Applying behavioural insights to encourage waste prevention and recycling at university campuses

Guidebook for practitioners

Content

Executive summary

Background

The Campus Living Labs Project is a partnership project between the Environmental Protection Agency (EPA) and the Irish Universities Association (IUA). As part of this project, The Behaviouralist worked with four partner universities, namely University College Dublin (UCD), Dublin City University (DCU), Maynooth University (MU), and Trinity College Dublin (TCD), and relevant stakeholders to conduct research aimed at encouraging waste prevention and recycling at university campuses.

This report presents findings from three trials that aimed to transmit waste prevention and recycling knowledge and to encourage the purchase and use of reusable cups among university students. In addition, the report discusses the key barriers and enablers of waste prevention and recycling behaviours and provides a step-by-step guide that practitioners can use to design and trial interventions within university campuses.

> ## Trial 1: The Waste Game
> Despite improved waste management infrastructure, waste is still poorly segregated due to a lack of motivation and knowledge among students and staff. Motivated by the need for a more cost-effective and systematic education method to complement current efforts in raising awareness about waste prevention and recycling, an online educational tool called the Waste Game was developed to transmit knowledge. The first trial of the project was conducted to assess its effectiveness.

Intervention design

The Waste Game is designed as a quiz and structured around the waste hierarchy framework, focusing on waste prevention followed by recycling. It includes gamification techniques to support learning and engagement. The game was designed in collaboration with participating universities and tailored to their local context.

Click to learn more about the game design and structure

Trial design and implementation

The effectiveness of the game was evaluated through a randomised controlled trial (RCT). Staff and students were randomly assigned to either a simplified version of the game, an enhanced version with additional gamification elements, or a control group. The game was trialled throughout the autumn trimester of 2022 across four participating universities.

Click to learn more about the about the trial design and implementation

Findings

Our analysis yields several key findings that apply to all participating universities:
- The waste game is effective in improving knowledge and key predictors of waste prevention and recycling behaviours, both in the short and the long term.
- Compared to the full version, the simplified version is more effective and engaging.

- Most students and staff found the game useful and rated the topics addressed in the game highly.
- Most participants are female students in post-graduate studies with strong pro-environmental identities.
- Pringles tubes, disposable coffee cups and packets of crisps are the most challenging waste items to sort. Future educational campaigns should focus on composite packaging and soft plastics.

Together, the findings from the trial suggest that The Waste Game is effective and may be better presented in a simplified version going forward. To improve the game, further research (e.g., A/B testing) should be conducted to identify specific gamification elements that can help drive engagement and enhance the effectiveness of the game. Future dissemination efforts should focus on better targeting those who are underrepresented.

Click to learn more about the findings

Trial 2 and 3: Encouraging the take-up and sustained use of reusable cups

Despite continued efforts by universities, single-use cups remain one of the most prevalent waste items found on campus and one of the most common waste contaminants of recyclables and compostables. A comprehensive reusable cup scheme is thus required to tackle behavioural barriers among students and staff. The second trial of the project was conducted to study the impact of discounts on reusable cup purchase while the third trial was conducted to assess the effectiveness of a reusable cup scheme (called the eCups scheme) in promoting sustained reusable cup use.

Intervention design
Two interventions were developed and trialled at UCD. The first intervention aimed to increase reusable cup uptake by offering discounted prices through an email campaign and providing information on their benefits and campus purchasing locations. The second intervention focused on promoting the habit of using reusable cups through a reusable cup scheme in collaboration with eCups. The scheme utilises a mobile app to track waste reduction and offer rewards based on reusable cup usage.

Click to learn more about the intervention design

Trial design and implementation
The effectiveness of discounts on reusable cup purchase was evaluated via a randomised controlled trial (RCT). Staff and students received randomised email offers with varying discount levels for their first eCup purchase. Discount redemption required presenting a QR code at one of nine participating campus outlets.

To assess the effectiveness of the eCups scheme in promoting reusable cup use, data was collected through the eCups mobile app and a follow-up survey. The survey aimed to understand eCup users' experience, including usage patterns, motivations, challenges, and suggestions for improvement. Non-participants were also surveyed to understand their reasons for not participating. Additionally, a comparative analysis of alternative reusable cup schemes was conducted across four universities.

Click to learn more about the about the trial design and implementation

Findings

Our analysis yields several key learnings:

- Discounts were ineffective in promoting reusable cup take-up, as early adopters of the eCups scheme were primarily motivated by pro-environmental attitudes rather than economic factors.
- The eCups scheme and mobile app did not provide additional motivation for users to use their reusable cups more frequently compared to generic reusable cups.
- The current eCups scheme did not fully address challenges related to inconvenience and forgetfulness, which could potentially be better resolved through a deposit and return scheme.

To reduce single-use cup waste on campus, a multifaceted approach is recommended. Universities should adopt a tailored strategy that leverages different motivators for various user groups. This strategy should include: (1) selling reusable cups to individuals who are likely to use them regularly, (2) implementing a deposit and return scheme with tracking and incentives or penalties through a mobile app, and (3) implementing a campus-wide ban on single-use cups.

Click to learn more about the findings

Identifying waste prevention and recycling barriers and enablers

As part of this project, a behavioural diagnosis was conducted to study the main barriers and enablers influencing waste prevention and recycling behaviours and to scope opportunities to trial interventions at universities. The behavioural diagnosis included an extensive literature review and in-depth interviews with participating universities.

Waste prevention

Five main barriers and five key enablers of waste prevention among university students were identified from literature review and stakeholder interviews. They include:

Barriers	Enablers
• Low environmental concern • Lack of knowledge and awareness • Lack of alternatives to single-use materials • Bad choice architecture • Lack of incentive to prevent waste	• Information and feedback on waste prevention • An environment conducive to waste prevention • Incentivising waste minimisation and disincentivising waste generation • Leveraging social norms to encourage waste reduction • Changing the default options

Click to learn more about waste prevention barriers and enablers

Waste recycling

Five main barriers and six key enablers of waste recycling on campus were also identified. They include:

Barriers	Enablers
• Lack of waste recycling infrastructure • Limited waste sorting knowledge • Lack of trust in the recycling process • Low environmental concerns • Low perceived collective waste recycling effort	• Providing adequate waste recycling infrastructure • Providing information about waste recycling • Incentivising waste recycling • Encouraging students to make personal or public commitments • Making social norms around waste recycling more visible • Supporting waste recycling advocates

Click to learn more about waste recycling barriers and enablers

Intervention design implications

Identifying the main barriers and enablers of the target behaviour(s) is an important step in designing and trialling behavioural interventions. The list of barriers and enablers can be used to inform the intervention design, as researchers start brainstorming solutions to reduce barriers and add additional fuels to achieve the desired outcome(s).

A step-by-step guide to designing and trialling behavioural interventions

As part of this project, behaviour change interventions were designed to encourage waste prevention and recycling behaviours. Behavioural design is an approach that helps us understand the factors driving a particular behaviour and, importantly, can help practitioners identify effective ways of changing behaviours. This guide provides actionable steps for practitioners to develop and trial their behavioural intervention.

Step 1: Defining your ultimate outcome and desired behaviours

The first step for designing behavioural interventions is to define an ultimate outcome and break it down into desired behaviours. This exercise helps set an achievable goal and translate it into behavioural terms.

Step 2: Identifying key behavioural barriers

The following step consists of identifying the barriers that impede your target audience from engaging in the desired behaviours. This step helps reveal the root causes of the problem you aim to address.

Step 3: Ideating solutions and selecting the most appropriate Intervention

The third step involves developing a behaviour change intervention by smoothing out barriers and encouraging your target audience to engage in your desired behaviour(s).

Step 4: Trialling your behavioural intervention

The final step is piloting your behavioural intervention to assess its effectiveness before rolling it out at scale. This involves making sure you have measurable outcome metrics, the ability to link your intervention to the outcome metrics, and a set of appropriate evaluation method.

Click to learn more about designing behavioural interventions

The Waste Game: an interactive online tool designed to encourage waste prevention and recycling on campus

The Waste Game: an interactive online tool designed to educate students

Background

Despite improvements in waste management infrastructure, waste continues to be poorly segregated by students due to a lack of motivation and knowledge.

While numerous efforts are made to raise awareness across universities about waste prevention and recycling, there is a need for a cost-effective and systematic way to transmit knowledge.

Game design and structure

The Waste Game is an online interactive tool that provides waste prevention and sorting tips and helps motivate players to take action. The game aims to complement existing university-led initiatives around waste management, as given its online nature, it can easily be promoted at scale on campus year-on-year.

The game is designed as a quiz and structured around the waste hierarchy framework: the first level of the game focuses on waste prevention, while the second level focuses on waste recycling. Within each level, players have to complete three different challenges. Each challenge includes a set of quiz questions on specific waste-related topics. Quiz questions are generally designed to inform players about the magnitude of a given problem (e.g., the amount of disposable cup waste produced on campus) and to highlight the importance of a related solution (e.g., the impact of using a reusable cup).

At the end of each level, players can choose to commit to a set of actions in real life before moving down the waste hierarchy and unlocking the following level. Players can earn points throughout the game and can compete against each other with a chance to win a reward based on their performance.

The game includes a set of gamification and behavioural techniques to improve engagement, support learning and encourage players to follow through with waste prevention and recycling actions in their day-to-day lives. The content of the game was informed by a literature review, waste characterisation studies conducted by participating universities and the EPA, and resources developed by MyWaste.ie.

The game was designed in collaboration with participating universities (UCD, DCU, MU and TCD) and relevant stakeholders (MyWaste.ie, An Taisce Green Campus and Regional Waste Authorities) and adapted to the specific context of each university. While the game was initially designed for students, it was also adapted to staff members.

Game structure

Introduction
The introduction sets the scene of the game by informing players about the amount of waste produced on campus and invites them on a mission to acquire the right skills and knowledge to reduce it.

Mentor selection
Players can choose a mentor that will help them build their waste prevention and recycling skills. Mentors are real-life figures that have insight into the waste management process (e.g., estate managers, cleaners, waste processing managers).

Level 1: Waste Prevention

Challenge 1: Preventing waste on campus
This first challenge focuses on reducing single-use waste on campus. It invites players to use reusable cups, flasks and lunch boxes on campus.

Challenge 2: Preventing waste when grocery shopping
This challenge focuses on reducing packaging waste and food waste when grocery shopping.

Challenge 3: Preventing waste at home
The last challenge of level 1 focuses on preventing waste at home. It looks into food storage, donating and collecting unwanted clothing and bulky items on campus.

Waste prevention commitments
Players are invited to commit to a set of waste prevention actions in real-life.

Level 2: Waste Recycling

Challenge 1: Reducing waste contamination
The first challenge of level 2 addresses the topic of waste contamination and its consequences.

Challenge 2: Uncovering waste recycling labelling
Challenge 2 aims to shed light on the meaning of different product labels (e.g., On-Pack Recycling labels).

Challenge 3: The ultimate waste sorting contest
To complete level 2, players can participate in a final contest where they must sort different items into appropriate bins.

Waste recycling commitments
Players are invited to commit to a set of waste recycling actions in real life.

Gamification and behavioural techniques

Overarching narrative

The game is framed as a rite of passage where players must first acquire a set of skills to contribute to the collective waste reduction efforts made on campus. The purpose of the narrative is to provide meaning to waste prevention and recycling and to transmit a sense of collective responsibility.

Interactive experience

The game simulates a dialogue between the player and a mentor. Players can choose a mentor at the beginning of the game. They are fictional characters that represent real-world roles, each with a specific waste-related expertise (i.e., Estate managers, Waste processing managers, Green Campus staff).
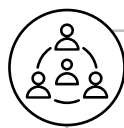
Social norms and comparisons

Players are matched together during the final waste-sorting contest and are rewarded or penalised based on their collective performance. The purpose of this feature is to allow players to compare themselves to others (Chou, 2015) and foster a sense of collective responsibility.

Progression and accomplishment

The game is divided into two levels, each containing three different challenges. Players can earn points by solving a challenge, and receive badges upon completing a level. Levels, points and badges are designed to transmit a sense of accomplishment and progression throughout the game to improve engagement (Chou, 2015).

Immediate feedback

Throughout the game, mentors provide feedback immediately after a player responds to a given quiz question. The feedback includes information on the correct answer along with other relevant information. Evidence suggests that providing immediate feedback is an effective and engaging way to transmit information (Luo et al., 2018; Soma et al., 2020).

Commitment devices

At the end of each level, students can commit to a set of waste-related actions in real life. They are also presented with a leaderboard that includes the names of all the players who have made commitments. Evidence suggests that encouraging individuals to make public commitments increases the likelihood that they reduce and recycle waste (Mickaël, 2014; Wang & Katzev, 1990; Kauffman et al., 2020).

Your goal

We, the TCD community, produce over **1,790 tonnes of waste** per year. That's roughly equivalent to 1,430 MINI Coopers filled with waste.

We are putting effort into reducing our environmental impact by working down the waste hierarchy - our top priority is to prevent waste and then recycle any remaining waste as best as possible. **But we need your help!**

The Waste Hierarchy

Level 1
Prevent waste

Level 2
Recycle

Take part in this collective effort by acquiring the right skills and knowledge to reduce your waste impact. **Your mission is to complete levels 1 & 2 of the waste hierarchy.**

Don't worry, you are not alone ...

Start

Powered by Qualtrics

Points: 3
level 1
level 2

Grace McBuild

You're halfway there! In what bin does this packaging material go?

🔴 Incorrect. This packaging is certified as <u>industrially compostable</u> and should be placed in the food waste bin. Although they might look like regular plastics, do not place them with other plastics because they are designed to break down and can contaminate recyclable plastics.

You and 1 other student you share the bins with sorted this item incorrectly and contaminated the bin. You all lose 2 points! 🙁🙁

next

Point and level indicator designed to resemble the waste hierarchy framework

Simulation of an interaction with a waste management expert

Example of a quiz question, presented as a chat between the mentor and the player

Once players select their choice, true/false cues are displayed to provide feedback

Feedback and detailed explanation is provided, points are awarded for correct responses

Challenge 3: Preventing waste at home

That's challenge 2 completed!

Now, imagine you have finished your grocery shopping and are back home. You can reduce waste at home by sharing or reusing goods. Here are three simple actions you can take:

☑ Avoid food waste by preparing smaller portions, covering leftovers properly, and freezing excess food.
☑ Set up a kitty with flatmates to share basic goods (e.g., milk, butter, oil, soap), and
☑ Collect or give away unwanted items for free on Freecycle

Let's see if you can figure out why… you'll earn 1 point for each question you answer correctly!

Accept challenge

Points: 4
level 1
level 2

Grace McBuild

Well done Lucy, you've completed level 1 and unlocked the second level of the waste hierarchy

3531 other students participating in this game have committed to preventing waste this year by adopting one or more actions mentioned below. Their names are listed in the table.

Join them by selecting the actions you want to commit to. Together, we can reduce over 30% of all waste at TCD by following the actions below.

Names	
1	Calum
2	Sam
3	Elenore
4	Meghan
5	Shannon
6	Sinead
7	Kevin
8	Iran
9	Rachel
10	Tom

Showing 1 to 10 of 3,531 entries

Previous 1 2 3 4 5 … 354 Next

I will prevent waste by using reusables (cups, bottles and lunchbox)

I will prevent waste when shopping by bringing a shopping bag, planning what I buy and minimising packaging

I will prevent waste at home by storing food thoughtfully, sharing basic goods and collecting/donating second-hand items

No, I'd rather produce waste

Level 2

Level and number of points to indicate progress in the game

Talking to the mentor throughout to support the overarching narrative

Badges and congratulatory messages to reinforce players' sense of accomplishment

Use of social norms and comparison to foster a sense of shared responsibility

Encouraging players to make real-life commitments to increase the likelihood of translating the knowledge they have gained through the game into action

Trial design and implementation

We evaluated the impact of The Waste Game on students' and staff's knowledge and key predictors of waste prevention and recycling behaviours through a randomised controlled trial (RCT).
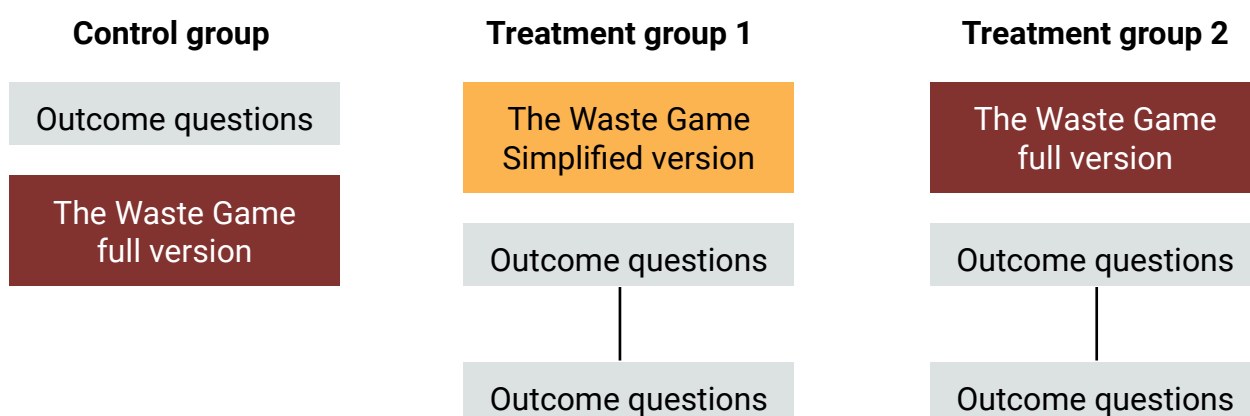
Waste prevention and recycling predictors include participant's confidence and intentions to reduce and sort waste, their perceived social norm (i.e., how determined others are in reducing their waste impact) and the share of responsibility in waste segregation they assign to different parties (i.e., the student population, estate services, and waste operators).

Participants were randomly assigned to one of three experimental groups:

- **Control group:** participants responded to a short survey containing a set of outcome questions before playing the game.
- **Treatment group 1:** participants played a simplified version of the game before responding to a set of outcome questions.
- **Treatment group 2:** participants played the full version of the game that included additional gamification elements before responding to a set of outcome questions.

The additional gamification elements included a point system, the opportunity to choose a mentor, leaderboards containing the names of the students who have committed to a set of waste prevention and recycling actions, and matching players with others during the waste sorting challenge.

Participants in the treatment groups also received a follow-up survey three weeks after completing the game via email. The follow-up survey included the same outcome questions participants responded to when playing the game for the first time. The follow-up survey aimed to assess how memorable the information and tips provided in the game were over time.

Control group	Treatment group 1	Treatment group 2
Outcome questions	The Waste Game Simplified version	The Waste Game full version
The Waste Game full version	Outcome questions	Outcome questions
	Outcome questions	Outcome questions

The design of this trial allowed us to assess the game's impact in both the short term and the long term. It also allowed us to assess the relative impact of adding gamification elements to the game and study the correlations between players' characteristics and key predictors of waste prevention and recycling behaviours.

Four universities were involved in the evaluation of The Waste Game: University College Dublin (UCD), Dublin City University (DCU), Maynooth University (MU) and Trinity College Dublin (TCD). The game was administered to students and staff members in all four universities. We estimated a minimum sample size of 3,000 across all four universities to provide adequate statistical power for the trial.

Universities engaged in multiple dissemination waves to raise awareness and encourage students and staff members to play the game. Overall, dissemination efforts spanned throughout the autumn trimester of 2022 using various channels: direct email blasts, social media, posters, promoting the game during in-person events, and leveraging existing communication channels used by the Student Union and other entities.

Findings

Participant profile

In this section, we provide background information on university students and staff members who participated in the waste game. We also discuss the results from correlational analysis that helps us better understand the associations between different socio-demographic characteristics and between different outcomes of interest.

Background information
The table below provides summary statistics on the number of students and staff members opening, starting and completing the game for each of the participating universities. A total of 6348 individuals opened the game, among which 4702 started and 2590 completed the game. On average, 74.1% and 40.8% of those who opened the game started and completed the game respectively.

University	Opened	Started	Completed
DCU	2145	1518 (70.8%)	806 (37.6%)
MU	801	665 (83.0%)	387 (48.3%)
TCD	1836	1529 (83.3%)	943 (51.4%)
UCD	1566	990 (63.2%)	454 (29.0%)
Total	6348	4702 (74.1%)	2590 (40.8%)

Students and staff from TCD make up the largest proportion of the waste game participants who completed the game, followed by DCU, UCD, and MU. The waste game participants are over-represented by females (about 67.8% of those who completed the game). We also found that among students who have completed the game, the majority of them are postgraduate students, followed by 1st year undergraduates who make up the second largest group. Finally, most of the individuals who have completed the game reported that it is extremely or very important for them to live a sustainable lifestyle (36.4% and 43.0% respectively).

Who is more likely to play the game?
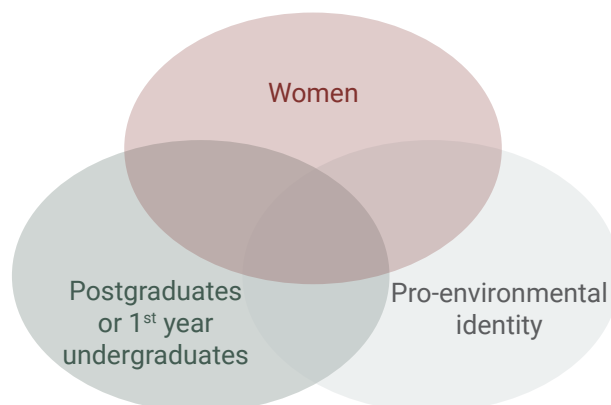
Participants' gender and green identity profiles are similar across all four participating universities. However, while the majority of participants who completed the game in TCD and UCD are postgraduate students, the largest group of participants in MU and DCU are 1st year undergraduate students.

Common profile of participants by university

		TCD	MU	DCU	UCD
	Women	**68.8%**	**65.9%**	**63.3%**	**74.9%**
	Postgraduates	**33.1%**	**23.3%**	**24.8%**	**34.6%**
	1st year undergraduates	**27.6%**	**27.2%**	**26.7%**	**15.8%**
	Pro-environmental identity	**79.3%**	**79.1%**	**79.5%**	**79.7%**

Graphs detailing the distribution of universities, gender, year of studies, and pro-environmental identity among players is available in the appendix (see graphs A1-A7).

Correlations

Our correlational analysis yields a number of interesting observations that apply to all participating universities. We found that females are generally more motivated to reduce their waste impact and more knowledgeable about waste prevention and sorting, even though they have less confidence in their knowledge. It is also observed that females generally assign more responsibility to all parties for segregating waste correctly. On the other hand, we found that despite having more confidence in their waste sorting and reduction knowledge, 1st-year undergraduate students are actually less knowledgeable.

What does the game tell us about its players?

- More knowledgeable
- More motivated to prevent and recycle waste
- Less confident in their waste sorting knowledge
- Greater sense of responsibility

- Less knowledgeable
- Less motivated to prevent and recycle waste
- More confident in their waste sorting knowledge
- Lower sense of responsibility

Those who performed better in the waste game also had better knowledge, a higher level of confidence to reduce and sort waste, greater motivation, and a higher likelihood of committing to reducing and sorting waste properly. Further, those with a higher level of confidence to reduce and sort waste also tend to have greater motivation, a more positive perceived social norm, a greater share of responsibility assigned to all parties, and a higher likelihood of committing to reducing and sorting waste properly.

These findings indicate that the outcomes of interest used to evaluate the game are good predictors of waste prevention and recycling intentions. They also highlight the importance of transmitting knowledge, confidence, a sense of collective effort and motivating staff and students.

What key aspects are associated with performing well in the game?

More likely to make a commitment

More knowledgable

Higher performance in the waste game

More motivated to reduce and sort waste

Higher level of confidence

Interestingly, there is a stronger positive relationship between performance in the waste game and making a commitment than between knowledge and making a commitment. This could be because, during the game, participants received immediate performance feedback, motivating them to continue their waste prevention and sorting efforts. The commitment device offered as part of the game allowed participants to continue their efforts beyond their participation in the game and for the long term.

In addition, we found that those who assigned a greater share of responsibility to campus services also tend to do the same to waste operators. This observation suggests that participants may not think there is much of a difference when it comes to the share of responsibility for segregating waste correctly between the two actors.

Graphs detailing our correlational analysis are available in the appendix (see graph A8 and table A2).

Effectiveness of the game

Overall effectiveness of the game
In this section, we present the main experimental findings from the trial across all participating universities (DCU, UCD, MU and TCU). The graph below shows the effect of the waste game on university students' and staff's waste prevention and recycling knowledge. Our analysis shows that the waste game had a statistically significant positive effect on knowledge both in the short and the long term. Students in the treatment groups scored on average 1.13 points (right after playing the game) and 0.59 points (3 weeks after playing the game) higher than the control group (who on average scored 5 points out of 8) in the knowledge assessment. While these numbers may not seem large on their own, they represent a 12-23% increase relative to the control group's knowledge score.
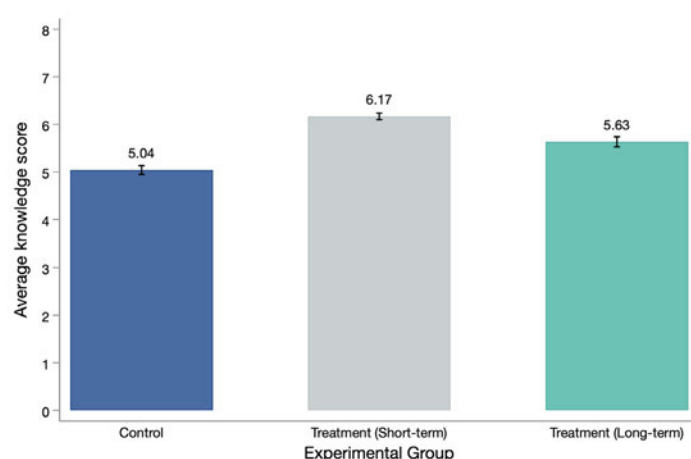
We also found that the waste game had a statistically significant positive effect on university students' and staff's confidence to reduce and sort waste. As shown in the graphs below, the confidence levels to reduce and sort waste for the treatment groups increased by 0.90 and 0.53 points in the short term respectively, when compared to the control group who on average reported 7.02 and 6.91 points (on a scale of 0 to 10). These effects are considerably large as they represent a 12.9% and 7.7% increase respectively relative to the control group's confidence to reduce and sort waste. Encouraging, these positive effects persisted 3 weeks after participants played the game.
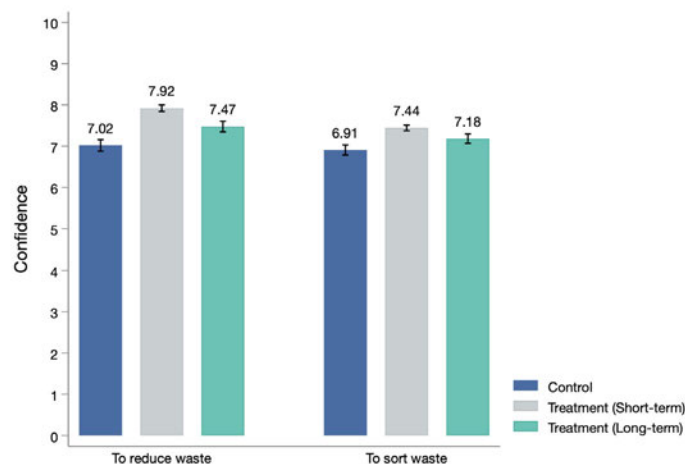
Further, we found that the waste game had a statistically significant positive effect on both motivation to reduce waste impact and perceived social norm (i.e., how determined others are in reducing their waste impact). As shown in the graphs below, the motivation level in the treatment groups increased on average by 0.72 points (from the 7.73 points out of 10 reported by the control group) in the short term. Similarly, the perceived motivation of others increased on average by 0.64 points for the treatment groups (from the 5.36 points out of 10 reported by the control group) in the short term. Again, these effects are considerably large as they represent a 9.3% and 11.9% increase respectively when compared to the control group. While the effect on motivation did not persist over time, the positive effect on perceived social norm persisted 3 weeks after participants played the game.
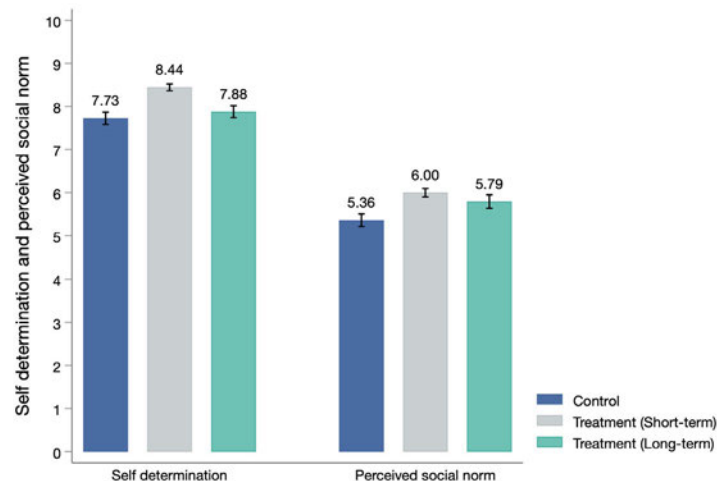
When asked to determine each party's share of responsibility in waste segregation, our analysis shows that both control and treatment groups thought that the student population is the most responsible for segregating waste correctly, compared to estate services and operators at waste processing plants. Those in the treatment groups assigned more responsibility to the students in the short term, with an increase of 0.17 points from the 8.52 points reported by the control group. While this effect only represents a 2% increase, it is statistically significant at the 5% level. Nevertheless, we do not observe similar significant effects on estate services' and waste operators' shares of responsibility. In other words, there are no differences between the control and the treatment groups when it comes to how responsible they think estate services and waste operators are for segregating waste correctly.

Further, we found no significant differences in the likelihood to make a commitment to preventing and sorting waste between those who received the full version of the commitment device and those who received the simplified version. Encouragingly, this is driven by the extremely high commitment rates observed in all groups, where more than 99% of those who completed the game made at least one commitment. This suggests a strong intention to prevent and recycle waste among the participants. In terms of the number of commitments made, we found that those who received the full version made slightly less commitments than those who received the simplified version. More specifically, those who received the full version made on average 0.25 less commitments than those who received the simplified version (who made on average 5.47 commitments out of the 6 offered to them).

Tables outlining the trial's balance check and overall effect of the game on key predictors of waste prevention and recycling behaviours are available in the appendix (see tables A3-A5).

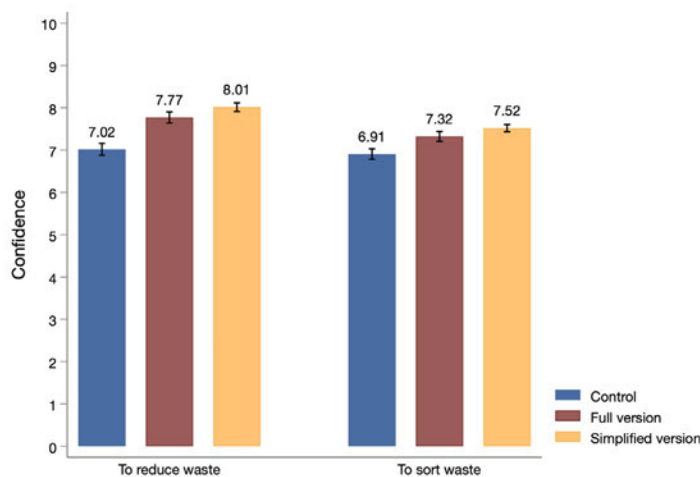***Full version vs simplified version of the game***
While our analysis shows that the waste game, in both versions, was effective in improving the key predictors of waste prevention and recycling behaviours (i.e., knowledge, confidence, perceived social norms, perceived responsibility of the issue, and intentions), one may be interested in the relative effectiveness of the full version of the game when compared to the simplified version. To assess and identify the version that performed better, we discuss the comparative effects of the waste game in its full version (compared to the simplified version) in this section.

The graph below shows the comparative effect of the fully featured waste game on university students' and staff's game performance (as measured by their game quiz score) and knowledge (as measured by their knowledge assessment score). Our analysis shows that those who played the full version of the game performed significantly better in the game, with an improved score of 15.6 out of the maximum 24 points in the game quiz (compared to the 15 points scored by those who played the simplified version). Interestingly, however, the better performance in the game did not translate into an improvement in knowledge for those who played the full version. In fact, those who played the full version scored 0.22 points lower in the knowledge assessment, when compared to those who played the simplified version (who scored 6.3 out of the maximum 8 points).

Further analysis shows that these effects are driven by only some of the participating universities. While participants from DCU and TCD who played the full version of the game performed significantly better in the game quiz, we found no such evidence for those from MU and UCD. In terms of the effect on knowledge, we found that only those from DCU who played the full version scored significantly lower in the knowledge assessment, but not participants from the other three universities.
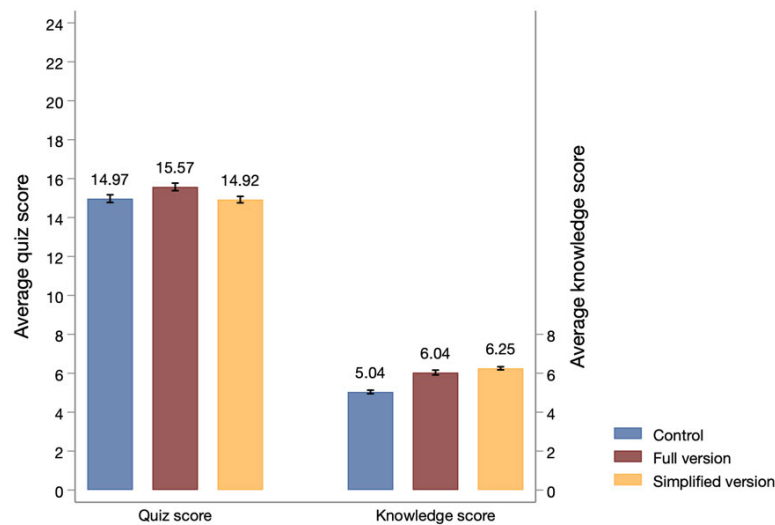
In addition, we found that those who played the full version of the waste game displayed significantly lower confidence in reducing and sorting waste. As shown in the graph below, the confidence levels to reduce and sort waste for those who played the full version are 0.24 and 0.20 points lower respectively, when compared to those who played the simplified version (who on average reported 8.01 and 7.52 points respectively). We also found that those who played the full version of the game assigned significantly more responsibility to estate services and waste operators (with an increase of 0.36 and 0.42 points respectively) than those who played the simplified version, but not to students.

