-survey revealed no improvement in recycling behavior or changes in attitudes.

Though our intervention was not successful, there are several takeaways and opportunities for future action from this research. One reason why education and awareness may not have been effective might be related to findings that suggest this method works best when the population is already motivated and willing to engage in pro-environmental behaviors (Grilli and Curtis, 2021). Our low survey response rate suggested that this topic was not of

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

interest to most community members. Further, our survey results provide evidence for skeptical attitudes about recycling, even amongst the highly motivated survey respondents. These individuals indicated distrust in recycling processes and expressed their lack of awareness about recycling. Though we did not directly test for this, these findings suggest that these attitudes might lead to a lack of motivation and decreased pro-environmental behavior. Further, our feedback was limited to recycling behavior on campus. Though this was effective in some studies (i.e. Kim et al., 2005), Dupre and Meineri (2016) reported improved recycling behavior only when social comparative feedback was given. Therefore, future research could involve collaboration with another campus to provide social comparative feedback.

Second, although we used student volunteers, or "block leaders" (Abrahamse & Steg, 2013) to act as our social influencers, we did not see an improvement in recycling, even during the intervention week. Our volunteers were primarily from the Biological Sciences program (one of four majors at CMU-Q) and perhaps they did not have enough influence over students from other disciplines or who may not have known these students personally. Future research might consider asking peer volunteers from a variety of disciplines or choosing students who are known leaders in the community, as they may have more potential influential power.

Although our survey did not test any theory directly as it was only designed to get insight into the community thinking around recycling, in post hoc discussion (and as noted by one kind reviewer) there is some suggestive evidence that future research might explore the Theory of Planned Behavior (TPB) (Ajzen, 1991) with regards to recycling behavior, and that this could be informative for creating impactful behavioral change (e.g., Arli et al., 2019; Largo-Wight et al., 2012; Strydom, 2018; Valle et al., 2005). The TPB posits that behavioral intentions (i.e., intention to recycle) can predict behavior when measured through three constructs. The first construct is perceived behavioral control. □n the context of recycling, this construct represents beliefs that the conditions to recycle allow the behavior to occur. This might be the convenient access to recycling bins or clear labeling of bins, for example, which we did not measure but was suggested by several survey participants. This was also suggested by Kim et al. (2015) as the provision of separated recycling bins acting as a "pre-condition" to encouraging recycling behavior. The second construct, attitude toward behavior, reflects beliefs that the behavior will result in the desired outcome. □n the case of CMU-Q recycling, many community members do not trust that recycling occurs and lack knowledge about how to recycle. The TPB would predict that these beliefs will deter recycling behavior. The third construct, subjective norms, refers to beliefs that key figures in one's life will approve of the behavior (i.e., recycling).

□n an expanded model of TPB, Largo-Wight et al. (2012) included two additional constructs to understand recycling intentions in a university population: perceived moral obligations, defined as perceived responsibility to others and the environment; and descriptive norms, or perceptions and beliefs about what other people are doing or what is socially expected. They found that moral obligations were the single strongest predictor of recycling intentions. This construct may be reflected in our survey participants who indicated that they recycle for environmental reasons, over and above social reasons and other factors. Examining behavior through the lens of TPB allows for more specific suggestions for targeting behavior. For example, Largo-Wight et al. (2012) suggested building specifically on moral obligations as a primary intervention target. Although we did not measure constructs according to the TPB, it would be interesting to do so in the future.

This present study has several limitations. The most significant limitation concerns the short time of the intervention (one week), as opposed to other studies, for example, 12 days (Kim et al., 2015) or 3 weeks (Dupré & Meineri, 2016). Other design limitations include the use of whiteboards during the informational phase, which may be a saturated medium and hence potentially overlooked in an HE□ setting. Additionally, our results are likely not generalizable to the country's population, since the population of CMU-Q comprises community members from various nationalities, including a large percentage of international students. This is extremely important to consider as the small sample size of survey responses (N= 77) amplifies this limitation. Further, as most survey responses were received from individuals with environmental concerns (i.e. pro-environmental intentions), the already small sample size also harbors a selection bias and likely is not representative of CMU-Q's community. Future studies may consider targeting social influence by using the most prominent community members, and through comparative social feedback. Additionally, the use of a control group would also be beneficial to control extraneous factors, such as news stories. Both comparative social feedback and a control group could be established in the case of Qatar's Education City working together with other university campuses affiliated with Qatar Foundation.

