Behaviour Change Wheel Driven Normative Feedback in a Serious Game for Energy Conservation

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ABSTRACT

Existing energy conservation interventions provide feedback in the form of graphs and numbers. There is a need for more persuasive and theoretically informed interventions in order to bring about a greater conservation effect. Using the Behaviour Change Wheel (BCW) systematic method of intervention design, we designed a mobile phone game which uses normative feedback as a behaviour change technique to promote energy conservation. This paper describes an application of the BCW method to the energy domain and presents the design of Energy Explorer—a serious game with the purpose of promoting positive energy conservation behaviours in the home—that incorporates meaningful reference groups, average player community score, and normative leaderboards.

Keywords

Serious games, climate change, social normative theory, normative feedback, energy conservation

INTRODUCTION

A recent study of nearly 12,000 abstracts of papers regarding climate change from the past two decades found that over 97% of studies agreed with the consensus that global warming exists and is caused by humans (Cook et al. 2013). In the latest report from the Intergovernmental Panel on Climate Change (IPCC)—which brings together the work of thousands of authors from more than 80 countries—they state that "warming of the climate system is unequivocal" (IPCC 2014, p.2) and that the "dominant cause" is extremely likely to be human influence (IPCC 2014, p.4). A major component of human influence on climate change is that of greenhouse gas (such as CO_2) emissions-to which the energy sector contributed around 35% in 2010 (IPCC 2014, p.46).

Within the energy sector, there is a chance to dramatically reduce energy consumption in the residential space (Ehrhardt-Martinez et al. 2010). Traditionally, methods for promoting energy conservation in this area have consisted of simple advertising techniques presenting educational materials. Whilst these methods have been effective in distributing information about the effects of energy consumption on the environment as

well as ways in which energy can be saved, their effectiveness at translating the gained knowledge into actual energy conservation has been questioned (Abrahamse et al. 2005; Carrico & Riemer 2011; Schultz et al. 2007). Having begun with simple power bill information, these feedback mechanisms include in-home displays (IHDs), and web-portals. The advancement of smart energy meters has enabled feedback mechanisms to become more accurate and provide information in a more real-time fashion—traits which have been shown to improve energy conservation (Ehrhardt-Martinez et al. 2010).

However, recent studies have suggested that simply providing feedback in the form of graphs and numbers (e.g. kilo-watt hours) only provides short-term improvements (Vaijayanthi & Marur 2012; Houde et al. 2012) and so there is a need for interventions which make better use of behaviour change theories.

This work addresses this need by making use of an intervention design methodology called the Behaviour Change Wheel (BCW; Michie et al. 2014) to aid the design of a novel intervention for energy conservation. This paper introduces the BCW and presents our application of it to energy conservation. The results of this process identify a serious game, delivered through a mobile phone as a promising delivery method for the selected target behaviours.
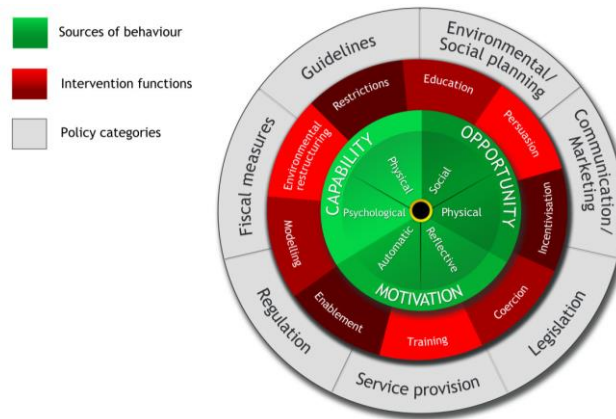
THE BEHAVIOUR CHANGE WHEEL METHODOLOGY
The Behaviour Change Wheel (Michie et al 2014) is the result of a synthesis of 19 existing frameworks of behaviour change identified by Michie et al. (2011).

The BCW describes a methodology by which intervention designers can systematically examine the behaviours the intervention aims to target. The methodology can be used for evaluating existing interventions, categorising interventions in a particular domain, and of interest to this paper, designing interventions. The purpose of the BCW is to allow intervention designers access to a systematic method for reviewing the full range of options available to them so that they may arrive at a suitable strategy. Designers are prompted to begin by thinking about the behaviour they wish to change within the frame of the COM-B model (described in the following section), then about which intervention functions (e.g. educating people, persuading people, modelling behaviour etc.) are appropriate, which behaviour change techniques (BCTs) are promising, and finally to consider the mode of delivery of the intervention.