Further, we found that there are no significant differences in the likelihood to make a commitment to preventing and sorting waste between those who played the full version and those who played the simplified version. Encouragingly, this is largely driven by the extremely high commitment rates observed in all groups, where more than 99% of those who completed the game made at least one commitment. In terms of the number of commitments made, those who played the full version made slightly fewer commitments than those who played the simplified version.

Tables outlining the differential effects of the waste game in its full version compared to the simplified version are available in the appendix (see tables A6-A8).

Effects of the game on different participant profiles

While the waste game was, in general, effective in improving the key predictors of waste prevention and recycling behaviours (i.e., knowledge, confidence, motivation, perceived social norms, perceived responsibility of the issue, and intentions), we were interested in whether the game was similarly effective for different participant profiles. Therefore, we conducted heterogeneity analyses based on a range of socio-demographic characteristics, including gender, year of studies, universities, and whether the participants are students or staff members.

In general, our analysis showed that the waste game has similarly positive effects for both females and males. However, there are differential effects for other population segments. The game has a greater positive effect on knowledge for 4th year undergraduates than for 1st year undergraduates, for students than for staff, and for TCD, UCD, and MU than for DCU participants. Furthermore, while the game significantly increased the confidence to sort waste for DCU and TCD participants, no such evidence was found for MU and UCD.

The findings from the trial suggest that the waste game is effective and may be better presented in a simplified version going forward. To improve the game, further research (e.g., A/B testing) should be conducted to identify specific gamification elements that can help drive engagement and enhance the effectiveness of the game.

Key effects of the waste game by university

	TCD	MU	DCU	UCD
Increase in knowledge	**+25.3%**	**+24.6%**	**+16.1%**	**+23%**
Increase in confidence to sort waste	**+10.4%**	**+3.3%** (not significant)	**+10.2%**	**+2.0%** (not significant)
Increase in motivation to sort waste	**+11.4%**	**+10.4%**	**+6.7%**	**+8.3%**

Tables outlining the effects of the waste game on different participant profiles are available in the appendix (see tables A9-A12).

User experience

Engagement

In terms of participants' engagement with the waste game, we found that those who were randomly assigned to the simplified version of the game were significantly less likely to drop out. Compared to the other two groups that had 63.8% and 65.9% of participants dropping out, 48.2% of those who received the simplified version dropped out of the game. Importantly, this finding applies to all four participating universities.

The graph below illustrates the proportion of participants in each experimental group that completed each section of the game. Two observations stood out from the graph. First, the largest drop off in engagement was right after the landing screen of the game, where many participants stopped progressing. This trend can be observed for both versions of the game. Second, participants who received the simplified version of the game were much more likely to engage and complete the waste game, as highlighted by the proportion of participants who progressed to the end of the game.
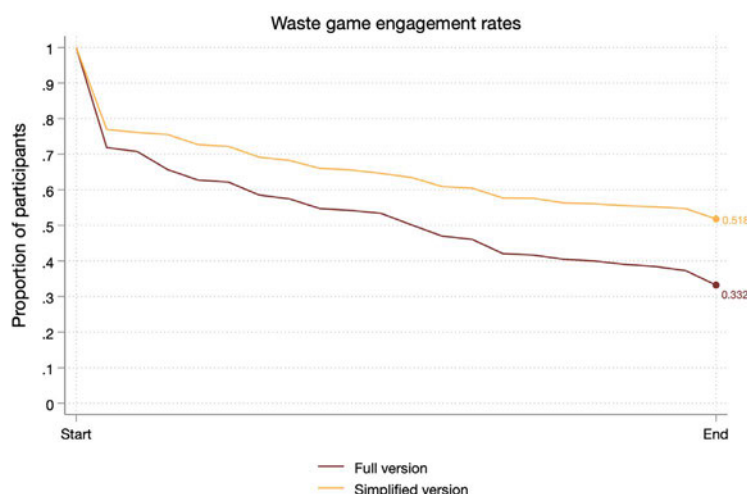
In terms of the amount of time participants spend in the waste game, students and staff spent a median of 8.6 minutes on the entire game, which consists of 2 levels with 3 challenges within each level. In each challenge individually, we found that participants spent a median of 0.8 to 1.8 minutes.

> *Tables detailing drop out rates and time spent on the waste game are available in the appendix (see tables A13, A14 and graph A9).*

Performance in the game
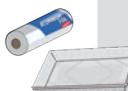
On average, participants in the game responded correctly to 15 out of 25 quiz questions, achieving a score of 60%. Staff appear to have performed better than students in the game by five percentage points, with an average score of 65%. When looking at how staff and students performed across universities, Trinity College Dublin (TCD) performed best, followed by Maynooth University (MU), Dublin City University (DCU) and University College Dublin (UCD).

Performance in the waste game

2nd **MU** score: 61%	**1st** **TCD** score: 63%	**3rd** **DCU** score: 59%	**4th** **UCD** score: 58%
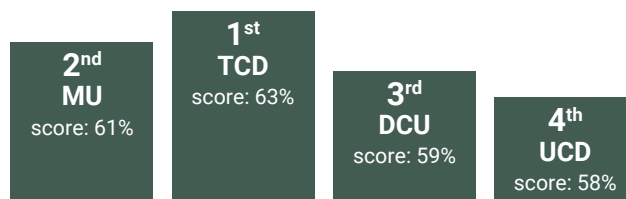
The final waste-sorting contest was generally the most challenging part of the game. Participants were asked to sort ten waste items into different bins. The waste items included in the game represent items that commonly contaminate waste streams based on waste characterisation studies conducted by the EPA and participating universities. On average, the waste items that participants were more likely to sort incorrectly in the waste game were Pringles tubes (71%), followed by packets of crisps (67%), disposable coffee cups (59%), and aluminium wraps and trays (46%). This suggests that staff and students might not be aware of recent changes in rules (i.e., since 2020, soft plastics, including packets of crisps, should be placed in recycling bins) and struggle with composite packaging (e.g., the pringles tubes and disposable coffee cups).

Waste items most commonly sorted incorrectly by university

	TCD	MU	DCU	UCD
Aluminium wrap and trays	40%	50%	52%	53%
Disposable coffee cups	56%	57%	65%	60%
Packets of crisps	69%	65%	67%	67%
Pringles tubes	71%	69%	69%	73%

For more information on participant's performance in the game by university and the share of students and staff that sorted waste items correctly see graphs A10-A15 in the appendix.

Perceived usefulness
In terms of the perceived usefulness of the game, almost all participants think the waste game is somewhat or very useful, as shown in the graph below. However, we found that those who played the full version were less likely to perceive the game as very useful. This observation applies to all four participating universities.

However, we found that those who played the full version were overall less likely to perceive the game as very useful. Interestingly, this finding only applies to participants from MU and TCD as we do not find significant differences for those from DCU and UCD.

Perceived usefulness of the waste game

Response	Full version	Simplified version
Very useful	0.59	0.70
Somewhat useful	0.37	0.27
Neither useful nor useless	0.02	0.01
Very useless	0.01	0.01
Somewhat useless	0.01	0.01

n = 1836
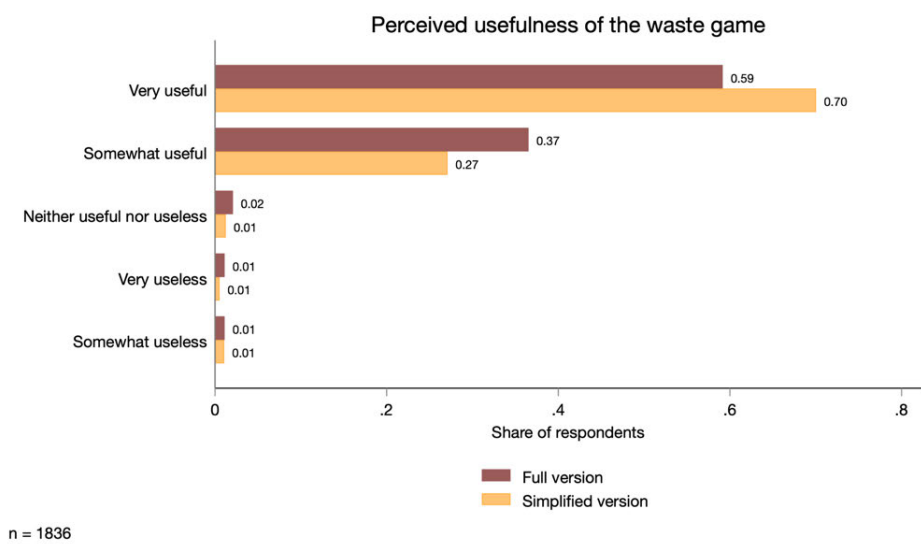
For more information on the perceived usefulness of the game see tables A15, A16 and graph A16 in the appendix.

Length and relevance

In the staff version of the game, we asked for feedback on both the length of the game and the relevance of each topic included in the game. We found that 2 in 3 staff members think that the length of the game is just right (i.e., neither long nor short), while the rest think that the game is somewhat or too long.

Feedback on the length of the waste game

Response	Full version	Simplified version
Neither long nor short	0.65	0.69
Somewhat long	0.28	0.27
Too long	0.06	0.04
Somewhat short	0.01	0.01

n = 278
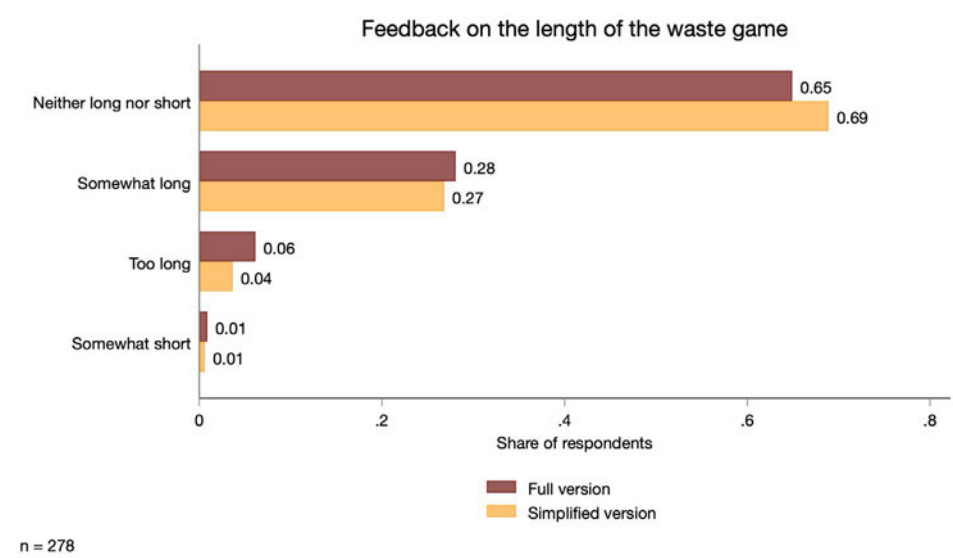
In terms of the relevance of the different topics in the game, all six topics are deemed very relevant by most staff members. Challenge 1 of level 2, which focused on recyclable waste contamination, was rated slightly more relevant than other topics across all participating universities. While there are some staff members who reported very low relevance for the topics, all six topics received around the same number of negative feedback (7-8% of the staff who answered this question). In other words, none of the six topics was identified to be more irrelevant than the others overall.

Feedback on the relevance of the waste game

n = 276
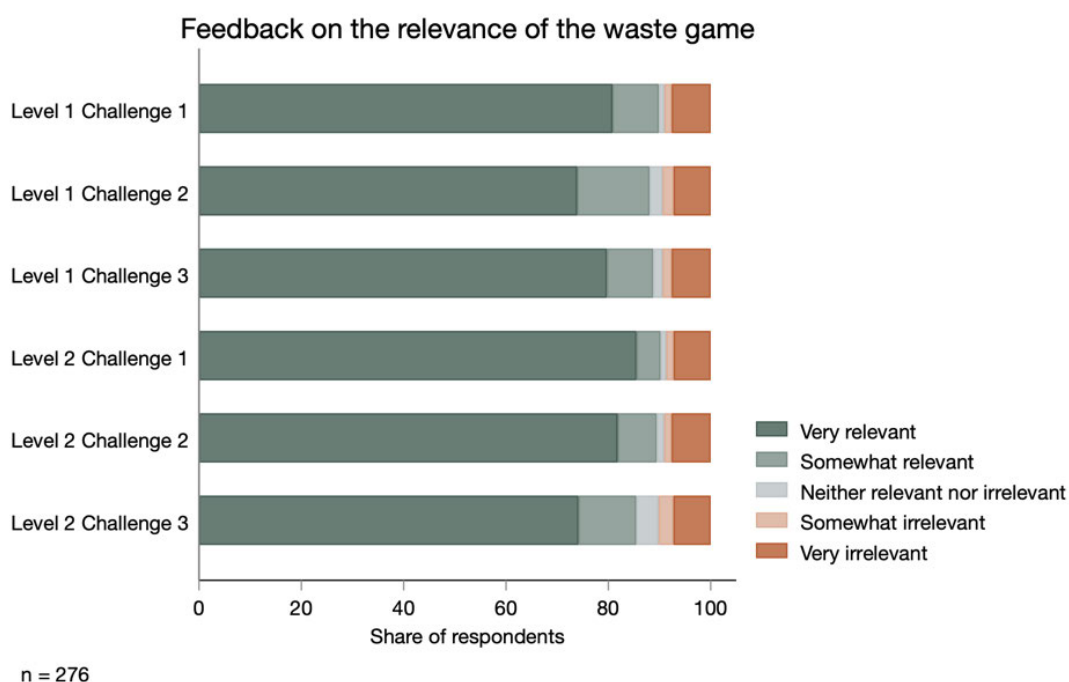
📎 *For more information on the length of the game and the relevance of difference topics addressed in the game see graphs A17 and A18 in the appendix.*

Qualitative feedback
Participants of the waste game were asked to provide feedback on the game and, more generally, on what would help them better reduce or recycle their waste on campus.

Overall, the game was received very positively. Students and staff found the game to be informative and engaging. Some players suggested including more visuals and making it more interactive. Other players suggested including a downloadable summary at the end of the game that players can keep beyond the game.

However, some players that received the full version of the game found that getting paired with other players during the final waste-sorting contest was frustrating. While pairing players with others helped transmit the concept of collective responsibility, players did not appreciate being penalised for the performance of others.

Below are examples of quotes that we collect from participants.

> "it seems very informative and allows for a variety of challenges which really gets you thinking! well done!" **– Participant A**

> "This was great game. Maybe a few more pictorial representations like real life images could be nice to go with different facts. Just an idea that popped into head right now. All in all, it was really interesting. Thank you" **– Participant B**

> "Send a summary of everything learned (maybe wrong questions) to email address. Might help for participants to remember longer period of time." **– Participant C**

> "Don't put students into groups, I lost lots of points even though I responded correctly, it was very frustrating and I lost motivation to read the explanations" **– Participant D**

Across all four universities, the most common feedback shared by participants relates to increased and improved waste bins , followed by increased and improved signage and more educational campaigns. Other commonly mentioned areas of improvement include, banning single-use materials on campus, and increasing the number of water fountains as well as providing information on their locations.

Below are examples of quotes that we collect from participants.
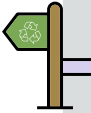
> "Add explanations on the bins of what should not go there (in addition to what should go) in reference to the commonly made mistakes (perhaps based on the data from this game)" **– Participant E from Trinity College Dublin**

> "There should be more general, recycling, compost bins rather than just the green bag bins that are all around campus. Signs displaying some of the information from this game placed above bins would make people more conscience of their actions. Ex. tell them that one contaminant leads to the whole recycling bin going to general waste." **– Participant F from University College Dublin**

> "Please please please put signs around the campus directing students towards water refilling stations. Having 15 of them around the campus is great but totally no good if no one knows they're there." **– Participant G from Maynooth University**

> "More clearly labelled bins in classrooms or more than one bin in classrooms and lecture halls, often there will only be one or a few bins with no labels so I just assume they are general waste" **– Participant H from Dublin City University**

Key actions that would help staff and students sort waste better by university

	TCD	MU	DCU	UCD
More and better bins	42%	31%	32%	23%
Improved signage	29%	31%	24%	23%
More educational campaigns	16%	15%	13%	8%

For a detailed account of participants' feedback on the waste game and on how to better reduce and recycle waste on campus please see graphs A19-A22 and tables A17-A18.

Dissemination

In this section, we assess the effectiveness of different channels and activities used to promote the game. The graphs below visualise the waste game cumulative open and completion rates, along with the promotional activities for each of the four universities.

In general, sharp increases in both the open and completion rates are observed on the days when the promotional activities were conducted. Across all universities, emails appear to be the most effective dissemination channel as the sharpest increase in the open and completion rates are when emails were sent to students to promote the game as well as to remind them to complete the game. On the other hand, the effectiveness of social media channels (e.g., Instagram and Twitter) is less conclusive; while there are increases in the open and completion rates in some instances, they are less stark (social media posts were, however, often launched at the same time as the emails). Lastly, posters and events appear to be the least effective.

Oct 3 - Launched and sent to students via email
Oct 14 - Promoted via student union newsletter and sent to staff
Nov 22 - Reminder sent to students via email and to staff via intranet
Dec 2 - Reminder sent to students via email
*The waste game was also promoted during the Walk-tober event, which spanned over the month of October
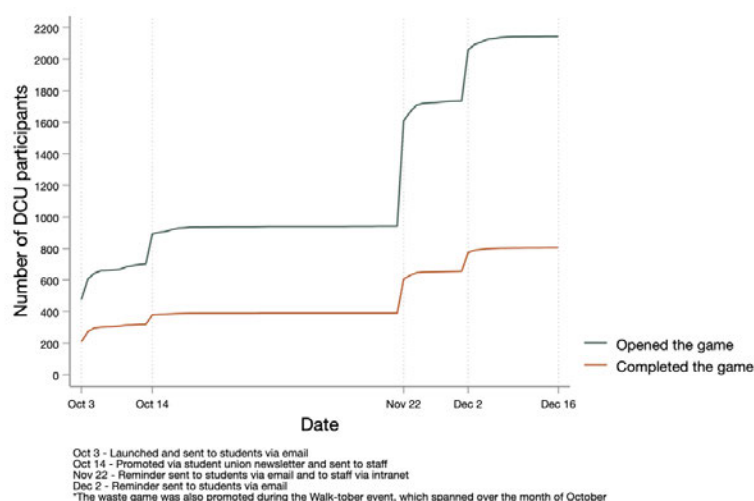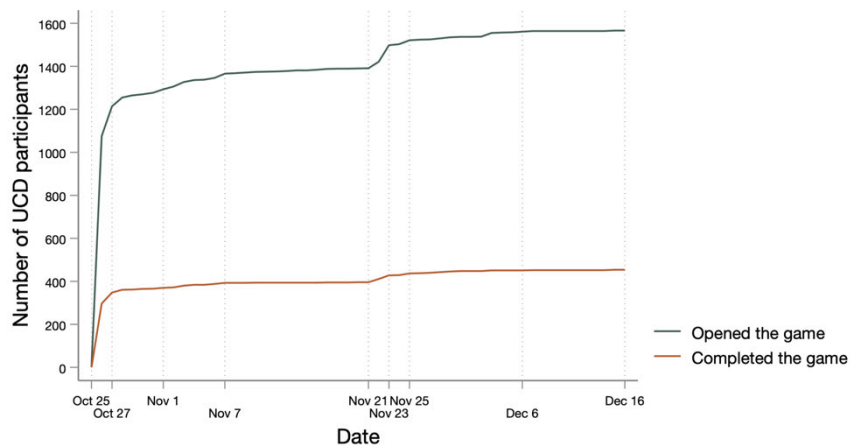
Oct 25 - Launched and promoted on Instagram
Oct 27 - Promoted on Instagram and sent via email to all students
Nov 1 - Sent to staff via intranet
Nov 7 - Promoted on Instagram
Nov 21 - Promoted on Instagram
Nov 23 - Sent via email to student residents
Nov 25 - Sent to estate staff via intranet
Dec 6 - Promoted in an email sent to student residents in collaboration with the pop-up recycling centres
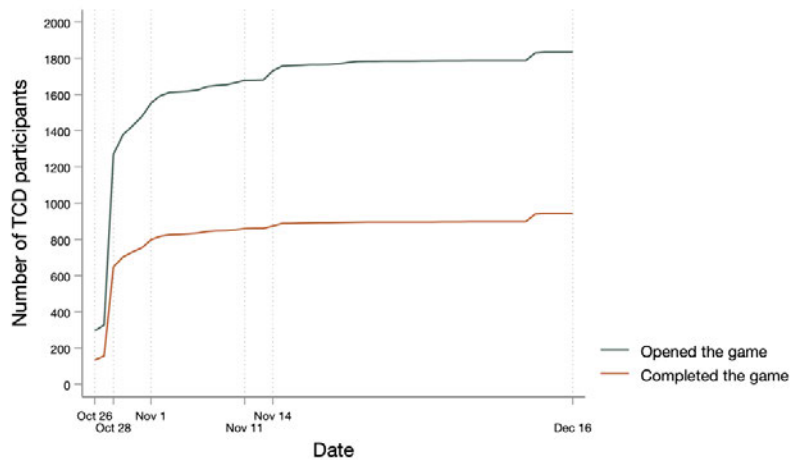
Oct 26 - Launched and sent to staff via email
Oct 28 - Sent to students via email
Nov 1 - Promoted via social media and student union newsletter
Nov 11 - Reminder sent to staff via email
Nov 14 - Promoted via social media
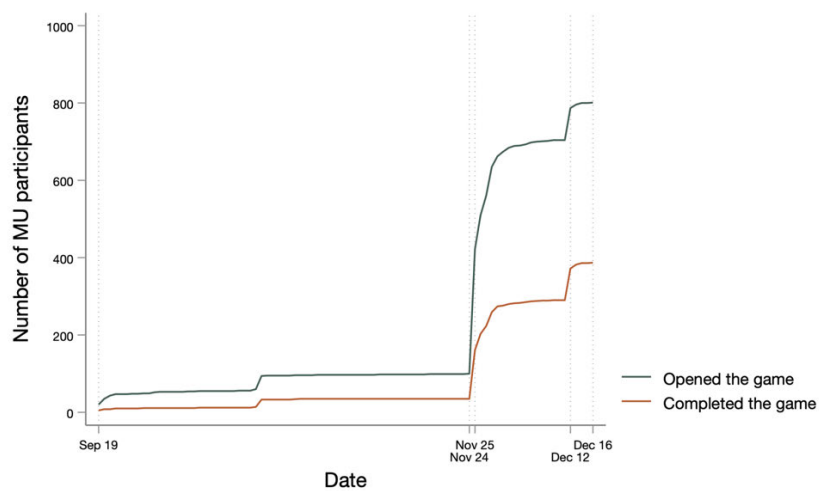
Sep 19 - Launched and promoted via Twitter, Instagram, and posters
Nov 24 - Promoted on Green Campus website
Nov 25 - Promoted on Instagram and sent to students via email
Dec 12 - Sent to staff via email

Learnings and recommendations

Participant profile

The waste game participants are overrepresented overall and in each university by:

Female students and staff

Postgraduate and 1st year students

Individuals who regard living a sustainable lifestyle as very or extremely important

Future dissemination efforts should focus on better targeting those who are underrepresented (e.g., males, 2nd to 4th year undergraduates). Campaigns that highlight social norms around waste prevention and recycling behaviours can be an effective approach to address these profiles (Geislar, 2017).

Effectiveness and experience of the waste game

Overall effectiveness

The waste game was **highly effective** in improving the key predictors of waste prevention and recycling behaviours, **both in the short and the long term** across all participating universities. Almost all of the participants made **at least one commitment to reducing and sorting waste properly.**

Short-term effects:
Better waste sorting and reduction knowledge
Higher confidence to reduce and sort waste
Improved motivation and perceived social norms
Higher share of responsibility in waste segregation assigned to the student population

Long-term effects:
Most of these positive effects persisted over time (i.e., 3 weeks after the game was played)

Simplified vs Enhanced version

The findings from the trial suggest that the waste game is effective and may be better presented in a simplified version going forward. Further research should be conducted to identify specific gamification elements to help drive engagement and enhance the effectiveness of the game.

Participants who played the Simplified Waste Game

👎 Performed worse in the game

👍 Performed better in knowledge assessment

👍 Reported higher confidence in sorting and reducing waste

👍 Assigned less responsibility in waste segregation to estate services

👍 Were more likely to complete the game

👍 Were less likely to drop out

The overall feedback on the game is largely positive: almost all individuals think the waste game is informative and useful. Suggestions to improve the game included providing key take-aways at the end, improving its usability, and avoiding elements where participants can lose points because of their group members' performance.

Effects of the game on different participant profiles

The waste game had...

Similarly positive effects on women and men

 =

Greater positive effects on knowledge

for...   than...

4th year undergraduates	1st year undergraduates
Students	Staff
TCD, UCD and MU students	DCU students

Significantly increased the confidence

for...   than...

DCU and TCD participants	MU and UCD students

> The waste game differentially influences participants and further research should be conducted to study why such phenomenons exist and inform future game designs.

Experience and feedback

TCD students and staff acheived the highest score in the game:

2nd MU score: 61%

1st TCD score: 63%

3rd DCU score: 59%

4th UCD score: 58%
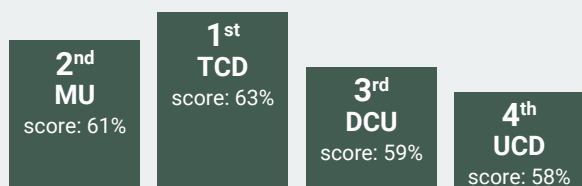
Across universities, participants struggled the most with sorting the following items:

> Future educational campaigns should focus on raising awareness about soft plastics and composite packaging. Also, findings suggest that gamified online tools are valued by both staff and students as an effective educational tool
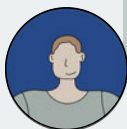
> Participants' feedback on what would help them better reduce or recycle waste on campus included improving signage to bins and water fountains, replacing single-use packaging with reusable lunchboxes and cups and providing more education on recycling.

Dissemination
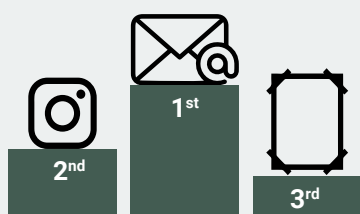
Across all universities, sharp increases in both the waste game open and completion rates are observed on the days when promotional activities were conducted. Emails appear to be the most effective dissemination channel, followed by social media while posters and university events appear to be the least effective

2nd (Instagram) **1st** (Email) **3rd** (Poster)

> Future dissemination efforts should leverage email blasts and reminder emails to engage staff and students in sustainability initiatives.

Switching to reusable: Encouraging the take-up and sustained use of reusable cups on campus
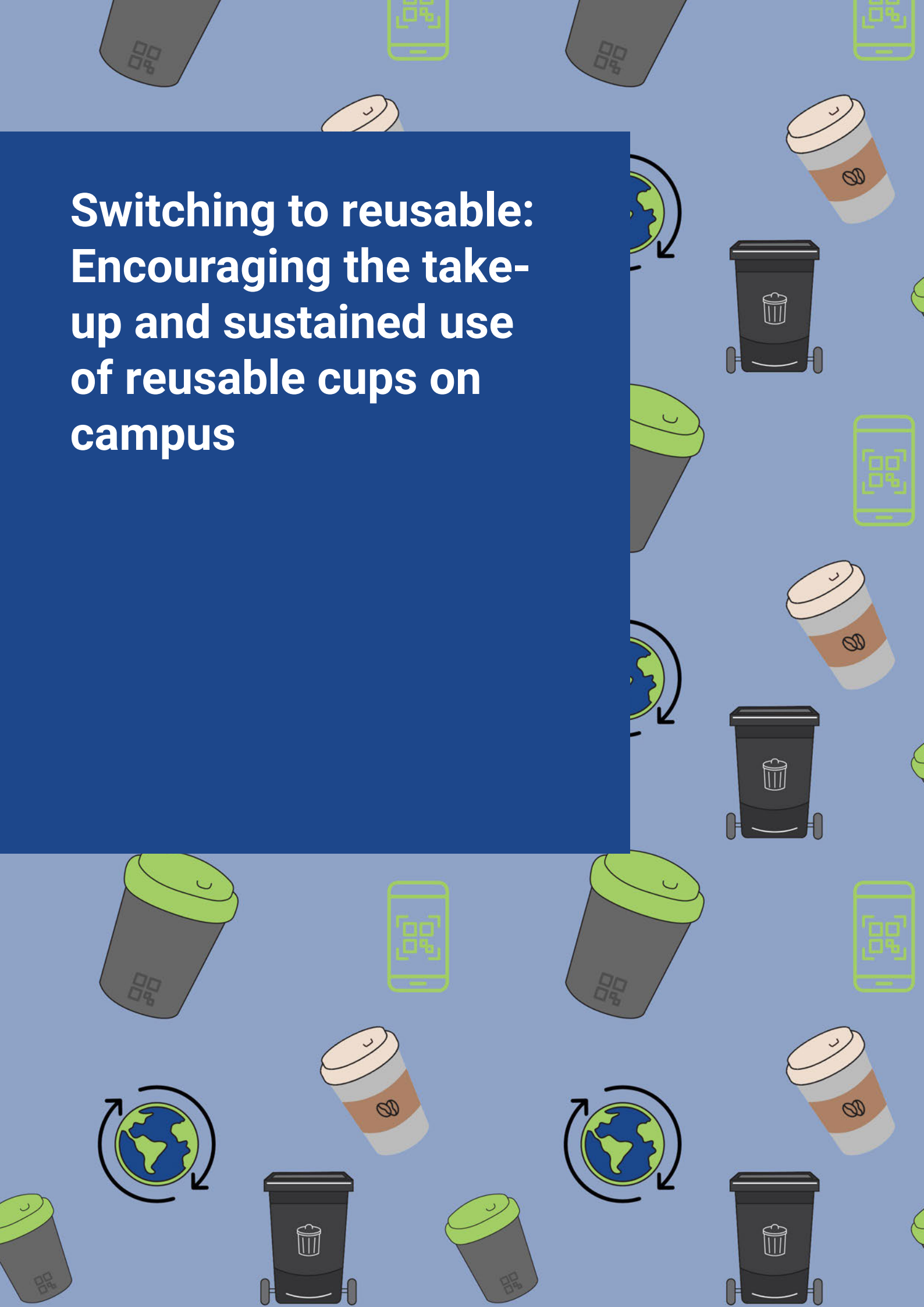
Encouraging the take-up and sustained use of reusable cups on campus

Background

Despite offering discounts for beverages when reusable cups are used, there is still a large amount of single-use cup waste being generated. The problem was exacerbated by health and safety concerns during the COVID-19 pandemic when people stopped using reusable cups in favour of disposable ones.

While reusable cups are available on campus, students lack the incentive to purchase them and to develop a habit of using them consistently over time. Therefore, there was a need to trial a comprehensive reusable cup scheme that addresses students and staff's behavioural barriers.

This study was conducted in collaboration with UCD and eCups, a reusable cup provider that served as an implementation partner for conducting these trials.

Intervention design

Promoting the take-up of reusable cups

The first intervention focused on encouraging the take-up of reusable cups on campus. Based on our review of literature and stakeholder interviews conducted with universities, there are a variety of barriers to the uptake of reusable cups amongst university students. These include:

High upfront cost: While reusable cups can save money in the long run, the upfront cost of buying a reusable cup can be a deterrent for some people (reusable cups available on campus cost on average €8.50). Some people may not be willing or able to spend money on a reusable cup if they are not sure how often they will use it or if they do not see the long-term benefits.

Low awareness of benefits: People may not be aware that most disposable cups are not recyclable, know about the environmental benefits of using reusable cups and that they are widely available on campus and increasingly used by peers.

Low accessibility: If reusable cups are not readily available or accessible at stores or shops, it can be difficult for people to purchase them. Some people may not be willing to go out of their way to buy a reusable cup or may not have access to stores that sell them.

Perceived inconvenience: While disposable cups are readily available and offered by default in most coffee shops, reusable cups are typically perceived as inconvenient to use. People must remember to bring their cup with them, carry it throughout the day, and rinse it after every use.

To address the identified barriers, we designed an email campaign in collaboration with UCD Green Campus to encourage reusable cup ownership, specifically eCups. The email campaign focused primarily on reducing the upfront cost of reusable cups by providing discounts. It also included information highlighting the key benefits of using reusable cups and where to buy them on campus. The design of the email followed the visual identity of UCD's Green Campus' monthly newsletter.

The key elements included in the email campaign are detailed below.

Environmental impact: The email included information that addressed the incorrect belief that disposable cups are widely recyclable. The purpose of this section is to initially capture the audience's attention and raise awareness about the environmental impact of disposable coffee cups.