Conclusion

□n summary, this study found poor recycling behavior and attitudes toward recycling on a university campus in Qatar. A campus-wide survey revealed themes of distrust and lack

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

of knowledge about recycling processes. A one-week intervention combining education and awareness through social influence was neither successful in improving recycling behavior nor attitudes. Since recycling responses and behaviors may depend on interest and pro-environmental motivation (Grilli & Curtis, 2021), it might be beneficial to incorporate environmental concerns into formal and informal discussions and education sessions (Manfredi et al., 2021). Furthermore, strengthening trust in the recycling activities of the university may improve community attitude (TPB, Ajzen, 1991) toward behavior. One of the ways this could be done is by increasing transparency on ongoing waste audits and sustainability programs designed by the CMU-Q Eco-campus. Future work might consider including lengthier interventions and additional education and social influence measures, such as comparative social feedback.

Acknowledgements

We would like to acknowledge CMUQ's Facilities Team in supporting this research by measuring and sorting recycled university waste. We would also like to extend a warm thank you to the support of the members of the Eco-Campus and to the student volunteers. We would like to especially recognize Thamanna Muhammed Hashir for her contributions to the execution of the project, to Rosemarie Florida for her administrative support and to Mr. Charles and his team for conducting the waste measurements.

Funding

This publication was made possible by the generous support of the Qatar Foundation through Carnegie Mellon University in Qatar's Seed Research Funding program. The statements made herein are solely the responsibility of the author(s).

References

Abrahamse, W., & Steg, L. (2013). Social influence approaches to encourage resource conservation: A meta-analysis. *Global Environmental Change*, *23*(6), 1773–1785. https://doi.org/10.1016/j.gloenvcha.2013.07.029

Ajzen, (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/07495978(91)90020-T

Arli, D., Badejo, F. A., Carlini, J., France, C., Jebarajakirthy, C., Knox, K., Pentecost, R., Perkins, H., Thaichon, P., Sarker, T., & Wright, O. (2019). Predicting intention to recycle on the basis of the theory of planned behaviour. *International Journal of Nonprofit and Voluntary Sector Marketing*, *25*. https://doi.org/10.1002/nvsm.1653

Armijo de Vega, C., Ojeda Benítez, S., & Ramírez Barreto, Ma. E. (2008). Solid waste characterization and recycling potential for a university campus. *Waste Management*, *28*, S21–S26. https://doi.org/10.1016/j.wasman.2008. 03.022

Bailey, J., Pena, M., & Tudor, T. (2015). Strategies for improving recycling at a higher education institution: A case study of the University of the West ndies, Cave Hill Campus, Barbados. *The Open Waste Management Journal*, *8*, 1–11. https://doi.org/10.2174/1876400201508010001

Bartelings, H., & Sterner, T. (1999). Household Waste Management in a Swedish Municipality: Determinants of Waste Disposal, Recycling and Composting. *Environmental and Resource Economics*, *13*(4), 473–491. https://doi.org/10.1023/A:1008214417099

Becker, J., Czamara, D., Scerri, T. S., Ramus, F., Csépe, V., Talcott, J. B., Stein, J., Morris, A., Ludwig, K. U., Hoffmann, P., Honbolygó, F., Tóth, D., Fauchereau, F., Bogliotti, C., annuzzi, S., Chaix, Y., Valdois, S., Billard, C., George, F., … Schumacher, J. (2014). Genetic analysis of dyslexia candidate genes in the European cross-linguistic NeuroDys cohort. *European Journal of Human Genetics*, *22*(5), 675–680. https://doi.org/10.1038/ejhg.2013.199

Cheung, T. Y., Fok, L., Cheang, C.-C., Yeung, C. H., So, W.-M. W., & Chow, C.-F. (2018). University halls plastics recy-cling: A blended intervention study. *International Journal of Sustainability in Higher Education*, *19*(6), 1038-1052. https://doi.org/10.1108/ SHE-10-2017-0175

Cialdini, R. B. (2003). Crafting normative messages to protect the environment. *Current Directions in Psychological Science*, *12*(4), 105–109. https://doi.org/10.1111/1467-8721.01242

Cialdini, R., Reno, R., & Kallgren, C. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, *58*, 1015–1026. https://doi. org/10.1037/0022-3514.58.6.1015

