The Gamification of Recycling Behaviour

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Abstract

The purpose of this study was to determine whether gamification of a public recycling receptacle would increase recycling rates. I reviewed research gamification, behavioural science, Human Computer Interactions, and eco-feedback, to inform my experimental design. The study consisted of an AB control-series experiment. In Phase A, I collected baseline data by monitoring four target bins for the weight, volume, and number of items of recyclables. In Phase B I installed the Recycling Arcade, a gamified recycling bin lid, at one site. I then collected data in the same way as the baseline phase and monitored any changes in recycling rates. Graphical analysis showed variable data on recycling rates, demonstrating no clear trends of whether recycling was increasing or decreasing. The results of a Two-Way repeated-measure ANOVA analysis found no interaction effect between bin type and game phase and a small effect size was also reported, showing that there was no effect of the game on recycling rates. The statistical and graphical analysis of the results underscore the complexity of this type of intervention, highlighting technical issues and the need for design improvements, and collaborations with game designers and Human Computer Interaction academics, for future research into this innovative and experimental area.

Acknowledgments

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Introduction

The purpose of this study was to determine whether gamification of a public recycling receptacle would increase recycling rates. In the next sections I review new research on the emerging field of gamification, followed by the use of psychology and behavioural science in pro-environmental interventions - any intervention which helps conserve the natural environment. I then introduce Human Computer Interaction research and the concept of eco-feedback, electronic feedback on a user's own green behaviour. Towards the end of this review, I report on interviews with two stakeholders in the Raglan community, where the research was undertaken. These dialogues with local environmental organisations ultimately led me to choose recycling as the focus of my research because it is a main concern to the community. In the methodology section, I will synthesise the findings from psychology, gamification, and eco-feedback into an experimental design for the Raglan Recycling Arcade. I then present the results and discuss them in context. Finally, I present some recommendations and conclusions.

Gamification

In the process of gamification, activities which are not games are re-designed in the style of a game (Morford, Witts, Killingsworth, & Alavosius, 2014). One researcher and game designer has advocated for games as a major vehicle for social change (McGonigal, 2010). McGonigal (2010) researched characteristics of gamers of the popular 'World of Warcraft' (WOW), and saw four major themes emerging. The first is 'urgent optimism' - when confronted with an obstacle, gamers attempt to immediately resolve it. The second theme is the 'building of social fabric', where experiencing defeat, a gamer is increasingly likely to cooperate with and trust another person with whom they have played. A third state is 'blissful productivity', describing a desire to be productive and engaged in meaningful work – the average WOW gamer spends 22 hours a week gaming (McGonigal, 2010). The last characteristic is 'epic meaning' which refers to the larger-than-life missions in games. McGonigal (2010) reports that the second biggest wiki (second to Wikipedia), is the WOW wiki, containing over 80,000 articles and averaging 5 million users a month.

In the following section, I will discuss how to transform these powerful contingencies into socially and, in this case, environmentally relevant causes, in games that engage the user in their own everyday situation.

Alternate Reality Games

An Alternate Reality game (ARG) is one which asks its players to act and document missions in the real world, thereby collecting points and reporting back on an online platform. Montola, Stenros, and Waern (2009) suggest that a successful ARG game "take[s] the substance of everyday life and weave[s] it into narratives that layer additional meaning, depth, and interaction upon the real world" (p. 37). One powerful example of an ARG which used an ecological theme was the game World Without Oil which, launched on April 30, 2007, ran for 2 months. It simulated a global oil crisis and invited its players to take actions in the real world to survive the crisis (Cohen & Harvey, 2014). Players then had to blog, take pictures and videos, and comment online about survival behaviours such as starting to grow their own food, or using post-oil transport, such as bicycles as transport (McGonigal, 2010). A narrative was created each day for the website and players accumulated points for each pro-environmental action. Overall 1,800 players participated in the ARG and were followed by 60,000 spectators (Cohen & Harvey, 2014). Players reported engaging with this environmental issue passionately, with some players reporting lasting behaviour change (McGonigal, 2010). Players documented their pro-environmental actions with photos and videos of garden projects, using cycling or walking as transport, and other such actions that did not use oil. Most importantly, World Without Oil engaged a vast number of players in taking ecological action in order to achieve a positive effect on the natural environment. It is therefore important for psychologists to study the contingencies which made this game so captivating, so that we can inform new pro-environmental interventions and achieve the same success.

In the following section, I describe another effective green intervention embedded into a public environment. In these cases, data were able to be collected and monitored at each location.

Volkswagen - the fun theory.

A Volkswagen campaign called 'Fun Theory' featured several ecological interventions (http://www.thefuntheory.com/). The World's Deepest Bin was a fixture placed in a public park targeting litter. The World's Deepest Bin had a sensor installed which detected when an item was thrown in and subsequently made a quirky whistling sound, as if playing out that the item was falling into an endless abyss. When the item apparently hit the bottom it made a small explosion noise. In one day 72 kg of trash was collected - more than the 41 kg collected in the normal rubbish bin a few metres away. Another pro-environmental initiative from Volkswagen was the Speed Camera Lottery. Reducing speeding is one way to lower greenhouse gas emissions. The Speed Camera Lottery displayed drivers' speed in large flashing lights, and was placed in a central city area which has pedestrian traffic as well. Speeders were photographed and fined, and this money subsequently went into a lottery pot for drivers who were obeying the speed limit. Prior to the intervention the average speed was 32 km an hour, and during the experiment the average speed was 25 km an hour, amounting to a 22% reduction in speed. Finally, in the Bottle Bank Arcade, a glass recycling station was refitted to flash with arcade lights and play electro-pop arcade music each time it was used. Each bottle deposited attracted points, and each of the five slots of the machine gave out a different number of points. The person depositing a bottle was required to wait for the light which indicated which slot they insert the bottle, put the bottle in, and redeem points. A player's points were displayed on a score board beside the highest number of points earned so far. In one night, 19 kg of glass bottles was deposited, whereas the nearby conventional recycling receptacle was used only 2 times.

Eco feedback

Eco feedback is an area of Human Computer Interaction (HCI) which aims to provide feedback back to the user, often in attempt to reduce their negative ecological impact (Froehlich, Findlater, & Landay, 2010). Froehlich et al. (2010) conducted a meta-analysis of research on eco-feedback technology within environmental psychology, behavioural psychology, HCI, and other disciplines which incorporated eco feedback into an intervention. In HCI, researchers conduct laboratory studies, which do not necessarily focus on attaining baseline measurements of target behaviours. In contrast, psychologists in the field strongly focus on baseline measurements, and conduct a wide range of field studies. HCI researchers publish extensively on the interface, graphics, and aesthetics, and seek users' views on experience with devices and perceived utility. Froehlich et al. (2010) suggest that these studies are often more informal in nature than psychological studies.

One such study in HCI was conducted on a product called the Power Aware Cord (Figure 1). The cord visibly displays the energy it is using rather than keeping it 'hidden or unknown' as in most devices. For instance, a Power Aware Cord can be connected to a mobile phone which has finished charging, and by pulsing with light, it indicates to the user that it is still using unnecessary energy.

Figure 1. The Power Aware Cord (from Pierce et al 2008).

Gustafsson and Gyllenswärd (2005) examined three visualisations of the Power-Aware Cord, and found that 13 out of 15 participants understood the message of the feedback, but that more participants preferred the 'pleasing' design over the 'informative' design. In their review of eco visualisations and discussion of the Power Aware Cord, Pierce, Odom, and Blevis (2008) state that "increased awareness and incentive to conserve may emerge through such playful engagement with the Power Aware Cord and electrical devices" (p. 5). However, the authors provide no evidence that such behaviour change is occurring. Further, Froehlich et al. (2010) emphasise the informal and untargeted nature of the studies on the device by quoting authors from another study: “At this stage, the Power-Aware Cord is meant to be a conceptual design statement, mostly used to test people’s reactions and provoke thoughts around the area of energy consumption.” (Gustafsson & Gyllenswärd, 2005) p. 4).

In contrast, psychological studies using eco feedback have often used only the most preliminary displays (see Figure 2), and did not research the differences in behavioural outcomes of aesthetic designs over informative designs. Froehlich et al. (2010) suggest that these are much more basic in design than interfaces used in HCI research.

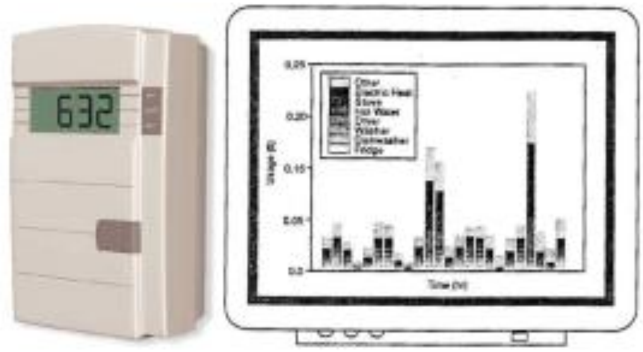


Figure 2. The most common eco feedback interfaces in psychology studies. Reproduced from Froehlich et al. (2010).

Another result of Froehlich et al. (2010) analysis showed that many HCI applications are not grounded in research in psychology – less than 50% of the studies cited behavioural psychology methods, and 58% of the studies referenced environmental psychology. A more pronounced result was found in the domain of environmental psychology – none of these studies cited any HCI research. Froehlich et al. (2010) suggest that this void between fields can be filled by holding future collaborations between HCI and psychological research.

One more example of eco-feedback is the game operating from a smart phone app called Power Agent. This uses Automatic Meter Reading (AMR) which measures home electricity, gas and heating, and provides data on a customer’s hourly consumption

(Gustafsson, Katzeff, & Bang, 2009). Six teenagers and their families participated in the game over 10 days. Rates of consumption were measured at baseline, during, and after the game had finished. Energy savings varied between players from savings of 11% to 36%. The authors report that no conclusions can be drawn about long-term behaviour change, as no follow up studies were conducted. Nevertheless, there is much potential for a game incorporating eco feedback such as Power Agent, as all households in Sweden were forecast to have AMR technology installed by 2009 (Gustafsson et al., 2009).