Discounts: The email included variable discount levels on reusable eCup purchases. By clicking on "claim discount" button, staff and students accessed a discount coupon with a unique QR code, which they had to show to the cafe staff at the point of purchase.

Benefits: We highlighted the environmental and economic benefits of using reusable cups and addressed the commonly held concern around the inconvenience of using reusable cups.

Ease of use: The email included a list of coffee shops that sell reusable eCups on campus. It also provided a step-by-step guide outlining how staff and students can participate in the eCups scheme upon purchasing a reusable eCup and a quick link to the eCups app.

The email campaign was part of a broader communications campaign that ran over the entire trial period (February - May 2023). Following the delivery of the initial email campaign, UCD Green Campus promoted the eCups scheme on social media by regularly publishing posts and videos (e.g., Instagram stories). The campaign also included physical and digital posters placed in coffee shops across campus, recruiting student ambassadors to further promote reusable cups via their networks, and setting up pop-up stands.

Encouraging the sustained used of reusable cups

Following the email campaign trial, we conducted a second trial that focused on ensuring the continued use of reusable cups, and forming a habit around their use.

Importantly, encouraging individuals to use their reusable cups regularly ensures that they are worthwhile from an environmental standpoint. Life-cycle studies suggest that on average a reusable cup should be used between 30-110 times, depending on the material they are made of, to start having a lower environmental impact compared to disposable coffee cups (CIRAIG, 2014).

Insights gathered from a literature review and stakeholder interviews conducted with universities suggested that key barriers to the continued use of reusable cups are:

Leaving reusable cups at home: Leaving reusable cups at home is a common barrier to the regular use of reusable cups. This is especially true for people who are not in the habit of carrying the cup with them every day. Over time, forgetting the cup can become frustrating and may lead people to give up on the idea of using a reusable cup altogether.

Inconvenience: The inconvenience of using a reusable cup can also be a barrier to regular use. Reusable cups require some effort to use, such as carrying the cup throughout the day and rinsing it after each use. Some people may find this effort to be too great, especially if they are used to the convenience of disposable cups.

Lack of motivation for continued use: While most coffee shops at UCD provide discounts on beverages sold using reusable cups, these incentives are not tied to the continued use of reusable cups over time. What's more, it is often hard to keep track of the long-term environmental impact of using reusable cups and to have a clear goal that sustains motivation over time.

To overcome the barriers identified, and more specifically the lack of motivation, it can be helpful to incorporate strategies that prompt habit formation. Literature on habit formation (Eyal, 2014) suggests that new habits can be instilled by providing an initial trigger that prompts individuals to perform an action, offering rewards and encouraging a sense of commitment to performing that action again, therefore creating a loop that leads to sustained behaviour change. This process can be summarised in the model shown below.

The four stages of habit formation

Trigger
Triggers are reminders or visual cues that prompt individuals to use their reusable cups.

Reward
Variable rewards create anticipation and motivate users to repeat the behaviour.

Investment
Investment stage increases the likelihoof of future actions, as people invest time, effort, or money in a goal, such as using a reusable cup.

Action
The action stage refers to the behaviour itself. In this case, it involces using a reusable cup instead of a disposable one.

To help form a habit of using reusable cups more frequently, we partnered with eCups, a reusable cup provider that was in the process of developing a mobile application that can be linked to one's reusable cup. The mobile app provides features that draw on strategies that prompt habit formation. More specifically, the app allows users to track the number of times they refill their reusable cup, provides feedback on the amount of single-use cup waste saved, and offers points and rewards that are conditional upon using the cup. A list of the strategies is provided below.

Trigger

Visual cues: Posters and table talkers promoting eCups placed in coffee shops.

Reward

Conditional rewards: The eCups app incentivises users to use their reusable cup by offering points after every cup refill that could be redeemed for a free drink.

Investment

Feedback on prevented waste: eCups users receive feedback on disposable cup waste prevented via the app, which can help motivate and reinforce reusable cup use over time.

Sense of progression & accomplishment: The eCup app provides users with points after every cup refill. They can also move up levels as they accumulate points and unlock greater rewards. This gives them a sense of progression and investment that can help users commit to using their reusable cup again.
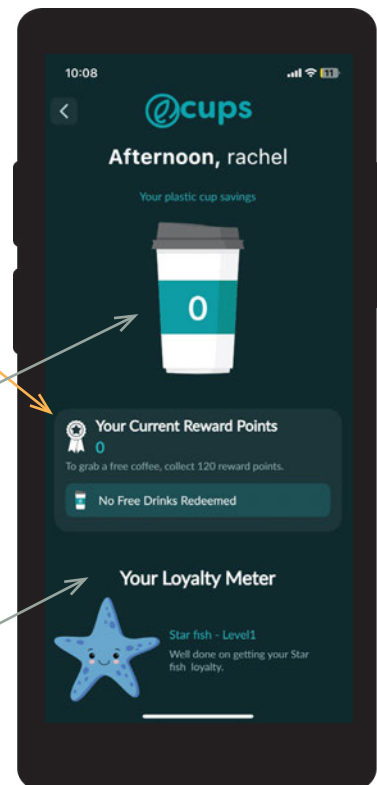
Trial design and implementation

Promoting the take-up of reusable cups

We evaluated the impact of the email campaign on students' and staff's take-up of reusable cups through a randomised controlled trial (RCT). The primary goals of the trial were to assess the effectiveness of discounts on reusable cup purchases and to determine the most cost-effective discount level. The email campaign was launched via the UCD Green Campus newsletter to a mailing list containing the contact details of 38,096 staff and students. Contacts were randomly assigned to one of three experimental groups:

- **Control group:** Staff and students received a plain version of the email campaign that did not offer a discount on reusable eCups.
- **Treatment group 1:** Staff and students received an email that offered a 10% discount on their first reusable eCup purchase.
- **Treatment group 2:** Staff and students received an email that offered a 50% discount on their first reusable eCup purchase.

The effectiveness of the email campaign was assessed by tracking the different price points of eCups sold at cafes on campus (i.e., at full price, at a 10% discount or at a 50% discount).

Control group	Treatment group 1	Treatment group 2
Email campaign • Behaviourally informed messaging • No discount	**Email campaign** • Behaviourally informed messaging • 10% discount	**Email campaign** • Behaviourally informed messaging • 50% discount
eCup sales at full price (€3.00)	eCup sales with 10% discount (€2.70)	eCup sales with 50% discount (€1.50)

Staff and students were able to purchase a reusable cup at nine different cafes and restaurants around the UCD campus, the list of which was displayed at the bottom of the email. To redeem their discounts, they had to access a single-use discount coupon in the email, which included a unique QR code, and present it to staff at the point of sale.

Encouraging the sustained used of reusable cups

The eCups scheme was initially ideated as a deposit and return scheme, whereby students pay a deposit on their first reusable cup and can then claim it back or collect a new reusable cup with their next drink upon returning their cup. However, for the purpose of this trial and due to feasibility constraints linked to setting up reusable cup collection and washing points, eCups were sold as products that one owns.

The eCups scheme that was trialled worked as follows:

1 Staff & students purchase an eCup at designated coffee shops on campus

2 Users download the eCups app on their phones and register their cup to the app

3 Users scan a QR code at the till with their phones every time they refill their reusable cup to collect points on the app

4 Users can collect points via the app and can earn free beverages as rewards
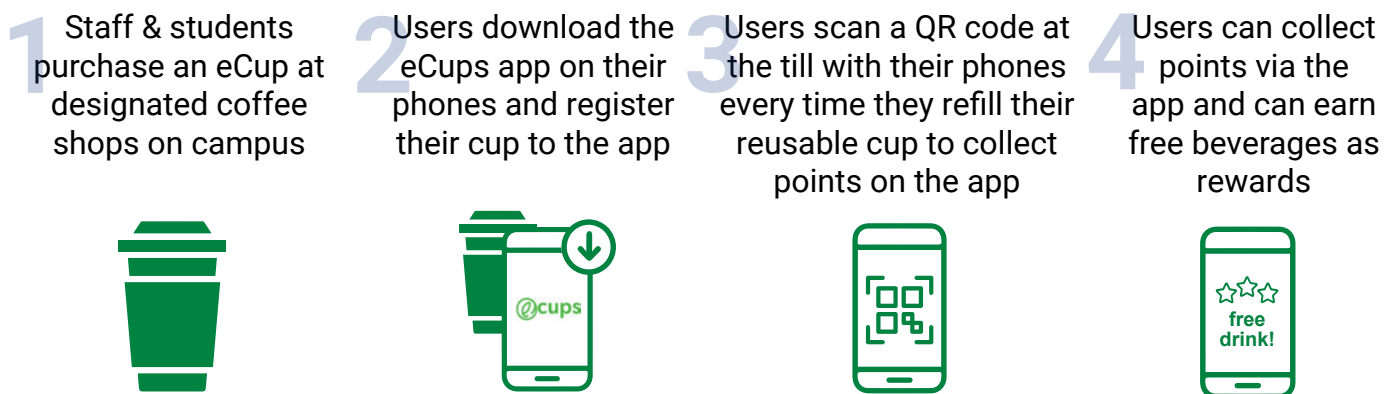
Prior to rolling out the eCups scheme, tablets that generated dynamic QR codes were installed at the till of every participating coffee shop or restaurant on campus. Staff working at the till were trained on how to operate the scheme and posters and table-talkers that explained to customers how the scheme worked were placed in coffee shops.

The eCups scheme was launched at UCD on February 7, 2023 for a duration of 11 weeks up until the end of the academic semester. During this period of time, data on the number of users who participated in the scheme, the number of reusable cup refills, and the number of rewards earned per user over time were collected via the eCups app.

In addition, a follow-up survey was sent via the UCD Green Campus newsletter to all students and staff registered at the university (i.e., 38,096) towards the end of the trial. The survey primarily sought to understand the experience of eCup users, their motivations to participate in the scheme, challenges they might have encountered, suggestions on how to improve the scheme, and their coffee/tea drinking habits. The survey was also accessible to individuals that did not purchase an eCup to better understand why they did not participate in the scheme.

> *More information on the profiles of university students and staff members who participated in the follow-up survey can be found in the appendix (see B1-B5).*

eCups trial

eCups pilot scheme roll-out

Data collection on user engagement
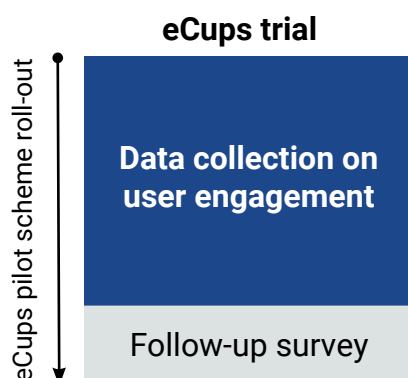
Follow-up survey

We evaluated the effectiveness of the eCups pilot by conducting a descriptive analysis that draws both on data collected via the eCups app and the follow-up survey. The goal of the descriptive analysis is to understand staff and students' reusable cup use patterns, their motivation to participate or not in the scheme, and potential barriers encountered.

Findings

Promoting the take-up of reusable cups

To better understand how to increase the take-up of reusable cups, we first discuss the results from the trial that examines the effect of discounts on reusable cup purchases. We then compare the socio-demographic profiles of those who adopted eCups and those who did not to understand the differences between them. In addition, we examine the motivations of getting eCups (and other reusable cups) among those who own reusable cups to understand what drives individuals towards getting reusable cups. To better understand why some individuals did not adopt reusable cups, we also assess the barriers to getting reusable cups among those who do not currently own reusable cups and the factors that would make them more likely to adopt reusable cups. Finally, we provide recommendations on how to promote the take-up of reusable cups more effectively based on the findings from both the trial and the survey.

Experimental results

In this section, we present the main experimental findings from the trial that assessed the effect of discounts on reusable cup take-up. A sample of 38,096 staff and students were randomly assigned to either the control group (12,698), the 10% discount group (12,694), or the 50% discount group (12,704), and were sent an email according to their assigned group. Overall, the email open rates were considerably high, with 28,082 out of 38,096 (73.7%) individuals contacted opening their emails. As the email subject line was identical, the likelihood of opening the email was similar between the three groups (ranging from 73.0% to 74.3%), indicating that the randomisation was properly conducted.

Over the trial period, a total of 364 eCups were sold. 258 eCups were sold at full price, 16 were sold with a 10% discount, and 90 with a 50% discount. In general, the sales of eCups were decreasing over time following the launch of the trial in February 2023.

> *Tables detailing the email open rates by experimental groups and the breakdown of eCup sales by month, price, and location are available in the appendix (see Table B1 and B2)*

The graph below shows the effect of providing discounts on the uptake of reusable cups. Our analysis shows that reducing the upfront cost of reusable cups had, surprisingly, a statistically significant negative effect on their uptake. Compared to the control group, the uptake of eCups was significantly lower in both of the treatment groups. This result should be interpreted with caution, however, as the uptake of eCups was in general very low (less than 1% of trial participants on average) and the negative effect observed can be potentially explained by one or both of the following:

- Providing financial incentives, such as discounts, may have discouraged some students who would have purchased a reusable cup in the absence of a discount for their own desire to be environmentally friendly. For example, financial incentives can make prosocial behaviours seem less socially desirable, thus undermining people's intrinsic motivation (see, for example, Frey & Oberholzer-Gee (1997) and Chao (2017)).

- Individuals who were offered a discount (i.e., those in the treatment groups) may have intentionally or unintentionally purchased a cup at full price rather than redeeming their discount. For instance, since the price of an eCup without discount (i.e., €3.00) is already low compared to other reusable cups sold on campus (which on average cost €8.50 each), the discount may not be sufficiently large to be worth the hassle of going through the process of redeeming the discount. Some students might have also purchased the cup on-the-go and forgotten about their discount, or were simply not aware of having one and paid the full price. As our outcome of interest (i.e., whether one purchased an eCup) is not directly linked to individual students and rather derived from eCups sales data (based on the price charged to students), those in the treatment groups who bought an eCup at the full price would be recorded as having purchased the cup as control participants, when they may have been treatment participants. In other words, the uptake of eCups may be overestimated for the control group (and underestimated for the treatment groups).
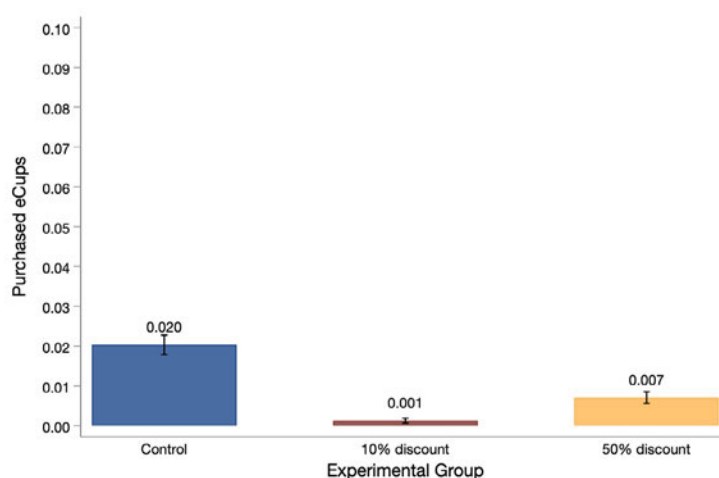
📎 *For the table outlining the effect of discounts on the uptake of reusable cups is available see Table B3).*

Notably, between the two treatment groups, those who received a higher discount (50%) were significantly more likely to purchase an eCup than those who were offered a lower discount (10%). This result can be potentially explained by one or more of the following:
- A 10% discount (which translated to €0.30) may be too small to drive behaviour changes. In other words, those in the 10% discount group may only be as motivated as those in the control group, and less motivated than those in the 50% group to purchase an eCup. Additionally, some of those in the 10% discount group who purchased an eCup may have purchased it at full price as they did not think it was worth the hassle to redeem the discount.
- Considering that providing a discount may have discouraged some people from purchasing reusable cups (because it made the action less socially desirable), a net negative effect on the uptake of reusable cups is more likely (and larger) with a 10% discount than with a 50% discount because the positive effect (i.e., financial benefits) of the 10% discount is lower than that of the 50% discount.

Overall, the results from the trial show that providing discounts does not lead to higher reusable cup uptake, suggesting that there may be other factors more important than price. In the following section, we investigate what these factors are by examining the key barriers and enablers and comparing the socio-demographic profiles between those who adopted eCups and those who did not.

Socio-demographic profiles of eCups adopters and non-adopters

In this section, we investigate and compare the profiles between those who purchased eCups and those who did not (including those who already have other reusable cups and those who do not have any reusable cups) to better understand both the adopters and the non-adopters. The table below provides summary statistics on the socio-demographic profiles of eCups users, other reusable cup users, and non-reusable cup users using data from the follow-up survey. Notably, it is observed that the profiles of eCups and non-eCups reusable cup users are rather similar. Compared to non-reusable cup users, they were more likely to report that it is important for them to live a sustainable lifestyle, more likely to be female and postgraduates, and more likely to get hot beverages on campus more often.

eCup user

Strong pro-environmental identity

More likely to...
- be a female — 79.3%
- be a student — 52.7%
- be a postgraduate — 55.2%
- study in the College of Science — 24.1%

Typically buys hot beverages on campus 1-4x a week

n=111

Other reusable cup users

Strong pro-environmental identity

More likely to...
- be a female — 71.6%
- be a student — 44.3%
- be a postgraduate — 51.7%
- study in the College of Science — 27.9%

Typically buys hot beverages on campus 1-4x a week

n=334

Non-reusable cup users

Weak pro-environmental identity

More likely to...
- be a female — 56.3%
- be a student — 53.8%
- be a postgraduate — 39.5%
- study in the College of Health and Agricultural studies — 25.6%

Typically buys hot beverages on campus 1-4x a week, but 15% never gets hot beverages

n=80

Motivations for purchasing reusable cups

To understand what drove eCups users to purchase their reusable cups, we examine their motivations. We found that reducing single-use cup waste was cited as the top motivating factor, followed by the bring-your-own-cup (BYOC) discounts at coffee shops on campus. About 40% of eCups users also reported the rewards offered through the eCups app to have motivated them to make a purchase, though only about 9% regarded the ability to track the number of single-use cups saved on the eCups app as a motivating factor.

Interestingly, we found that the motivating factors are similar for eCups adopters and other reusable cup adopters. Like eCups adopters, other reusable cup users also cited reducing single-use cup waste as the top motivating factor, followed by BYOC discounts. Notably, for both eCups and other reusable cup users, the price of the reusable cup does not appear to be an important motivating factor for reusable cup purchase, reinforcing our main trial finding and highlighting the difference in enablers between those who own reusable cups and those who do not. The former group appears to be primarily driven by pro-environmental attitudes whilst the latter are likely to be more motivated by factors concerning economic benefits and convenience (as discussed in the following section).

Motivation to get an eCup

	Share of eCups users
Reduce waste	0.784
BYOC discount	0.559
Ecup rewards	0.396
Convenience	0.207
Cup design	0.162
Cup price	0.162
Other	0.090
Tracking ability	0.090

n = 111

Motivation to get a reusable cup

	Share of other reusable cup users
Reduce waste	0.865
BYOC discount	0.392
Convenience	0.311
Cup design	0.246
Other	0.108
Cup price	0.021

n = 334
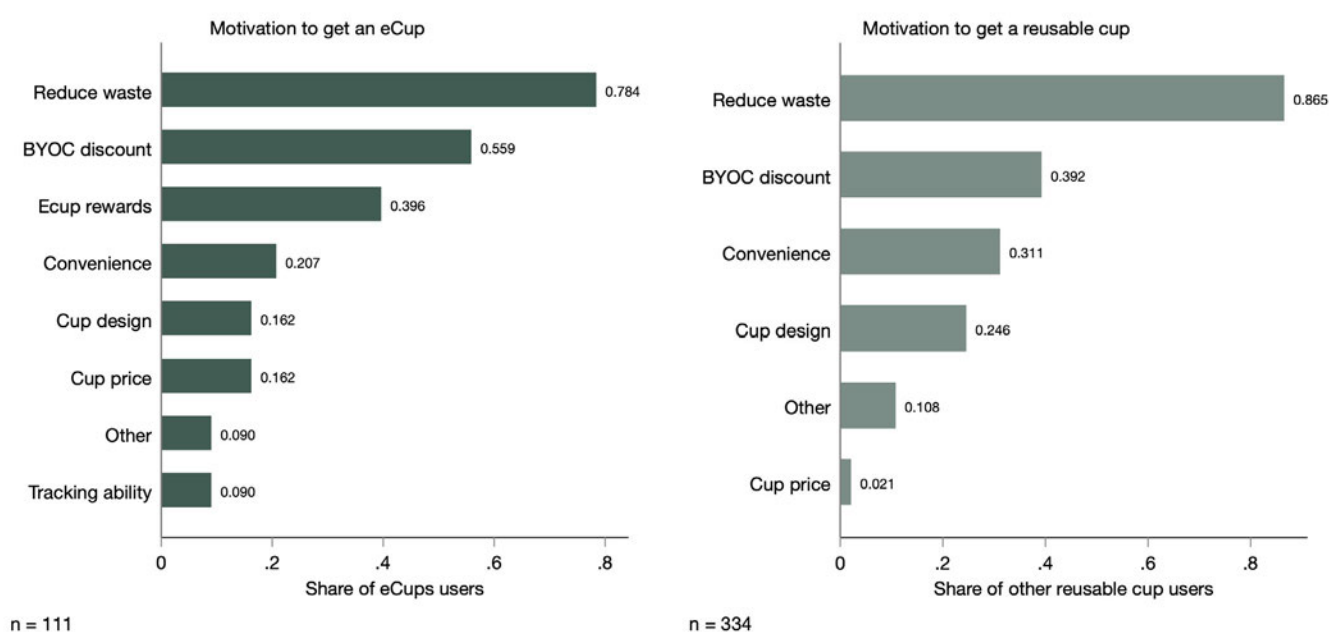
Barriers to purchasing reusable cups

To better understand why some individuals did not adopt eCups (and other reusable cups), we assess the barriers to getting reusable cups among those who do not currently own reusable cups as well as the factors that would make them more likely to adopt reusable cups.

Among the key barriers reported by those who do not have reusable cups, the most commonly cited are convenience factors, such as they would forget to bring the reusable cup to campus (reported by more than half of them), followed by the inconvenience of using reusable cups and reluctance to clean the cup (cited by 35% and 27.5% respectively).

In terms of the factors that would make them more likely to adopt reusable cups, more than half of those who do not currently have reusable cups cited bring-your-own-cup (BYOC) discounts at coffee shops on campus. A sizable proportion of those respondents also mentioned the ability to earn rewards when they use reusable cups on campus (47.5%), being given a reusable cup for free (46.3%), and having a reusable cup deposit & return scheme on campus (43.8%).

Barriers to getting a reusable cup

	Share of non-reusable cup users
Would forget to bring	0.550
Inconvenient to use	0.350
Don't want to clean	0.275
Reusable cups are expensive	0.250
Prefer single-use cup	0.150
Other	0.125
Perceived non-impact	0.100
Prefer regular mugs	0.050
Don't buy hot drinks	0.050
Shops don't accept	0.050
Chemical smell/taste	0.025

n = 80

Factors that would make reusable cup adoption more likely

	Share of non-reusable cup users
BYOC discount	0.525
Ability to earn rewards	0.475
Free reusable cup	0.463
Deposit & return scheme	0.438
Other	0.162
None	0.112
Info on environmental benefits	0.050

n = 80

Conclusions

While the results from the trial show that providing discounts on reusable cups had, surprisingly, a significantly negative effect on their uptake, survey results reveal that those who purchased eCups were primarily motivated by pro-environmental attitudes rather than economic factors. This group of individuals who purchased an eCup within the first two months of the eCups scheme being introduced can be considered as early adopters as eCups are not generic reusable cups, but rather a new and innovative reusable cup scheme that was not previously known by staff and students at the university. In other words, discounts did not appear particularly effective at encouraging reusable cup take-up as the early adopters did so mainly because of environmental motivations.

As a reusable cup scheme becomes more established and early adopters start using them, behaviourally-informed strategies such as providing reusable cups for free, highlighting the ease of use of reusable cups, and norm-based messaging could potentially encourage late adopters to take them up, especially amongst those who do not have strong pro-environmental attitudes.

Our review of the key barriers and enablers related to the take-up of reusable cups also suggest that everyone (i.e, both early and late adopters) could benefit from a system that makes reusable cups more convenient to use. For example, a deposit and return scheme could directly address key barriers such as students forgetting to bring the reusable cup and their reluctance to clean the cup.

Taken together, encouraging the take-up of reusable cups might be more effective if a multifaceted approach is adopted. In the short term, campaigns should focus on pro-environmental messaging targeting early adopters who are generally motivated by reducing waste. In the medium to long term, efforts should target late adopters who have weak pro-environmental attitudes through campaigns that highlight the economic benefits and convenience of reusable cups.

Encouraging the sustained use of reusable cups

Having considered how universities can effectively encourage the take-up of reusable cups, we next turn our focus to the sustained use of reusable cups. To better understand how to encourage individuals to use their reusable cups regularly, we evaluate the eCups scheme as an example of an initiative that is designed to motivate reusable cup use over time.

In this section, we first analyse eCups users and their patterns of use over time. We then assess users' experience of the eCups app, which is a distinctive feature of the eCups scheme that is linked to the eCups and includes functionalities that are designed to promote regular usage. Next, we discuss factors that hinder and encourage the sustained use of reusable cups and examine individuals' feedback on how the eCups scheme can be improved. We also assess the economic and environmental viability of the eCups scheme and review the advantages and challenges of alternative schemes being trialled at other universities. Finally, we provide recommendations on how to effectively promote the sustained use of reusable cups over time.

eCups frequency and patterns of use

To better understand the level of user engagement with the eCups scheme and the potential impact it can have, it is important to investigate eCups use.

Over the trial period, 219 individuals were registered with eCups and a total of 761 refills were recorded via the eCups app. Based on follow-up survey data, it is estimated that there were 1,384 actual eCups refills since eCups users reported that they only recorded their refills on the app 55% of the time.

Overall, the take-up of eCups marginally decreased over time and average eCups use remains low in general, as shown in the graph below.

Frequency of eCups use by week
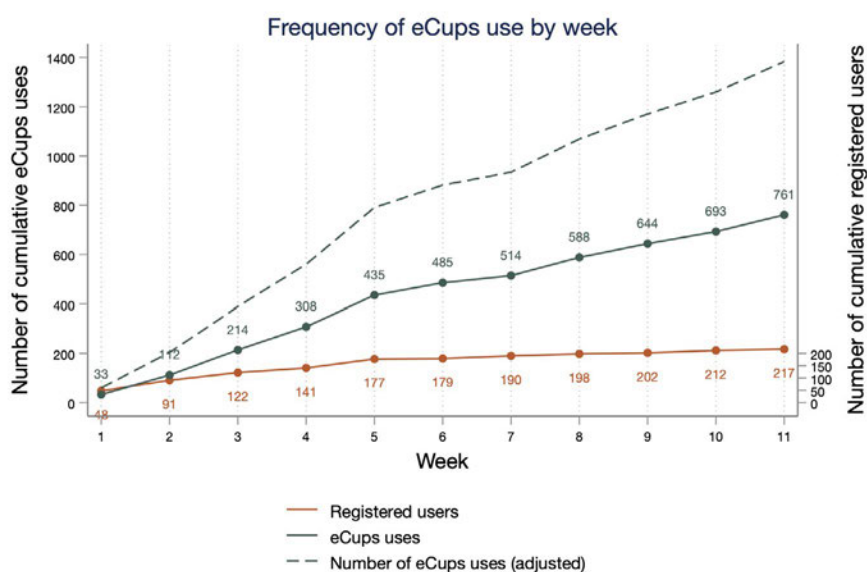
While the average number of eCups refills is low, usage was not equally distributed across eCups users. eCups app data revealed that most eCups users did not appear to have used their cups frequently. As shown in the graph below, over the trial period, about half of the users have either not used their eCups or used it only once, and about 90% of the users have used their eCups less than 10 times.

n = 219
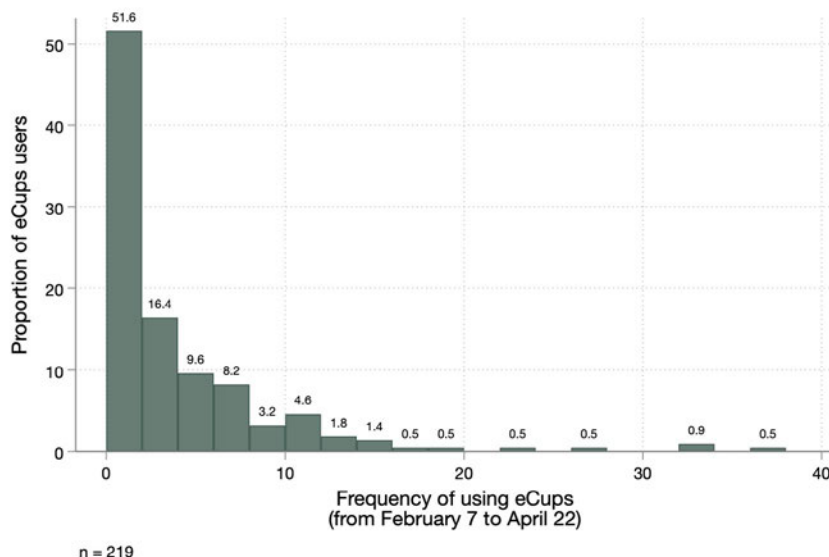
To further investigate the patterns of eCups use among different user profiles, we categorised users into four groups based on the frequency of their eCups uses as follows:
- **No engagement** (i.e., registered but never used eCups)
- **Low engagement** (i.e., used eCups less than once a week)
- **Moderate engagement** (i.e., used eCups at least once a week)
- **High engagement** (i.e., used eCups at least twice a week)

The table below provides summary statistics on the socio-demographic profiles of eCups users with low, moderate, and high engagement.

Notably, it is observed that those with high engagement were more likely to report that it is extremely important for them to live a sustainable lifestyle and more likely to buy hot beverages on campus more often (irrespective of their use of eCups). On average, they also purchased their eCups at a higher price compared to those with low and moderate engagement, suggesting that those who got their eCups for free may have valued them less and thus use them less often.

Together, these observations reinforce the idea that most active users are early adopters with strong pro-environmental attitudes and that discounts may have discouraged some individuals from regularly using their reusable cups by making the behaviour seem less socially desirable. Overall, the patterns of eCups use among different user profiles suggest that in the long run, it may actually be more sustainable to keep the price of reusable cups at full price so that people who will use them more regularly and thus overcome the break-even point where reusable cups have a lower environmental cost than disposable cups will be self-selected into the scheme. While selling reusable cups at discounted prices or giving them out for free may get more people to own them, it might actually be less environmentally sustainable as these individuals are unlikely to use them regularly.

Minimally engaged users

Moderate pro-environmental identity

Bought an eCup for €1.50 on average

More likely to...

- ♀ be a female — 85.2%
- 🎓 be a student — 59.3%
- 📜 be a postgraduate — 50%
- ⚛ study in the College of Science — 31.3%

Most likely to buy hot beverages on campus 1-4x a week

n=111

Moderately engaged users

Weak pro-environmental identity

Bought an eCup for €1.97 on average

More likely to...

- ♀ be a female — 78.6%
- 🎓 be a student — 44.4%
- 📜 be a postgraduate — 58.3%
- 🌱 study in the College of Health and Agricultural studies — 33.3%

Most likely to buy hot beverages on campus 1-4x a week

n=26

Highly engaged users

Strong pro-environmental identity

Bought an eCup for €2.05 on average

More likely to...

- ♀ be a female — 76.9%
- 🎓 be a student — 53.9%
- 📜 be a postgraduate — 53.6%
- ⚖ study in the College of Social Sciences and Law — 42.9%

Most likely to buy hot beverages on campus 1-4x a week, but 15% never gets hot beverages

n=8

In addition, we examine the number of cumulative eCups uses for each of the user profiles, as shown in the graphs below. While the number of cumulative eCups uses increased steadily over time for all three groups, it is clear that highly engaged users used their eCups most frequently on average. By the end of the trial period, 8 highly engaged users had used their eCups a total of 157 times (i.e., about 20 times per user over 11 weeks), compared to users with low (n = 111) and moderate engagement (n = 26) who had used their eCups a total of 353 and 251 times respectively (i.e., about 3 and 10 times per user over 11 weeks respectively).

Frequency of eCups use by week (Low engagement)

Number of cumulative eCups uses values: 33, 56, 78, 88, 100, 102, 105, 107, 108, 111, 111 (registered users); 57, 68, 128, 180, 237, 252, 261, 289, 310, 332, 353 (eCups uses)

n = 111

Frequency of eCups use by week (Moderate engagement)

Values: 4, 14, 15, 18, 18, 19, 22, 23, 26 (registered users); 21, 53, 80, 120, 136, 147, 171, 199, 222, 251 (eCups uses)

n = 26

Frequency of eCups use by week (High engagement)

Values: 2, 3, 4, 6, 6, 6, 6, 7, 7, 8 (registered users); 21, 23, 33, 48, 78, 97, 106, 128, 135, 139, 157 (eCups uses)

n = 8

— Number of registered users
— Number of eCups uses
-- Number of eCups uses (adjusted)

We also assessed the average number of eCups uses per user for each of the user profiles, as shown in the graph below. While we found a decreasing trend in eCups use over time for all user profiles in general, there are a number of differences worth noting between different user profiles. For highly engaged users, despite a decrease from about 7 to 4 eCups uses on average between the first and second week, they were able to sustain their level of regular use for a month before it gradually decreased. On the other hand, moderately engaged users appeared to be able to regularly use their eCups every week, but only for about once a week. For those who had low engagement with the scheme, their eCups were practically not used after the first week of joining the program.