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service

Corsten, M., Worrell, E., Rouw, M., & van Duin, A. (2013). The potential contribution of sustainable waste management to energy use and greenhouse gas emission reduction in the Netherlands. *Resources, Conservation and Recycling*, *77*, 13–21. https://doi.org/ 10.1016/j.resconrec.2013.04.002

Cortese, A. D. (1992). Education for an environmentally sustainable future. *Environmental Science & Technology*, *26*(6), 1108–1114. https://doi.org/10.1021/es50002a012

Davison, N., Young, W., Ross, A., Cockerill, T., & Rajput, S. (2022). ⊠nvestigating the impacts of behavioural-change interventions and COV⊠D-19 on the food-waste-generation behaviours of catered students in the UK and ⊠ndia. *Sustainability*, *14*(9), Article 9. https://doi.org/10.3390/su14095486

Dupré, M., & Meineri, S. (2016). ⊠ncreasing recycling through displaying feedback and social comparative feedback. *Journal of Environmental Psychology*, *48*, 101–107.https://doi.org/10.1016/j.jenvp.2016.07.004

Fritz, J. N., Dupuis, D. L., Wu, W.-L., Neal, A. E., Rettig, L. A., & Lastrapes, R. E. (2017). Evaluating increased effort for item disposal to improve recycling at a university: Effects of bin location on recycling. *Journal of Applied Behavior Analysis*, *50*(4), 825–829. https://doi.org/ 10.1002/jaba.405

Geng, Y., Liu, K., Xue, B., & Fujita, T. (2013). Creating a "green university" in China: A case of Shenyang University. *Journal of Cleaner Production*, *61*, 13–19. https://doi. org/10.1016/j.jclepro.2012.07.013

Grilli, G., & Curtis, J. (2021). Encouraging pro-environmental behaviours: A review of methods and approaches. *Renewable and Sustainable Energy Reviews*, *135*, 110039. https://doi.org/10.1016/j.rser.2020.110039

Hoornweg, D., & Bhada-Tata, P. (2012). What a Waste: A Global Review of Solid Waste Management. http://hdl.handle.net/10986/17388

Kaiser, F. G., Schultz, P. W., & Scheuthle, H. (2007). The theory of planned behavior without compatibility? Beyond method bias and past trivial associations. *Journal of Applied Social Psychology*, *37*(7), 1522–1544. https://doi.org/10.1111/j.1559-1816.2007.00225.x

Katzev, R., & Mishima, H. R. (1992). The use of posted feedback to promote recycling. *Psychological Reports*, *71*(1), 259–264. https://doi.org/10.2466/pr0.1992. 71.1.259

Kaza, S., Yao, L., Bhada-Tata, P., & Woerden, F. V. (2018). *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. World Bank Publications.

Kim, S., Lee, S. H., & Cho, Y. S. (2015). Control processes through the suppression of the automatic response activation triggered by task-irrelevant information in the Simon-type tasks. *Acta Psychologica*, *162*, 51–61. https://doi.org/10.1016/j.actpsy.2015.10.001

Kim, S., Oah, S., & Dickinson, A. M. (2005). The impact of public feedback on three recycling-related behaviors in South Korea. *Environment and Behavior*, *37*(2), 258–274. https://doi.org/10.1177/0013916504267639

Lakshmi, G., Nguyen, K., Mazhikeyev, A., Hack-Polay, D., & Anafiyayeva, Z. (2022). Nudging student recycling behaviour: An experimental study in Kazakhstan and UK higher education. *Journal of Cleaner Production*, *377*, 134164. https://doi.org/10.1016/j.jclepro.2022. 134164

Largo-Wight, E., Bian, H., & Lange, L. (2012). An empirical test of an expanded version of the theory of planned behavior in predicting recycling behavior on campus. *American Journal of Health Education*, *43*, 66–73. https://doi.org/10.1080/19325037.2012.10599221

Largo-Wight, E., Johnston, D., & Wight, J. (2013). The efficacy of a theory-based, participatory recycling intervention on a College Campus. *Journal of Environmental Health*, *76*, 26–31.

Leicht, A, Heiss, J & Byun, W. (2018). ⊠ssues and trends in education for sustainable development. Paris: UNESCO. viewed 02 Aug 2023, http://unesdoc. unesco.org/images/0026/002614/261445e.pdf.