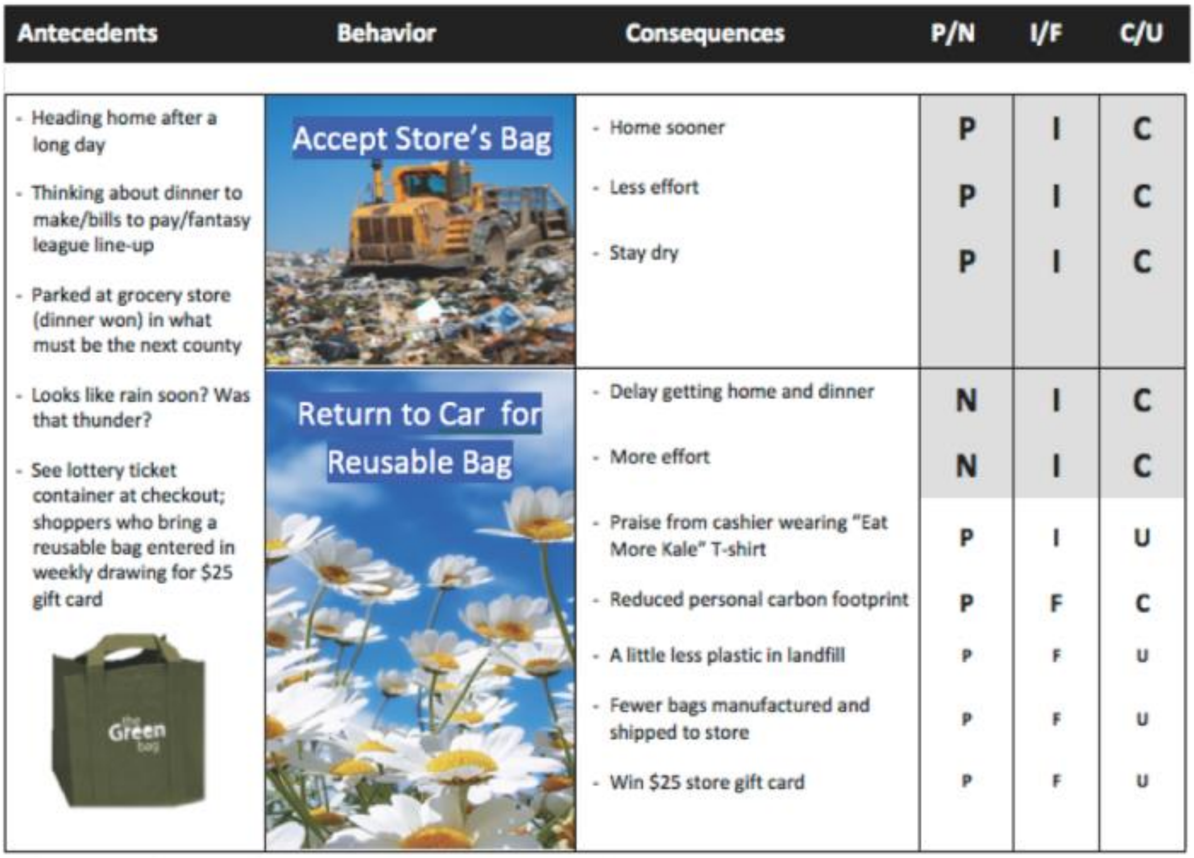
Psychology, Applied Behaviour Analysis, and Ecological Issues.

Brothers, Krantz, and McClannahan (1994) found that paper recycling in an office environment could be increased with a simple intervention of placing the recycling bin closer to employees. In this study, the researchers compared recycling bins which were in the hallways with smaller recycling bins stationed on employees' desks. In the hallway, 28% of paper was recycled, while in on the desk top 89 – 94% of paper was recycled. Brothers et al. (1994) call this effect 'proximity'.

In a study of energy conservation, Siero, Bakker, Dekker, and Van Den Burg (1996) used comparative feedback to obtain greater energy savings in a metallurgic factory setting. Comparative feedback was given to groups by showing them their own energy savings against the savings of another group. The comparative feedback group increased their energy saving by 74.2% compared to the group which obtained only feedback about their own performance (who returned to baseline levels of energy saving).

Along with the above findings, a research paper at a conference of the Association of Behaviour Analysis International (ABAI, 2013) considered proximity and reinforcement. In organisational behaviour management, a model called PIC-NIC (Daniels, Tapscott, & Caston, 2000) examines three levels of consequences for performing a behaviour; PIC: (P/N -

Positive or Negative), temporal proximity (I - Immediate or future), and probability (C- Certain or uncertain). While this model has been used in an organisational behaviour setting, it has a more far-reaching potential to be used in an analysis of ecological behaviour (Heward & Kimball, 2013). Behaviour which leads to immediate and positive consequences is more likely to occur (PIC), and people will work to maintain the positive outcome. Negative outcomes (NIC) are more likely to be avoided (Heward & Kimball, 2013). However, as temporal proximity of these outcomes diminishes, their power as contingencies decreases thereby competing with other proximal outcomes (Heward & Kimball, 2013). Heward and Kimball (2013) illustrate this with an example; a reusable supermarket bag which the shopper has forgotten in their car. In Figure 3, the authors show that the PIC (Immediate, Positive, and Certain) consequences of accepting the supermarket's plastic bag at the checkout, outweighs the response cost (or effort) of returning to the car to retrieve the reusable bag. Additionally, there are more future consequences than immediate consequences, and even more uncertain consequences than certain consequences, for acting pro-environmentally in this scenario.



Antecedents	Behavior	Consequences	P/N	I/F	C/U
- Heading home after a long day - Thinking about dinner to make/bills to pay/fantasy league line-up - Parked at grocery store (dinner won) in what must be the next county	Accept Store's Bag	- Home sooner	P	I	C
		- Less effort	P	I	C
		- Stay dry	P	I	C
- Looks like rain soon? Was that thunder? - See lottery ticket container at checkout; shoppers who bring a reusable bag entered in weekly drawing for $25 gift card	Return to Car for Reusable Bag	- Delay getting home and dinner	N	I	C
		- More effort	N	I	C
		- Praise from cashier wearing "Eat More Kale" T-shirt	P	I	U
		- Reduced personal carbon footprint	P	F	C
		- A little less plastic in landfill	P	F	U
		- Fewer bags manufactured and shipped to store	P	F	U
		- Win $25 store gift card	P	F	U

Figure 3. A PIC-NIC analysis at a supermarket reproduced from Heward and Kimball (2013). The font size illustrates the relative strength of each consequence. The imminent consequences for a pro-environmental response is less rewarding than the environmentally damaging behaviour.

In summary, the PIC-NIC analysis may be a useful tool in an ecological intervention. IN the next section, I will discuss ways in which such interventions can be engaging.

Raglan's Environmental Needs

In the following sections, I report on meetings with two important environmental groups in Raglan; The Whaingaroa Environment Centre and Xtreme Zero Waste.

Whaingaroa Environment Centre

A meeting was held with a coordinator of the Whaingaroa Environment Centre (WEC) where we discussed some current pressing environmental issues as assessed by WEC and by the Raglan community. The first issue we discussed was of plastic litter which is disposed of on streets in the town centre and eventually drifts into Te Kopua Domain beach and into the sea. Each year WEC runs an initiative that is part of a global sustainability movement called Plastic Free July (http://www.plasticfreejuly.org/). In this challenge, Raglan residents must try to reduce the amount of single-use plastic they consume. The campaign focuses on reducing the use of the 'Top Four' - plastic bags, plastic bottles, straws, and coffee cup lids. To highlight the community's dependency on plastic and provide some solutions, the Environment Centre also organised a weekly meeting at a local bar called 'Plastics Anonymous'. Keen residents could go and share their experiences and struggles with the challenge of reducing their own plastic use. In Plastic Free July in 2014, the Environment Centre reported that both supermarkets in Raglan cooperated in the initiative, providing paper bags at the checkout. According to the PIC NIC analysis of re-usable shopping bags earlier in this section, one advantage in Raglan is that both supermarkets are relatively small, and have small parking areas which therefore means that the NIC (Negative Immediate Consequence) of returning to one's car for a forgotten re-usable bag is not as punishing as returning to an expansive carpark in which the car may be far away from the supermarket. In addition, the proximity effect (Brothers et al., 1994), where the reusable bag is in close proximity to the person, may be amplified and aid this green behaviour. In July 2014 Xtreme Zero Waste (the recycling contractor in Raglan) conducted an audit on street bins on Bow St in Raglan (see following section). Figures 4 and 5 reveal the contents of the bins by weight and volume.

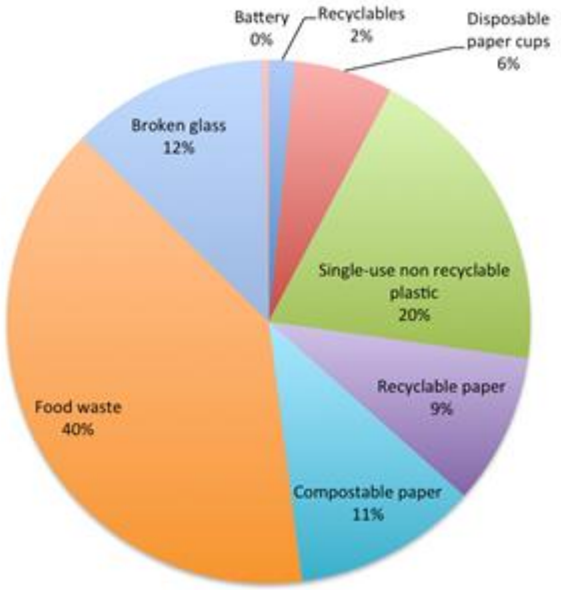


Figure 4. Audit of the Bow St. bins by weight.

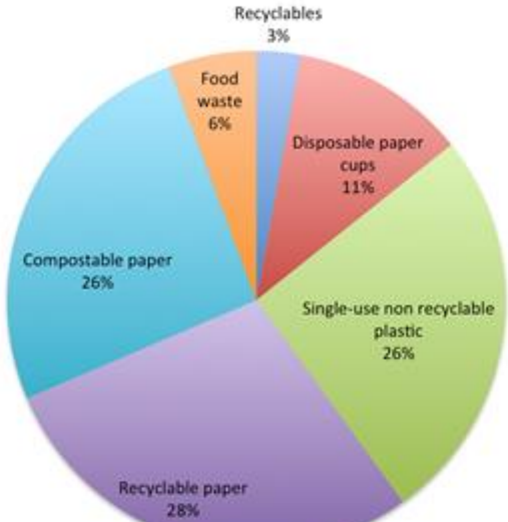


Figure 5. Audit of street bins on Bow St. by volume

Figures 4 and 5 show that single-use non recyclables filled 20% by weight and 26% by volume. WEC and Xtreme Zero Waste intended these graphs to be an educational tool to show people that a large percentage of the waste was comprised of this single-use plastic. This educational tool was, in a way, a method of comparative feedback.

WEC reported that the alternative ecological needs were the promotion of the new facility to recycle soft plastics, such as bread bags and cling wrap. These could be deposited in the regular curb side recycling bins, but WEC reported that residents were not yet recycling these in significant numbers. They suggested contacting Xtreme Zero Waste for data on this material, and also suggested that these data may be interesting to follow in the long term in order to track behaviour change - as the facility has only been recently introduced.

Finally, WEC discussed the need to address the problem of cigarettes butts being disposed of in the main streets in town (which happens particularly during weekends) and is also causing pollution in the jetty and open sea. These reports prompted me to investigate research in this area. Litter is a significant environmental problem, and different materials may pose different threats. Cigarette butts have shown the potential in laboratory studies for immediate and long term secretion of several heavy metals (Shevchenko, 2012). Another study showed that when one cigarette butt was soaked in half a litre of water 50% of the fish that were exposed to this water died (Register, 2000). Finnie (1973) reviewed 4 major cities in the United States which implemented litter research. In Richmond, the intervention implementers found that the placement of a newly launched bin called the Peli-can along highways achieved a reduction litter by 28%. In an urban setting the placement of Peli-cans resulted in a reduction of 6.8% when positioned every fourth block, and 16.7% when stationed at every block. In another study, researchers compared two methods employing stimulus control to reduce litter at a university football game (O'Neill, Blanck, & Joyner, 1980) . They used one orange rubbish bin (the same as those on the university campus) and an experimental rubbish bin with an addition of a football hat – similar to those worn by the football fans. The latter bin also had participants open it by a prompt with a printed word to "PUSH" its flap, whereby they could dispose of their rubbish and could view the words

“THANK YOU” printed on the inside of the bin. Results show that the experimental rubbish bin collected on average twice the weight of rubbish than the standard control. Lastly, a design company has manufactured a machine to target cigarette butt litter in urban areas, using gamification. Fumo, (Figure 6), the interactive ‘smoke pole’ displays multi-coloured lights and plays different musical tracks whenever a smoker disposes of their cigarette butt in its receptacle (https://www.youtube.com/watch?v=eutUgxIqHRY).