Frequency of eCups use per user by week
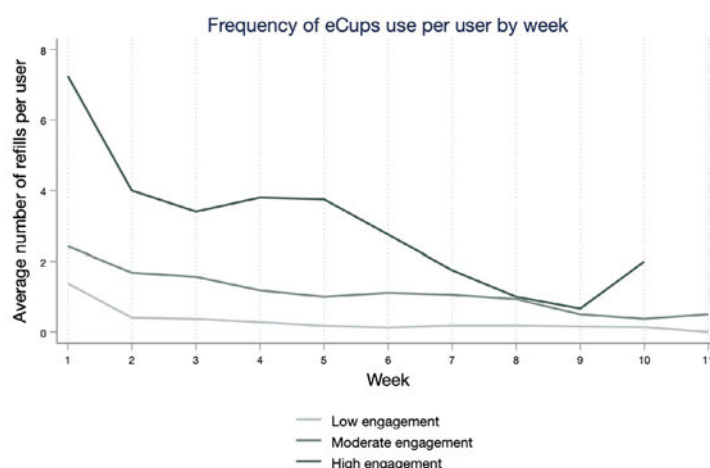
While eCups usage appears low and unequally distributed across users, it does not seem to differ compared to generic reusable cup usage. Indeed, the self-reported usage is relatively similar between eCup users and generic reusable cup users. As shown in the graph below, about 12% of both eCups and other reusable cup users reported using their cups 10-40% of the time. While a higher proportion of eCups users used their cups 40-80% of the time, a larger share of other reusable cup users reported using their cups 80-100% of the time. This suggests that the current eCups scheme does not perform worse than generic reusable cups; however, it does not appear to motivate users to use their reusable cups more often either.

Frequency of using eCups or other reusable cups

n = 111 (eCups users), 334 (other reusable cup users)
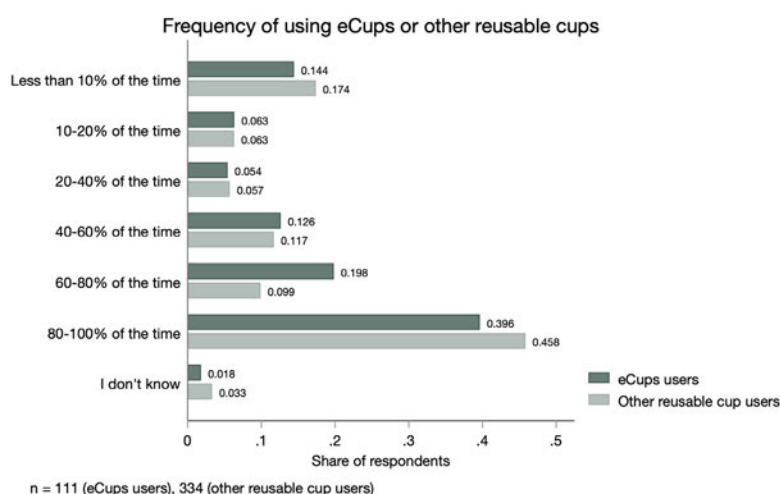
Having examined eCups usage, we turn to the eCups mobile app use (which is a distinctive feature of the scheme) in the following section.

User experience of the eCups app

A unique feature of the eCups scheme is the eCups app which is linked to the eCups and includes functionalities that are designed to promote regular usage. In this section, we assess users' experience of the app to better understand its usage and effectiveness.

Based on self-reported data, we found that most eCups users have downloaded the app (69.4%) and most of those who have downloaded the app have registered their eCups on the app (85.7%).

To understand why some users did not download the app or register their eCups on the app, we examine the main barriers they face. For those who have not downloaded the eCups app, half of them reported that it is because they did not know it exists and about a quarter mentioned that they did not want to have the app on their phone. For those who have downloaded the eCups app but have not registered their eCups, the most commonly cited reasons are forgetting to register and that registering the cup to the app is complicated.

As the primary barriers to downloading the app and registering eCups on the app are a lack of awareness and forgetfulness, it is important for universities to engage in intensive promotional efforts when a new reusable cup initiative is rolled out in order to raise awareness about the scheme and ensure individuals understand how it works. In addition, when introducing new reusable cup schemes that are relatively complex (such as the eCups scheme), it is important to ensure that the onboarding process is as smooth and seamless as possible (e.g., the registration and scanning procedures) to minimise dropout and maximise engagement.

Barriers to downloading the eCups app

Don't know it exists	0.500
Don't want to have app on phone	0.265
Other	0.206
Don't fully understand the benefits	0.206
Downloading is difficult	0.147

Share of eCups users who did not download app

n = 34

Barriers to registering eCups to the app

Forget to register	0.364
Registering is complicated	0.364
Other	0.273
Don't know the cup has to be registered	0.182
Don't want to register to app	0.000

Share of eCups users who did not register their cups

n = 11

Next, we turn our focus to the app usage among those who have downloaded the app and registered their eCups. Interestingly, we observe two main polarising groups – those who reported that they used the app to record their refills less than 10% of the time (24.2%) and those who recorded their refills 80-100% of the time (40.9%). In other words, it appears that users either like and use the eCups app, or not at all. In terms of the perceived effectiveness of the eCups app, we observe a similar pattern of polarisation between users. There are two main groups of users – those who said the eCups app did not motivate them to use their reusable cups more frequently (37.8%) and those who said it did (33.3%).

For the graph showing the distribution of perceived effectiveness of the eCups app see Graph B6.

Frequency of using eCups app to record refills

	Share of eCups users
Less than 10% of the time	0.242
10-20% of the time	0.030
20-40% of the time	0.076
40-60% of the time	0.121
60-80% of the time	0.106
80-100% of the time	0.409
I don't know	0.015

n = 66
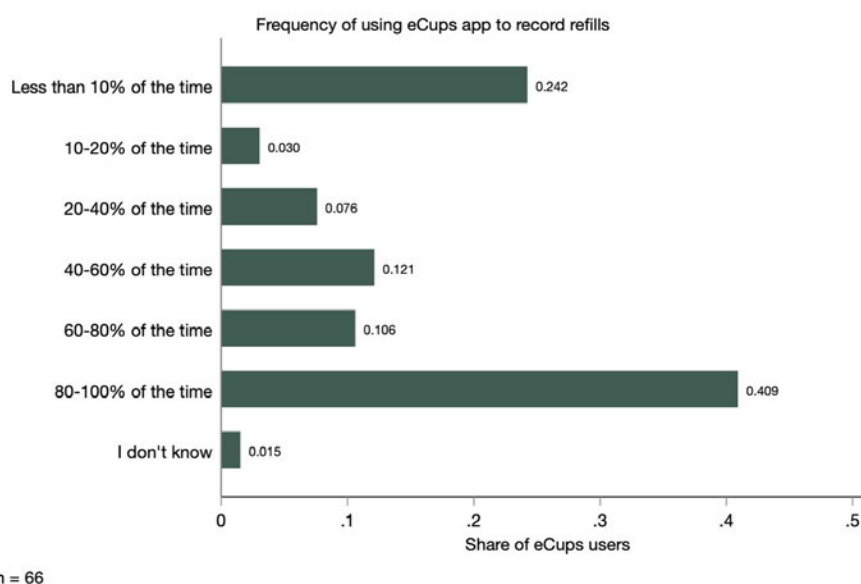
To understand what hinders users from regularly using the eCups app to record refills, we examine the barriers to eCups app use reported by users. We found that the most cited barrier is forgetting to scan the QR code at the till (45.9%). About a third of the eCups users also said that the shops they usually go to on campus do not participate in the eCups scheme and that scanning the QR code at the till is inconvenient.
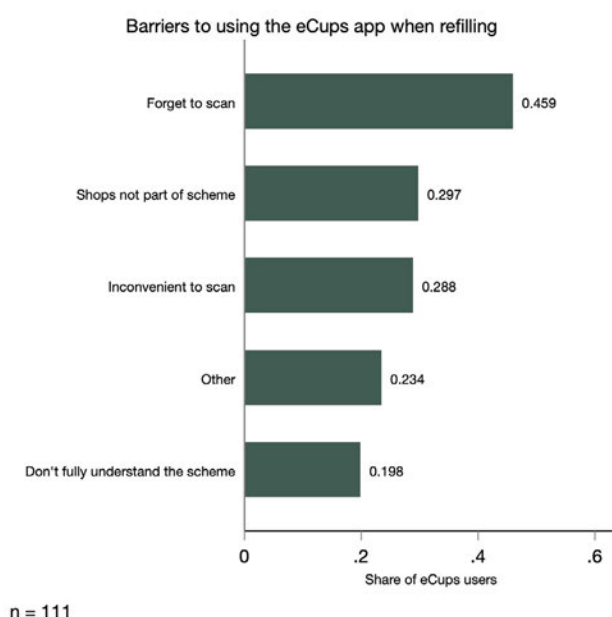
Barriers to using the eCups app when refilling

	Share of eCups users
Forget to scan	0.459
Shops not part of scheme	0.297
Inconvenient to scan	0.288
Other	0.234
Don't fully understand the scheme	0.198

n = 111

Nevertheless, despite more than one-third of the users reporting that the app did not motivate them to use their eCups more often, the majority of eCups users thought the eCups scheme is very or somewhat effective in reducing single-use cup waste on campus.

Perceived effectiveness of eCups scheme in reducing single-use cup waste on campus

Category	Share of eCups users
Very effective	0.153
Somewhat effective	0.640
Neither effective nor ineffective	0.081
Somewhat ineffective	0.099
Very ineffective	0.027

n = 111
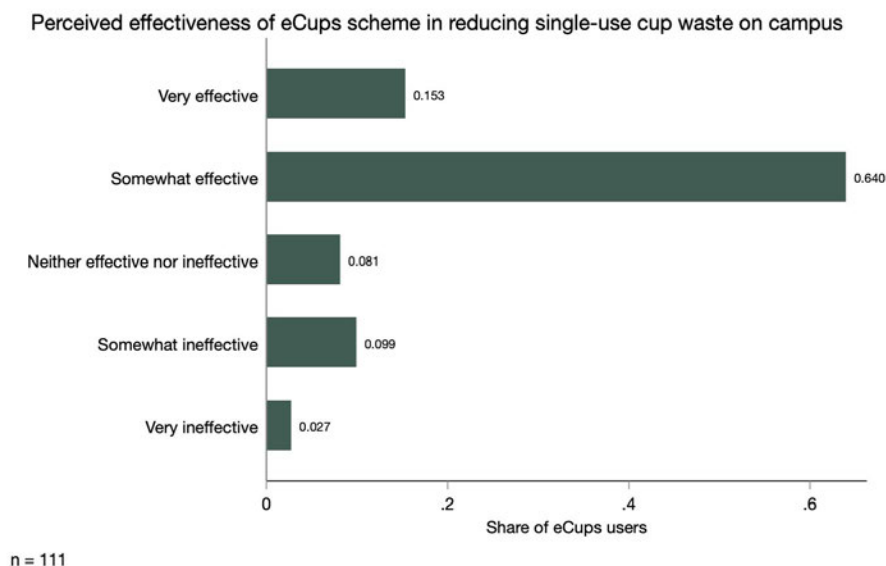
While the eCups scheme was perceived by most as effective in reducing waste in general, we observed a pattern of polarisation among users in terms of app usage and perceived effectiveness of the app. We also found that forgetfulness and convenience factors hindered users from regularly using the eCups app to record refills. It is therefore important to ensure the user experience of the app is as seamless as possible and to raise awareness about how it works. Since the eCups app did not appear to be effective in promoting reusable cup use, we examine the barriers to using reusable cups regularly in the next section.

Key barriers to the sustained use of reusable cups

In this section, we examine what hinders users from using their eCups on a regular basis. We found that the top barrier to using reusable cups regularly that eCups users encounter is forgetting to bring the cup to campus. A fair amount of eCups users also cited forgetting to rinse their reusable cups and thus having to use single-use cups instead as one of the barriers.

Notably, the barriers eCups face are very similar to those experienced by generic reusable cup users. Like eCups users, the primary barriers reported by other reusable cup users also concern convenience factors. This observation indicates that the current eCups scheme does not directly solve the main barriers to the sustained use of reusable cups.

Nevertheless, despite more than one-third of the users reporting that the app did not motivate them to use their eCups more often, the majority of eCups users thought the eCups scheme is very or somewhat effective in reducing single-use cup waste on campus.

Barriers to using eCups regularly

	Share of eCups users
Forget to bring	0.568
Forget to clean	0.387
Other	0.270
Shops don't accept	0.135
Inconvenience	0.081
Don't understand the scheme	0.072
Prefer single-use cup	0.009

n = 111

Barriers to using reusable cup regularly

	Share of other reusable cup users
Forget to bring	0.665
Other	0.249
Forget to clean	0.216
Inconvenience	0.108
Shops don't accept	0.036
Prefer single-use cup	0.021

n = 334
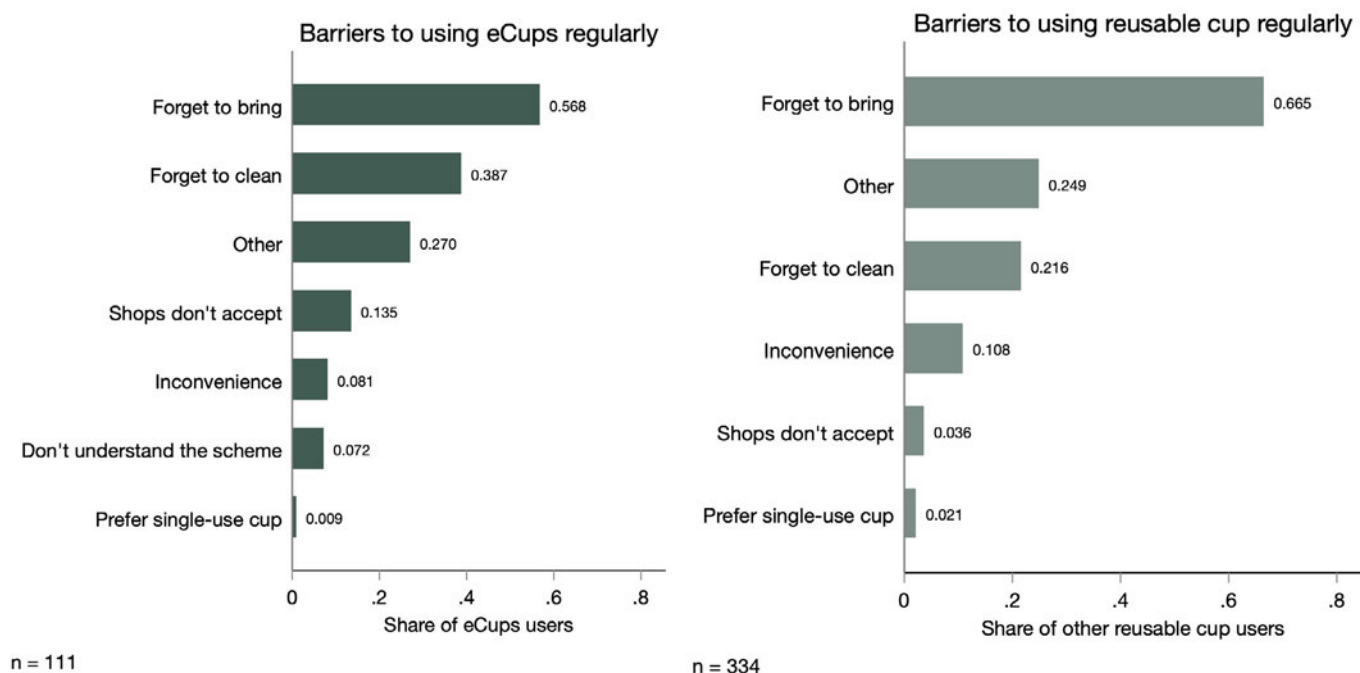
As the current eCups scheme does not appear to fully solve the primary barriers to using reusable cups regularly (i.e., those concerning inconvenience and forgetfulness), we next turn to examining the factors that would help encourage the sustained use of eCups.

Key enablers for the sustained use of reusable cups

To better understand what will encourage the sustained use of reusable cups, we discuss the key enablers for the regular use of eCups in this section. For current eCups users, the most cited enablers include a ban on single-use cups (47.7%), a deposit and return scheme (45.9%), and increased rewards offered via the eCups app (43.2%).

Enablers for using eCups regularly

Enabler	Share of eCups users
Ban on disposable cups	0.477
Deposit & return scheme	0.459
Increased eCups rewards	0.432
Other	0.225
Timely reminders	0.162
Info on environmental benefits	0.099

n = 111
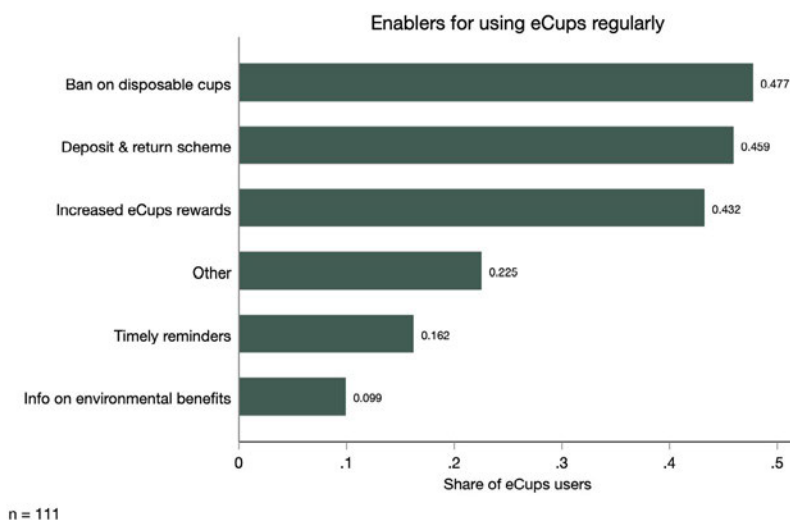
We also assessed and compared the likelihood of using eCups going forward between current eCups users, other reusable cup users, and non-reusable cup users. We found that most current eCups users (about 80%) are likely to continue using their eCups (along with the eCups mobile app). For those who are not currently involved in the eCups scheme, less than half of them reported that they are likely to participate in the future.

Likelihood to participate in the eCups scheme

	eCups users	Other reusable cup users	Non reusable cup users
Very likely	0.532	0.117	0.112
Somewhat likely	0.270	0.335	0.375
Neither likely nor unlikely	0.090	0.123	0.150
Somewhat unlikely	0.081	0.189	0.100
Very unlikely	0.027	0.237	0.262

Share of respondents

n = 111 (eCups users), 334 (other reusable cup users), 80 (non-reusable cup users)
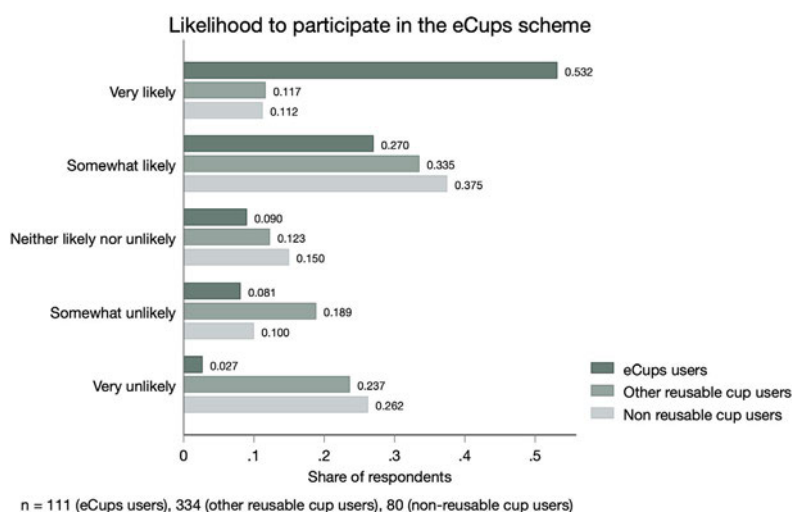
📎 *More information on what might make non-eCups users participate in the eCups scheme in the future can be found in the appendix (see Graph B7-B10).*

Considering that many of those who are not currently involved in the eCups scheme said that they are unlikely to participate in the future, it is important to assess the ways the current scheme can be improved. In the next section, we discuss individuals' feedback on how the eCups scheme can be improved.

How could the eCups scheme be improved?

This section considers the feedback gathered from students and staff who participate in the scheme and those who do not, together providing valuable insight for how the eCups scheme could be improved moving forward.

Increase shop participation and availability of eCups
Students expressed a strong desire for the increased adoption and availability of eCups on campus. They emphasised the need to roll out the scheme to all shops, including campus coffee stops and Student Union (SU) shops. Their responses suggested that the increased acceptance of eCups at more locations would make it easier to participate in the scheme, as purchasing coffee is often a spontaneous activity.

Roll out to SU shops and ensure availability at ALL shops on campus"
- Participant A from UCD

Easier scanning process
Participants of the eCups scheme highlighted the need for improvements in the scanning process of eCups, particularly with regards to the accessibility of QR codes at shops. They suggested making the scanning process more user-friendly by placing the scanning step after the point of sale, and having them in more accessible places at the cafes. Furthermore, some students suggested ways to streamline the scanning process, such as only having to scan the app and not the cup or eliminating the scanning step completely, which can become tricky if the shop is busy.

"Between the QR code at the till and scanning the other coffee app Squid and paying for your coffee it can get pretty hectic if there is a line behind you. If the eCups scheme could be simplified and perhaps didn't involve scanning it would likely work a bit better."- Participant B from UCD

Improve the design of eCups
Students expressed the desire for improved design of eCups, from an aesthetic and a functional point of view. Respondents suggested incorporating different choices of colours for both the cup and lid to make it more visually appealing and fashionable. Some participants specifically mentioned their preference for glass cups, as they believed they offer better taste quality compared to plastic cups. Others suggested having different cup types to differentiate between various types of drinks. Regarding the functionality of the eCups, students highlighted the need for better insulation and more secure lids to prevent spills. The simple design and low quality of eCups was also widely mentioned as a barrier to switch to the eCups scheme by students who own another reusable cup, which may be better-looking or more personalised.

"Make them look nicer, if you make it a fashion thing with different choices of look you can make it more 'hip' to bring one" – Participant C from UCD

Increase opportunities to clean eCups

Respondents, particularly students commuting to campus, highlighted the need for more opportunities such as "rinse stations" to wash and clean their reusable cups. The lack of accessible and hygienic spaces for cup cleaning was a common concern among students participating in the eCups scheme as well as students who use other, generic reusable cups. They emphasised the inconvenience of using bathroom facilities for washing cups and the burden of carrying dirty cups around throughout the day. Some students expressed their interest in a deposit and return scheme as an alternative, so that they could opt for a more environmentally friendly alternative without having to clean them.

> "It would be helpful to have more places to clean the cups. That is my main issue with reusable cups" *– Participant D from UCD*

Better rewards and incentives to use cup

Students expressed the need for better rewards and incentives to encourage the use of eCups. Suggestions included banning or significantly increasing the price of single-use cups to create a stronger incentive for individuals to switch to reusable options. Some participants mentioned the need for a more convenient app system, as they found it tedious to have multiple apps for different rewards systems. They suggested integrating the eCups scheme with existing apps like Squid, which offers better rewards (free drink after every 10th purchase instead of after every 12th as in the case of eCup) to create a unified reward system.

> "I don't really get the incentive to use eCups. I already get a discount at the till for using a reusable cup." *– Participant E from UCD*

Integration of the eCups scheme with existing reusable cup

A recommendation often expressed by students who already own a reusable cup is the opportunity to participate in the scheme, however without the need to purchase a new reusable eCup. They highlighted the convenience and familiarity of using their own cups and saw the potential benefit of extending the scheme to include these existing cups. By integrating the eCups scheme with various types of reusable cups, students believed it would enhance the overall accessibility and appeal of the initiative.

> Can you use it with a regular reusable cup? I like my own cup, so would only use the eCups scheme with it." *– Participant F from UCD*

Increase awareness

Lastly, students emphasised the need for increased awareness about the eCup initiative on campus. They suggested various methods to achieve this, such as making more announcements, displaying posters, and conducting widespread advertising campaigns. There was also a desire for improved information dissemination, both through the app and other communication channels, to provide clearer instructions on how to initially register to the scheme. Lastly, some respondents suggested giving out free eCups to incoming students to create momentum and make participation in the scheme the norm.

> "I am sure the eCup scheme has been advertised, however I missed it! Continue to advertise it as it's a great idea!" *– Participant G from UCD*

Cost-benefit analysis

Economic costs and benefits for the university

To assess whether it is beneficial for universities to implement a reusable cup initiative, we conducted cost-benefit analysis on the eCups scheme. We found that, over the trial period (i.e., February and March 2023), the total cost of running the eCups scheme was €2,302 and the total revenue was €952, resulting in a net cost of €1,350. A total of 364 eCups were purchased and together they were used 1384 times over the trial period, translating into €3.71 spent per eCup adopted and €0.98 spent per disposable cup waste prevented.

Based on the cost and revenue figures from the trial, we also conducted a cost-benefit analysis on the eCups scheme using 1-year projected estimates for two different scenarios. In the conservative scenario, the estimated take-up of eCups was based on the trajectory observed in the trial period. In other words, we assumed a marginally decreasing downward slope based on eCups sales data in February and March 2023, and estimated the take-up of eCups in each month to be 59.65% of the preceding month. In the best case scenario, the estimated take-up of eCups was based on the raw sales figures recorded in the trial period and we assumed the take-up of eCups in each month to be 100% of the preceding month (i.e., the same monthly eCups take-up would be sustained for an academic year).

With conservative estimates, we estimated 556 eCups to be purchased and together used 6,148 times over a full academic year. The total cost of running the eCups scheme would be €3,431 and the total revenue would be €1,668, resulting in a net cost of €1,763. These figures translate into €3.17 spent per eCup adopted and €0.29 spent per disposable cup waste reduced.

In the best case scenario, we estimated 1,456 eCups to be purchased and together used 16,100 times over a year. The total cost of running the eCups scheme is estimated at €8,039 and the total revenue at €4,368, resulting in a net cost of €3,671. These estimates translate into €2.52 spent per eCup adopted and €0.23 spent per disposable cup waste reduced.

> *For the full cost-benefit analysis from the university's perspective, please refer to Table B4-B7 in the appendix.*

Economic costs and benefits for students and staff

On the other side of the equation, it is also important to examine whether it is beneficial for the users to participate in a reusable cup initiative. From the students' and staff's perspectives, we found that an initial investment of €3.00 on an eCup will pay for itself on the 10th use. Users receive a €0.15 discount on their beverage purchase every time they use their eCups (provided by most UCD outlets), accumulating their savings to €1.50 on their 10th eCups use. They are also eligible for a free beverage (worth €3.00) after every 10 eCups uses. In other words, as long as an eCup is used at least 10 times, students and staff will not only recoup their initial investment, but also enjoy a net benefit of at least €1.50. It is also likely that staff and students will recoup their initial investment sooner once the government latte levy (amounting to €0.20 per drink) is implemented.

> *For the full cost-benefit analysis from the user's perspective, please refer to Table B8 in the appendix.*

Estimated impact on waste reduction

Over the trial period, it is estimated that the eCups scheme prevented 1,384 disposable cup waste. Additionally, the decrease in the number of disposable cups entering the waste streams also helped contribute to a reduction in waste contamination on campus. Our calculations suggest that the eCups scheme has helped prevent approximately 2.55kg of disposable cup waste from causing waste contamination.

Under our projections, if the eCups were to be implemented for a full academic year, it will conservatively lead to 6,148 less disposable cups used and prevent about 11.31kg of disposable cup waste from causing waste contamination. In the best case scenario, the eCups scheme will help reduce disposable cup use by 16,100 times and prevent about 29.62kg of disposable cup waste from causing waste contamination.

Other benefits

Engaging in waste prevention initiatives, such as rolling out a reusable cup scheme, can positively impact the university's reputation and influence students' behaviours. Studies suggest that students are more likely to prevent and recycle waste when they perceive that their university shows leadership by engaging in environmental programmes or initiatives (Sallaku et al., 2019). Students' feedback and the eCups scheme's perceived effectiveness in reducing waste suggest that this trial may have helped establish a positive institutional image. While it is hard to quantify, this can, in turn, motivate students to put more effort into reducing waste in the long run.

How to make the scheme more viable?

While there are net financial costs to be borne by universities to implement a reusable cup scheme, there can be a net benefit from the university's perspective if the environmental benefits are internalised. For the trial period, our calculation suggests that there is a net benefit if each disposable cup waste reduction (and the decrease in waste contamination) is valued at more than €0.98. Under our 1-year projections, there would be a net benefit if each disposable cup waste reduction (and the decrease in waste contamination) is valued at more than €0.29 (in the conservative scenario) and €0.23 (in the best case scenario).

To improve the viability of the eCups scheme, universities should consider the following recommendations in order to minimise the costs and maximise the benefits of the initiative:

☑ Working with participating outlets to reduce the €1.00 handling fee charged on the sale of eCups

☑ Increasing the sale price of the eCups (if they continue to be sold as a reusable cup that users own as opposed to a deposit and return scheme). Importantly, based on our findings, increasing the cost of eCups would not only not negatively affect take-up (at least in the short term), but might actually self-select staff and students that are more likely to use the Cups more regularly, further improving the environmental viability of the scheme

☑ Ensuring that flexible contracts where prices are charged by waste collectors based on the weight of waste produced are used. Such contracts can help incentivise the reduction in the amount of waste produced and in waste contamination

☑ Designing and implementing more promotional campaigns that use insights from behavioural science to increase eCups take-up and use (e.g., through norm-based interventions)

Insights from other schemes

This section delves into the successes and challenges of the reusable cup schemes introduced at three prominent Irish universities: University College Cork (UCC), the University of Galway and Dublin City University (DCU). By analysing these distinct cases – the 2GoCup scheme introduced either as a complete replacement alongside the ban of single-use cups or simply as a sustainable alternative as well as the Vytal scheme of introduced at DCU –, we can gain a comprehensive understanding of the various approaches taken and evaluate their effectiveness in promoting sustainable practices.

University of Galway and the 2GoCup scheme

The University of Galway has embraced the 2GoCup scheme in the 2022/23 academic year as one part of its approach to combat the generation of single-use plastic waste in its cafés and restaurants. The University of Galway has adopted a gradual implementation of 2GoCups commencing in 2019. The 2GoCup scheme in combination with long-life cups and ceramic in-house catering options has resulted in the elimination of single-use cups in most campus restaurants since January 2023. Additionally, the university offers reusable cups to incoming first-year students, the University views the 2GoCup scheme as a convenient and eco-friendly alternative for those who forget their own cup at home.

In our interview conducted with the university, they mentioned the need to ban the use of disposable cups altogether, to completely eliminate single-use cups. In this regard, the University is procuring an additional supply of 2GoCups in advance of the next academic year and all restaurants will be required to eliminate single-use cups. Nevertheless, it is interesting to compare how leaving students with an option to opt for a reusable cup alternative while still having the disposable cup available poses different challenges. The advantages and shortcomings of the 2GoCup scheme in this context are summarised in the table below.

Advantages	Challenges
Environmental impact: the scheme reduced the use of single-use cups and provided an easy deposit-and-return alternative for when students forgot to bring their own reusable cups. Students and staff also received a 20c discount if they opted for a reusable cup alternative.	**Slow return rate:** Despite efforts to generate awareness and encourage students to bring back the cups, the return rate has not been as fast as desired, making the management of stock challenging.
Student engagement and behaviour change: The scheme has motivated sustainable behaviours among students in other domains. For example, they expressed interest in having microwaves and other facilities in catering locations to bring and heat their own food from home.	**Low uptake:** Ceramic cups, long-life cups (that are not branded 2Go Cups) and single-use cups also used by the campus community which impacts the uptake of the 2GoCup
Collaboration with catering contractors: The 2GoCup provided a scheme which is one of a number of schemes the university achieved to get catering contractors on board with. This was essential for successful implementation and ensuring consistent availability of reusable cups.	**Difficulties washing the cups:** A small number of operations without wash-up facilities are challenged and work continues to identify solutions for washing reusable cups.
	Training and awareness: There was a need for training catering staff on the scheme, particularly regarding charging the deposit and ensuring consistent messaging to students.

University College Cork (UCC) and the 2GoCup scheme

As part of their commitment to go completely plastic free, UCC announced the complete elimination of all disposable cups and plastic bottles in its operations throughout all of campus dining, shops and vending machines from January 2023. UCC introduced 2GoCup, a deposit and return scheme allowing students, staff, and guests to use reusable cups for a €2 deposit.

With the 2GoCup scheme, customers can conveniently order their hot beverage of choice, and leave a €2 cash or card deposit on top of their drink order to receive a 2GoCup. They can then return the cup to any participating outlet to receive the €2 deposit back or reorder and exchange for a new 2GoCup. While the introduction of the scheme was initially welcomed by students and resulted in a high uptake of cups given the complete ban of single-use plastics, it has also presented various challenges and learning opportunities, summarised below.