Ludwig, T. D., Gray, T. W., & Rowell, A. (1998). ⊠ncreasing recycling in academic buildings: A systematic replication. *Journal of Applied Behavior Analysis*, *31*(4), 683–686. https://doi.org/10.1901/jaba.1998.31-683

Manfredi, L. R., Stokoe, M., Kelly, R., & Lee, S. (2021). Teaching sustainable responsibility through

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

informal undergraduate design education. *Sustainability*, *13*, 8378. https://doi.org/10.3390/su13158378

Miller, N. D., Meindl, J. N., & Caradine, M. (2016). The effects of bin proximity and visual prompts on recycling in a university building. *Behavior and Social □ssues*, *25*(1), 4–10. https://doi.org/10.5210/bsi.v25i0.6141

Moqbel, S., Abu-Zurayk, R., Bozeya, A., Alsisan, R., & Al Bawab, A. (2020). Assessment of sustainable recycling at The University of Jordan. □*nternational Journal of Sustainability in Higher Education*, *ahead-of-print*. https://doi.org/ 10.1108/□JSHE-11-2019-0334

Mozo-Reyes, E., Jambeck, J. R., Reeves, P., & Johnsen, K. (2016). Will they recycle? Design and implementation of eco-feedback technology to promote on-the-go recycling in a university environment. *Resources, Conservation and Recycling*, *114*, 72–79. https://doi.org/10.1016/j.resconrec.2016.06.024

Nigbur, D., Uzzell, D., & Lyons, E. (2006, September 15). □*ncreasing Recycling Through Community Action*. https://www.semanticscholar.org/paper/□ncreasing-Recycling-Through-Community-Action-Nigbur-Uzzell/2b4e886d5e5b775d18978a4c9ee2019950855ec6

Noeke, J. (2000). Environmental management systems for universities: A case study. □*nternational Journal of Sustainability in Higher Education*, *1*(3), 237–251. https://doi.org/10.1108/14676370010378167

O'Connor, R. T., Lerman, D. C., Fritz, J. N., & Hodde, H. B. (2010). Effects of number and location of bins on plastic recycling at a university. *Journal of Applied Behavior Analysis*, *43*(4), 711–715. https://doi.org/ 10.1901/jaba.2010.43-711

Passafaro, P., & Livi, S. (2017). Comparing determinants of perceived and actual recycling skills: The role of motivational, behavioral and dispositional factors. *The Journal of Environmental Education*, *48*(5), 347–356. https://doi.org/10.1080/00958964.2017.1320961

Qatar Second National Development Strategy. (2018-2022). *About National Development Strategy*. Retrieved from Planning and Statistics Authority: www.psa.gov.qa/en/knowledge/Documents/NDS2Final.pdf

Sallaku, R., Bonfanti, A., Vigolo, V., & Baratta, R. (2020). Recycling behaviour in higher education institutions: A systematic literature review. *Sinergie □talian Journal of Management*, 127–148. https://doi.org/10.7433/s110.2019.06

Schultz, P. W. (1999). Changing behavior with normative feedback interventions: A Field Experiment on Curbside Recycling. *Basic and Applied Social Psychology*, *21*(1), 25–36. https://doi.org/10.1207/s15324834basp2101_3

Strydom, W. F. (2018). Applying the theory of planned behavior to recycling behavior in South Africa. *Recycling*, *3*(3), Article 3. https://doi.org/10.3390/recycling3030043

Tangwanichagapong, S., Nitivattananon, V., Mohanty, B., & Visvanathan, C. (2017). Greening of a campus through waste management initiatives: Experience from a higher education institution in Thailand. □*nternational Journal of Sustainability in Higher Education*, *18*(2), 203–217. https://doi.org/10.1108/□JSHE-10-2015-0175

Taube, O., Kibbe, A., Vetter, M., Adler, M., & Kaiser, F. G. (2018). Applying the Campbell Paradigm to sustainable travel behavior: Compensatory effects of environmental attitude and the transportation environment. *Transportation Research Part F: Traffic Psychology and Behaviour*, *56*, 392–407. https://doi.org/10.1016/j.trf.2018.05.006

Valle, P. O. D., Rebelo, E., Reis, E., & Menezes, J. (2005). Combining behavioral theories to predict recycling involvement. *Environment and Behavior*, *37*(3), 364–396. https://doi.org/10.1177/0013916504272563