Figure 6. Fumo, a gamified ‘smoke pole’ designed to reward correct disposal of cigarette waste.

Although there seems to be no empirical research measuring the impact of Fumo as an intervention, the design agency asserts its efficacy in reducing litter and is set to implement this intervention in new locations, including at the entrance of a hospital, and at various festivals. Much like the other gamified interventions, the Fumo pole may provide positive, immediate, and certain consequences (PIC), which may outweigh the consequences of littering.

Xtreme Zero Waste

Another stakeholder in Raglan is the main contractor of refuse and recyclables, Xtreme Zero Waste (XZW). Raglan’s community goal is to achieve zero waste to landfill by the year 2020, meaning that 100% of discarded materials will be recycled, reduced, reused, or upcycled. The centre’s systems and educational initiatives have resulted in an overall landfill diversion rate of 75% in 2014, and 72% in 2015, a hugely successful outcome even by international standards. These figures are regularly publicised to the Raglan community and are another form of comparative feedback. As with WEC, Xtreme Zero Waste were supportive of a new project in their area, and gave suggestions for projects which targeted local environmental needs. The first suggestion they made was to implement a simple recycling intervention whereby the standard opaque metal bin is replaced by a transparent plastic bin- where users can see its contents. This suggestion was based on their observation that when changing from an opaque bin to a caged bin (where most of the contents are visible), the recycling rates increased. Overall, XZW expressed a desire to be involved in my project, and we discussed the possibility of sharing responsibilities of the experiment such as the collection of recyclables.

One idea which addresses a need from Xtreme Zero Waste's perspective is to design an intervention which addresses the recycling of containers. Research in New Zealand has shown that it is possible to divert one billion drink containers from landfill each year by offering 10 cents in return for these bottles, producing a savings of disposal costs for ratepayers of 14 million dollars a year (Snow, 2007). The organisation was interested in producing more research that may lead to such container deposit legislation. 'Reverse vending machines' (Figure 7) and Festival bins (Figure 8) have been used in some countries where this legislation exists – where the consumer deposits their used container in the machine and receives money in return.

Figure 7. Vending machines and a ‘reverse vending machine’. In the latter, the used container is deposited into the receptacle and the person receives money in exchange.

After meeting with the management team and discussing these potential ideas, the education coordinator at XZW gave me a tour or the working site and presented XZW’s new caged bins design which are used in festivals and events.

Figure 8. Festival Bins on site at Xtreme Zero Waste

Some important features of these bins are the lids, which were slightly heavy to open and the education coordinator suggested that these fostered an awareness in the user, as it was more difficult to dispose of something than simply throwing something into an open bin and passing quickly by. From a behavioural perspective, the response cost may be larger in the use of these lids than a lighter lid. The signs' indication 'landfill', 'recycling', and 'composting', each with pictures of the relevant may also come under stimulus control. The use of the term 'landfill' rather than 'rubbish' or 'waste' is designed to notify the user that this rubbish ends up in the ground and has an inevitable negative impact. Another important feature is the use of clips on the signage, which allow the caretaker of the bins to clip actual items, for example potato starch compostable plates from the festivals' food stalls, visibly on the compost bin. This is a good example of where clear picture cues may be useful in increasing recycling rates (Austin, Hatfield, Grindle, & Bailey, 1993). One drawback of the bins which was discussed with the education coordinator was their high cost, pricing at $1000 each, due to the cost of galvanised steel and labour. Another limitation which was mentioned was that the bins were more difficult to transport than the standard plastic recycle and rubbish bins.

The Final Research Concept

The meetings with the stakeholders clarified the environmental priorities of these two organisations. The focus of recycling is one which has received much support from both organisations. The final research concept will centre on the design the Fun Theory campaign's Bottle Bank Arcade. I decided to replicate this design because an empirical study had not yet been conducted. Relevant permission was also granted by the Waikato District Council.

Figure 12. A recycling receptacle to be used for the project.

The points score will consist of comparative feedback (Siero et al., 1996) - the participant's own score, as well as the highest score. The sign-posted picture and written cues of what can be recycled (plastics, glass and cans) on the receptacle may increase the stimulus control of the receptacle (Austin et al., 1993) – meaning that the pictures come to function as a prompt for recycling. The proximal location of town centre may increase the likelihood of recycling there (Brothers et al., 1994). According to the PIC-NIC analysis (Lattal, 2013) the reward of a response could make the behaviour Positive, Immediate, and Certain (PIC). The discussion and observation by participants and their peers will also play an active role in maintaining the recycling (Guerin, 1994, 2001, 2004, 2005). Finally, the contingencies of the game (Calvillo-Gámez, Cairns, & Cox, 2010; McGonigal, 2010; Morford et al., 2014) may also act as powerful cues for the recycling behaviour.

Some Considerations

The setting in which the machine was placed was important, and care was taken so that it didn't interfere with essential activities which took place there. As it was placed outside WEC, which is inside the town hall complex, all the business within about twenty metres were approached. I discussed the proposed project and the noise levels and potential volume of the arcade music. I suggested that if the noise level is impacting an organisation or business, it is possible for me to lower this volume. All of the surrounding businesses approached were very positive about the project, and I left my contact details with them in case they had any further questions. Also, WEC was very enthusiastic and offered to inform and update me of people's responses to the Recycling Arcade, and also to inform me of vandalism or maintenance needed – as I was not going to be observing the arcade at all times.

Hypothesis

It is hypothesised that the experimental site, the Recycling Arcade, will show increased recycling rates in weight, volume, and number of items, than its control counterpart, an ordinary recycling receptacle across the street

Method

Participants and Setting

Participants were any voluntary members of the public, who deposited recycling into one of the target bins. This includes participants who played the Recycling Arcade game. The arcade was placed outside the Environment Centre on Bow Street.

Apparatus

The psychology technician embedded the game into the lid of the current recycling bin as he suggested that the design will be maximised by making it completely removable. The Arcade operated on 12 volt batteries (12 Ah), and supported by a small solar panel (300 miliamps). It needed replacing every 1 - 2 days. An Arduino micro-controller was programmed with other micro components and incorporated into a circuit by the technician. The Arduino formed the ‘computer’ of the Arcade, and had capacity to store players’ scores for as long as the equipment did not restart. The internal wooden panels were made from recycled wood, and covered with Persepex thermoplastic. Perspex was chosen due to its rigidity and tensile strength, a hard and aesthetic surface, and ability to withstand outdoor conditions (http://perspex.com/product-ranges/perspex/clear/). Considered a durable material, it was also chosen to provide some protection against vandalism. Polyvinyl chloride (PVC) pipes covered each tube and contained two transmitters and two receptors (also called sensors). When an item was inserted it broke the light beam of one set of these sensors and the next set of sensors. The breaking of these two beams equated points scored. A ten panel LED screen functioned as the scoreboard. Blue LEDs were also installed around each tube to indicate where the recycling should be placed during a game. A start button was also installed. In order to prevent the Arcade being stolen it was padlocked onto the recycling bin during the day and removed and stored at my house at night. The following picture shows the Recycling Arcade before installation.

Figure 13. The Recycling Arcade at the university campus.

Apparatus used in Recycling Analysis

A scale measuring up to 10 kg, a scale measuring up to 100 kg, a whiteboard and marker, a measuring tape, and two 20 L vessels were used. A tarpaulin was also laid out. Initially, I only recorded one dependent variable - the weight of each item. The analysis was either done by me or a research assistant.

Experimental Design

An AB control-series design was used. The study consisted of baseline phases (A), followed by the intervention (B) of the Recycling Arcade game. In the control-series design, the study is conducted over a long period (a time-series) in order to control for extraneous variables which may influence the independent variable, such as population. According to Xtreme Zero Waste, the recycling rates vastly increase in Raglan in the summer, due to a large tourist population (Brodie, C, personal communication, May 1, 2015). A study that is conducted not only in summer, but spread over a long period of time can therefore attempt to control for this. Internal validity is strengthened in time-series studies which attempts to account for such extraneous variables (Kratochwill, 2013). The control-series design is also called a non-equivalent control group design. Two groups are measured; the intervention group and another group not randomly assigned. The design is called ‘non-equivalent’ because it is not so robust as a randomly assigned group (García-Celay & León, 2007). In this study, the control group was chosen rather than randomly assigned for ease of access. ‘Non-equivalent’ may also refer to the fact that the baseline measures from the different groups may not be equivalent.

Additional benefits of the control-series design are that it eschews novelty and disruption effects, whereby the intervention produces effects only at the beginning, and the innovation and its behavioural influence wears off over time (Kratochwill, 2013). Similarly, this design avoids disruption effects whereby some routines in the experimental setting are disrupted, generating a reduced intervention effect (Kratochwill, 2013).

A control-series study also allows for a detailed and precise description of the independent variable to be developed (Kempthorne & Curnow, 1961). Finally, this design minimises the risk of multiple-intervention interference, another threat to internal validity, whereby a second intervention (such as another environmental initiative in Raglan to improve recycling) occurs at the same time. This would make it difficult to determine which intervention was impacting the independent variable (Cox, 1958; Kazdin & Kopel, 1975; Lana & Lubin, 1963).

Baseline

Baseline data were collected in October and November, and also in January and February. The baseline period was longer than anticipated, but due to technical issues the arcade was not ready to be placed in public earlier.

Data Collection

Data were collected on 4 days in the week during baseline; Monday, Tuesday, Wednesday, and Saturday. Data were also collected during long weekends and noted separately when graphed. During the intervention, data were collected every day of the week.

Method of Data Collection

I collected recycling bags from the target bin and accompanying waste bin, as well as the control recycling bin and its adjoining waste bin from across the street and took the bags to my house for analysis.

For the first two weeks, I recorded the main recycling items; glass, plastic, cans (ferrous and non-ferrous), and paper. In addition, I recorded every other material found in both the recycling bin and the waste bin. I used a waste-audit template, provided to me by Xtreme Zero Waste during this stage. This original template and guidelines for recycling categories appears in Appendices A1 and A2.

This analysis was very extensive – accounting for every single item in the bin. After a 2-week period of collecting data in this way, I narrowed the scope of data collection to only include recyclable glass, plastic and cans – as the scope of my research only encompassed recycling – and not other waste items. I also removed recyclable paper as a dependent variable as its weight varied greatly depending on whether it was wet or dry (it was approximately 5 times heavier when it was wet). I consulted with the operations management at Xtreme Zero Waste but they did not have any suggestions for measurement methods or statistical compensation for wet paper. I therefore decided not to include paper in my analysis.