Advantages	Challenges
Environmental impact: As a result of the scheme, 18,000 2GoCups in circulation, 250,000 single-use cups and 80,000 bottles are avoided every three months.	**Lack of incentives or reminders to return them:** Given the small deposit fee, the lack of reminders or time limit in which they need to be returned, students are slow at returning the cups, making the management of stock challenging.
2GoCups are widespread outside campus: all KSG outlets around campus offer 2GoCups and are also widespread across Ireland, with over 400 shops participating in the scheme making it easier to return cups.	**Limited student adoption and preferences:** Students found the 2GoCups to be small and inconvenient for certain drinks. The lack of options available outside campus led students to purchase coffee elsewhere.
Flexible stock and free replacement of cups: UCC first introduced the scheme with 10.000 cups, however as the uptake increased, new stock could be flexibly added to optimise for the changing demand. Furthermore, if a cup gets damaged, 2GoCups offers an automatic replacement.	**Negative impact on sales:** Coffee sales went down 40% after introducing the scheme and banning disposable cups, affecting businesses and leading to layoffs. Students preferred buying coffee outside campus to avoid leaving a deposit or paying upfront costs for reusable cups.
Deposit cash or card: students can leave a €2 cash or card deposit, making it easy to use the scheme	**Increased workload for staff:** additional staff was required to communicate and explain the scheme to students.
Cost pushed down to students: Following the complete ban of disposable cups, 2GoCup offered a quick solution for those students who did not already have a reusable cup. Outlets do not have to invest in a stock. Participating in the scheme costs €1 per day per outlet.	**Increased communicational and promotional efforts required:** the scheme appears to require extensive communication effort, such as banners, signage and posters to increase awareness.
	Minimal cost savings through waste reduction: Made savings in waste generated from waste collectors who are paid monthly, however as bin companies offer fixed contracts, the reduction in waste did not influence the cost.

Dublin City University (DCU) and the Vytal scheme

DCU initially planned to introduce the 2GoCup scheme. However, the implementation of the 2GoCup scheme faced difficulties such as concerns about the increased workload of café staff and conflict with the university's cash-free campus. As returning the €2 cash deposits to students appeared too complicated from a practical standpoint, the university eventually opted for partnering with Vytal, a reusable cup and container system that is completely cashless and does not require a deposit. Furthermore, as opposed to the 2GoCup scheme, Vytal offers a complementary app to remind users to return their cups and track the cups in circulation. Since its introduction in February 2023, Vytal cups and containers are available at all their cafés and canteens around campus, including self-service canteens. As opposed to UCC, disposable cups are still available, however students get a discount if they opt for a reusable alternative.

Vytal offers a comprehensive variety of reusable cups and containers designed to fit all food and beverages, whether it is coffee, soup or burgers. To use the scheme, customers download the app on their mobile device and ask for a Vytal cup or container when ordering at a participating outlet or simply take one of the cups that are stacked at the self-service coffee stations. Each Vytal product contains a QR code, which is then scanned through the app and registered under the customer's account. No deposit fee is required, however customers do need to add their bank details to the app as there is a charge if the cup/container is not returned within 14 days. Vytal cups or containers can be returned to a participating outlet or "smart bin" within 14 days, no charges are deducted. A charge of €10 is applied, if a customer does not return their Vytal product within this timeframe. Vytal charges DCU a per cup use rate of ~ €0.15 per cup refill similar to the cost of a disposable cup/lid/sleeve etc.

The advantages and challenges DCU experienced regarding the introduction of the Vytal scheme as well as the challenges it faced are summarised below.

Advantages	Challenges
👍 **Environmental impact:** Within the first month of introducing the scheme, 107 staff and students registered to the scheme and refilled their cups 214 times.	👎 **Concerns about increased workload** There was some initial resistance from staff, who were concerned about increased workload related to scanning, collecting, and washing cups.
👍 **No upfront cost & financial benefits:** Students are not charged for the cups as long as they return them within 14 days.	👎 **Concerns about student compliance:** Initial concerns by staff were raised about customers taking the cups and containers from the self-service canteen without downloading the app or scanning the product or finding other ways to beat the system such as returning the lid but keeping the container.
👍 **Cashless:** The Vytal scheme is cashless, which fits the cashless campus of UCD and eliminates the deposit and return problem other schemes may have.	
👍 **High return rate:** The scheme achieved a return rate of 94% in this initial period. This suggests that charging people if they do not return the cups after 14 days rather than incurring an upfront cost is more incentivising.	👎 **Potential conflicts between canteen and supplier regarding stock:** Staff are incentivised to order a larger stock so as to not have to wash the cups so frequently, however the supplier needs to ensure the correct amount of stock is in circulation.

👍 **Variety and versatility of cups and containers:** The Vytal scheme offers a number of different cup sizes as well as containers suitable for carrying any food from soups to salads.

👍 **Independent use through self-service, smart bins and reminders:** Students are able to use the scheme at self-checkout restaurants, no staff is necessary to register it. Similarly, students can easily return them to "smart bins". The scheme is also effective in sending reminders to return the cups within the app.

👍 **Potential cost savings:** the replacement of single use cups with the Vytal cups should be cost neutral but there are additional savings by eliminating waste charges and costs related to waste contamination. The Vytal scheme covers costs such as the cost of cups and containers and transportation costs.

👍 **Meeting Climate Action Mandate:** As all single use ware in canteens are required to be eliminated in 2023 this scheme provide the ability to comply with this mandate.

👎 **Implementation and operational challenges:** The scheme poses operational challenges, such as staff training about the benefits, coordination, maintaining stock levels, regular collections of bins, and dealing with liquid in return bins.

👎 **Compatibility with visitor experience or events:** Finding solutions for visitors to participate in the scheme as well as events where beverages are typically provided pose challenges that need to be addressed.

👎 **Having to enter bank details in the app:** The app requires users to add their bank details to their account when registering, which represents a barrier.

👎 **Returning cups with liquids inside:** Students often do not empty the content of the cups before placing them into the collection bins. As a potential solution, DCU is considering stalling a liquid bin next to the return bins.

Overall, the trial findings from the universities in Ireland reveal the progress made in reducing waste generated by disposable coffee cups, the challenges faced in implementing reusable cup schemes, and most importantly, valuable insights for other universities to learn from.

Firstly, one common challenge experienced across universities is the need to maintain cups in circulation within deposit and return systems. While approaches like upfront deposits have shown some success in reducing cup loss, slow returns from consumers remain a significant issue. In contrast, schemes with time-sensitive penalties instead of upfront costs, like Vytal's, have initially proven effective in driving cup returns.

Secondly, effective communication and training also plays a crucial role in the success of these initiatives. Introducing reusable cup schemes or single-use cup bans at the beginning of the academic year and implementing robust communication campaigns through various channels, such as social media, posters, and signage, help raise awareness and foster a plastic-free campus environment.

Lastly, aligning the interests of staff members and addressing any misconceptions or concerns surrounding increased workload or disruptions to their working practices is vital. By providing clear communication and comprehensive training, universities can ensure staff engagement and support, which is essential for the smooth implementation and ongoing success of reusable cup schemes.

These key learnings provide a roadmap for future improvements. While any intervention that promotes sustainable behaviours is beneficial, as the above examples have shown, as long as single-use plastic cups are the default option, their uptake and impact will be limited.

Conclusions

Overall, our analysis indicates that the current eCups scheme is not worse than generic reusable cups, but it does not provide extra motivation for users to use their cups more frequently. The scheme also fails to fully address the challenges of inconvenience and forgetfulness associated with reusable cup usage. To promote regular use of reusable cups on campus, future interventions should focus on improving the user experience, raising awareness about the scheme and app, and adopting a multifaceted approach tailored to different user profiles.

For highly engaged users, interventions should aim to sustain their usage beyond the initial month. This can be achieved through reminders, personalised feedback on savings and waste reduction, and increased rewards. Users with low and moderate engagement require interventions that both increase and maintain their cup usage over time. Implementing a deposit and return scheme could help overcome barriers such as inconvenience and forgetfulness for these users. Additionally, implementing institutional policies like banning single-use cups on campus can be highly effective in promoting reusable cup usage.

Furthermore, analysing eCups usage patterns among different user profiles suggests that, in the long run, it may be more sustainable for universities to continue selling reusable cups at full price. This approach would self-select highly engaged users who would surpass the break-even point where reusable cups have a lower environmental impact than disposable cups. Selling cups at discounted prices or giving them for free may attract more users initially, but it might not be environmentally sustainable if low and moderate engagement users do not utilise them regularly. For this group, a deposit and return scheme is a more effective solution as it keeps cups in circulation and addresses barriers like forgetfulness and inconvenience.

An overview of reusable cup schemes trialled at different universities:

	@cups	Vytal	2GoCup
Benefits	• Cheaper than most reusable cups sold on campus (€3 instead of €8) • Linked to an app that provides rewards • App promotes habit formation	• Cashless and linked to an app that penalises late returns • Incentivises timely returns resulting in a high return rate • Offers a variety of cups and containers of different sizes	• Widespread availability beyond campus • Small cash or card deposit (€2) • Flexible stock and free replacement of cups
Challenges	• While eCups was originally designed as a deposit & return scheme, it has not been trialled as such • Providing rewards and feedback are effective only for a small share of users • Scanning and registration process to the app is complex	• Resistance from shops and concerns about increased workload • Concerns about student compliance • Having to enter bank details in the app	• Slow returns resulting in stock management implications • Upfront deposit as not all outlets offer returns via card • No app or tool to track usage and returns

Learnings and recommendations

Overall recommendation

Implement a multifaceted strategy to reduce single-use cups on campus. This may include:

Continued sale of lifelong reusable cups

A deposit and return scheme that tracks usage and incentivises timely returns via a tool such as a mobile app

a campus-wide ban on single-use cup

Encouraging the take-up of reusable cups

To effectively promote the take-up of reusable cups, universities should adopt a tailored approach that pulls on different motivational levers for different user groups at different moments in time.

Motivate early adopters through **pro-environmental messaging.**

Target users with weaker pro-environmental attitudes through highlighting the **convenience and economic benefits**. Leverage **social norms** when the scheme is already established through the early adopters.
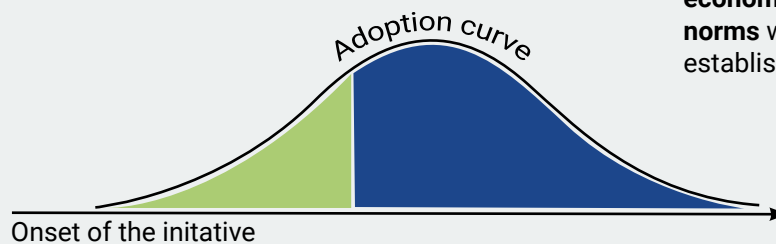
Adoption curve

Onset of the initative

Encouraging the sustained use of reusable cups

Encouraging the sustained use of reusable cups is important, as in order to ensure that they have a lower footprint than disposable ones, they need to be used repeatedly.Our analysis shows that universities should adopt an mixed approach that consists of reusable cups for sale and a deposit and return scheme, tailored to different user profiles' attitudes and habits.

Users with high engagement

→ **Owning a lifelong reusable cup may work best**

  ↳ Avoid free or discounted cups to self-select highly engaged users who are motivated to reduce waste

  ↳ Further encourage regular use through timely reminders, conditional rewards and feedback on usage

Users with moderate or low engagement

→ As it is not environmentally sustainable to have users with low and moderate engagement buy and own reusable cups, a **deposit and return scheme** may be the most effective solution

  ↳ Reusable cups can remain in circulation and be used more frequently over their lifespan

  ↳ Key barriers to sustained use of reusable cups such as forgetfulness and inconvenience can be addressed

Improving the effectiveness of deposit and return schemes

Based on the experiences of other universities that have trialled deposit and return schemes, a common challenge is that reusable cups are not returned on time or at all, leading to issues with cup stocks in outlets, even in the case where an upfront deposit is requested.

1. Tools to track usage
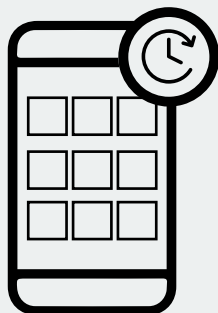
Tools such as **mobile apps...**

Can play an important role in tracking usage and incentivising timely returns

Motivate sustained use to some extent (eg. through rewards and feedback)

Are unlikely to have negative effects

A reusable cup initiative should therefore be complemented by an app, available at users' disposal

2. Penalty over an upfront fee

€ > €
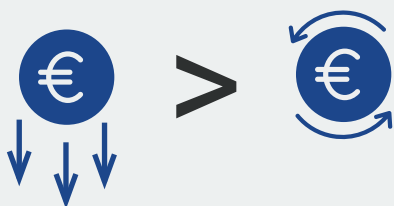
Schemes that do not require an upfront deposit but rather apply a **penalty if the cup is not returned** within a set timeframe (such as the Vytal scheme) offer a promising solution. Penalties are cashless, therefore remove the upfront logistical and financial barrier to reusable cups on top of prompting timely cup returns and high return rates.

3. Campus-wide single-use bans

Another important initiative that can encourage the sustained use of reusable cups, is to simply ban disposable cups on campus.

Despite the willingness of most staff and students to reduce waste, disposable cups represent a convenient alternative which can be difficult to forgo, indirectly hindering the take-up and sustained use of reusable cups. This phenomenon is also experienced by universities that have introduced deposit and return schemes while keeping disposable cups available.

Important to keep in mind...

Supported by students and staff

👍 The ban should be coupled with intensive and continuous awareness raising efforts to engage students, especially at the beginning of a new academic year.

👍 Also discourage or ban single-use cups beyond campuses through legislation (e.g., through a latte levy) to prevent the demand of drinks in disposable cups being redirected to shops outside campus, which in turn would lead to decrease in sales for outlets on campus.

Limitation

⚠️

It is important to note that part of the findings and recommendations are based on self-reported survey data (which was collected from a sample of 525 respondents and from qualitative accounts of staff working in universities) and they might not be fully generalisable and as robust as typical experimental results.

Understanding waste prevention and recycling from a behavioural perspective

Waste prevention barriers

Based on previous research, there are a variety of barriers to waste prevention amongst university students. In this section, we discuss the key barriers that were identified from literature review and stakeholder interviews.

Low environmental concern

One of the primary barriers to waste prevention is low concern for the environment. Intuitively, those without pro-environmental attitudes are less likely to practise pro-environmental behaviours.

Students who are more concerned about environmental issues are found to be more likely to minimise waste (Robertson and Walkington, 2009). In addition, a meta-analysis highlighted the feeling of guilt and concern for the environment as some of the major motivators of food waste reduction (Stangherlin and de Barcellos, 2018).

Lack of knowledge and awareness

Another important barrier to waste prevention is the lack of knowledge and awareness about waste-related issues.

Interviews with universities reveal that while water filling stations have been installed on campus to reduce plastic bottle waste, few marketing efforts were made to promote them. As a result, there is a lack of awareness among the student population about the availability and the locations of the infrastructure that enables plastic bottle waste prevention.

A study at an Italian university found that the less aware students are about the issue of food waste, the less likely they are to reduce leftovers and plan their purchases by making a shopping list to reduce food waste. In contrast, when students are concerned about food freshness and safety due to the misunderstanding of expiration dates, their food waste increases (Principato et al., 2015).

Lack of alternatives to single-use materials

Low availability and accessibility of alternatives to single-use materials can be a significant barrier to waste prevention among university students. Having the equipment and infrastructure that provide an alternative to single-use items is essential in enabling students to adopt sustainable behaviours that minimise waste.

Based on interviews with participating universities, food service providers on campus are reluctant to use reusable materials as it is more convenient and less costly to use single-use materials, despite interest from the university in banning single-use plastics. In such cases, students simply have no alternatives to single-use materials and therefore have no other options than to continue generating waste.

On the other hand, a study at an Australian University found that providing students with free reusable cups increased their use by about 2.5 times compared to the control group where no reusable cups were provided (Novoradovskaya et al., 2021).

Bad choice architecture

Bad choice architecture (the design and presentation of choices in different ways that influence decision-making) can lead to undesirable behaviours. Though often unintended, default options, when not thought through and planned well, can become a barrier to waste prevention on campus.

For example, the default plate size, portion size, and plate materials can determine whether students are more likely to waste their food. Multiple studies have found that more food is wasted when larger plates and larger portions are provided (Freedman and Brochado, 2010; Kallbekken and Sælen, 2013; Wansink and van Ittersum, 2013; Reynolds et al., 2019). Another study found that people waste more food when eating on disposable plates compared to reusable plates (Williamson et al., 2016).

An interview with a participating university also revealed that bulky waste, caused mainly by duvets, is a major issue within student accommodations. As new students are defaulted into receiving new duvets when they first move in, and because there is only limited demand for used duvets from charities, a huge amount of bulky waste is generated and disposed of each year.

Lack of incentive to prevent waste

Even when equipped with the tools, infrastructure, and environment that enable waste minimisation, students may still lack the incentive to prevent waste.

Based on interviews with a participating university, students appear to have no incentive to consistently use the reusable cups that were given to them for free as a welcome gift. According to the Green Campus staff, students might forget the cups at home and the cup designs may not be particularly appealing to some students.

Waste prevention enablers

Considering the different barriers to waste prevention, multiple interventions aimed at reducing waste have been designed, implemented, and evaluated. In this section, we discuss the key enablers and discuss insights that leverage behavioural techniques in promoting behaviour change that can lead to waste minimisation.

Providing information and feedback on waste prevention

Providing relevant information on waste-related issues and feedback on the amount of waste generated on campus can help students overcome barriers related to the lack of awareness and knowledge.

To help students minimise their waste, universities should provide information that is relevant and salient. For example, a food waste awareness campaign that included information cues at strategic locations, food ordering tips, and information cards about resource use in food production significantly reduced students' food waste (Manomaivibool et al., 2016). To increase the efficacy of an information intervention, universities should also consider adding prompts that encourage students to take action, as providing feedback on the amount of food waste generated and delivering a simple prompt-based message via a poster were found to be effective in reducing food waste (Whitehair et al., 2013).

Other than the more traditional and passive approaches (e.g., flyers and posters), universities can adopt a gamified approach where students are invited to play an online quiz game with points and rewards. Soma et al. (2020) found that a gamified quiz increased self-reported awareness of food wasting and decreased food waste.

Creating an environment conducive to waste prevention

To enable and encourage waste prevention, it is essential that universities provide students with an enabling environment that minimises the barriers and costs associated with waste reduction.

To enable students to switch away from single-use materials, it is important to ensure that reusable alternatives are readily available. A study by Poortinga and Whitaker (2018) found that simply having reusable cups for sale within coffee shops increases their use by 2.5% and distributing them for free by another 4.3%. These results suggest that universities should, at the very least, make sure that reusable cups are available for purchase at all locations on campus where beverages are sold. To further encourage the use of reusable cups, universities can consider providing a discount for reusable cups sold on campus.

Another common issue for universities is the large number of bulky items (e.g., furniture and beddings) at student accommodations that need to be disposed of, especially at the end of every academic year when students move out. To prevent such waste, universities could create an on-campus network or platform through which university staff and students can give out and/or receive used items. For example, an existing platform called Warp It is currently being used by many universities and has helped some schools reuse as much as £26,000 worth of items in a single week at the end of a semester (Warp It, 2018).

Incentivising waste minimisation and disincentivising waste generation

Habit formation can take time, especially if the behaviour change requires upfront cost and delayed gratification. To facilitate behaviour change among students, universities should consider implementing incentives for waste minimising behaviours and disincentives for waste-generating activities.

Though many universities are currently providing in-shop discounts on beverage purchases with reusable cups, a more effective approach may be to change the framing by adding 'charges' on single-use cups and making the charges salient to students. A study that compares incentives (in the form of a discount for using a reusable cup) against disincentives (in the form of a charge on disposable cups) found that while a discount did not result in any changes, a charge on disposable cups increased the use of reusable coffee cups (Poortinga and Whitaker, 2018).

To encourage students who may be reluctant to invest in a reusable cup, universities could also implement a deposit-and-return scheme (Starbucks, 2022; Local Authority Prevention Network, 2019). Such schemes allow students to get their beverages in a reusable cup for a small deposit. After using the reusable cup, they can either return it to the store and get their deposit back or exchange it for a fresh beverage in a clean cup at no additional charge. Early results from the pilot programmes in Dublin suggest that there was a significant take-up of the scheme and overall engagement increased by about 10% per month after the launch (Local Authority Prevention Network, 2019).

Leveraging social norms to encourage waste reduction

Social norms, the shared rules of acceptable beliefs, attitudes, and behaviours, are a phenomenon commonly leveraged in behavioural science research. University students, like other communities, have a tendency to look to one another and evaluate their own behaviours in accordance with how others behave before conforming to the norm.

Social norms interventions were found to be effective in changing household food waste behaviours, while providing information alone (e.g., the environmental costs of food waste) were not (Barker et al., 2021). To encourage waste minimisation, universities can also leverage social norms by designing and displaying signs that deliver norm-based messages near campus facilities. For example, results from an intervention aimed at encouraging water-saving behaviours at Stanford University show that signs delivering a norm-based message about water conservation reduced students' laundry loads by almost 30% over a 3-week intervention period, compared with a reduction of 2.5% for the control group (Sparkman and Walton, 2017).

Changing the default options

A simple way to encourage behaviour change when people are roughly indifferent between two options or when they exhibit high levels of 'inertia', is to change the default option.

As previous studies have found that plate size, portion size, and plate disposability can influence whether students are more likely to waste their food, universities should change the default options in canteens. For example, universities can provide students with smaller plates and portions as the default options while allowing them to request more food should they choose to do so. These modifications will help ensure that there is less room for food wastage that is due to the excessive amounts of food being served.

To reduce bulky waste in student accommodations, universities should also consider changing the default policy regarding duvets. Rather than providing new duvets to new student residents as a default, universities can switch to offering pre-owned duvets (that are in good condition) with an opt-out option when students first move into university accommodations.

Waste recycling barriers

There are various barriers to waste sorting and recycling amongst university students: the physical environment around them, which includes waste infrastructure and signage, psychological factors, such as attitudes and beliefs, and the social context. In this section, we discuss the key barriers that were identified from the literature review and stakeholder interviews.

Lack of waste recycling infrastructure

Low availability of bins in convenient locations and inconsistent signage can be a significant barrier to waste recycling.

> Waste contamination is a common issue across universities. Some universities have different bin types with inconsistent signage, which can confuse students and contribute to poor waste segregation. To make waste segregation easier, a participating university has recently applied standardised bin signage throughout campus. All bins are now assigned a specific colour (e.g., green bins for mixed dry recyclables), and visual prompts have been placed on bin lids to remind students what they should dispose of in each bin.

Limited waste sorting knowledge

Limited knowledge of why recycling waste is important, how to sort waste correctly and when to bring waste out for collection are important barriers (Schultz, Oskamp & Mainieri, 1995; Linder, Lindahl & Borgstrom, 2018; Miafodzyeva et al., 2013). A lack of knowledge can also reduce students' confidence and motivation to sort waste correctly (Geiger et al., 2019).

> Based on interviews with participating universities, students appear to have limited waste sorting knowledge and are unsure about how to sort specific items (e.g., disposable coffee cups, used tissues and pizza boxes). Foreign students, in particular, may not be familiar with national waste worting guidelines. Understandably, sorting waste can be confusing as waste management systems are typically designed around the technical capabilities of waste recycling facilities rather than how individuals intuitively classify items (Ordenez et al., 2015; Dupre, 2016).

Low environmental concerns

Students that do not associate themselves with pro-environmental identities, have low environmental concerns and that do not have positive attitudes towards waste recycling are less likely to sort waste correctly.

> A meta-analysis identified low environmental concern and negative attitudes towards recycling as crucial factors affecting students' waste-sorting intentions and behaviours in higher education institutions (Salluku et al., 2019).

Lack of trust in the recycling process

The lack of trust in the recycling process and the belief that one does not produce enough waste, specifically food waste, to be worth recycling are common misconceptions that make individuals less likely to sort waste. (Milford et al., 2015; Schultz, Oskamp & Mainieri, 1995).

Findings from a survey conducted at a participating university suggest that there is a misconception among students that all waste ultimately goes into the same general waste truck and ends up at the same place regardless of whether and how they were segregated and sorted (though sometimes it indeed happened, it was because of contamination issues). This misconception potentially acts as a barrier because some students may not realise the importance of proper waste sorting and recycling.

Low perceived collective effort

Although some individual students might put effort into sorting waste correctly, it's important that they feel confident that there is a collective effort that does so as well. If they perceive that others do not put an equal amount of effort, they may feel discouraged and recycle less, too.

A study conducted in China assessed the effect of social pressure on residential waste recycling. A waste collection company regularly visited residents face-to-face to encourage them to sort their household waste and rewarded them with 'green tokens'. While the face-to-face visits did boost residents' waste sorting knowledge, it was less effective at promoting actual waste sorting. One of the reasons why the scheme failed was that residents did not feel confident that their waste-sorting efforts were matched by those of their neighbours (Xu, Ling & Wu 2018).

Waste recycling enablers

Waste recycling is a complex behaviour that is affected by students' knowledge, attitudes and beliefs, the physical environment, and the social context. As such, successful behaviour change interventions should seek to combine multiple of the techniques that we list below.

Providing adequate waste recycling infrastructure

Making it easy and convenient is one of the most important prerequisites for encouraging waste recycling. Co-locating differentiated bins, placing them in convenient locations, and adding visual prompts and cues (e.g., stickers on bin lids) reduces the hassle of sorting waste and can improve waste segregation.

A study found that placing stickers on bin lids reminding residents to dispose of food waste in the appropriate bin increased the amount of food waste collected by 20% (Shearer et al., 2016). Similarly, bins with specialised waste disposal slots can serve as prompts that remind users of the type of waste that should be disposed of in each bin. These have been found to be effective at reducing waste contamination (Duffy & Verges, 2008).

Providing information about waste recycling

Providing information alone does not change behaviour. However, it can be useful if coupled with other interventions, such as recycling infrastructure. Typically, information about how to recycle is more effective amongst low-recyclers (i.e., how to sort waste, frequency of waste collections, and waste facilities). Whereas, information about the outcomes of recycling is more effective among individuals that are already enthusiastic about recycling (Dupré, 2014).

A study conducted in Sweden found that providing residents with a leaflet that includes information on how to sort waste and normative messaging alongside two free waste recycling liners was effective at instilling a food waste recycling habit among residents. Encouragingly, the effect of this intervention appears to endure in the long term (Linder, Lindahl & Borgstrom, 2018).

Making social norms around waste recycling more visible

People have a tendency to conform to what the majority of other people do or think, especially if they are part of the same social group as them or if they are perceived as relatable. For this reason, communications that highlight what other students do or think (i.e., social norm messaging) can be effective at motivating students to recycle waste.

A study found that informing residents about how many of their neighbours recycle waste encouraged them to recycle waste (Geislar, 2017). Social norm messaging interventions work best when coupled with informational interventions outlining how to recycle waste and with interventions that make recycling more convenient, e.g. providing free bin liners (Linder et al., 2018; Behavioural Insights Team, 2018).

Incentivising waste recycling

There is mixed evidence about the effectiveness of financial incentives on waste recycling behaviour. While they can help individuals take-up recycling, the effect fades away over time. What's more, incentives can backfire by crowding out students' intrinsic motivations. For this reason, incentives are more suited when targeting students that don't have strong environmental concerns to get them to start recycling. Incentives can then be removed later on once students have adopted a waste recycling habit.

A study that investigated the effect of a waste recycling scheme found that although the incentive did initially motivate residents to recycle, their behaviour became predominantly habitual over time (Li et al., 2020). This suggests that incentives can be effective but only for an initial period of time. Moreover, to ensure that incentives do not backfire, it is important to align them with individuals' intrinsic motivations and frame them as a form of social recognition for sorting waste correctly (Ling, Xu & Xiang, 2021).

Encouraging students to make personal or public commitments

Getting students to sign commitments can help them follow through with their waste recycling intentions. This technique harnesses individuals' desire to appear consistent and can help create accountability (Varrotto & Spagnoli, 2017). The effectiveness of commitments can be enhanced by fostering social pressure and making individual commitments visible to the public (Cialdini, 2001).

A study conducted at a university in France found that providing students with information about how to recycle waste and asking them to commit to act upon their recycling intentions had a positive effect on students' self-reported waste recycling frequency and quality (Dupré, 2014). Though no studies have investigated the effects of public commitments in the context of waste recycling due to the difficulty of scaling this strategy to society at large, it could be a promising approach within university campuses, given that they are closed social environments.

Supporting waste recycling advocates

In-person visits by waste recycling advocates can be an effective way to transmit information about recycling. Face-to-face communication is a powerful channel for sharing relevant information, especially if it comes from a trusted figure who is part of the target audience's social group (Dupré, 2014). Messengers can also convey confidence, a sense of belonging, and a collective effort, all of which are important predictors of waste recycling behavior (Xu, Ling & Wu, 2018).

A study evaluated the effectiveness of having building block leaders as recycling advocates compared to waste collection staff. Findings suggest that residents were more likely to participate in the waste recycling scheme when they were approached by building block leaders rather than waste collection staff. In addition, the effect of the interventions was stronger in building blocks which had strong social cohesion (Ling et al., 2021).

Conclusions

Identifying the main barriers and enablers of the target behaviour(s) is an important step in designing and trialling behavioural interventions. The list of key barriers and enablers of waste prevention and recycling behaviours presented above can be used to inform the intervention design phase. Researchers and practitioners can draw on these to brainstorm and develop solutions that encourage waste prevention and recycling behaviours on university campuses.

A guide to designing and trialling behavioural interventions
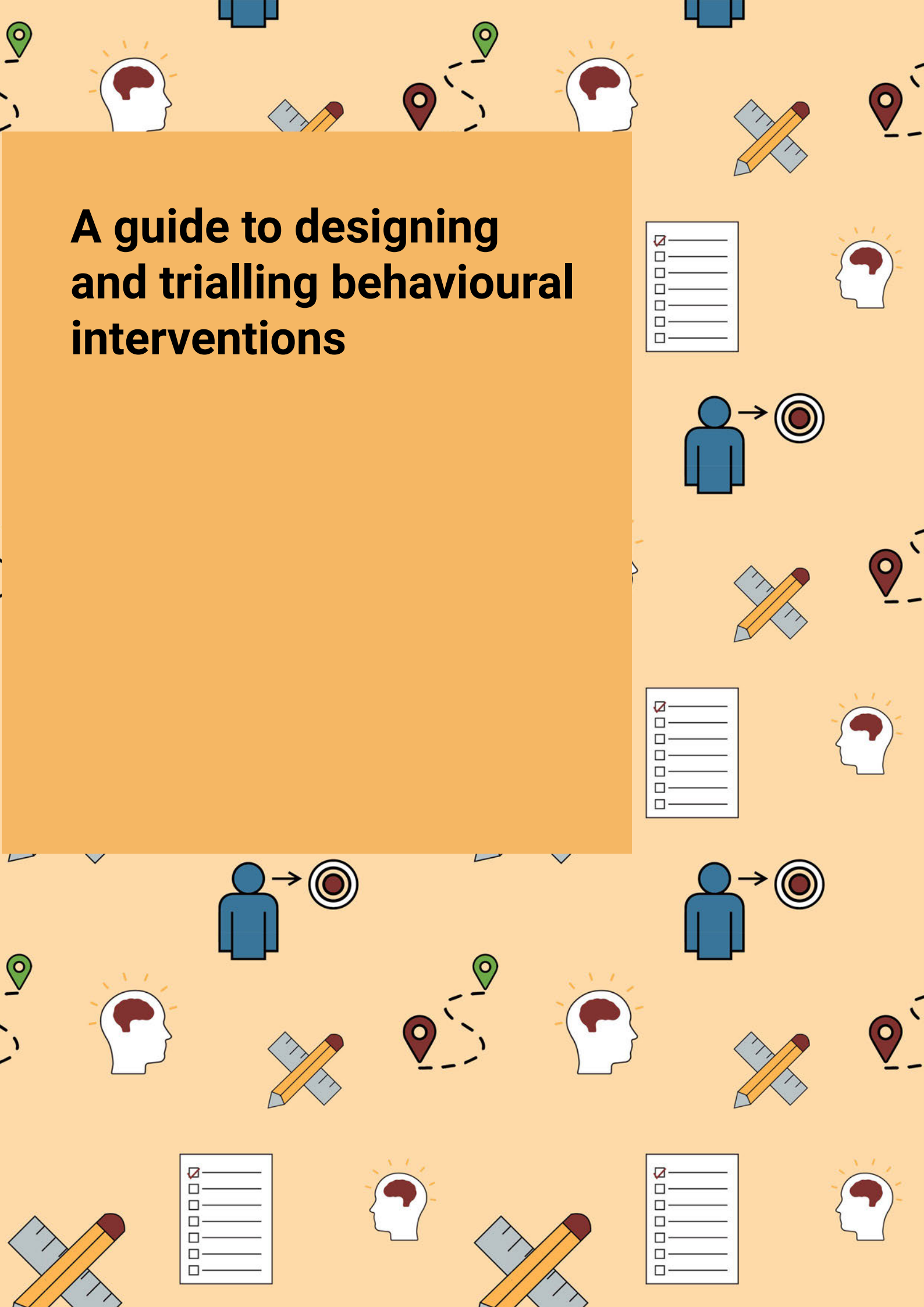
A guide to designing and trialling behavioural interventions

Step 1: Defining your ultimate outcome and desired behaviour

This guide will help you build a theory of change. A theory of change is a method that maps out the necessary steps that need to happen for a behaviour change to occur. It provides a systematic approach for designing behaviour change interventions and for identifying outcome metrics you can track to evaluate your intervention.

The first step for building a theory of change is to define your ultimate outcome. We will then work our way backwards to identify the aspects that need to occur to reach your outcome.