Velazquez, L., Munguia, N., & Sanchez, M. (2005). Deterring sustainability in higher education institutions: An appraisal of the factors which influence sustainability in higher education institutions. □*nternational Journal of Sustainability in Higher Education*, *6*(4), 383–391. https://doi.org/10.1108/14676370510623865

Waste recycling in Europe. (2022, November 11). https://www.eea.europa.eu/ims/waste-recycling-in-europe

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

Appendix 1: Recycling at CMU-Q Survey

Demographics

Are you a...?
- Student
- Faculty
- Staff

What is your gender?
- Male
- Female
- Prefer not to say

Recycling Attitudes

Do you recycle at CMU-Q?
- Yes
- No

How often do you recycle at CMU-Q?
- Daily
- Weekly
- Monthly
- Once in a while
- Not sure

Which items do you recycle at CMU-Q?
(check all that apply)
- Plastic
- Paper
- Cardboard
- Glass
- Metal
- Clothing
- Electronic waste
- Other (please list below):

Why do you choose to recycle at CMU-Q? (check all that apply)
- For environmental reasons (i.e pollution, climate change, and global warming)
- t saves money and energy by improving the reuse of products
- t is convenient, as there are bins provided for recycling
- see others doing it, so do it as well
- Other (please list below):

Why do you choose not to recycle at CMU-Q?
(check all that apply)
- am not interested
- There is no urgent need to do so
- do not understand how to recycle
- t is too inconvenient/time-consuming
- do not think the waste is actually being recycled
- do not think that recycling makes a difference on the environment
- No one around me is keen on recycling, so neither am
- Other (please specify):

Do you believe that you can make a difference to the recycling at CMU-Q?
- Yes
- No

Demographics

How confident are you about your awareness of the recycling policies at CMU-Q?
- Very confident
- Somewhat confident
- Not confident

Do you think you (and others around you) need more understanding of how recycling works at CMU-Q?
- Yes
- No

Please answer how likely you are to do the following at CMU-Q:		
	Likely	Unlikely
Separate your waste based on the bins found at the University	○	○
Reuse items instead of disposing of them (for example, sharing clothes, using metal straws, reusing containers)	○	○
Reduce waste (for example, using 2-sided printing, not using plastic straws, not ordering cutlery with food, etc.)	○	○

Which bin would you throw the following waste items in at CMU-Q?					
	Plastic	Paper	Metal	Glass	General
Pizza Box	○	○	○	○	○
Plastic boxes with food	○	○	○	○	○

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

Soda can	○	○	○	○	○
Plastic bags	○	○	○	○	○
Tetra pack juice	○	○	○	○	○

Where do you think the recycled waste goes after being disposed of at CMU-Q?
- □t gets sent to respective facilities and manufactured into new products
- Nowhere specific, mixed with the general waste
- □t gets dumped into the landfill
- □don't know
- Other (Please specify below)

Where do you think the unrecycled waste (in the "general" bins) goes after being disposed of at CMU-Q?
(check all that apply)
- The oceans
- A landfill
- □t gets separated at the disposal site
- □t gets burned
- □don't know
- Other (Please specify below)

□nitiatives at Carnegie Mellon University in Qatar have encouraged me to recycle.
- True
- False

The new sustainability changes at Qatar Foundation (car-free day, use of trams, e-scooter, etc.) encouraged me to start recycling.
- True
- False

Scenario Questions

□n the exercises below, we ask you to imagine 4 brief scenarios and answer a question regarding each scenario. Please be fully honest with your responses, as this is important for us to understand attitudes and awareness toward recycling:

a) □magine you have a pile of papers to throw away and you are in a hurry. There are two bins to choose from — the general waste bin, which is closest to you, and the recycling bin, which is further away. What would you most likely do?
- □would throw the paper in the closer general waste bin
- □would throw the paper in the recycling bin, even if it is further away

b) □magine you go to a cafeteria to buy water. They have two options: plastic or glass bottles. The glass bottle is a bit more expensive. What would you do?
- □would buy the plastic bottle
- □would buy the glass bottle

c) □magine you just left your home to go shopping and you forgot your reusable tote bags. □t will take you about 5 minutes to go back home and get them. What would you do?
- □would just use the plastic bags at the grocery store
- □would go back to pick up the tote bag

d) □magine you want to dispose of the waste from your take-out food. However, the waste is a combination of paper, plastic, and metal. What would you do?
- Put it all in the most convenient bin
- Separate the items and put them in their respective recycling bins

Recycling at CMU-Q

How do you suggest recycling can be improved on campus?