In these initial 2 weeks of data collection, I also considered whether to analyse the contents of the waste bin at all – as this seemed to be one of the more time-consuming tasks. I continued however, with the analysis of these bins, because I found regular instances of recyclables in the waste bin.

I also added volume and number of items as dependent variables. Volume was measured in several ways: if a bottle or can displayed its volume in millilitres or litres, and was mostly uncrushed, I would record this number. For cups and other cylindrical items, I used a cylinder calculation ($V = \pi r2h$). For other shapes, I used a standard volume calculation (length x height x width). I worked together with research assistants at times. This provided valuable insights into how to standardise and improve the measurement of the recycling. For example, measuring the volume of an item always took longer than the other measures and was often inconsistent when an oddly shaped item appeared (for example a half-crushed tin can). During one session we found a solution that proved to be quicker and more accurate: we filled a 2-litre jug (with external markings indicating every 50 millilitres) with water and then poured this into the item. We then calculated the volume as the amount of missing water from the 2-litre jug. These data were either recorded onto the whiteboard, or entered into a Microsoft Excel sheet.

One potential problem with the way in which the data were being collected, was the timing of collection. I noticed that the current collection time – between 5pm and 5:30pm, was a busy hour on Bow Street. My presence at both sites, being seen to remove and replace recycling and waste bags was problematic because the public in Raglan were unaware that research was being conducted using data from the bins. Frequency recording was therefore conducted on three occasions in the early evening (see Figure 13 for the area of recording). Due to the high presence of people at that time I changed the time of data collection to between 8pm and 8:30pm.

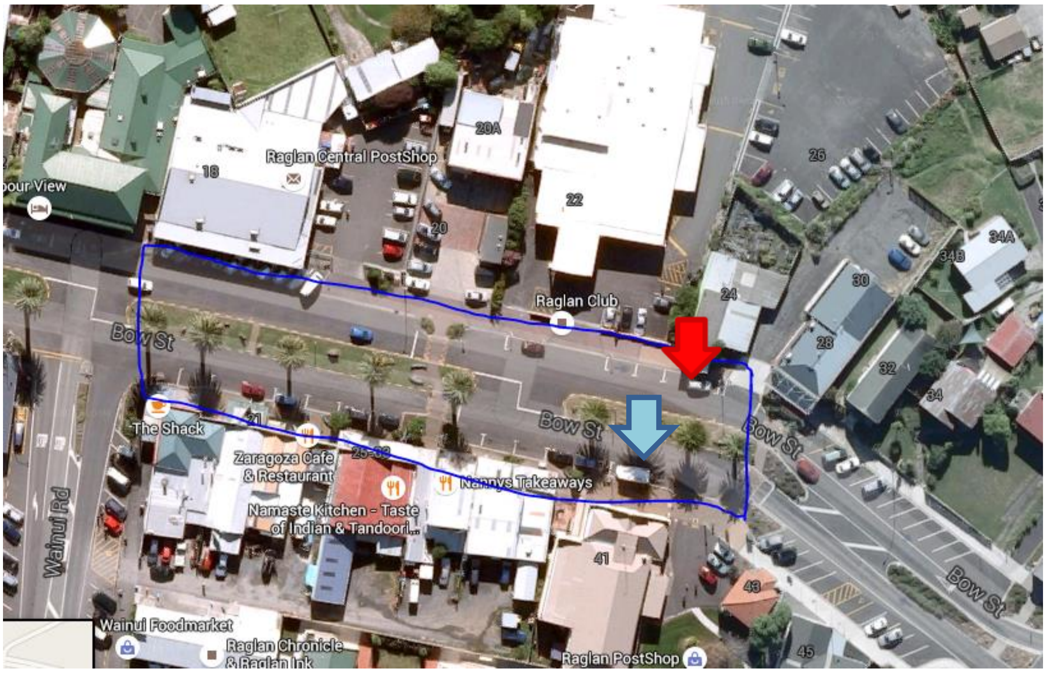


Figure 14. Bow Street. The target area for the frequency recording is shown by the blue rectangle. The blue arrow indicates the experimental site and the red arrow shows the control site.

Intervention

The Recycling Arcade was installed each morning and removed in the evening, at the same time in which the recycling bags were collected. The same procedure for analysis was used during the intervention phase. Bags were collected at the same time each day, brought to my house, and underwent the weight, volume, and number of items of recyclables, was recorded on a whiteboard or directly entered the data into a Microsoft Excel sheet.

Procedure

The Recycling Arcade was installed outside the Environment Centre, and was ready to be played at all times. The LED board displayed the player's score and the previous high score of the day. Participants could insert any of the recycling materials which were sign-posted on the receptacle (plastics, glass, and cans), in the slot and receive points on the scoreboard.

The sequence of events for a recycling game was as follows:

1. A participant walked up to the Arcade and pressed start.
2. The Arcade lit up and played a tune.
3. One of the lights of the three tubes flashed.
4. The participant inserted their recyclable (plastic, glass, or can) into the tube which the light indicated.
5. A ‘celebration’ theme tune occurred when the material was placed through the tube and the participant received 10 points on the LED screen.
6. The next light flashed and the participant was prompted to insert another recyclable.
7. The game ended when a participant did not have any more recyclables.
8. The participant left and the game could start again with a new participant.

I anticipated that some people passing by would want to play but may not have recyclables. Therefore, the technician designed a ‘cheat’ feature; if a player put their hand in and out of the tubes to try to attain points, the arcade does not register this – and the player did not gain points.

Trial 1

In the first installation of the arcade, I observed some issues. The first and most noticeable problem was that the messages on the LED screen were almost invisible due to the glare of the full sun. Participants in the game therefore could not read the instructions of the game “insert recycling to try for a high score” or see any other message.

A second problem was that the transmitters and receptors which detect inserted objects were not functioning fully. A test with a tennis ball examining all three slots revealed that the sensors only functioned at 50% accuracy. This meant that players did not receive reinforcement for much of the time.

The sounds and music presented another challenge. Sounds on the street were louder than anticipated, with loud music playing from the radio station in the town hall building, muffling any sounds from the Arcade game. The sounds and the music of the Arcade itself were also muffled, because the Arcade was designed to fit compactly on top of the existing recycling receptacle, this meant that the speakers were in effect playing underneath the lid, and it was difficult to hear the sounds. This initial set of speakers also did not have a high volume.

A further difficulty was posed by the rubber seals on the recycling receptacle lid (these seals are designed to keep rain out). Players had to push a recyclable through all the way past both light transmitters and receptors – this activated the 'cheat' function, designed to detect occurrences where a player puts their hand in and out of the receptacle, to try to accumulate points without recycling. These seals therefore prevented player from obtaining points.

Due to the issues outlined above, the Recycling Arcade did not function correctly. I subsequently removed the Arcade at the end of the first day of installation and delivered it to the technician for repair.

Additional Observations from Trial 1

There were mixed reactions from the public during Trial 1. Some participants played the game successfully. Several children took interest in the arcade, although they could not hear the sounds due to technical issues, they were interested by the bright neon lights and approached the game. It is also worth noting that the game was at eye level for children, which helped capture their attention. Adults were seen to walk by the game, and looked with some interest but did not move toward the game. Other adults walked straight onwards, did not look around, and therefore did not see the game. This highlighted of an intervention which was visible for people of different heights.

Consequent Recommendations for Repairs

The following amendments were made to the Recycling Arcade game before it was installed in the experimental phase:

1. A loud automated theme tune was programmed into the game to attract attention
2. All transmitters and receivers were corrected as much as possible.
3. New speakers were installed, with a dial so that volume could be increased or decreased by the researcher.
4. The rubber seals from the existing recycling receptacle were removed.
5. A game instruction sign was created. This sign was mounted at the eye-level of an average adult.

Figure 15 shows the game on-site after these changes were made.

Figure 15. The Recycling Arcade and instruction sign at the experimental site.

Background Information

In order to put the results from the main study into context, I collected data on external factors which might simultaneously influence public recycling. I obtained data on the number of people present in Raglan (tourists and residents), and also on rainfall during the experimental period. In the summer period, the population surges due to surfing and beach tourism in the town. Data from Xtreme Zero Waste showed that waste and recycling levels had consistently increased as the population surged during the peak season each year (reference). Figure 16 shows that January had the most people (8653), followed by March (8019) and April (7818). October and November had lower numbers of people (7500 and 7342 respectively). Having these two distinct periods allowed me to compare the intervention to both a low population period, and a peak population period. This provided somewhat of a control for this extraneous variable.

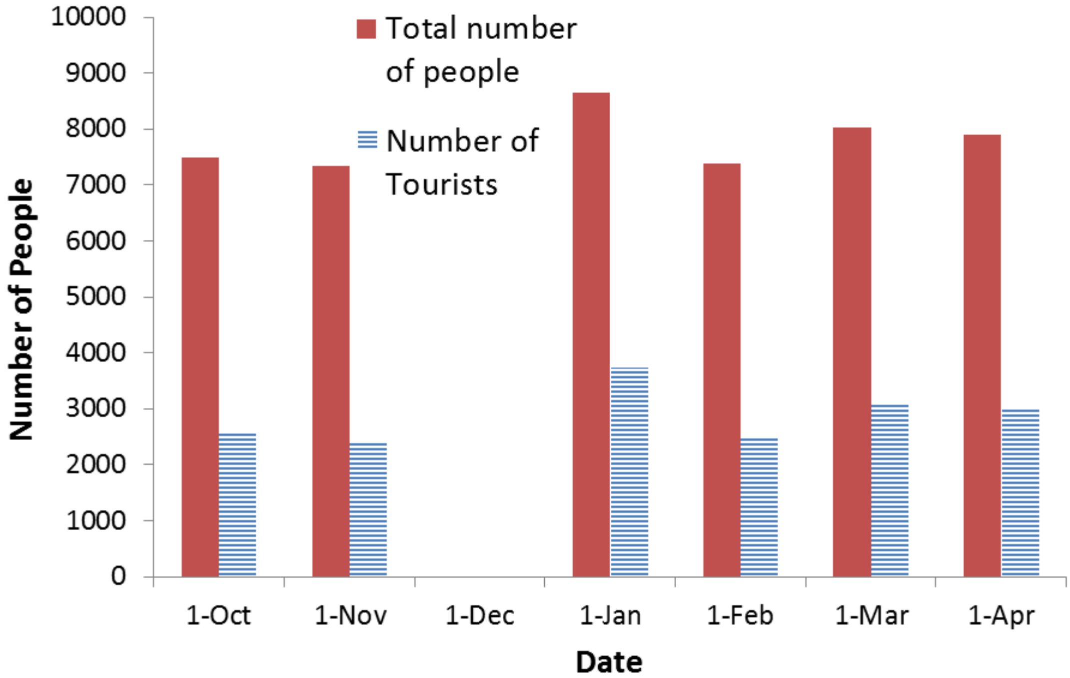


Figure 16. Number of tourists and local residents in Raglan during the research period. These data were obtained by counting the number of people which entered the Raglan iSite for information. (T. A. Maihi, personal communication, May 25, 2016).

Likewise, rainfall also needed a control, as I found that there was less recycling in weight and volume on rainy days (those in which it rained for one hour or more). Figure 17 shows that November had the highest rainfall (115 mm) followed by February (78 mm). I would therefore expect that in these two months recycling levels would be somewhat reduced.