Your Theory of Change:

Start here
↓

1 Current behavioural problem	2 Behavioural intervention	3 Desired behaviour	4 Ultimate outcome
Example: Current behavioural problem	Behavioural intervention	Students use their reusable cups on a regular basis	Reduction in waste generated by disposable cups around campus
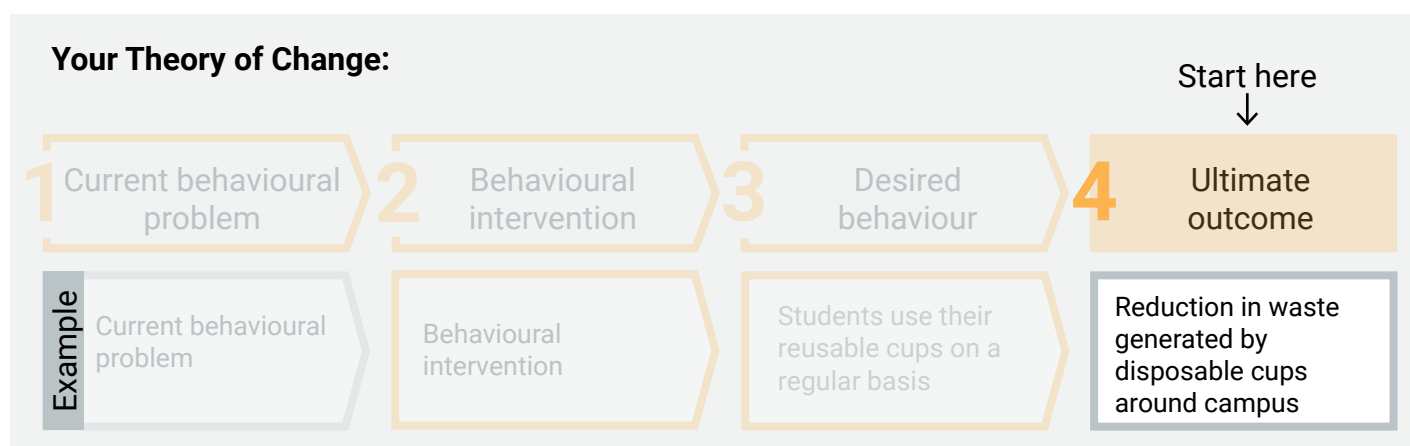
1) Begin by defining the ultimate goal you want to achieve. For example, your desired outcome may be to reduce disposable cup waste on campus.

2) Then, break down your ultimate goal into specific desired behaviours. In other words, list the behaviour(s) that will allow you to reach that outcome. For example, desired behaviours may include: (i) students purchase a reusable cup, or (ii) students use their reusable cup on a regular basis.

3) Make your desired behaviour(s) as specific as possible. Investing time into defining them is a crucial step to designing a successful behaviour change intervention.

The example below demonstrates a clear definition of a desired behaviour for the outcome of reducing waste generated from disposable cups.

Who needs to take action?	Why do things need to change?	What does our target group need to do?	When do they need to do the behaviour?	Where does the behaviour need to happen?	How often do they need to do it?
Students who purchase hot drinks at outlets on campus	Disposable coffee cups are major waste contaminants on campus	Use a reusable cup on a regular basis	Before purchasing a hot drink on campus	At outlets and restaurants on campus	Every time they purchase a hot drink on campus

Step 2: Identifying key behavioural barriers

Once you have defined your ultimate outcome and broken it down into desired behaviours, the next step is to look into the barriers that prevent your target audience from engaging in them.

Your Theory of Change:

You are here
↓

1 Current behavioural problem	**2** Behavioural intervention	**3** Desired behaviour	**4** Ultimate outcome
Example: Students who have reusable cups forget them at home	Behavioural intervention	Students use their reusable cups on a regular basis	Reduction in waste generated by disposable cups around campus
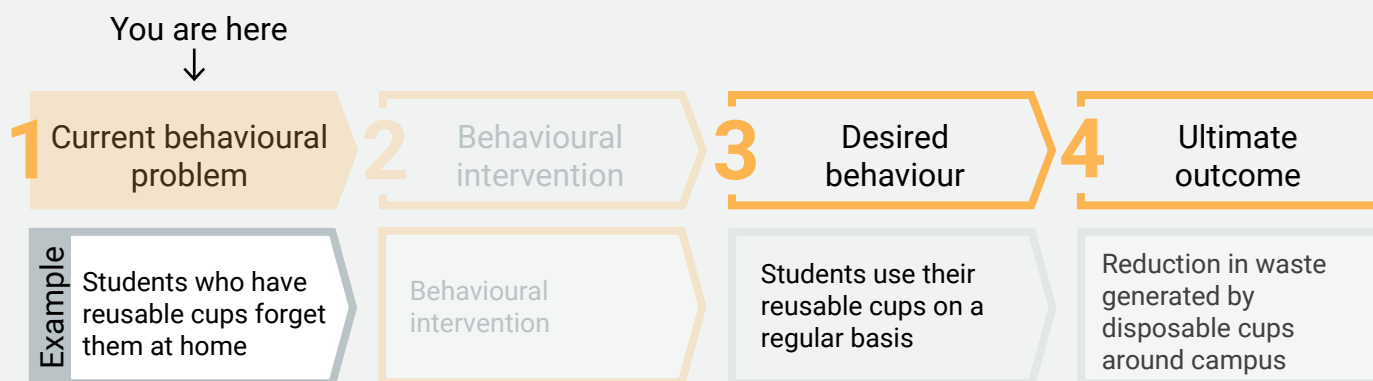
Use a systematic approach, such as the COM-B framework to identify barriers unique to your desired behaviour. The COM-B model posits that for a person to engage in a behaviour, they need sufficient capability, opportunity, and motivation. Review each section of the model below and write down the barriers your target audience might face.

> **TIP**
> You can start by reviewing the barriers outlined in the section "Understanding waste prevention and recycling from a behavioural perspective" of this guidebook and identify relevant ones.

Behaviour
(eg. students use their reusable cup on a regular basis)

Capability	**Motivation**	**Opportunity**
Do people have the skills, ability and knowledge to perform the desired behaviour?	Do people have the desire, habit or intention to perform the desired behaviour?	Does the physical and social environment enable people to perform the desired behaviour?
Barriers can include: Lack of knowledge or awareness, lack of ability to bring reusable cups.	**Barriers can include:** Lack of incentives, inconvenience, existing habits.	**Barriers can include:** Availability of sustainable alternatives, noticeable social norms.
Example: Most students don't know that disposable cups are not recyclable.	**Example:** Students are likely to forget their reusable cups at home.	**Example:** Reusable cups are expensive and are a new practice to many students.

Step 3: Ideate potential solutions and select the most appropriate intervention

With the list of barriers at hand, it is time to think about how to smooth them out. We can now start brainstorming solutions to reduce barriers and encourage our target audience to engage in waste prevention and recycling behaviours.

Your Theory of Change:

You are here
↓

1 Current behavioural problem	2 Behavioural intervention	3 Desired behaviour	4 Ultimate outcome
Example	Students who have reusable cups forget them at home	Instill a habit of using reusable cups through timely reminders, feedback and conditional rewards	Students use their reusable cups on a regular basis	Reduction in waste generated by disposable cups around campus

You can use the COM-B model to list ideas of how barriers in capability, opportunity and motivation domains can be addressed.

TIP

You can start by reviewing the enablers outlined in the section "Understanding waste prevention and recycling from a behavioural perspective" of this guidebook and identify relevant ones.

If you want to **ENCOURAGE** people to do something, try making it:

- ☑ **Normal** - done by their peers
- ☑ **Easy** - using little resources, time or effort
- ☑ **Attractive** - enjoyable and meaningful
- ☑ **Routine** - so that they don't have to think about it!

If you want to **DISCOURAGE** people to do something, try making it:

- ☑ **Abnormal** - not seen as part of normal behaviour
- ☑ **Difficult** - involve barriers put in the way
- ☑ **Unpleasant** - lead to unwanted outcomes
- ☑ **Reflective** - so that they have to disrupt their routine!

Behaviour
(eg. students use their reusable cup on a regular basis)

Capability	Motivation	Opportunity
Do people have the skills, ability and knowledge to perform the desired behaviour?	Do people have the desire, habit or intention to perform the desired behaviour?	Does the physical and social environment enable people to perform the desired behaviour?
Barriers can include: Lack of knowledge or awarness, lack of ability to bring reusable cups. **Example:** Most students don't know that disposable cups are not recyclable.	**Barriers can include:** Lack of incentives, inconvenience, existing habits. **Example:** Students are likely to forget their reusable cups at home.	**Barriers can include:** Availability of sustainable alternatives, noticeable social norms. **Example:** Reusable cups are expensive and are a new practice to many students.
Usually solved by: Improving ones' understanding, providing reminders, developing physical or cognitive skills. **Example:** Infrom students that disposable cups have a plastic lining inside them making them unrecyclable.	**Usually solved by:** Providing feedback and a sense of accomplishment, forming or breaking old habits, harnessing or shaping values. **Example:** Provide rewards and feedback on reusable cup use.	**Usually solved by:** Providing sustainable alternatives, making social norms noticeable, fostering peer pressure. **Example:** Make reusable cups more accessible and noticeable.

Next, try to prioritise your intervention ideas using the following criteria. If you have multiple intervention ideas, use a rating system or simple quantitative judgements such as low, medium, high.

- ☑ **Acceptability:** How will your target audience receive your intervention? Are there any adverse spill-over effects that may occur?

- ☑ **Impact:** How effective do you expect your intervention idea to be in achieving your desired behaviour(s)? Can you base your estimates on past case studies?

- ☑ **Cost-effectiveness:** How expensive do you expect the implementation of your intervention to be?

- ☑ **Feasibility:** How feasible is it to implement your intervention in practice? Will you need buy-in and support from stakeholders?

- ☑ **Measurability:** Can you track outcome metrics to assess the effectiveness of your intervention? Can you link your outcome metrics to the administration of your intervention?

Step 4: Trial your behavioural intervention

Now that you have detailed your behavioural intervention, you can trial it to assess whether it achieves its intended effects. Your theory of change will help you have a clear understanding of how your intervention works and the outcomes that it is expected to achieve.

Your Theory of Change:

1 Current behavioural problem	**2** Behavioural intervention	**3** Desired behaviour	**4** Ultimate outcome
Example Students who have reusable cups forget them at home	Instill a habit of using reusable cups through timely reminders, feedback and conditional rewards	Students use their reusable cups on a regular basis	Reduction in waste generated by disposable cups around campus

Assess whether your behavioural intervention achieves your desired behaviour

☑ **1) Have a set of measurable outcome metrics:** Start by identifying outcome metrics that allow you to assess the effectiveness of your intervention. Understand whether you can track actual behavioural measures (e.g., number of reusable cups refills), self-reported behaviours or predictors of behaviours (e.g., self-reported reusable cup use), or proxy measures (e.g., number of disposable cups sold at outlets).

☑ **2) Link the administration of your intervention to your outcome metrics:** Check whether you can link the administration of your intervention to your outcome metrics. This ensures that changes in your outcome metrics are directly attributable to your intervention.

☑ **3) Choose a feasible evaluation method:** Understand if you can compare the effectiveness of your intervention against a counterfactual (i.e., a comparable group of students that did not receive the intervention). This condition will allow you to determine your trial's most suitable evaluation method.

When determining the evaluation method, it is helpful to start with the most robust method and gradually work your way down based on feasibility constraints. The diagram below shows the most common research methods for impact evaluation, from most robust to least robust.

Randomised control trial	Difference-in-differences	Simple difference	Pre-post test
Description Measure the differences in outcomes between randomly assigned participants and non-participants after the intervention took effect.	Measure the differences in outcomes for participants before and after the intervention relative to a comparable group of non-participants.	Measure the differences in outcomes between participants after the intervention took effect and another group who did not participate in the intervention.	Measure the differences in outcomes for participants before the programme and after the programme took effect.
Required data Outcome data for randomly assigned participants and non-participants (the treatment and control groups).	Data on outcomes of interest for participants as well as another group of non-participants before and after the intervention is rolled out.	Outcome data for participants as well as another group of non-participants after the intervention is rolled out.	Data on outcomes of interest for participants before and after the intervention is rolled out.

Option 1: Can you randomise rolling out the intervention to participants and non-participants?

yes → Randomised control trial

no →

Option 2: Can you have outcome data from a comparable group of non-participants?

yes → Difference-in-difference or Simple difference

no →

Option 3: Can you have access to pre-post intervention outcome data from participants?

yes → Pre-post

☑ **4) Trial your intervention:** Before rolling out your behaviour change intervention on a large scale, do a trial run. Even if you have completed all the above steps and believe the intervention will be successful, it is best practice to test it on a small scale and see how it works.

☑ **5) Reflect and improve:** How could the behavioural intervention be improved? Could it be made even more attractive or part of your target group's routine? If the intervention was successful, increase its scale and roll it out more widely across the campus. Make sure to gather feedback from key stakeholders, including your target population and synthesise key takeaways and learnings for the next round of testing.

Technical appendix
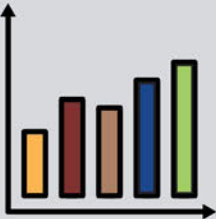
The Waste Game: an interactive online tool designed to encourage waste prevention and recycling on campus

Trial design and implementation

Table A1. Dissemination efforts by participating universities

University	Date	Channel	Game version
UCD	06/12/2022	UCD Green Campus included a section on the waste game in an email sent to student residents in collaboration with the pop-up recycling centres, which are additional bin stores for students vacating at the end of the first semester	Student-version
UCD	23/11/2022	Sent a Green Campus newsletter-style email specifically about the Waste Game to all student residents (n=4,115)	Student-version
UCD	25/11/2022	Sent message to estates staff via the UCD intranet	Staff-version
UCD	01/11/2022	Sent message to all university staff via the UCD intranet	Staff-version
UCD	27/10/2022	Sent a Green Campus newsletter-style email to all students specifically about the waste game	Student-version
UCD	25/10/2022	Instagram post on Green Campus account	Student-version
UCD	27/10/2022	Instagram post on Green Campus account	Student-version
UCD	07/11/2022	Instagram post on Green Campus account	Student-version
UCD	21/11/2022	Instagram post on Green Campus account	Student-version
UCD	N/A	Included a section on the Waste Game in a SU newsletter	Student-version
UCD	N/A	Emailed UCD alumni working group	Student-version
UCD	N/A	Asked the Sustainable research Initiative Resource Group to disseminate the Waste Game in their school	Student-version
DCU	03/10/2022	Sent email with link to the Waste Game to all university students	Student-version
DCU	02/12/2022	Sent an email reminder to all students to complete the Waste Game	Student-version
DCU	22/11/2022	Sent an email reminder to all students to complete the Waste Game	Student-version
DCU	22/11/2022	Sent a reminder to all staff members via the DCU intranet to complete the Waste Game	Staff-version
DCU	12/10/2022	Send message to all DCU staff members	Staff-version
DCU	12/10/2022	Included a section on the Waste Game in a SU newsletter	Student-version
DCU	End of October	Promoted the Waste Game during the Walk-tober event, a competition where students walk and count their steps.	Student-version
TCD	26/10/2022	Sent email to all staff members at TCD (n=3,500)	Staff-version
TCD	28/10/2022	Sent email to all students at TCD (n=18,500+)	Student-version
TCD	End October - early November	Promoted the Waste Game via social media	Student-version
TCD	End October - early November	Included a section on the Waste Game in a SU newsletter	Student-version
TCD	11/11/2022	Send a reminder email to all staff members to complete the game	Staff-version
TCD	Week of the 14/11/2022	Promoted the game via TCD's social media accounts	Student-version
MU	19/09/2022	Promoted the game on MU Green Campus' Twitter and Instagram account	Student-version
MU	19/09/2023	Stuck posters of the game in key locations around campus	Student-version
MU	25/11/2022	Promoted the game on MU Green Campus Instagram account. The post was reshared by other university societies Instagram accounts.	Student-version
MU	25/11/2022	Send email to all students to promote the game (n=12,000)	Student-version
MU	24/11/2022	Added a post on the Waste Game in the news section of MU green campus website	Student-version
MU	12/12/2022	Send email to all staff members at MU	Staff-version

Findings

Participant profile
Background

Graph A1. Share of participants by university
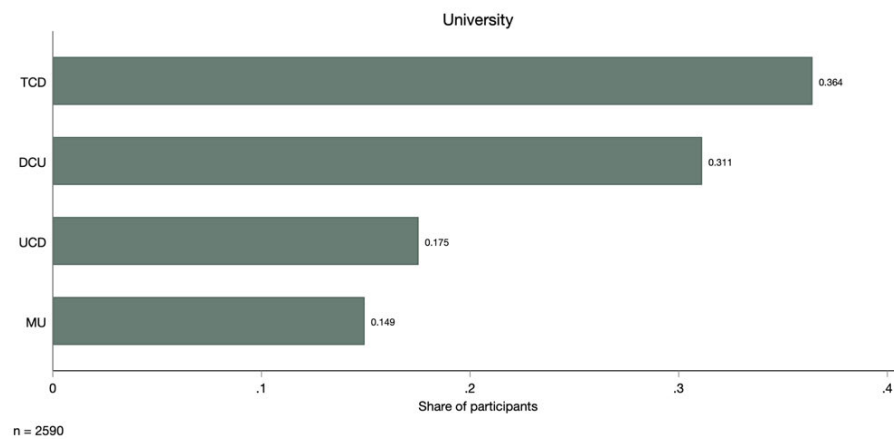
Graph A2. Share of participants by gender
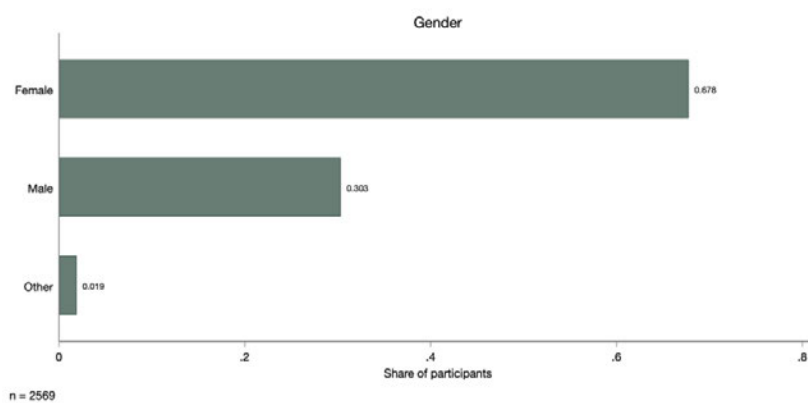
Graph A3. Share of participants by gender by university
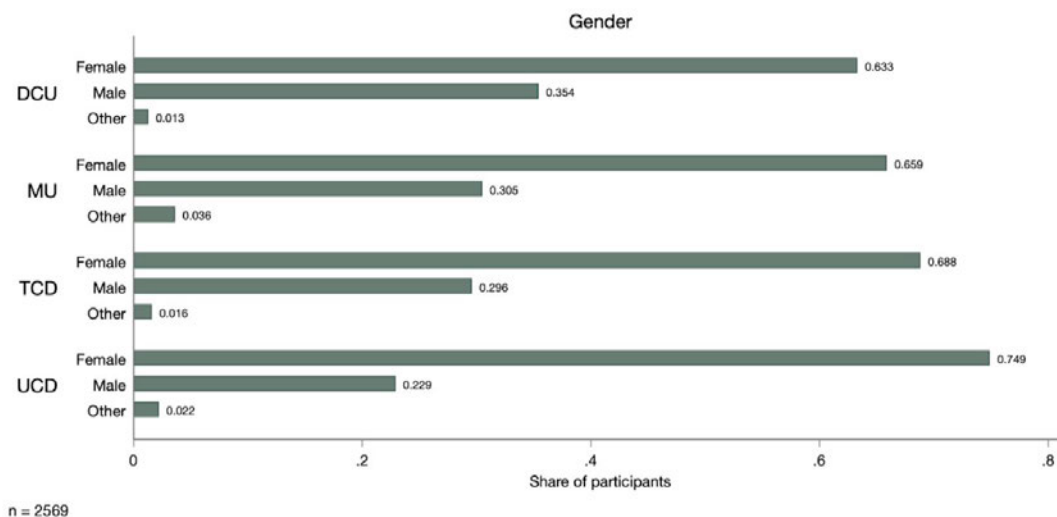
Graph A4. Share of participants by year of studies

Year of studies

Year	Share of participants
Postgrad	0.294
1st year undergrad	0.249
2nd year undergrad	0.146
3rd year undergrad	0.136
4th year undergrad	0.122
Other year	0.054

n = 2183
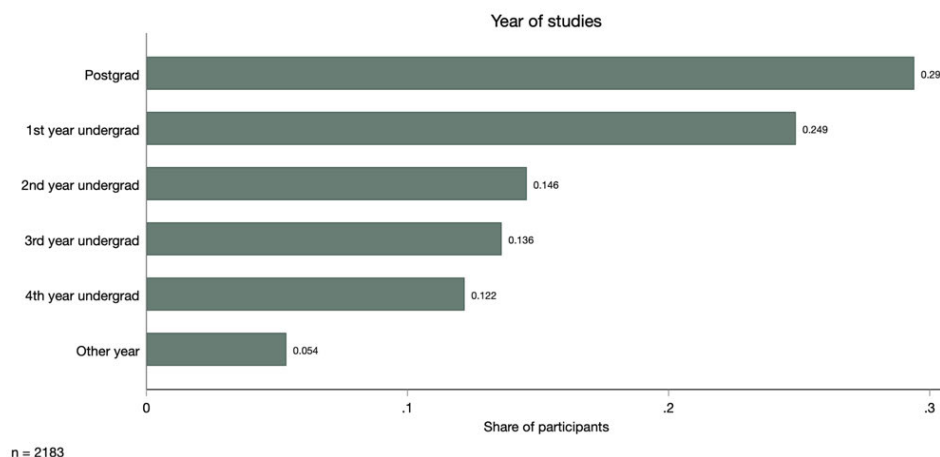
Graph A5. Share of participants by year of studies by university

Year of studies

DCU
- 1st year undergrad: 0.267
- 2nd year undergrad: 0.197
- 3rd year undergrad: 0.139
- 4th year undergrad: 0.132
- Other year: 0.017
- Postgrad: 0.248

MU
- 1st year undergrad: 0.272
- 2nd year undergrad: 0.133
- 3rd year undergrad: 0.237
- 4th year undergrad: 0.086
- Other year: 0.039
- Postgrad: 0.233

TCD
- 1st year undergrad: 0.276
- 2nd year undergrad: 0.120
- 3rd year undergrad: 0.113
- 4th year undergrad: 0.140
- Other year: 0.020
- Postgrad: 0.331

UCD
- 1st year undergrad: 0.158
- 2nd year undergrad: 0.113
- 3rd year undergrad: 0.106
- 4th year undergrad: 0.097
- Other year: 0.179
- Postgrad: 0.346

n = 2183

Graph A6. Share of participants by green identity

How important is it for you to live a sustainable lifestyle?

Response	Share of participants
Very important	0.430
Extremely important	0.364
Fairly important	0.189
Slightly important	0.014
Not at all important	0.003

n = 2590
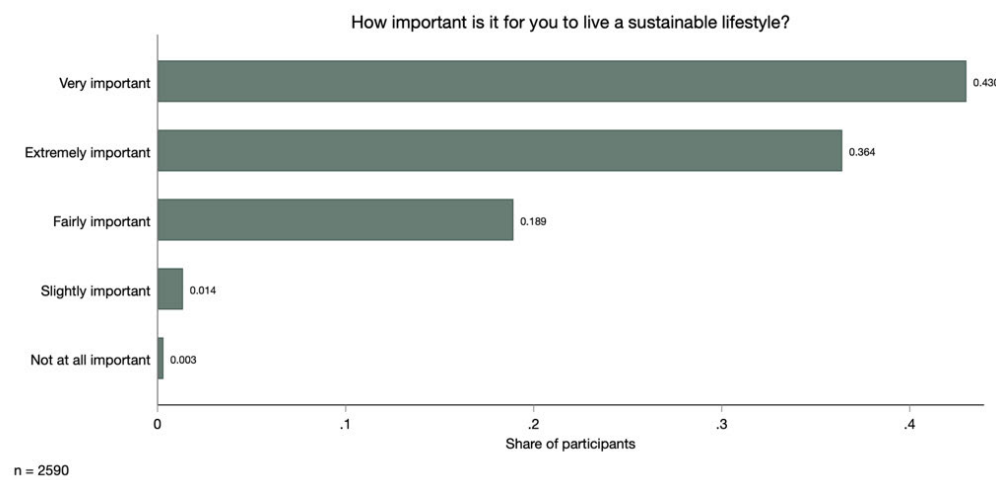
Graph A7. Share of participants by green identity by university

How important is it for you to live a sustainable lifestyle?

University	Response	Share of participants
DCU	Very important	0.444
DCU	Extremely important	0.351
DCU	Fairly important	0.189
DCU	Slightly important	0.014
DCU	Not at all important	0.002
MU	Very important	0.406
MU	Extremely important	0.385
MU	Fairly important	0.196
MU	Slightly important	0.013
MU	Not at all important	0.000
TCD	Very important	0.421
TCD	Extremely important	0.372
TCD	Fairly important	0.189
TCD	Slightly important	0.015
TCD	Not at all important	0.003
UCD	Very important	0.445
UCD	Extremely important	0.352
UCD	Fairly important	0.185
UCD	Slightly important	0.011
UCD	Not at all important	0.007

n = 2590

Correlations

Table A2. Correlation matrix

	Female	1st year	Green identity	Quiz game score	Knowledge score	Confidence to sort waste	Confidence to reduce waste	Motivation	Perceived social norm	Responsibility (student)	Responsibility (campus services)	Responsibility (waste operators)	Committed (any)	Committed (L1)	Committed (L2)
Female	1														
1st year	-0.0492*	1													
Green identity	0.0215	-0.0326	1												
Quiz game score	0.0232	-0.0369	0.0449*	1											
Knowledge score	0.0750***	-0.0637**	0.0328	0.346***	1										
Confidence to sort waste	-0.0518**	0.0158	0.192***	0.160***	0.198***	1									
Confidence to reduce waste	-0.0333	0.0647***	0.148***	0.108***	0.108***	0.393***	1								
Motivation	0.103***	0.0392*	0.330***	0.126***	0.128***	0.385***	0.533***	1							
Perceived social norm	0.00427	-0.00803	0.134***	0.0256	-0.0213	0.198***	0.321***	0.456***	1						
Responsibility (student)	0.0863***	0.00125	0.0894***	0.0967***	0.163***	0.244***	0.211***	0.283***	0.146***	1					
Responsibility (campus services)	0.0858***	-0.0904***	0.0846***	0.000548	-0.0111	0.106***	0.104***	0.178***	0.145***	0.212***	1				
Responsibility (waste operators)	0.0737***	-0.0498*	0.0605*	-0.0423*	-0.0146	0.0539**	0.0554*	0.104***	0.116***	0.128***	0.633***	1			
Committed (any)	0.0379	-0.0122	0.0138	0.689***	0.202***	0.0652***	0.110***	0.128***	0.0575**	0.0897***	0.0228	-0.0173	1		
Committed (L1)	0.0404*	-0.0135	0.0190	0.681***	0.200***	0.0686***	0.113***	0.133***	0.0586**	0.101***	0.0217	-0.0194	0.986***	1	
Committed (L2)	0.0382	-0.0101	0.0157	0.798***	0.258***	0.0910***	0.112***	0.128***	0.0686***	0.0837***	0.00999	-0.0327	0.721***	0.710***	1

* p<0.05 ** p<0.01 *** p<0.001

Graph A8. Correlation matrix
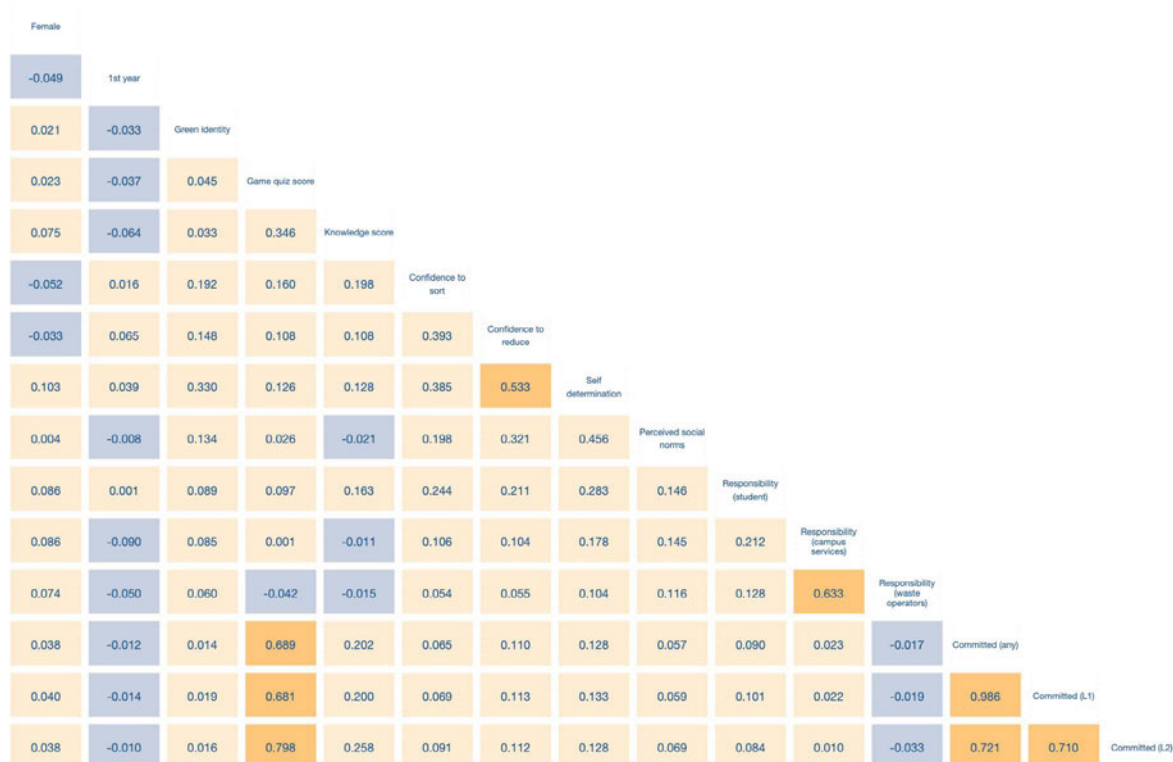
Effectiveness of the game
Overall effectiveness of the game

Table A3. Balance table

Variable	(1) Control group N	Mean/SE	(2) Treatment group 1 N	Mean/SE	(3) Treatment Group 2 N	Mean/SE	t-test Difference (1)-(2)	(1)-(3)	(2)-(3)
female	1365	0.661 [0.013]	770	0.677 [0.017]	1164	0.662 [0.014]	-0.016	-0.001	0.015
male	1365	0.319 [0.013]	770	0.300 [0.017]	1164	0.323 [0.014]	0.019	-0.004	-0.023
other gender	1365	0.020 [0.004]	770	0.023 [0.005]	1164	0.015 [0.004]	-0.004	0.004	0.008
undergrad_year1	1213	0.259 [0.013]	651	0.237 [0.017]	991	0.269 [0.014]	0.022	-0.011	-0.033
undergrad_year2	1213	0.153 [0.010]	651	0.158 [0.014]	991	0.135 [0.011]	-0.005	0.018	0.023
undergrad_year3	1213	0.135 [0.010]	651	0.137 [0.013]	991	0.146 [0.011]	-0.002	-0.011	-0.010
undergrad_year4	1213	0.114 [0.009]	651	0.114 [0.012]	991	0.125 [0.011]	0.000	-0.011	-0.011
other year	1213	0.079 [0.008]	651	0.055 [0.009]	991	0.044 [0.007]	0.024*	0.035***	0.011
postgrad	1213	0.260 [0.013]	651	0.300 [0.018]	991	0.280 [0.014]	-0.040*	-0.020	0.020
green identity	1485	0.794 [0.010]	1557	0.785 [0.010]	1659	0.754 [0.011]	0.009	0.040***	0.031**
dcu	2025	0.338 [0.011]	2168	0.339 [0.010]	2155	0.336 [0.010]	-0.002	0.001	0.003
mu	2025	0.118 [0.007]	2168	0.127 [0.007]	2155	0.133 [0.007]	-0.009	-0.015	-0.005
tcd	2025	0.286 [0.010]	2168	0.286 [0.010]	2155	0.296 [0.010]	-0.000	-0.010	-0.010
ucd	2025	0.258 [0.010]	2168	0.247 [0.009]	2155	0.235 [0.009]	0.011	0.023*	0.012

Notes: Table A3 shows the balance between the three experimental groups, confirming that the randomisation was conducted correctly, and that the experimental groups were statistically 'identical' at baseline. Achieving balance at baseline allows us to interpret any subsequent differences between the groups as the causal effects of the treatments. The value displayed for t-tests are the differences in the means across the groups. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table A4. Treatment effects on outcomes of interest in the short and the long-term

	(1) Knowledge score	(2) Confidence to reduce waste	(3) Confidence to sort waste	(4) Motivation	(5) Perceived social norm	(6) Responsibility (student)	(7) Responsibility (estate services)	(8) Responsibility (waste operators)
Treatment (short-term)	1.127*** (0.0583)	0.902*** (0.0829)	0.534*** (0.0719)	0.718*** (0.0829)	0.640*** (0.0889)	0.170** (0.0785)	0.0678 (0.129)	-0.0189 (0.137)
Treatment (long-term)	0.593*** (0.0717)	0.456*** (0.0977)	0.275*** (0.0858)	0.153 (0.101)	0.435*** (0.109)	-0.0646 (0.0972)	0.0265 (0.154)	-0.0197 (0.165)
Constant	5.040*** (0.0468)	7.018*** (0.0720)	6.907*** (0.0626)	7.726*** (0.0724)	5.357*** (0.0742)	8.522*** (0.0656)	6.991*** (0.108)	7.118*** (0.114)
Observations	1481	1453	1453	1451	1451	1222	1222	1222