Appendix 2

Participants were asked what could be done on campus to improve recycling behavior. The responses are listed below and have been organized according to three categories for improving pro-environmental behavior provided by Grilli & Curtis (2021). The categories have been color coded and matched to the responses. Note, there were no comments that reflected the third category "social influence" or the fifth category "incentives".

Category mapping:

1. Education and awareness: Keywords/Concepts: *awareness, accessibility, education, feedback*
2. Outreach and relationship building: Keywords/Concepts: *groups/events and sustainability initiatives*
3. Nudges and behavioral insights: Keywords/Concepts: *initiatives that change the default and need a "nudge" to revert, bin number/design*

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

APPEND□X TABLE 1. Participant Responses to the survey question: "How do you suggest recycling can be improved on campus?"

Participant Response to the Survey Question: *"How do you suggest recycling can be improved on campus?"*	**Answers aligned to Grilli & Curtis (2021) categories**
Larger opening bins and larger bins for recycling. Awareness of where the recycled material goes. Also there is no recycling bin for Glass. Only Paper plastic and metal. Please introduce a bin for glass. Set up stations which collect e-waste. Collaborate with corporates that recycle electronic waste. Raise more awareness on campus. Monitor and encourage the community to take 2-sided prints.	education and awareness, outreach and relationship building, nudges and behavioral insights
Have been and larger bin. Educated the CMUQ community on recycling. Stop selling bottles and encourage people to bring their bottles to refill.	education and awareness, outreach and relationship building, nudges and behavioral insights
Assurances/explanations of where the recycling goes, since there is so little confidence that it is anything other than window-dressing. □find things like car-free day to actually diminish my confidence, since it certainly isn't car-free and shows little consideration for other factors (such as it disproportionately affects parents who can't add extra time to drop off routines).	education and awareness, outreach and relationship building
There needs to be more awareness and events should be more sustainable. Bring your own mug/water bottle/etc. □t's hard because now we have to do boxed lunches which causes more trash/recycling, so we have to be diligent about making sure the waste goes to the right place.	education and awareness, outreach and relationship building
Larger bins, labeled with examples of items to avoid confusion; larger and more waste bins for general trash; post info about "last semester EC recycled ____ kg of plastic" as motivation; share info about how to organize recycling bins in your own neighborhood for staff/students who live elsewhere so they can encourage expansion of this behavior; use infographics to demonstrate how much refuse we generate each year here; compare it in terms of how much is saved (we saved 100 trees; by recycling 100 aluminum cans you saved enough to feed 7 people for one day, etc.)	education and awareness, nudges and behavioral insights
Having more recycling bins and prompting students to do so (by putting signs, have professors mention them...etc)	education and awareness, nudges and behavioral insights
The bins are hard to understand. Also, guidance for things like fast food waste would be really helpful.	education and awareness, nudges and behavioral insights
Add more recycling bins around campus, sometimes when □m in a class and the only option is the general bin, □won't walk to the hallway and find a recycling bin □ll just throw my trash in the general bin.	education and awareness, nudges and behavioral insights
More awareness campaigns and also availability of recycle bins in more locations across the building	education and awareness, nudges and behavioral insights
Make videos on how to dispose properly (what items go where), the impact (in numbers/percentages), show that we have recycling facilities in Qatar (which □don't think we have).	education and awareness
Show us the results. Show us numbers and statistics of how the waste is being recycled. □ would put in the effort if □know it has some fruits	education and awareness