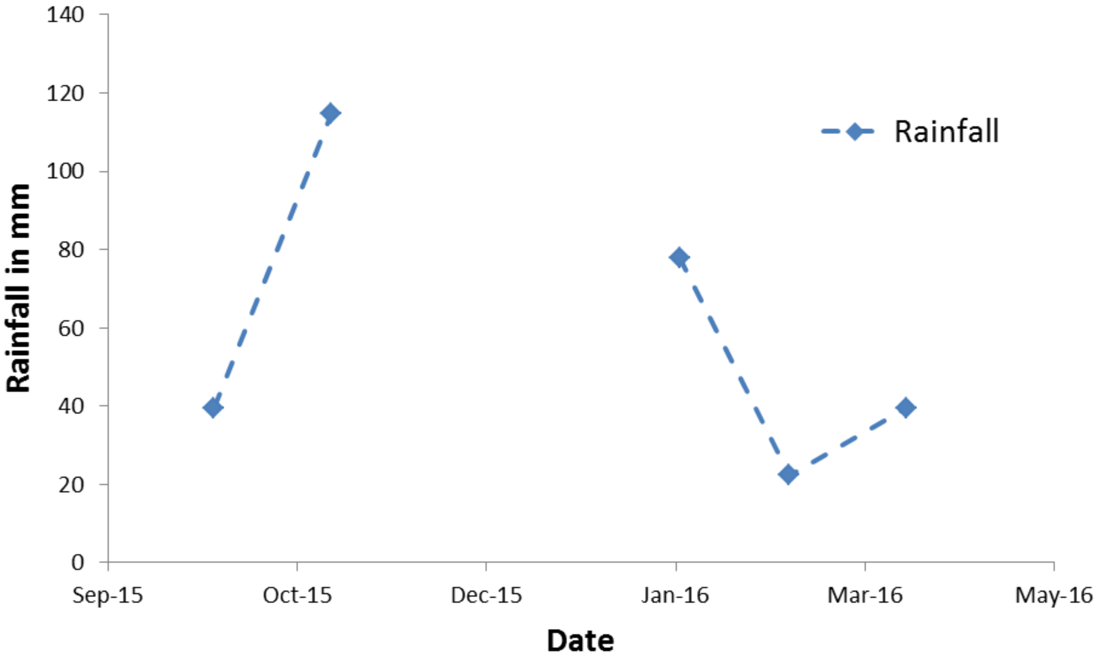


Figure 17. Rainfall in Hamilton Aws Metservice station at latitude -37.835 and longitude 175.336 during the research period. Retrieved from http://cliflo.niwa.co.nz/pls/niwp/genf.genform11 (Statistics Code 0, Agent Number 2122, Network Number CV5834)

Results

The results are presented separately for weekdays and weekends. I use the terms 'Game Bin' and 'Control Bin' here – but the reader should consider that during the baseline 'Game Bin' describes the experimental bin before the game was installed.

Baseline Results for Weekdays

In the October and November baseline period, I collected similar data for the two sites. Figure 18 shows that during October, both sites received similar weights of recycling, and during November the Game site received more. Figure 19 shows the same trend for volume.

In the second baseline period, during the months of January and February, weights and volumes differed slightly, with the Game Bin receiving a slightly greater weight (Figure 18) and volume (Figure 19) of recycling than the control.

The volume of recycling in the *waste* bin, materials in this bin do not get recycled but put into landfill instead, is displayed in Figure 20. Figure 20 shows that the game site had more variation than the control site, which remained at a similar level (and slightly increased each week). It is also apparent that there was much less recycling in the waste bin (Figure 20) than in the recycling bins (Figures 18 and 19)

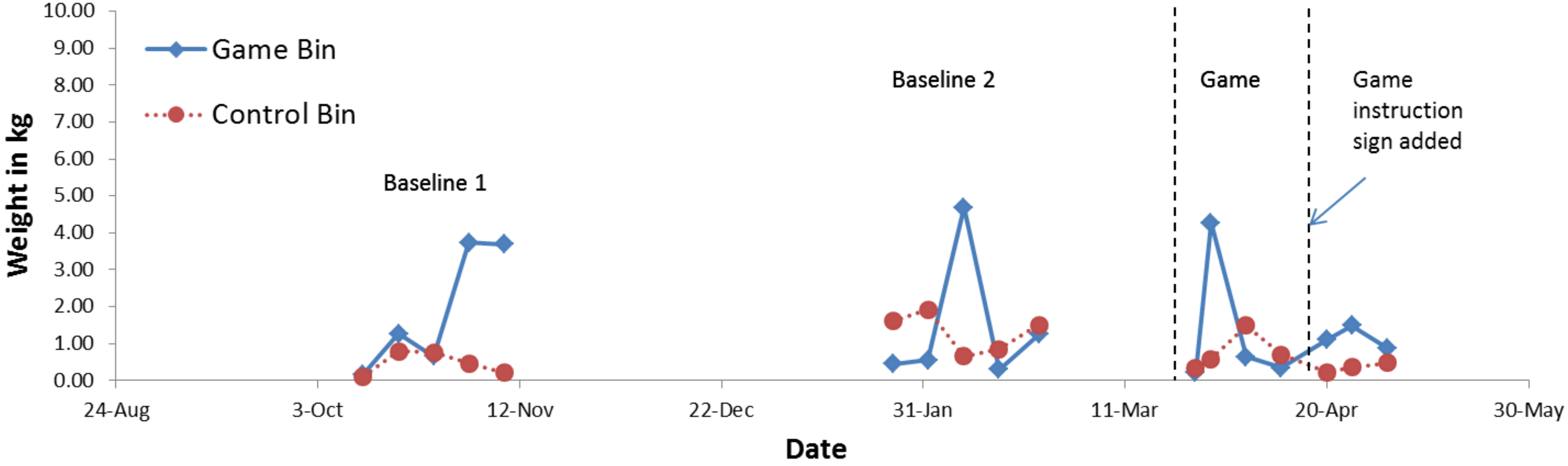


Figure 18. Weight of recycling in Game Bin and Control Bin during the weekdays.

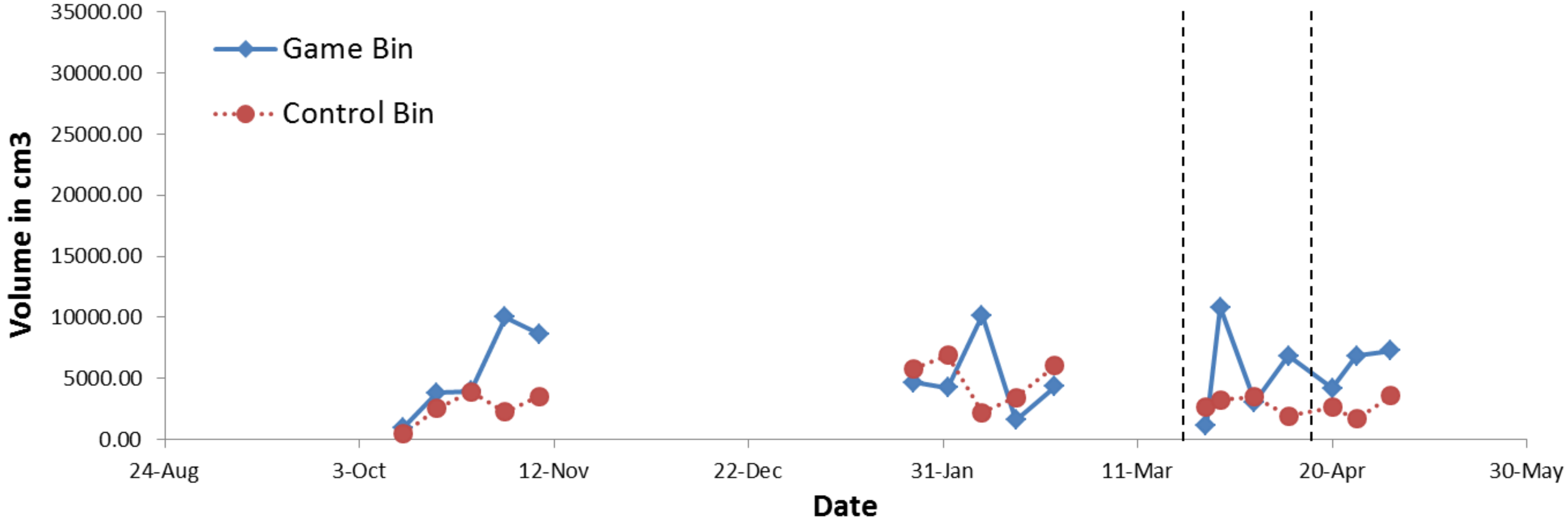


Figure 19. Volume of recycling in Game Bin and Control Bin during the weekdays.

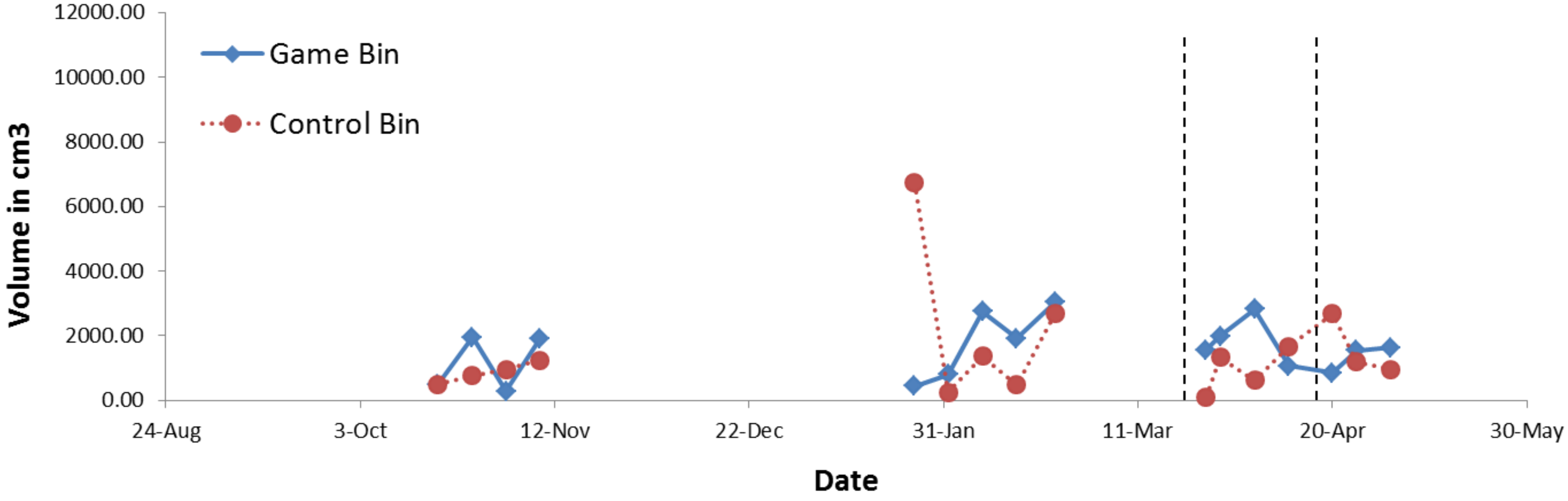


Figure 20. Volume of recycling in the waste bin by the Game Bin and waste bin by the Control Bin during the weekdays.