Robust standard errors in parentheses
* p<.1 ** p<.05 *** p<.01

Table A5. Treatment effects on commitment rates and number of commitments made

	(1) Committed (any)	(3) Committed to L1	(5) Committed to L2	(1) No. of commitments made (L1 & L2)	(3) No. of commitments made (L1)	(5) No. of commitments made (L2)
Full commitment	0.00130 (0.00275)	0.00195 (0.00336)	-0.000522 (0.00319)	-0.248*** (0.0543)	-0.133*** (0.0293)	-0.115*** (0.0277)
Constant	0.995*** (0.00219)	0.992*** (0.00268)	0.994*** (0.00236)	5.472*** (0.0380)	2.714*** (0.0207)	2.758*** (0.0193)
Observations	2590	2590	2590	2590	2590	2590

Robust standard errors in parentheses
* p<.1 ** p<.05 *** p<.01

Full version vs simplified version of the game

Table A6. Differential effects on quiz and knowledge scores

	(1) Game quiz score	(2) Knowledge score
Full version	0.652***	-0.217***
	(0.130)	(0.0744)
Constant	14.92***	6.253***
	(0.0849)	(0.0401)
Observations	1857	1857

Robust standard errors in parentheses
* p<.1 ** p<.05 *** p<.01

Table A7. Differential effects on confidence, motivation, perceived social norm, and share of responsibility

	(1) Confidence to reduce waste	(2) Confidence to sort waste	(3) Motivation	(4) Perceived social norm	(5) Responsibility (student)	(6) Responsibility (estate services)	(7) Responsibility (waste operators)
Full version	-0.242***	-0.196***	-0.0338	0.0571	0.0563	0.363**	0.423***
	(0.0848)	(0.0738)	(0.0831)	(0.101)	(0.0875)	(0.145)	(0.152)
Constant	8.014***	7.518***	8.457***	5.975***	8.670***	6.917***	6.935***
	(0.0513)	(0.0437)	(0.0518)	(0.0623)	(0.0562)	(0.0935)	(0.0991)
Observations	1836	1836	1836	1836	1560	1560	1560

Robust standard errors in parentheses. * p<.1 ** p<.05 *** p<.01

Table A8. Differential effects on commitment rates and number of commitments made

	(1) Committed (any)	(2) Committed (L1)	(3) Committed (L2)	(4) No. of commitments made (L1 & L2)	(5) No. of commitments made (L1)	(6) No. of commitments made (L2)
Full version	0.00132	0.00130	-0.000490	-0.237***	-0.114***	-0.123***
	(0.00320)	(0.00403)	(0.00383)	(0.0670)	(0.0358)	(0.0343)
Constant	0.995***	0.992***	0.994***	5.472***	2.714***	2.758***
	(0.00219)	(0.00268)	(0.00236)	(0.0380)	(0.0207)	(0.0193)
Observations	1857	1857	1857	1857	1857	1857

Robust standard errors in parentheses
* p<.1 ** p<.05 *** p<.01

Effects of the game on different participant profiles

Table A9. Heterogeneous effects on outcomes of interest (gender)

	(1) Knowledge score	(2) Confidence to reduce waste	(3) Confidence to sort waste	(4) Motivation	(5) Perceived social norm	(6) Responsibility (student)	(7) Responsibility (estate services)	(8) Responsibility (waste operators)	(9) Committed	(10) No. of commitments made
Treatment	1.149***	0.952***	0.668***	0.853***	0.697***	0.195	0.506**	0.277	0.00434	-0.265**
	(0.108)	(0.154)	(0.137)	(0.168)	(0.176)	(0.152)	(0.252)	(0.258)	(0.00736)	(0.109)
Female	0.154	0.0839	0.0500	0.599***	0.145	0.314**	0.936***	0.787***	0.0119**	0.265***
	(0.104)	(0.159)	(0.141)	(0.168)	(0.173)	(0.150)	(0.247)	(0.255)	(0.00603)	(0.0866)
Treatment # Female	0.0808	-0.0718	-0.197	-0.174	-0.0779	-0.0198	-0.607**	-0.401	-0.00498	-0.00197
	(0.126)	(0.183)	(0.161)	(0.192)	(0.204)	(0.177)	(0.292)	(0.303)	(0.00762)	(0.125)
Constant	4.932***	6.959***	6.872***	7.306***	5.256***	8.302***	6.333***	6.566***	0.987***	5.296***
	(0.0879)	(0.134)	(0.121)	(0.148)	(0.151)	(0.129)	(0.215)	(0.219)	(0.00588)	(0.0757)
Observations	2569	2569	2569	2569	2569	2194	2194	2194	2569	2569

Robust standard errors in parentheses
* p<.1 ** p<.05 *** p<.01

Table A10. Heterogeneous effects on outcomes of interest (year of studies)

	(1) Knowledge score	(2) Confidence to reduce waste	(3) Confidence to sort waste	(4) Motivation	(5) Perceived social norm	(6) Responsibility (student)	(7) Responsibility (estate services)	(8) Responsibility (waste operators)	(9) Committed	(10) No. of commitments made
Treatment	1.003***	0.698***	0.462***	0.362**	0.446**	0.223	-0.414	-0.329	0.00398	-0.219*
	(0.130)	(0.179)	(0.154)	(0.182)	(0.197)	(0.173)	(0.277)	(0.289)	(0.00399)	(0.121)
2nd year undergrad	-0.0350	-0.440*	-0.0721	-0.329	-0.0816	0.109	-0.0546	-0.0278	-0.0114	-0.0135
	(0.179)	(0.245)	(0.209)	(0.241)	(0.262)	(0.226)	(0.372)	(0.366)	(0.0115)	(0.153)
3rd year undergrad	0.105	-0.701***	-0.122	-0.684**	-0.548**	-0.103	0.733**	0.418	0.00398	-0.240
	(0.162)	(0.260)	(0.264)	(0.295)	(0.260)	(0.240)	(0.352)	(0.387)	(0.00399)	(0.154)
4th year undergrad	0.0164	0.00321	-0.402	-0.612**	-0.380	-0.117	0.0808	0.00423	0.00398	0.225*
	(0.184)	(0.269)	(0.257)	(0.267)	(0.263)	(0.232)	(0.384)	(0.400)	(0.00399)	(0.128)
Other year	0.128	-0.625	-0.203	-0.677*	-0.734**	-0.0870	-0.544	-0.734	0.00398	0.276
	(0.221)	(0.418)	(0.325)	(0.390)	(0.331)	(0.314)	(0.482)	(0.544)	(0.00399)	(0.168)
Postgraduates	0.0358	-0.305	-0.0866	-0.292	0.408*	0.112	0.199	0.0933	-0.00348	0.143
	(0.143)	(0.206)	(0.179)	(0.211)	(0.222)	(0.185)	(0.300)	(0.321)	(0.00661)	(0.112)
Treatment # 2nd year	0.0639	0.373	0.210	0.279	0.0764	-0.124	0.692	0.474	0.0114	-0.0354
	(0.210)	(0.287)	(0.243)	(0.283)	(0.319)	(0.270)	(0.444)	(0.444)	(0.0115)	(0.209)
Treatment # 3rd year	0.111	0.241	-0.150	0.463	0.558*	-0.109	0.190	0.263	-0.0167*	0.0628
	(0.197)	(0.304)	(0.294)	(0.333)	(0.318)	(0.281)	(0.422)	(0.463)	(0.00982)	(0.223)
Treatment # 4th year	0.546**	-0.308	0.355	0.386	0.283	0.173	0.577	0.324	-0.00398	-0.342*
	(0.216)	(0.315)	(0.293)	(0.316)	(0.327)	(0.276)	(0.466)	(0.482)	(0.00399)	(0.202)
Treatment # Other year	0.459	0.317	-0.0829	0.782*	1.016**	0.0542	1.355**	1.094*	-0.0307	-0.354
	(0.281)	(0.475)	(0.370)	(0.441)	(0.421)	(0.381)	(0.596)	(0.653)	(0.0191)	(0.273)
Treatment # Postgrad	0.249	0.247	0.0432	0.383	-0.161	-0.119	0.708**	0.356	-0.00187	0.00113
	(0.173)	(0.237)	(0.208)	(0.242)	(0.267)	(0.219)	(0.360)	(0.384)	(0.00762)	(0.161)
Constant	4.959***	7.342***	7.007***	8.068***	5.342***	8.500***	6.870***	7.082***	0.996***	5.390***
	(0.109)	(0.157)	(0.134)	(0.159)	(0.160)	(0.149)	(0.229)	(0.242)	(0.00399)	(0.0834)
Observations	2183	2183	2183	2183	2183	2183	2183	2183	2183	2183

Robust standard errors in parentheses.
* p<.1 ** p<.05 *** p<.01

Table A11. Heterogeneous effects on outcomes of interest (student vs. staff)

	(1) Knowledge score	(2) Confidence to reduce waste	(3) Confidence to sort waste	(4) Motivation	(5) Perceived social norm	(6) Committed	(7) No. of commitments made
Treatment	0.818***	1.284***	0.550***	0.985***	0.898***	0.00613	-0.194*
	(0.163)	(0.220)	(0.161)	(0.207)	(0.222)	(0.00612)	(0.105)
Student	-0.375***	0.277	-0.154	-0.0368	-0.568***	0.000894	-0.302***
	(0.124)	(0.215)	(0.154)	(0.203)	(0.211)	(0.00655)	(0.0851)
Treatment # Student	0.357**	-0.445*	-0.0212	-0.316	-0.314	-0.00573	-0.0688
	(0.174)	(0.238)	(0.179)	(0.226)	(0.242)	(0.00684)	(0.121)
Constant	5.364***	6.778***	7.040***	7.758***	5.848***	0.994***	5.730***
	(0.113)	(0.200)	(0.138)	(0.187)	(0.195)	(0.00612)	(0.0737)
Observations	2590	2569	2569	2569	2569	2590	2590

Robust standard errors in parentheses
* p<.1 ** p<.05 *** p<.01

Table A12. Heterogeneous effects on outcomes of interest (university)

	(1) Knowledge score	(2) Confidence to reduce waste	(3) Confidence to sort waste	(4) Motivation	(5) Perceived social norm	(6) Responsibility (student)	(7) Responsibility (estate services)	(8) Responsibility (waste operators)	(9) Committed	(10) No. of commitments made
Treatment	0.794***	0.770***	0.691***	0.535***	0.415***	0.171	0.382	-0.113	0.00663	-0.218**
	(0.117)	(0.140)	(0.133)	(0.138)	(0.160)	(0.142)	(0.232)	(0.242)	(0.00638)	(0.106)
MU	-0.0598	-0.475**	0.394**	-0.314	-0.583**	0.0300	0.590*	0.641*	0.0111**	0.0837
	(0.151)	(0.234)	(0.197)	(0.242)	(0.258)	(0.223)	(0.325)	(0.351)	(0.00553)	(0.121)
TCD	0.175	-0.173	0.0502	-0.327*	-0.191	-0.204	0.353	-0.125	0.00856	0.250***
	(0.117)	(0.169)	(0.156)	(0.169)	(0.176)	(0.166)	(0.270)	(0.281)	(0.00609)	(0.0953)
UCD	0.249*	-0.529**	0.200	-0.471**	-0.616***	0.0208	-0.232	-0.577*	0.00603	0.184
	(0.138)	(0.213)	(0.182)	(0.209)	(0.212)	(0.175)	(0.310)	(0.323)	(0.00751)	(0.114)
Treatment # MU	0.406**	0.411	-0.456**	0.259	0.521*	-0.179	-0.764*	-0.746*	-0.00663	0.156
	(0.190)	(0.266)	(0.226)	(0.273)	(0.302)	(0.269)	(0.399)	(0.433)	(0.00638)	(0.169)
Treatment # TCD	0.502***	0.118	0.0212	0.336*	0.357*	0.0535	-0.598*	0.214	-0.00589	-0.0484
	(0.146)	(0.195)	(0.178)	(0.194)	(0.213)	(0.197)	(0.320)	(0.336)	(0.00710)	(0.135)
Treatment # UCD	0.538***	0.104	-0.552***	0.0907	0.0229	0.0433	-0.0920	0.561	-0.0132	-0.231
	(0.172)	(0.251)	(0.213)	(0.247)	(0.260)	(0.212)	(0.374)	(0.390)	(0.0106)	(0.169)
Constant	4.938***	7.251***	6.793***	7.978***	5.630***	8.579***	6.847***	7.198***	0.989***	5.339***
	(0.0910)	(0.120)	(0.116)	(0.117)	(0.132)	(0.121)	(0.198)	(0.201)	(0.00553)	(0.0754)
Observations	2590	2569	2569	2569	2569	2194	2194	2194	2590	2590

Robust standard errors in parentheses
* p<.1 ** p<.05 *** p<.01

User experience
Engagement

Table A13. Dropout rates by waste game version (overall and by university)

Dropout	(1) Control N	(1) Control Mean/SE	(2) Full version N	(2) Full version Mean/SE	(3) Simplified version N	(3) Simplified version Mean/SE	t-test Difference (1)-(2)	t-test Difference (1)-(3)	t-test Difference (2)-(3)
Overall	2025	0.638	2168	0.659	2155	0.482	-0.021	0.156***	0.177***
		[0.011]		[0.010]		[0.011]			
DCU	684	0.668	736	0.702	725	0.503	-0.034	0.165***	0.199***
		[0.018]		[0.017]		[0.019]			
MU	239	0.552	276	0.594	286	0.413	-0.042	0.140***	0.182***
		[0.032]		[0.030]		[0.029]			
TCD	579	0.560	620	0.523	637	0.385	0.037	0.175***	0.138***
		[0.021]		[0.020]		[0.019]			
UCD	523	0.725	536	0.789	507	0.611	-0.065**	0.113***	0.178***
		[0.020]		[0.018]		[0.022]			

The value displayed for t-tests are the differences in the means across the groups.
***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Graph A9. Waste game engagement rates by university
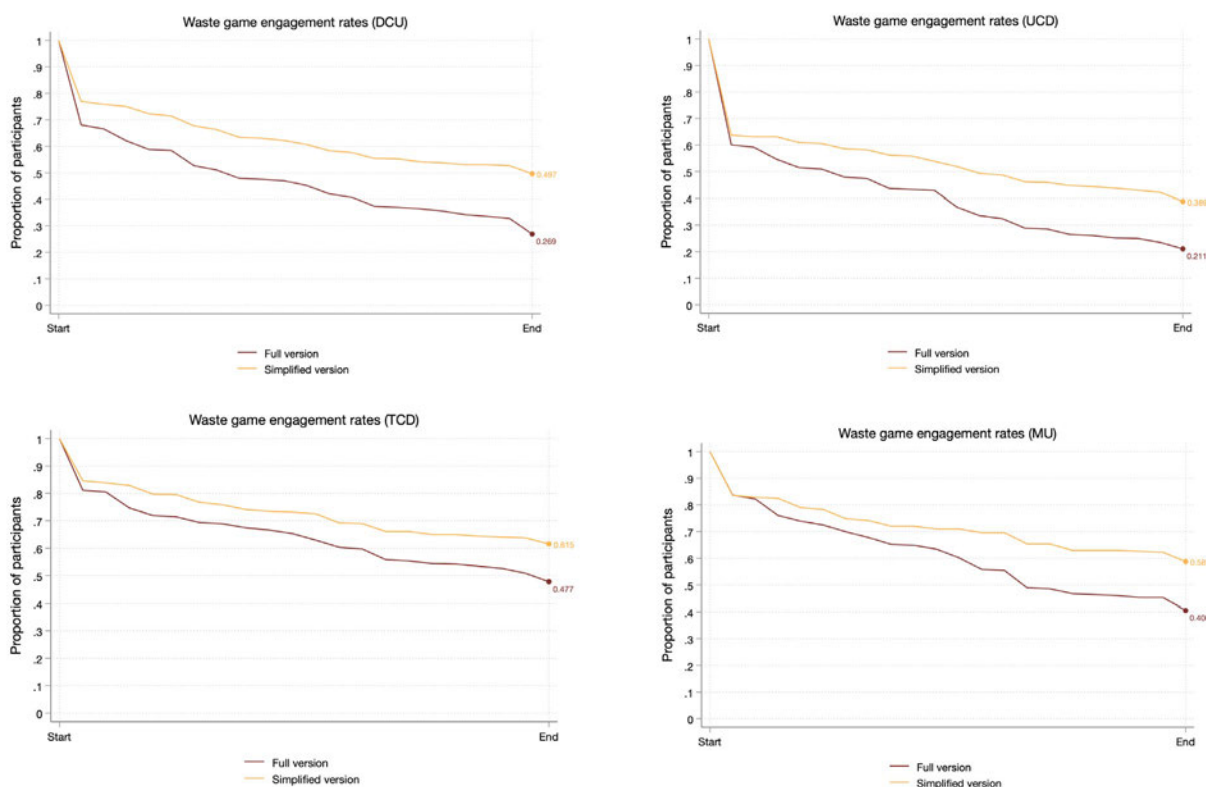
Table A14. Summary statistics on time spent on the waste game

Time spent (minutes)	Mean	Median	SD	Num. of observations
On the game overall	54.48	8.55	427.83	2766
On Level 1 Challenge 1	5.37	0.83	127.89	3832
On Level 1 Challenge 2	4.44	1.00	88.63	3647
On Level 1 Challenge 3	3.39	0.92	57.02	3570
On Level 2 Challenge 1	2.95	1.08	32.00	2957
On Level 2 Challenge 2	5.33	0.87	120.78	2874
On Level 2 Challenge 3	3.02	1.83	17.91	2803

Performance in the game

Graph A10. Overall waste game score by participating universities
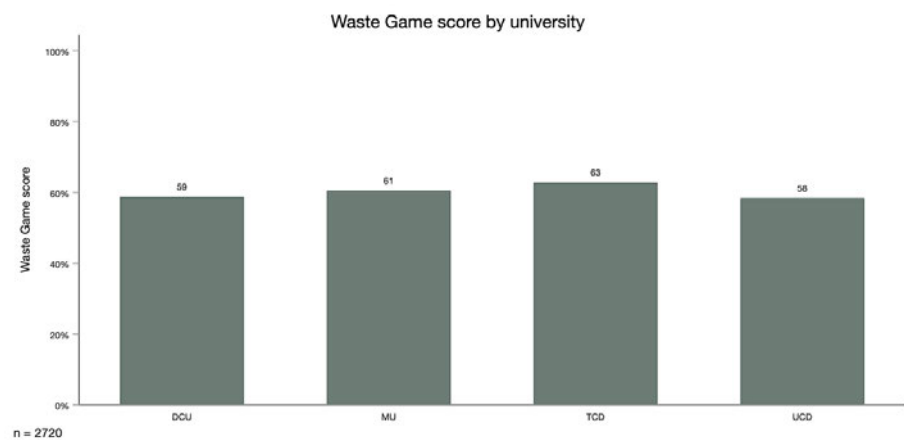
Graph A11. The share of staff and students that sorted waste items correctly during the final waste-sorting contest
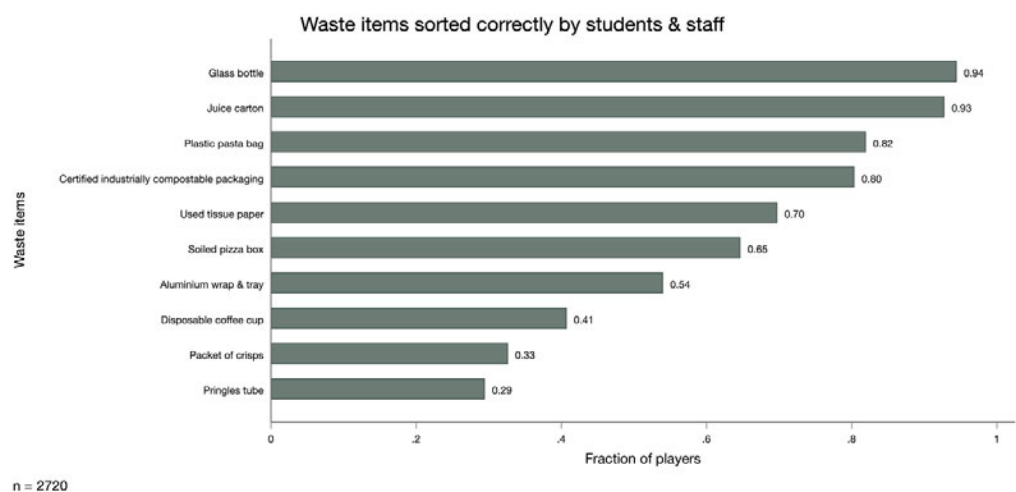
Graph A12. The share of TCD staff and students that sorted waste items correctly during the final waste-sorting contest
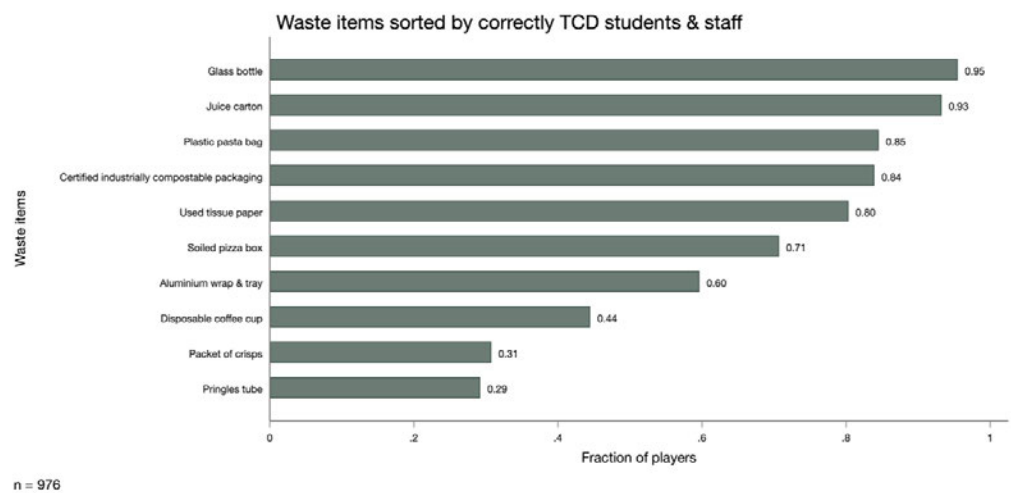
Graph A13. The share of MU staff and students that sorted waste items correctly during the final waste-sorting contest.

Waste items sorted correctly by MU students & staff

Waste items	Fraction of players
Juice carton	0.94
Glass bottle	0.94
Plastic pasta bag	0.82
Used tissue paper	0.81
Certified industrially compostable packaging	0.80
Soiled pizza box	0.72
Aluminium wrap & tray	0.50
Disposable coffee cup	0.43
Packet of crisps	0.35
Pringles tube	0.31

n = 410
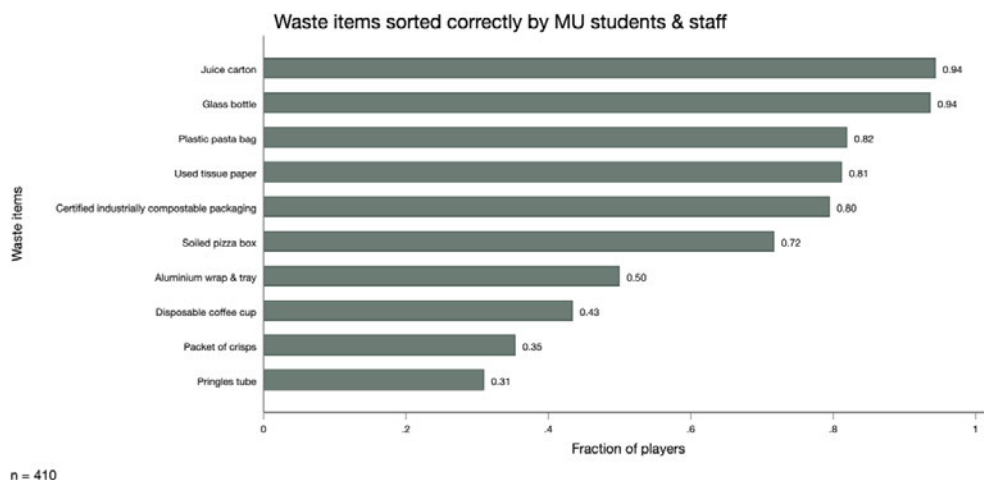
Graph A14. The share of DCU staff and students that sorted waste items correctly during the final waste-sorting contest.

Waste items sorted correctly by DCU students & staff

Waste items	Fraction of players
Glass bottle	0.93
Juice carton	0.92
Plastic pasta bag	0.78
Certified industrially compostable packaging	0.77
Soiled pizza box	0.76
Used tissue paper	0.76
Aluminium wrap & tray	0.48
Disposable coffee cup	0.35
Packet of crisps	0.33
Pringles tube	0.31

n = 850
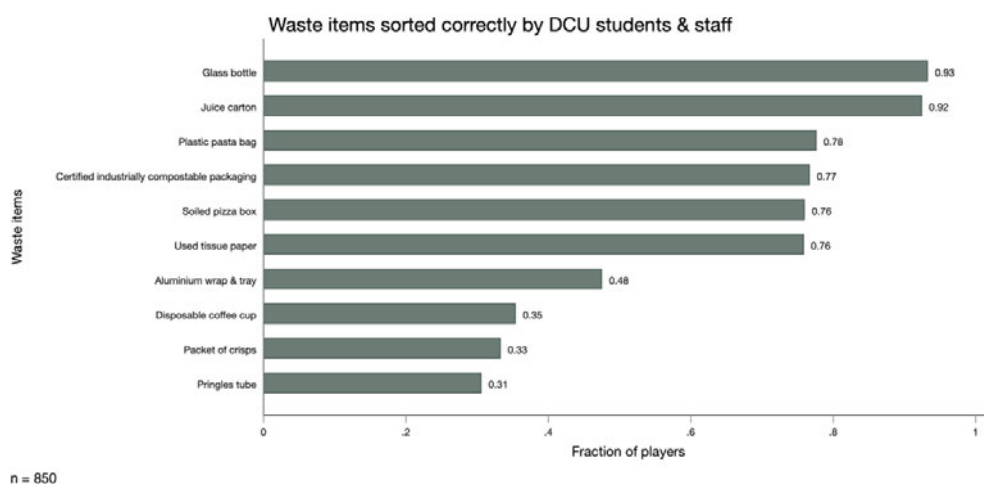
Graph A15. The share of UCD staff and students that sorted waste items correctly during the final waste-sorting contest.

Waste items sorted by correctly UCD students & staff

Waste items	Fraction of players
Glass bottle	0.95
Juice carton	0.91
Plastic pasta bag	0.84
Certified industrially compostable packaging	0.80
Aluminium wrap & tray	0.57
Disposable coffee cup	0.40
Packet of crisps	0.33
Used tissue paper	0.28
Pringles tube	0.27
Soiled pizza box	0.27

n = 484
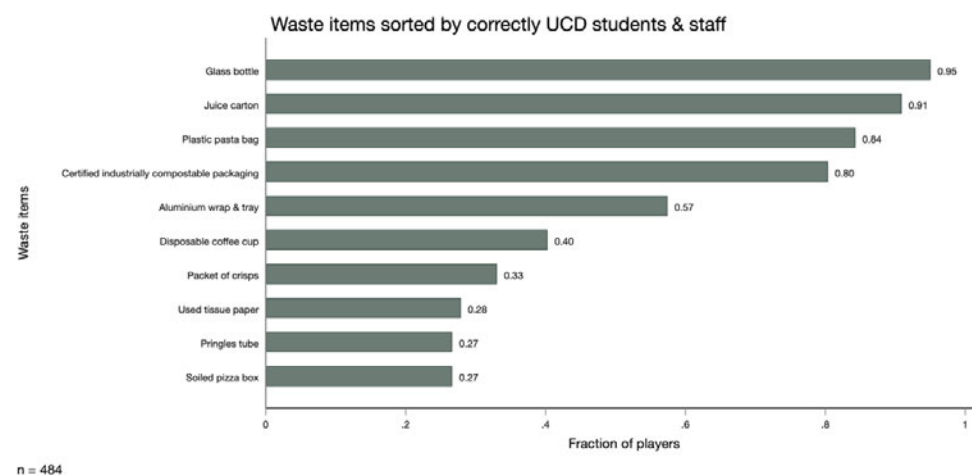
Perceived usefulness

Table A15. Differential effects on game usefulness

	(1) Perceived game to be somewhat or very useful	(2) Perceived game to be very useful
Full version	-0.0145	-0.110***
	(0.00908)	(0.0229)
Constant	0.971***	0.701***
	(0.00499)	(0.0137)
Observations	1836	1836

Robust standard errors in parentheses
* p<.1 ** p<.05 *** p<.01

Table A16. Differential effects on game usefulness by university

	(1) Somewhat or very useful	(2) Very useful	(3) Somewhat or very useful	(4) Very useful	(5) Somewhat or very useful	(6) Very useful	(7) Somewhat or very useful	(8) Very useful
Full version	-0.0288*	-0.0548	-0.0268	-0.244***	-0.00483	-0.111***	0.00391	-0.0668
	(0.0163)	(0.0403)	(0.0271)	(0.0590)	(0.0148)	(0.0369)	(0.0195)	(0.0583)
Constant	0.983***	0.742***	0.964***	0.708***	0.964***	0.699***	0.970***	0.624***
	(0.00676)	(0.0231)	(0.0144)	(0.0352)	(0.00939)	(0.0232)	(0.0123)	(0.0346)
University	DCU	DCU	MU	MU	TCD	TCD	UCD	UCD
Observations	558	558	280	280	688	688	310	310

Robust standard errors in parentheses
* p<.1 ** p<.05 *** p<.01

Graph A16. Perceived usefulness of the waste game by university

n = 1836
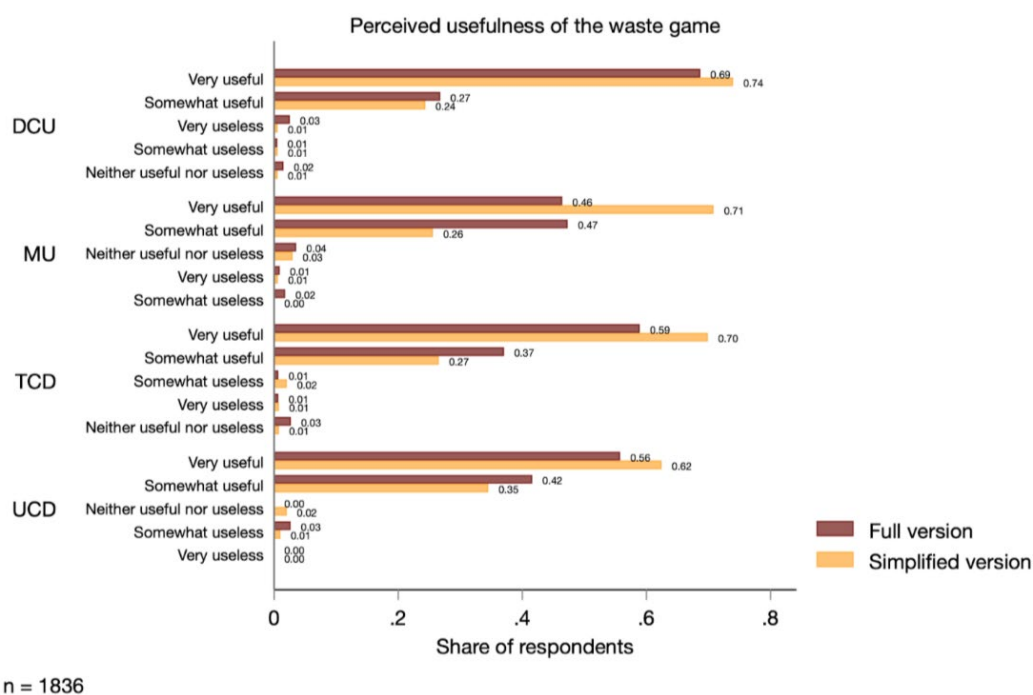
Length and relevance

Graph A17. Feedback on the length of the waste game by university

Feedback on the length of the waste game

n = 278
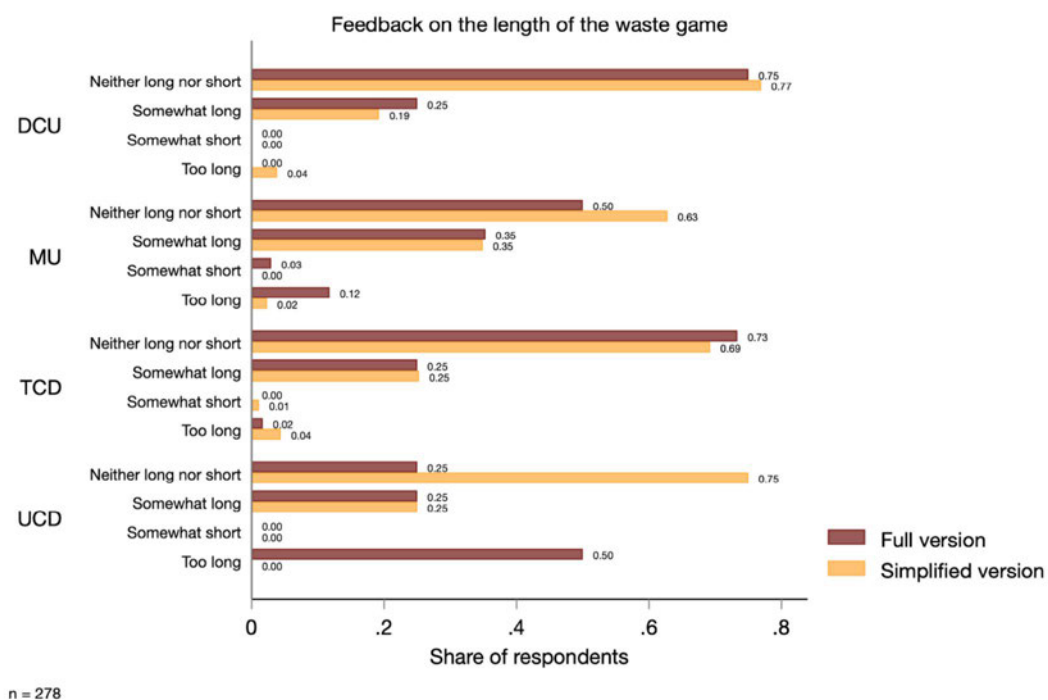
Graph A18. Feedback on the relevance of the waste game by university