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

Participant Response to the Survey Question: *"How do you suggest recycling can be improved on campus?"*	**Answers aligned to Grilli & Curtis (2021) categories**
prove that the recycled bins are actually going to be recycled rather than just being there for decoration	education and awareness
By more transparency/education concerning where recycled waste goes.	education and awareness
would like to know if indeed waste is recycled. Things have changed in the US regarding recycling (municipalities have stopped taking some things in some areas.) f it truly is recycled, m happy to recycle.	education and awareness
Educate People , more recycle and reuse option to user in the building	education and awareness
education and supplies	education and awareness
Make it easier to recycle, and give examples of how long it would take because if people assume that separating food/takeout containers will take 10 minutes then they'd never do it	education and awareness
Engage facilities to help large recycling needs. have an office full of paper need to recycle and have not heard back from facilities for 2 months. also think knowing which recycling is actually recycled, and how. s food-stained cardboard recyclable? Does glass actually get broken down and reused?	education and awareness
More awareness campaigns. More recycling options.	education and awareness
Explain to students and staff how their actions of recycling makes a difference. Possibly explain what happens to the stuff in the recycling bin at CMUQ.	education and awareness
Creating awareness and building confidence on people make the effort that their efforts are being helping with improving the recycling initiative on campus.	education and awareness
More information on what you can and can't put in each bin. Also information on how CMUQ recycles.	education and awareness
There is a common belief that recycling bins end up in the same general trash. Confidence in recycling process can be improved. A short video that describes the journey of recycling bins would be super helpful	education and awareness
t would be helpful to have an understanding where the recycled items end up i.e. separated accordingly and reused. This would improve my recycling habits enormously.	education and awareness
Awareness campaign and clear directives.	education and awareness
Need more awareness, maybe a recycling club, at least a committee, there's SO MUCH to do!	education and awareness
By creating more awareness	education and awareness
Awareness campaign	education and awareness
More awareness	education and awareness
More awareness on policies	education and awareness
Awareness campaigns	education and awareness

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0

Participant Response to the Survey Question: *"How do you suggest recycling can be improved on campus?"*	**Answers aligned to Grilli & Curtis (2021) categories**
raising awareness	education and awareness
More awareness	education and awareness
By raising awareness.	education and awareness
Awareness	education and awareness
Recycling bins to be available at proximity of events. we provide the big black bin where everything is dumped into without sorting.	education and awareness
Make it more accessible and teach people how to recycle	education and awareness
□would love to recycle as □am still fairly new to Qatar (6 months) and it doesn't seem to be commonly practiced. □did not know there were such recycling initiatives at CMUQ so □would like to know more about them and how □can recycle better.	education and awareness
Better visibility/access of recycling bins; clear messaging that items are actually recycled.	education and awareness
From an educational standpoint? □like following Bloom's revised taxonomy as it sees the affective components of learning—from awareness to aligning with the new value. □think we need to align with the value of tilting at windmills until policy shifts catch up.	education and awareness
Most of the students do not know how to use the waste bin. □n waste bins of CMUQ there are separate sections to dispose paper, metal, plastic and general waste . Many students do not know which wastes fall in which category. □t would be better to organize a "recycling session" where students would be taught the proper ways to use a waste	education and awareness
making all the trash cans available the recycling kind, this way people are forced to think into how they throw away their trash	outreach and relationship building, nudges and behavioral insights
more food events, as ordering food always comes with extra plastic packaging and bags	outreach and relationship building
place something in place that is efficient and cost effective for average income family	outreach and relationship building
Put eyeballs on the bins. Seriously, people behave better if they feel they are being watched.	nudges and behavioral insights
Have more recycling bins around campus as there are some general areas that do not have them i.e. at the cafeteria/cafe the recycling bins are further away, also maybe paper recycling bins in classroom or hallways. Also, if in certain areas if bigger recycling bins (bigger bin openings) are provided it would be more convenient to use. For example, quite often □would order food and then struggle to recycle the packaging sometimes as the package is bigger than the bin's opening and needs to be bent or just can't fit forcing me to throw it in the bigger general bin.	nudges and behavioral insights
bigger bin holes, hard to stuff paper and cardboard in the small boxes	nudges and behavioral insights
Provide bigger recycling bins	nudges and behavioral insights
This is sort of a minor inconvenience but some of the openings of the waste bins are quite small: sometimes it's difficult to fit larger items such as the larger takeaway lunch boxes we sometime get from events.	nudges and behavioral insights
Having transparent bins so that people can see what goes inside each bin instead of randomly choosing one.	nudges and behavioral insights
To increase the number of recycling bins	nudges and behavioral insights
One bin for trash and one bin for all recycling that's sorted later	nudges and behavioral insights

DOI: 10.48762/wcf5-5249 | Published by Carnegie Mellon University Library Publishing Service | CC BY 4.0