Baseline Results for Weekends

There were higher amounts of recycling on weekends than weekdays. Typically this was due to bars being open late and people recycling more alcohol containers such as beer bottles and cans. In Baseline 1, shown in Figures 18 and 19, the weight and volume at both sites were similar.

In Baseline 2, as depicted in Figure 18, there was initially a higher weight of recycling, but it remained similar at both sites, showing a decreasing trend. Figure 19 shows this same declining trend for recycling volume.

The volume of recycling in the *waste* bin is shown in Figure 20. Overall the Game Bin received higher amounts of recycling, with a downward trend. The Control Bin remained at a low and mostly stable level.

The main findings from these baseline results were that there was considerable variability in both baselines. The Control Bin had overall less recycling than the Game Bin.

Game Phase - Weekday Results

After the game was introduced, there was an initial increase recycling at the Game Bin in both weight and volume (Figures 18 and 19), after which levels reduced and remained steady for the duration of the experiment. The Control Bin shows slightly lower levels of recycling (Figures 18 and 19), similar to levels at baseline.

The volume of recycling in the *waste* bins is exemplified in Figure 20 – both sites show similar variability.

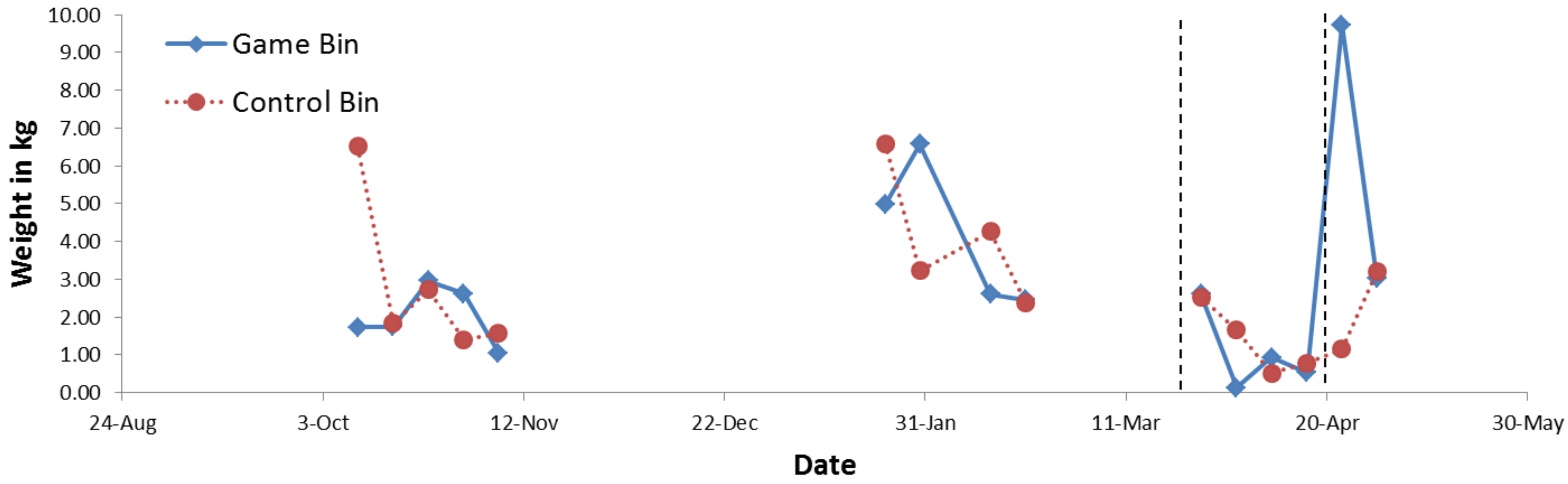


Figure 21. Weight of recycling in Game Bin and Control Bin during the weekends.

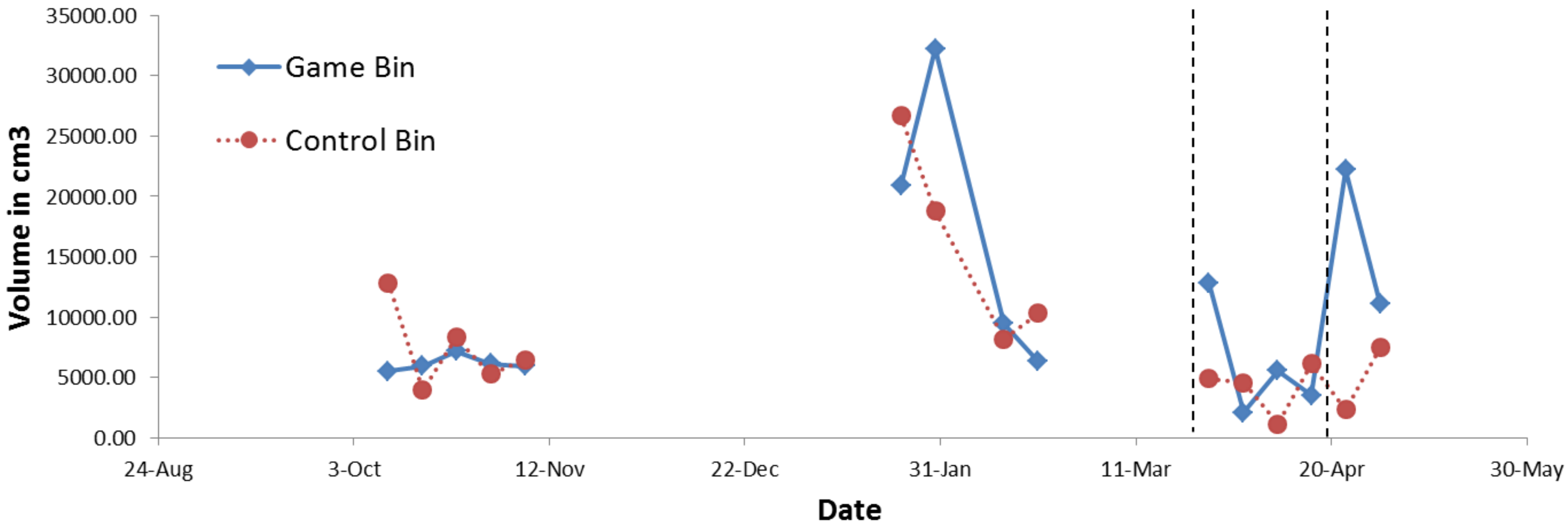


Figure 22. Volume of recycling in Game Bin and Control Bin during the weekends.

Game Phase – Weekend Results

There was one difference in the results during the weekends – a very high weight and volume (Figures 21 and 22) of recycling in the Game Bin, on the weekend after the introduction of the instruction sign. Apart from this result, the both bins received similar levels of recycling.

The volume recycling in the *waste* bin is shown in Figure 23. The Control Site received higher volumes of recycling. Less recycling was deposited in the waste bin in the phase that the game was active.

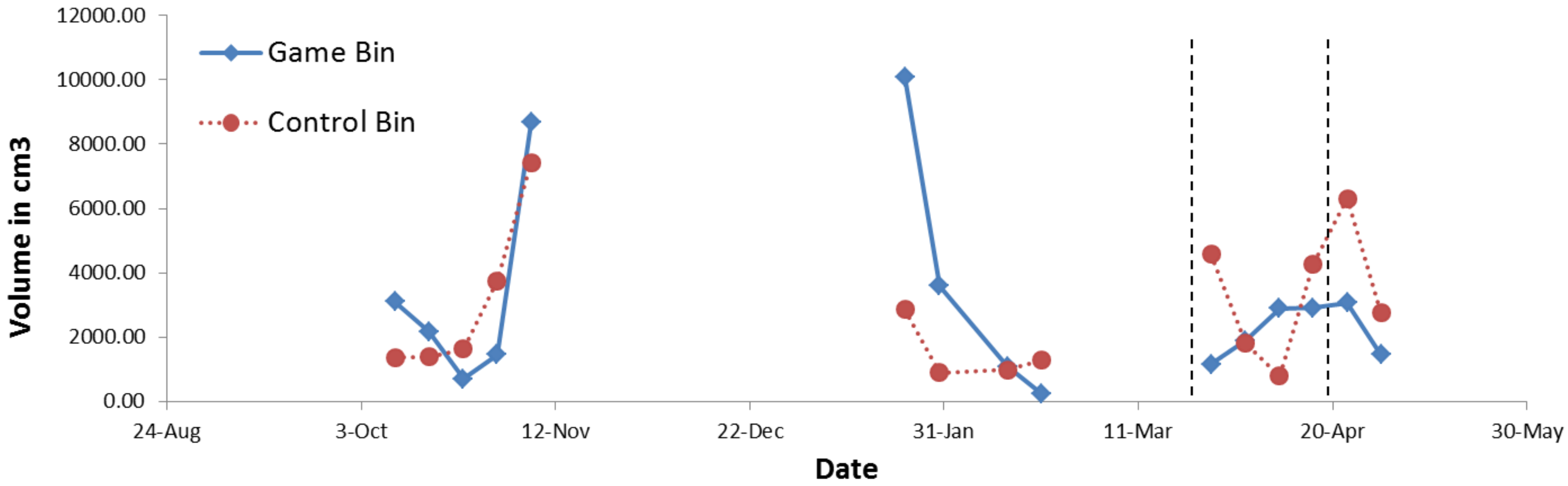


Figure 23. Volume of recycling in the waste bin by the Game Bin and waste bin by the Control Bin during the weekends.

Main Findings from Graphical Analysis

The main findings from these baseline results were that there was considerable variability in both baselines. The Control Bin had overall less recycling than the Game Bin. The same was found during the game phase.

High Score Results

This set of results give a sense for how much the game was played by recording the highest score of the day. Note that one recycling item won 10 points in the game. Figure 24 shows a recording of the high scores for each day, for the first 5 days of the intervention. Overall, members of the public were playing the game during these first 5 days. The highest score was 130 points. An on-site behavioural observation revealed that this high score was obtained by one player cheating in the game by inserting a bottle into one slot, and pulling it out from another slot to score as many points as possible.

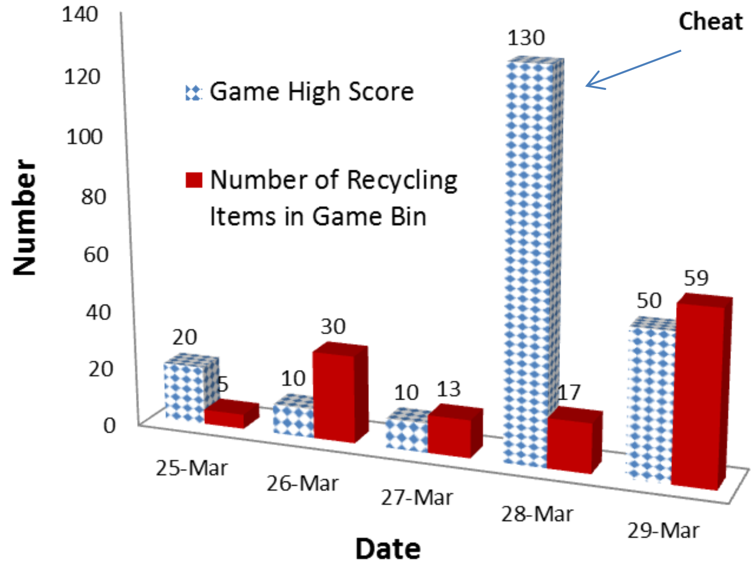


Figure 24. Comparison of the game's high score with the number of recycling items in the bin in the first five days that the game was installed.