Feedback on the relevance of the waste game

n = 276
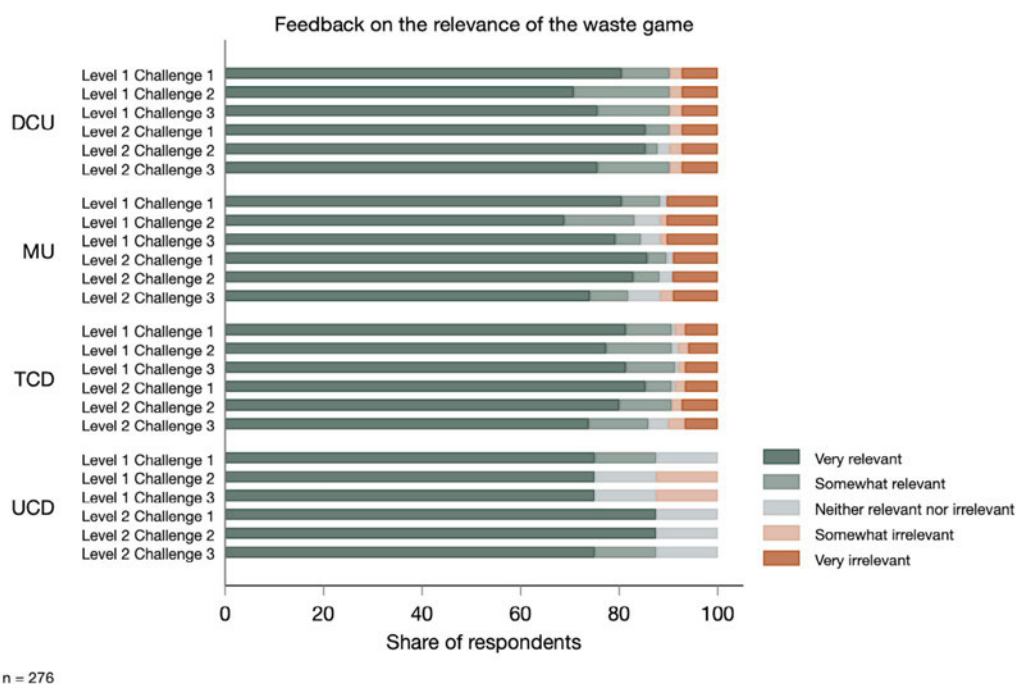
Qualitative feedback

Graph A19. DCU participants' feedback on what would help them better reduce or recycle waste

What would help DCU participants better reduce or recycle their waste on campus

n = 119
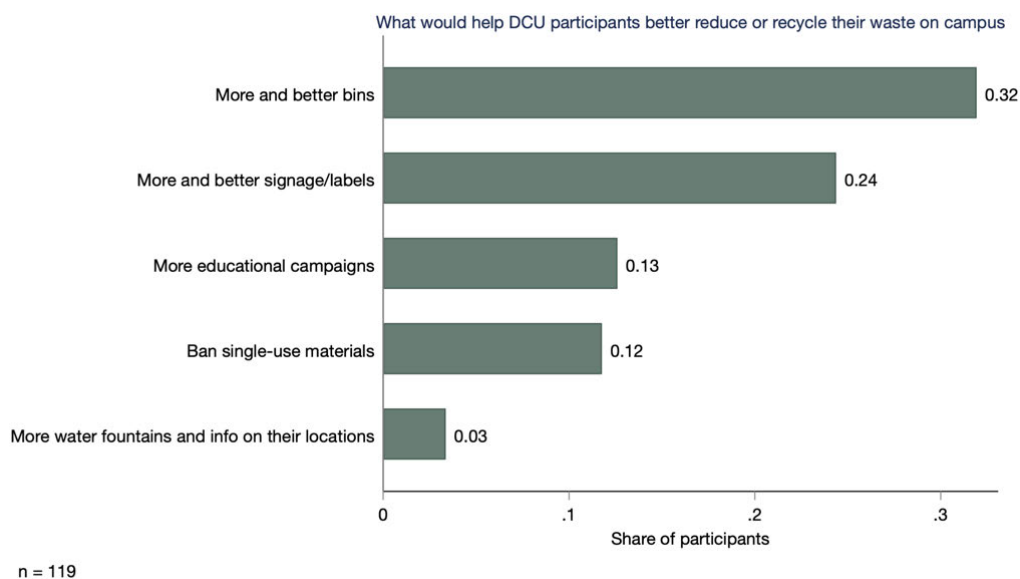
Graph A20. TCD participants' feedback on what would help them better reduce or recycle waste

What would help TCD participants better reduce or recycle their waste on campus

n = 86
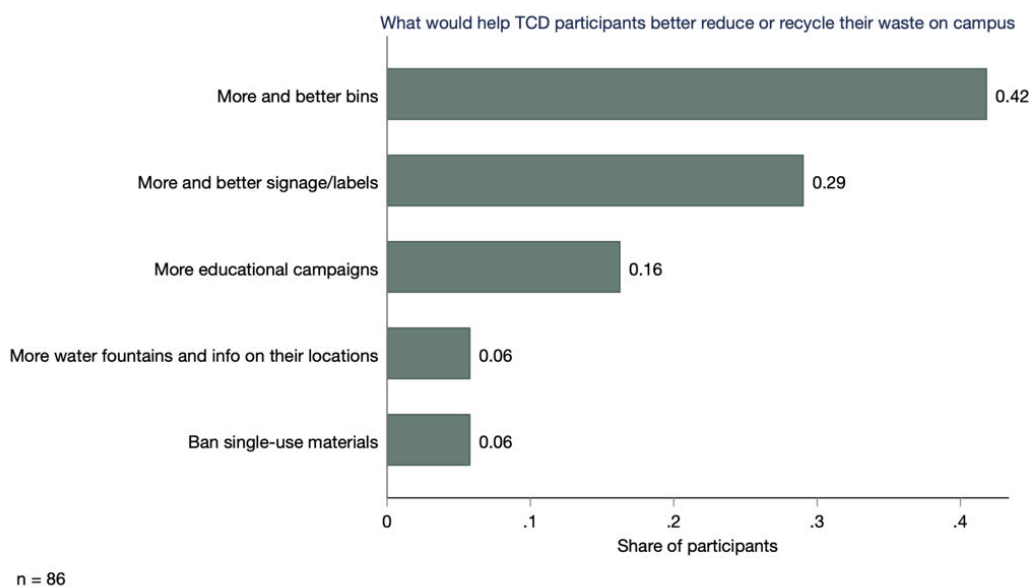
Graph A21. MU participants' feedback on what would help them better reduce or recycle waste

What would help MU participants better reduce or recycle their waste on campus

Category	Share
More and better signage/labels	0.31
More and better bins	0.31
More educational campaigns	0.15
More water fountains and info on their locations	0.11
Ban single-use materials	0.10

Share of participants
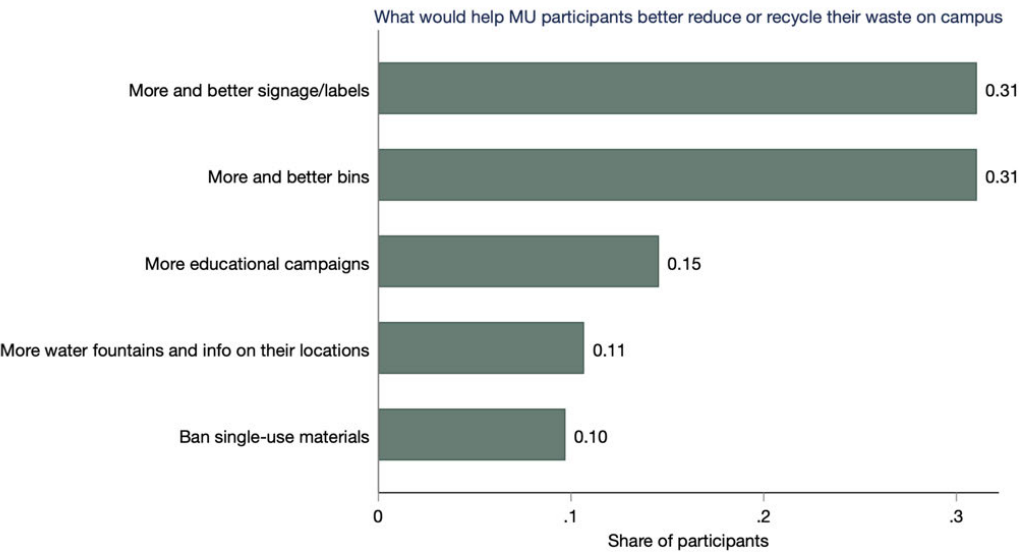
n = 103

Graph A22. UCD participants' feedback on what would help them better reduce or recycle waste

What would help UCD participants better reduce or recycle their waste on campus

Category	Share
More and better signage/labels	0.23
More and better bins	0.23
More water fountains and info on their locations	0.08
More educational campaigns	0.08
Ban single-use materials	0.00

Share of participants
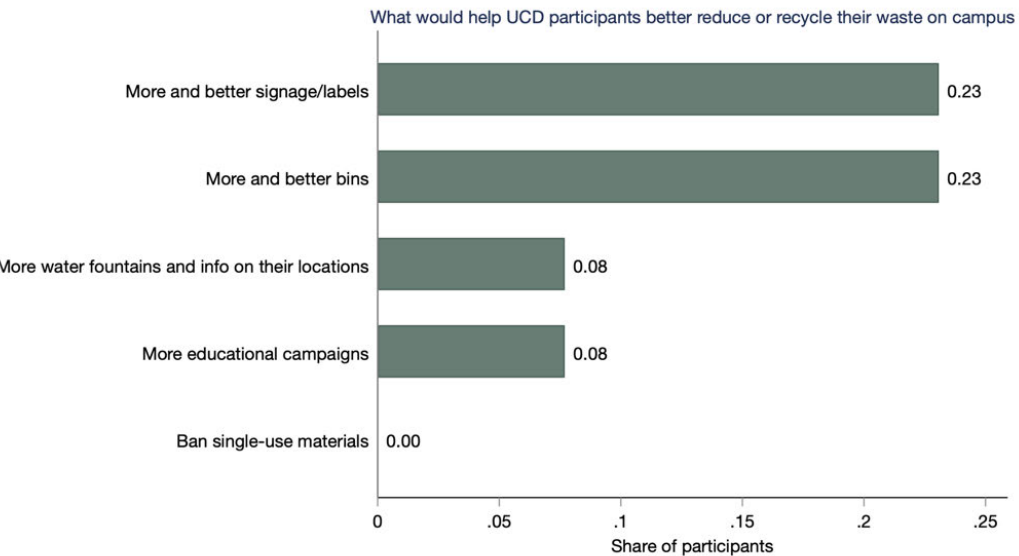
n = 13

Table A17. Participants' feedback and quotes on how to improve the waste game

Theme	Subtheme	Example quotes
Game design	Make the game shorter, more visual and interactive	"This was great game. Maybe a few more pictorial representations like real life images could be nice to go with different facts. Just an idea that popped into head right now. All in all, it was really interesting. Thank you"
	Better calibrate points and incentives provided in final waste sorting contest	"Don't put students into groups, I lost lots of points even though I responded correctly, it was very frustrating and I lost motivation to read the explanations"
	Provide feedback and key take-aways at the end of the game	"Send a summary of everything learned (maybe wrong questions) to email address. Might help for participants to remember longer period of time."
	Improve the game usability	"I'm colour blind and found it the "Bin" icons small and difficult to see their logos (near the end of the game). The colour of the binds wasn't helpful."
Game content	Make the game more challenging and informative	"Make the question more difficult so I actually need to think about them, rather than just have it be the most obvious answer (e.g., the highest/lowest numbers)."
	Include additional waste related topics in the game	"I'd like to learn more about the symbols on packaging, and how to dispose of electronics, batteries, furniture, et cetera."
	The game is informative and useful	"it seems very informative and allows for a variety of challenges which really gets you thinking! well done!"
Game dissemination	Make the game compulsory	"Make it compulsory! I learnt loads and I thought I already knew enough!"

Table A18. Participants' feedback and quotes on what would help them better reduce or recycle waste on campus

Theme	Subtheme	Example quotes
Single-use materials	Remove single-use materials	"Stricter policies against disposable coffee cups: for example, UCC has removed ALL disposable coffee cups from its campus coffee shops and restaurants. We can too!"
Waste recycling infrastructure and signage	Provide more co-located bins with appropriate signage	"More bins around campus. Always accompany a general bin with a compose + recycling bin. CLEAR labelling + instructions on what can and cannot be put in each bin. Signs in bathroom stalls. Education programmes."
Waste prevention infrastructure and signage	Provide cleaning facilities for lunchboxes and reusable cups	"More staff kitchen space, to ensure reusable lunchboxes, keep cups, etc., can be cleaned down. Such kitchens would benefit from microwaves and toasters. Also, publicly available water fountains configured to clean reusable cups."
	Improve water fountain signage	"Please please please put signs around the campus directing students towards water refilling stations. Having 15 of them around the campus is great but totally no good if no one knows they're there"
Educational campaigns	Provide more information on waste sorting	"I would like to be more educated. I learnt a lot from doing this game. Explanations of symbols and bins may help."
	Foster trust in the recycling process	"1) Posters above recycling bins that show what should go where. 2) Information about what happens to recycling bins exactly. Some people believe that recycling bins are part of 'greenwashing' : recycling waste actually goes in landfill or gets shipped to low-income countries."

Switching to reusable: encouraging the take-up and sustained use of reusable cups on campus

Trial design and implementation

Survey respondents profile

Graph B1. Share of eCups, other reusable cup, and non-reusable cup users
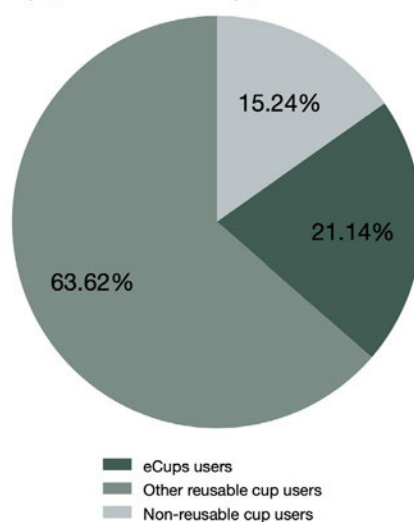
Graph B2. Share of respondents by gender
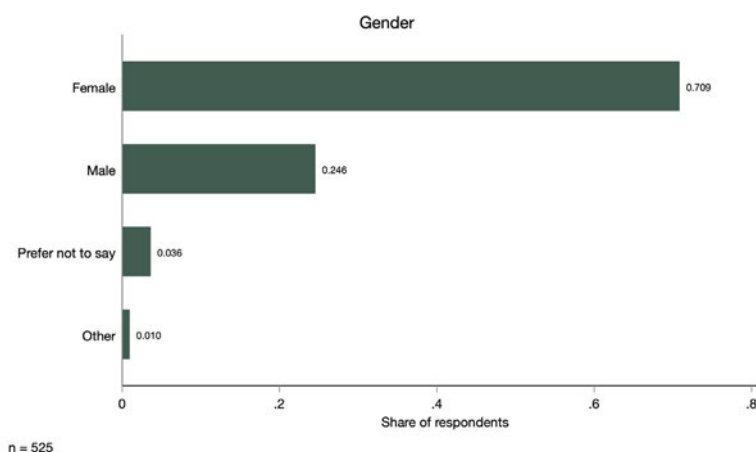
Graph B3. Share of respondents by year of studies

Year of studies

Year	Share
1st year undergrad	0.137
2nd year undergrad	0.153
3rd year undergrad	0.093
4th year undergrad	0.069
Postgrad	0.504
Other year	0.044

Share of student respondents

n = 248
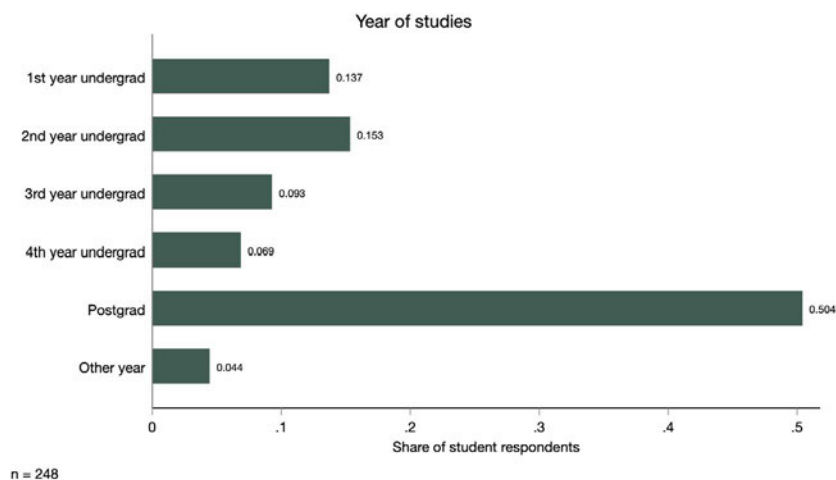
Graph B4. Share of respondents by college

College

College	Share
College of Science	0.258
College of Health and Agricultural Studies	0.222
College of Social Sciences and Law	0.165
College of Engineering and Architecture	0.137
College of Arts and Humanities	0.117
College of Business	0.073
Don't know	0.028

Share of student respondents

n = 248
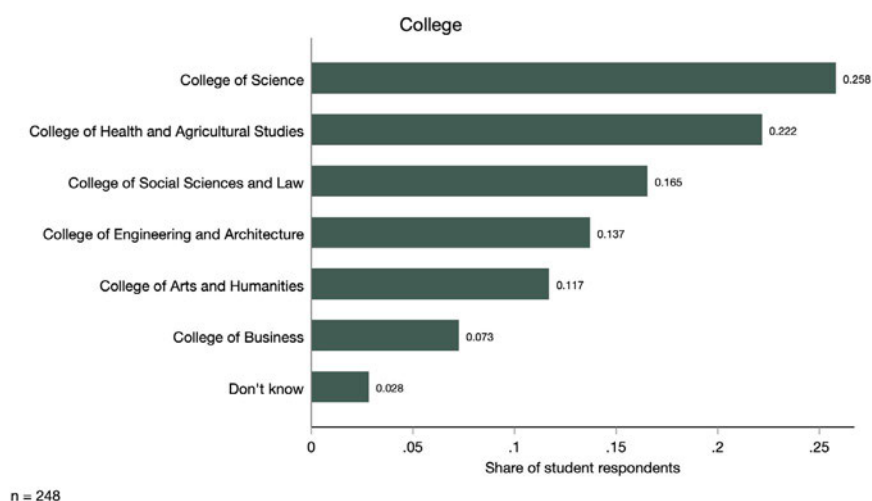
Graph B5. Share of respondents by green identity

How important is it for you to live a sustainable lifestyle?

Importance	Share
Extremely important	0.291
Very important	0.442
Moderately important	0.232
Slightly important	0.025
Not at all important	0.010

Share of respondents

n = 525
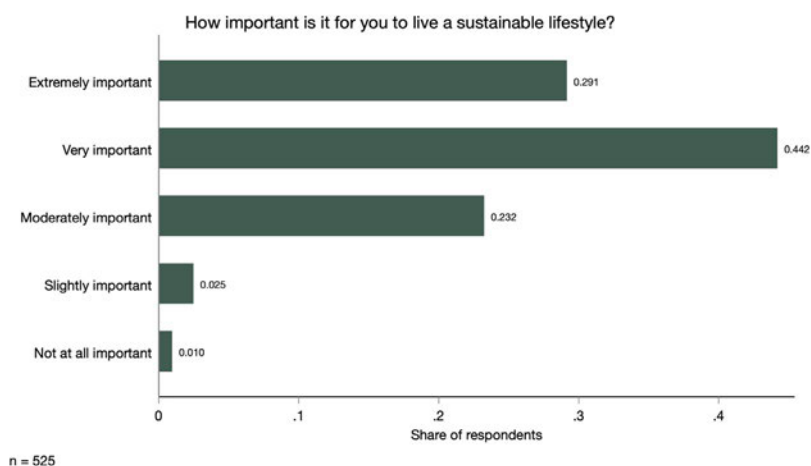
Trial findings

Promoting the take-up of reusable cups

Experimental results

Table B1. Email open rates by experimental group

Variable	(1) Control N	(1) Control Mean/ SE	(2) Treatment (10% discount) N	(2) Treatment (10% discount) Mean/ SE	(3) Treatment (50% discount) N	(3) Treatment (50% discount) Mean/ SE	t-test Difference (1)-(2)	t-test Difference (1)-(3)	t-test Difference (2)-(3)
Opened email	12698	0.730	12694	0.738	12704	0.743	-0.009	-0.014**	-0.005
		[0.004]		[0.004]		[0.004]			

Notes: While there is a statistically significant difference in email open rates between the control group and the 50% discount treatment group, the difference is small in magnitude and rather negligible. This observation makes intuitive sense as the email subject line is identical for all three groups and therefore should not have influenced a student's likelihood of opening the email.
The value displayed for t-tests are the differences in the means across the groups.
***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table B2. Breakdown of eCups sales by month, price, and location

Month	February 2023			March 2023		
eCups Price	€ 1.50	€ 2.70	€ 3.00	€ 1.50	€ 2.70	€ 3.00
Smurfit	4	0	14	4	0	11
Richview	0	0	3	3	0	3
Bluebird	21	5	78	1	1	50
Quinn	3	0	15	1	0	13
Pulse Café	5	3	0	4	0	1
Law Café	1	1	14	3	0	1
Pi Restaurant	19	3	31	16	1	17
Vets	2	2	4	3	0	3
Total	55	14	159	35	2	99
Monthly Total eCups Sales		228			136	

Table B3. Effect of discount on reusable cup purchase

|	(1)	(2)
	Purchased eCups	Purchased eCups
Treatment	-0.0161***	
(Overall)	(0.00132)	
Treatment		-0.0191***
(10% discount)		(0.00129)
Treatment		-0.0132***
(50% discount)		(0.00146)
Constant	0.0203***	0.0203***
	(0.00125)	(0.00125)
Observations	38096	38096

Robust standard errors in parentheses
* p<.1 ** p<.05 *** p<.01

Encouraging the sustained use of reusable cups

User experience of the eCups app
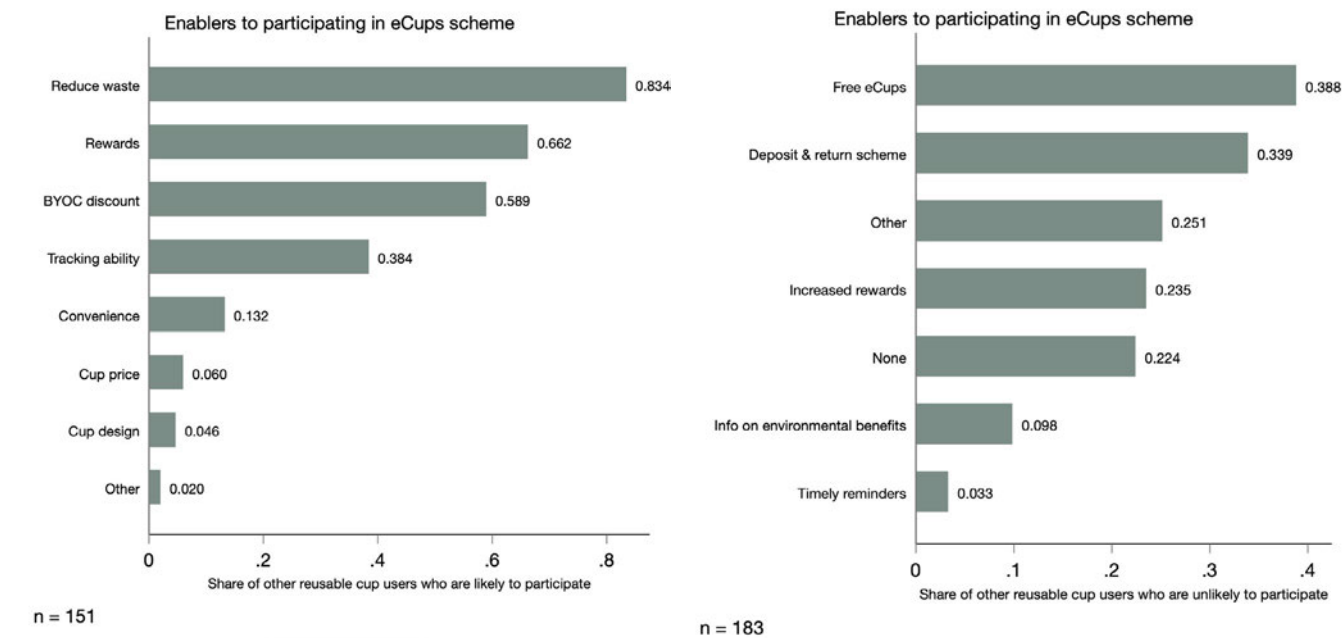
Graph B6. Perceived effectiveness of the eCups app

Has the eCups app motivated you to use your reusable cup more frequently?

- Yes
- No
- Maybe
- Don't know

33.33%
14.41%
14.41%
37.84%
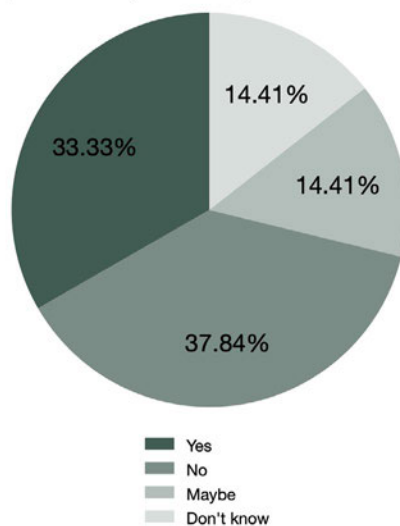
Key enablers for the sustained use of reusable cups

Graph B7 and B8. Enablers for participating in the eCups scheme (for other reusable cup users)

Enablers to participating in eCups scheme

Enabler	Share of other reusable cup users who are likely to participate
Reduce waste	0.834
Rewards	0.662
BYOC discount	0.589
Tracking ability	0.384
Convenience	0.132
Cup price	0.060
Cup design	0.046
Other	0.020

n = 151

Enablers to participating in eCups scheme

Enabler	Share of other reusable cup users who are unlikely to participate
Free eCups	0.388
Deposit & return scheme	0.339
Other	0.251
Increased rewards	0.235
None	0.224
Info on environmental benefits	0.098
Timely reminders	0.033

n = 183

Graph B9 and B10. Enablers for participating in the eCups scheme (for non-reusable cup users)

Enablers to participating in eCups scheme

Enabler	Share of non-reusable cup users who are likely to participate
Reduce waste	0.718
BYOC discount	0.590
Rewards	0.590
Tracking ability	0.205
Cup price	0.103
Other	0.051
Convenience	0.051
Cup design	0.000

n = 39

Enablers to participating in eCups scheme

Enabler	Share of non-reusable cup users who are unlikely to participate
None	0.366
Deposit & return scheme	0.341
Free eCups	0.293
Increased rewards	0.171
Other	0.146
Timely reminders	0.073
Info on environmental benefits	0.024

n = 41

Cost-benefit analysis

Economic costs and benefits for the university

Table B4. Cost-benefit analysis for the trial period

Trial period (11 weeks)	
Revenue	
Selling Price	€ 1.50 or € 2.70 or € 3.00
Total Cup sold	364
Total Revenue	€ 952.20
Cost of disposable cup	€ 0.15
Total disposable cups saved	1384
Total Disposable Cup Saving	€ 207.55
Cost	
VAT 23%	€ 0.35 or € 0.62 or € 0.69
Handling fee	€ 1.00
Tablet cost	€ 585.00
eCups cost	€ 2.95
Free drinks cost	€ 3.00
Total free drinks redeemed	20
Total Cup sold	364
Total Cost	€ 2,302.24
Discount on drinks bought with reusable cup	€ 0.15
Total refills	1384
Total Discounts on Drinks	€ 207.55
Net Benefit / Cost	-£1,350.04
Total Cost per eCup adopted	–€3.71
Total Cost per disposable cup waste reduced	–€0.98
There will be a net benefit if we value each disposable cup waste reduction at more than €0.90.	

Table B5. Cost-benefit analysis for 1-year projection using conservative estimates

Projected (1-academic-year/32-week scheme conservative estimates)	
Revenue	
Selling Price	€ 3.00
Total Cup sold	556
Total Revenue	€ 1,668.00
Cost of disposable cup	€ 0.15
Total disposable cups saved	6148
Total Disposable Cup Saving	€ 922.24
Cost	
VAT 23%	€ 0.69
Handling fee	€ 1.00
Tablet cost	€ 585.00
eCups cost	€ 2.95
Free drinks cost	€ 3.00
Total free drinks redeemed	89
Total Cup sold	556
Total Cost	€ 3,431.45
Discount on drinks bought with reusable cup	€ 0.15
Total refills	6148
Total Discounts on Drinks	€ 922.24
Net Benefit / Cost	-£1,763.45
Total Cost per eCup adopted	-€3.17
Total Cost per disposable cup waste reduced	-€0.29
There will be a net benefit if we value each disposable cup waste reduction at more than €0.29.	

Table B6. Cost-bnefit analysis for 1-year projection using best-case-scenario estimates

Projected (1-academic-year/32-week scheme best-case-scenario estimates)	
Revenue	
Selling Price	€ 3.00
Total Cup sold	1456
Total Revenue	€ 4,368.00
Cost of disposable cup	€ 0.15
Total disposable cups saved	16100
Total Disposable Cup Saving	€ 2,415.07
Cost	
VAT 23%	€ 0.69
Handling fee	€ 1.00
Tablet cost	€ 585.00
eCups cost	€ 2.95
Free drinks cost	€ 3.00
Total free drinks redeemed	233
Total Cup sold	1456
Total Cost	€ 8,039.02
Discount on drinks bought with reusable cup	€ 0.15
Total refills	16100
Total Discounts on Drinks	€ 2,415.07
Net Benefit / Cost	-£3,671.02
Total Cost per eCup adopted	-€2.52
Total Cost per disposable cup waste reduced	-€0.23
There will be a net benefit if we value each disposable cup waste reduction at more than €0.23.	

Table B7. Assumptions behind cost-benefit analysis for 1-year projections

Assumptions	Projected (1-academic-year/32-week scheme conservative estimates)	Projected (1-academic-year/32-week scheme best-case-scenario estimates)
Selling Price	Assumed to be €3 for all eCups sold	Assumed to be €3 for all eCups sold
Total Cup sold	Assume a marginally decreasing downward slope based on sales data in Feb and March 2023 - cups sold in each 4 weeks are 59.65% of preceding 4 weeks	Assume a constant rate based on sales data in Feb and March 2023 - cups sold in each 4 weeks are 100% of preceding 4 weeks
Total refills / disposable cups saved	Adjusted for under-recording of eCups use (based on survey data). Assume each eCup to be used 0.35 times per week (based on trial data)	Adjusted for under-recording of eCups use (based on survey data). Assume each eCup to be used 0.35 times per week (based on trial data)
Total Disposable Cup Saving	Assumed to be cancelled out by the total discounts on drinks bought with reusable cups	Assumed to be cancelled out by the total discounts on drinks bought with reusable cups
Total Discounts on Drinks	Assumed to be cancelled out by the total disposable cup savings	Assumed to be cancelled out by the total disposable cup savings
Handling fee	Assumed to stay the same	Assumed to stay the same
Tablet cost	Assumed to stay the same - as a fixed cost	Assumed to stay the same - as a fixed cost
eCups cost	Assumed to stay the same	Assumed to stay the same
Free drinks cost	Assumed to stay the same	Assumed to stay the same
Total free drinks redeemed	Assume 1 free drinks redeemed per 69.2 refills (based on trial data)	Assume 1 free drinks redeemed per 69.2 refills (based on trial data)

Economic costs and benefits for students and staff

Table B8. Cost-benefit analysis for eCups users

Times used	eCups cost	Drink discount	Free drinks	Net
1	€ 3.00	€ 0.15	€ 0.00	-€ 2.85
2	€ 0.00	€ 0.15	€ 0.00	-€ 2.70
3	€ 0.00	€ 0.15	€ 0.00	-€ 2.55
4	€ 0.00	€ 0.15	€ 0.00	-€ 2.40
5	€ 0.00	€ 0.15	€ 0.00	-€ 2.25
6	€ 0.00	€ 0.15	€ 0.00	-€ 2.10
7	€ 0.00	€ 0.15	€ 0.00	-€ 1.95
8	€ 0.00	€ 0.15	€ 0.00	-€ 1.80
9	€ 0.00	€ 0.15	€ 0.00	-€ 1.65
10	€ 0.00	€ 0.15	€ 3.00	€ 1.50
For the students and staff, an Ecup will pay for itself on the 10th use.				

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