Figure 25 shows the last 7 days of the intervention period. The results here show that either there was less uptake in the game – with several zero scores – or that there was a malfunction in the game, resulting in scores of zero. In the first and last days of this period, there were another two cheat scores (as observed on site).

Overall, there was some uptake of the game, particularly in the first phase. It is unclear whether there was a technological failure in the last period of the game, or whether there was less uptake.

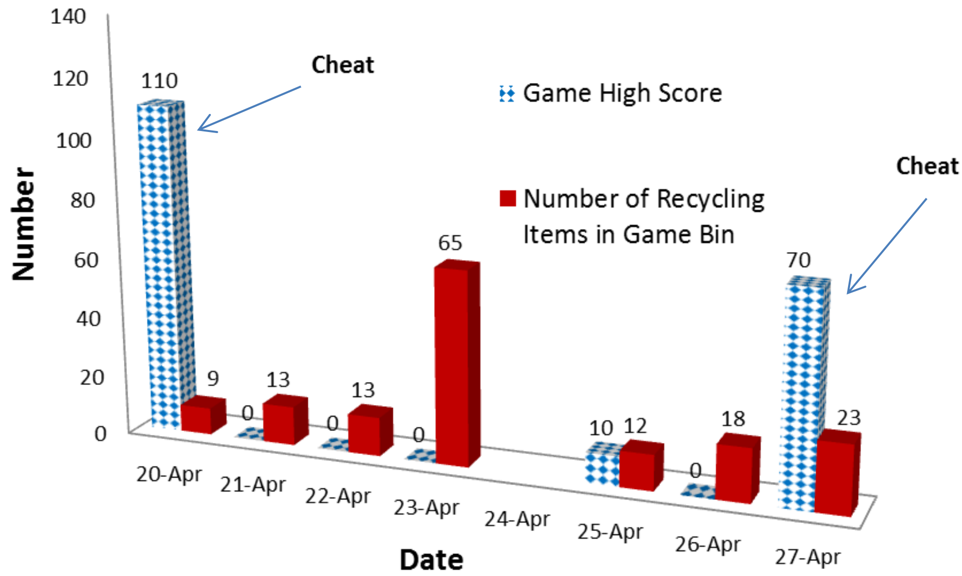


Figure 25. Comparison of the game's high score with the number of recycling items in the bin in the last seven days of the game.

Significance Testing

I conducted a Two-Way (3-x-2) Mixed Analysis of Variance (ANOVA), with the game phases (Baseline 1, Baseline 2, and Game Phase) as a repeated-measure independent variable and bin type (Game vs. Control) as a between-subjects independent variable, and the recycling volume totals as the dependent variable. No main effect was found for game phase ($F(2, 16) = .34$, $p = .72$, $r = .20$), and there was no interaction between game phase and bin type ($F(2, 16) = .65$, $p = .54$, $r = .27$). The main effect of bin type ($F(1, 8) = 4.9$, $p = .058$, $r = .62$) approached, but did not meet, significance. Figure 26 displays these results.

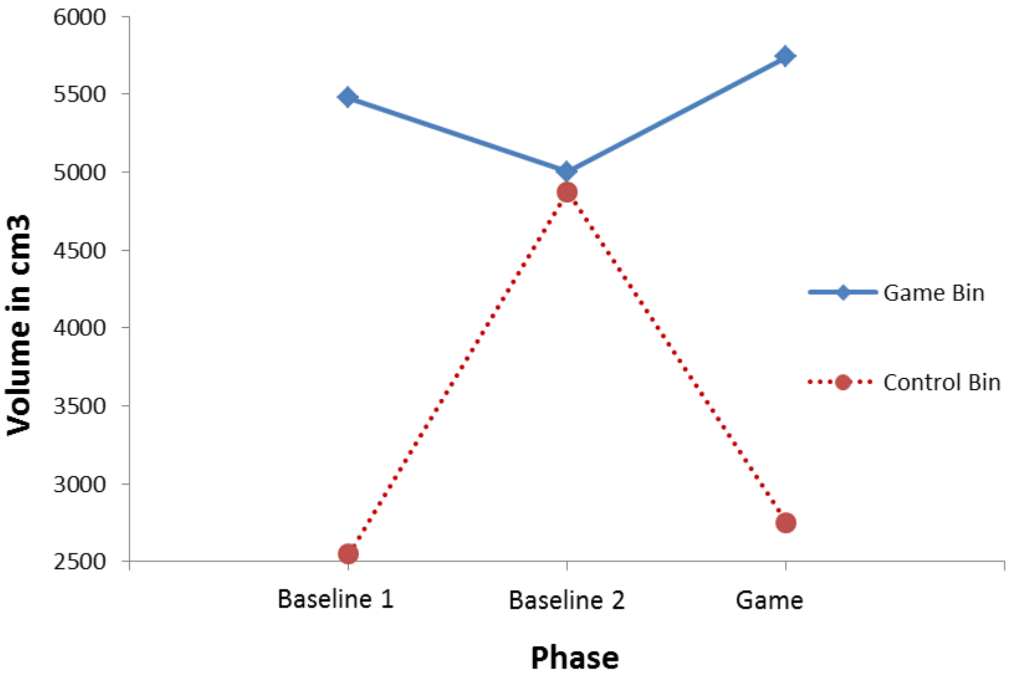


Figure 26. Estimated marginal means at each phase during weekdays.

A 2-x-2 mixed ANOVA was conducted omitting Baseline 2. Again, the main effect of bin type approached, but did not reach significance (see Figure 27); $F(1, 8) = 3.60$, $p = .095$) which showed that overall there was less recycling in the control bin during the baseline *and* experimental phases. There was no indication of an interaction in the second ANOVA ($F(1, 8) = .06$, $p = .81$).

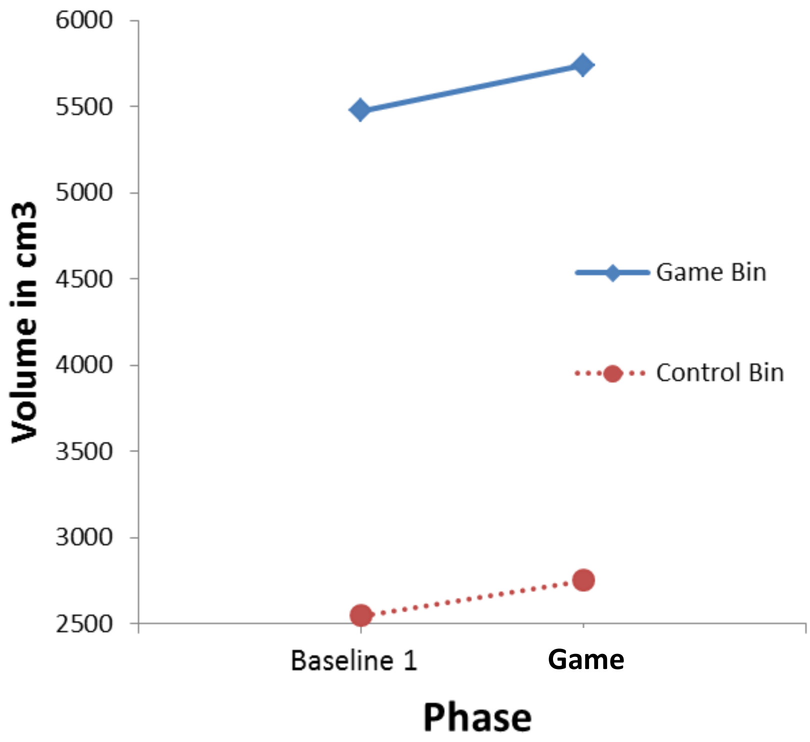


Figure 27. Estimated marginal means of two phases during weekdays.

Summary of the Main Findings

Two-Way Mixed Analyses of Variance (ANOVA) showed there was an almost a significant difference between the experimental group (the Game Bin) and the control. However, this only indicates that overall there was less recycling in the control bin across all phases. An interaction between bin type and game phase would demonstrate that the increased volume of recycling in each bin was determined by whether the game was active or not. Nevertheless, there was no evidence of an interaction in the ANOVA.

Discussion

Main Results

I began the main analysis with graphical analysis, a tool often used in single-case design (Baer, 1977; Michael, 1974; Parsonson & Baer, 1978, 1986). Statistical tests can be used in conjunction with graphical analysis (Parker & Brossart, 2003). Kazdin (1982) suggests that statistical tests should be used together with graphical analysis when the baseline is variable, and extraneous variables in the environment require statistical control. The results illustrated in the graphical analysis of Figures 18 to 23 showed considerable variability, and two salient extraneous variables existed in the experiments; the population and rainfall variability (see further discussion below). It was therefore necessary to conduct statistical analyses. There was an almost significant result of $p = 0.05$ for the experimental group. There have also been many critiques of traditional significance testing using the 0.05 p level (Berkson, 1938; Cohen, 1994; Loftus, 1996; Snyder & Lawson, 1993). Further, statistical significance does not inform the researcher *how* effective the intervention was (Barnette, 2006). Consequently p levels should be reported with a range of other statistics (Ferguson, 2009). Another metric which can be used is the effect size, which provides information on the intervention's efficacy (Barnette, 2006; Kline, 2004; Nix & Barnette, 1998). In the results of the first ANOVA, the effect size was high ($r = .62$), indicating the possibility of a difference between the Game Bin and Control Bin. However Figure 26 shows that the control bin has less recycling overall - excepting Baseline 2 which had a similar volume of recycling, but this was not the game phase in which a difference in groups was anticipated.

A second ANOVA was conducted without Baseline 2, the peak tourist season. High tourist numbers rendered this baseline period as an unfit comparison (see Figure 18). A significant interaction between bin type and game phase would demonstrate that the volume of recycling in each bin was determined by whether the game was active or not. There was no indication of an interaction in the ANOVA, ($F(1, 8) = .06$, $p = .81$). The effect size for the interaction was $r = .09$, a small effect size (Ferguson, 2009). My hypothesis that gamification would increase recycling behaviour was rejected.

Technical Failures

The Recycling Arcade game was unreliable during the experimental phase. At times it did not switch on, and at other instances certain components of the game were not functioning. For example, the sensors which detect items were not sensitive to all materials. Frequently plastic was not detected. As a transparent material it would not break the light beams of the sensor – disabling the mechanism by which players could score points. Another issue occurred when a material was dropped in too quickly, in that it was often not detected. This was a difficult behaviour for players to adjust as recycling at the public bins happened rapidly (a behavioural observation indicated that recycling took roughly 2 to 5 s from having the material in hand to placing it in the bin). After observing this speed in which recycling was put into the bin, I created the instruction sign with careful wording to "drop your item slowly for max points". It is unclear whether this had an effect. Another issue appeared in only one slot, in which the sensors were misaligned and therefore not detecting any items. Better sensors would be needed for further research with this equipment.

Battery life was also a complication. We initially used a 7-volt battery (which was not powerful enough), and soon changed to two 12-volt batteries – one which would be on site, and the other charging. Nevertheless there were still issues with the batteries and connections at the terminal. A similar concern presented with the wiring of the circuit, when a fuse or diode blew, the game did not work. At times these problems appeared before the daily installation at 10am and could be fixed easily on site or at home. At other times the Arcade was sent into the laboratory for repair. At times I arrived at the end of the day to find the game off, or stuck in mid game, and I would not be able to determine how long it had been out of operation. One of the dependent variables was the high score of the day. The repeated malfunctions of the game resulted in these scores being unavailable on those days, and I could not record the high scores for the whole intervention. More testing in the laboratory and at the experimental site with the actual recycling materials would have improved the reliability of the game.

In the literature review, I highlighted the main components which informed the design of the Recycling Arcade. These were gamification, proximity, comparative feedback, picture cues, eco-feedback and the PIC NIC analysis. These were all influenced by the technical failures of the game.

Gamification

The purpose of the study was to determine whether gamification will increase recycling rates. The statistical analyses show that there was no significant difference between the game phase and baseline, or the game and the control. This result was heavily influenced by the frequently occurring technical issues. Where players did not receive points for recycling items, the reinforcement schedule became a variable ratio schedule, rather than a continuous reinforcement schedule, which establishes new behaviours (Herrnstein, 1970). Internal validity of the basic operation of the game should have been established as a minimum for a time-series experiment (Campbell & Stanley, 1966). A pilot phase with the game could have improved this. Supplementary behavioural recording would have greatly increased the validity of any findings on that matter. The current behavioural recording was inadequate - spanning only the first three days of the game phase. A better methodology could have incorporated behavioural recording of the game site at a set time, once a day.

Proximity

Behavioural observations revealed that the chosen location, while convenient, was not the most proximal. The busiest location in terms of foot traffic was outside the supermarket on Bow Street. However, a more data-driven approach to finding a suitable location for the recycling bin would have been to conduct waste audits of all the bins in the centre of Raglan before choosing the experimental and control bins. Even a visual audit, over a few weeks, would have provided key baseline information. It can be said that in this experiment, a proximal location was not in force.

Comparative and Eco-feedback

Behavioural observations on site showed that as soon as the game started, players focused their attention on the slots which lit up, and not the score board. The instruction sign contained a message to compensate for this "check your points on the screen". However, observations were not conducted to discern if this instruction was effective. This was exacerbated by the glare of the sun onto the LED screen – which in midday made the screen almost illegible. Messages on the screen were intended to provide comparative feedback ("your score" and the "highest player score"). This was also a form of eco-feedback – information on ecological actions delivered to the consumer. Again, the glare of the sun made this feedback inaccessible to players. During the dark hours, it is possible that the screen was attended to more, as all the lights from the arcade were visually salient. The comparative and eco-feedback components were therefore in effect for some of the experimental period, but it is uncertain as to what extent. It is unclear whether there was an effective reinforcer in place.

The PIC NIC Analysis

A key concept behind the game was that a point scored provided Positive, Immediate, and Certain reinforcement. When a player deposited an item into the game and the sensors did not detect it, this reinforcement could not be provided. However, some reinforcement was certainly in place, as outlined in the next paragraph, some players tried to play the game even when they didn't have any recycling.

Cheaters

One interesting phenomenon from the results was the presence of cheaters. During the design stage of the Recycling Arcade we tried to anticipate how people might cheat while playing a game. We came up with one design mechanism, as discussed in the method section, to try to account for cheaters. This mechanism turned out to be too simple, as some players found other ways to score points without depositing recycling in the game.

On three occasions I observed or was told about players who cheated in order to score points (and there were probably more instances not directly observed). It is a positive sign that some children were eager to play the game. It shows that when the game was functioning, it was rewarding and engaging.

Consultation with Human Computer Interaction Researcher

Advice was sought from a Human Computer Interaction (HCI) researcher Robert Akscyn to improve the design of the recycling arcade for future research. Akscyn had also previously supervised a student in the field of gamification of language learning. The consultation with Mr Akscyn was during the last few weeks of the experimental phase, and we therefore went to examine the game on site. The following section will describe his recommendations (R. Akscyn, personal communication, April 1, 2016).

- The blue LED lights in should be in direct vision of the player – as the player normally standing in front of the screen when playing. In the current design the LED were evenly spaced on each slot but not in direct vision of the player. Adding this feature would increase the perceptual intensity for the player.

- Slowing down the speed of the moving lights during a game was suggested as a way of maximising the chance that a player has at success. Success at scoring a point was the most important factor, as a player is more likely to keep playing if they are winning, or receiving rewards. This had already been an issue, seen in the results, where players had attempted to play correctly, but were not rewarded due to a technical failure.
- After the player obtained some points, the lights could speed up progressively in moving around each slot, as in the popular 1970's game Simon (Baer & Morrison, 1976). This would increase the challenge for the player and make it more fun.
- The sounds and music should be embedded on the inside the Arcade. In my study, the speakers were attached to the light pole approximately a metre higher than the Arcade (so as to be less prone to vandalism or theft). As soon as a player pushed the start button and heard the music, they lifted their gaze to the source of the sound, and away from the instructions on the screen.
- A green start button should be used to symbolise 'go' and 'eco', rather than the red button, which has connotations of 'stop' and 'warning'.

In addition, Mr Akscyn was enthusiastic about the potential of the Recycling Arcade to further engage young people in the Raglan community in technological education such as teaching computer programming in workshops and camps, whereby children and teenagers can build a similar recycling game and continually improve on its design. He also saw great possibilities in incorporating these workshops into an ecological alternate reality game, whereby an online platform supports the project and adds additional gamification elements.

Conclusions

I found that the gamification of recycling did not increase recycling behaviour in Raglan. Some issues were identified with the technology of the game. As an observer on the experimental site, witnessing malfunctions occur time and time again, I sense that the results may have been different if the technology had been more reliable. Excitement from members of Raglan showed that overall the project was a positive one. Enthusiasm from a researcher in the Human Computer Interactions field for the potential for the project shows that there is scope for collaboration and further scientific research. Future investigation in designing another recycling game should include several behavioural observations, of the site, conditions, type of recyclables, and behaviours, before beginning the design process. Having more of this type of data in my study would have been invaluable. Finally, a future project should be truly transdisciplinary, with researchers in game design, HCI, recycling organisations, members of the public, and indubitably grounded in the science of behaviour.

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Appendix

Xtreme Waste Audit Template

Worksheet 3	Waste Audit - Waste Sent to Landfill		
Date			
Time			
Physical address of the site			
Sheet Number			
Name of recorder			
Number of collection days			
Number of full time equivalent staff at the site			

Waste Category	Description	Container weight (kg)	Day 1
Recyclable paper			0.3
Corrugated Cardboard			0.28
Disposable paper cups			0.48
Compostable paper			2.78
Recyclable plastics PET & HDPE			
Plastic cups, plates & cutlery			0.06
Multi-other plastics			0.92
Putrescibles kitchen food			2.84
Putrescibles multi-other organic			
Ferrous metals steel cans			
Ferrous metals multiother			0.02
Non-ferrous Aluminium cans			
Non ferrous metals multiother			
Recyclable glass			0.22
Non recyclable glass			
Textiles			0.04
Sanitary paper			
Rubble			
Timber			
Rubber			
Printer cartridges			
Hazardous			
Other			
Other			
Other			
Other			
Other			
TOTAL			
	Input weight of empty bins (tare weight) into apricot cells		
Presort (black bags)	Input data from each bin weighed into yellow cells		8.02
Sorted	Input audit details into green cells		7.94

Collaborator Information

Thank you for taking an interest in the Raglan Recycling Arcade game! This game was part of a research project. I am a Masters student in Applied Psychology at the University of Waikato, supervised by Dr. Mary Foster, and Dr. Rebecca Sargisson. I am studying the effects of gamification (inserting game features into non-game activities) on recycling behaviour. If you played this game, you got points for each recyclable you put in. I wanted to see if positive rewards (points, music, lights) would increase the amounts people recycle, right here on Bow St. Unfortunately, it didn't have a significant effect! You may have noticed that sometimes the game wasn't working, and there were many technological issues. But that is science! In the future, we would like to test this idea again, with improved technology, and game designers' input.

Players of this game were anonymous – I did not take any data on who played the game – only on volume, numbers, and weight of this recycling bin.

The findings will be reported in my Masters thesis which will be reposited at the University of Waikato library. Results may also be published in any relevant journal such as the Journal of Applied Behaviour Analysis.

This research is supported by the University of Waikato Masters Research Scholarship.

If you have any questions or suggestions please feel free to contact me via email at melissajanson22@gmail.com or by phone at 022-3595-022, or my supervisors Dr. Mary Foster or Dr. Rebecca Sargisson at the School of Psychology, University of Waikato.

This research project has been approved by the School of Psychology Research and Ethics Committee of the Faculty of Arts and Social Sciences, University of Waikato. Any questions about the ethical conduct of this research may be sent to the convenor of the

Research and Ethics Committee Dr James McEwan, phone 07 838 4466 ext. 8295, email: jmcewan@waikato.ac.nz

Information Sign

Thank you for playing the Raglan Recycling Arcade!

This game was part of a research project. Information about this project is available Here!

Waste Audit Cards

Primary Categories	Includes (but not limited to)
Kōata Glass	Bottles, jars and any other glass. Please note: drinking glasses and glass panes are not recyclable and can't be placed in recycling bins.
Kirihou Hangarua Recyclable Plastic	Plastic bottles and containers and bags (recyclable in your area). PET (number one) & HDPE (number two) are generally recyclable in all regions. Some regions collect plastic bags for recycling.
Kirihou Hangarua-Kore Non-recyclable plastics	All the plastic bottles, containers and bags that can't be recycled in your area, as well as plastic wrapping and any other bits of plastic. Also use this category for composite materials which are made up of two or more things such as chippy packets or tetra paks. For example tetra paks are made up of alumimium foil, plastic and paper. I also put thrown away dish clothes for wiping benches that are of a plastic nature in this category.
Paper (clean)	Newspaper, clean newsprint, magazines, office paper, thin cardboard boxes (e.g. weetbix).
Paper (dirty)	Hand towels, tissues, paper from tables, paper towels, dirty or

	greasy paper bags or any paper that is dirty - spilt food or drinks on it for example.
Cardboard (corrugated)	Corrugated cardboard boxes
Ferrous metals and Non-ferrous metals	Ferrous metals such as steel (tin) cans are made with iron ore and these metals stick to a magnet. Non-ferrous metals don't stick to a magnet as they don't have any iron in them and these include aluminium (tin) foil, gold, brass, silver, copper and aluminium.
Food waste	Food, bones, guts, shells, peelings, etc
Green waste	Lawn clippings, weeds, branches
Textiles	Clothes, shoes, curtains, cloth, teatowels
Sanitary	Nappies and sanitary products
Rubble	Gib, concrete, broken plates, crockery
Timber	Wood, iceblock sticks, chopsticks
Rubber	Jandals, rubber bands
Potentially Hazardous	Batteries, electronic waste, medicines, cleaners