As illustrated in Figure 1, the center of the BCW's conceptual wheel represents the sources of behaviour that could be targeted by interventions. The surrounding layer represents the intervention functions that the intervention can use, and the outer layer the types of policy changes that can be used for delivery of the intervention functions.

The BCW design process consists of three main steps. The first is to simply define the problem in behavioural terms. This allows the designers to be clear that all stakeholders are working on the same problem, with the same parameters, including where the behaviour happens, and who is involved. The method prompts designers to consider a long list of possible target behaviours relevant to the overarching problem. This list is then prioritised based upon their impact upon the overarching problem, the likelihood of changing the behaviour, the likelihood of spillover effects onto other behaviours, and how easy it is to measure the behaviour.

Figure 1: The Behaviour Change Wheel by Michie et al (2014) showing the COM-B model, intervention functions, and policy categories.

This step also prompts designers to analyse the target behaviour(s) within the COM-B model of behaviour. The core behavioural theory behind the BCW is the COM-B model, and this is represented as the inner layer of the conceptual wheel. The main aspects of this model as described by Michie et al. (2011) are:

- Capability: "an individual's […] capacity to engage in the activity concerned" (Michie et al. 2011, p.4), which can be psychological (comprehension, reasoning, etc.) or physical (strength, skill, etc.);

- Opportunity: "all factors that lie outside the individual that make the behaviour possible or prompt it" (Michie et al. 2011, p.4), which can be physical (environmental) or social (afforded by culture, and what is socially acceptable);

- Motivation: "all those brain processes that energize and direct behaviour, not just goals and conscious decision-making" (Michie et al. 2011, p.4), which can be reflective (evaluation, planning to do something, etc.), or automatic (involving emotions, impulses, etc.).

With identification of areas of the COM-B in which change is needed, the second step in the BCW is to identify promising intervention functions for these areas. Intervention functions defined by the BCW are education, persuasion, incentivisation, coercion, training, restriction, environmental restructuring, modelling, and enablement (full treatment of these intervention functions is given in Michie et al (2014, pp.111–112).

According to Michie et al (2014), evaluation needs to be undertaken not only in terms of potential effectiveness, but also with consideration of the relevant social context. To aid in this, they introduce the APEASE criteria for evaluating options (for full definitions see Michie et al (2014, pp.23–24)): affordability, practicability, effectiveness, acceptability, side-effects, and equity.

The final step in the BCW process is to identify Behaviour Change Techniques (BCTs) and a delivery method for those techniques. A BCT is defined as "an active component of an intervention designed to change behaviour" (Michie et al 2014, p.145). At this point, designers are able to select behaviour change techniques that are appropriate (based upon the APEASE criteria) for the intervention functions. This is aided by the BCTTv1

(Behaviour Change Technique Taxonomy (v1)) taxonomy produced by Michie et al. (2013). The taxonomy contains 93 techniques as found in a wide range of areas, and the BCW attempts to link these to the different intervention functions.

As part of this final step, the designer is prompted to think about the mode of delivery for the intervention, and consider (using the APEASE criteria) various options that are face-to-face on an individual and group level, and over distance on an individual (e.g. phone call or mobile phone text), and population level (advertising, or software).

In summary, the Behaviour Change Wheel methodology allows us to gain a better understanding of the behaviours that an intervention is targeting by prompting designers to consider components of the behaviour and the proposed intervention systematically and within a social context using the APEASE criteria.

At the time of writing, a systematic method mapping Behaviour Change Techniques with actual behaviour change theories that can be used to guide the specific details of an intervention does not exist. This work is still in progress as the BCW is a relatively new methodology, and is a logical next step considering the authors have already developed a summary of 83 prominent behaviour change theories and synthesized them in one book titled The ABCs of Behaviour Change Theories (Michie et al. 2014). The advice from the authors for theory selection is to consider the constructs comprising each theory that have been identified for the theories described in the book, and determine their relevance to the selected BCTs (Personal Communication, Michie 2015).

With an understanding of the BCW process, the following section reports on our application of the methodology within the domain of energy conservation.

USING THE BEHAVIOUR CHANGE WHEEL METHODOLOGY TO AID THE DESIGN OF AN ENERGY CONSERVATION SERIOUS GAME

This section reports on our application of the BCW methodology for aiding in the designing an energy conservation intervention. This is split into sections representing the three main steps of the BCW, as well as a description of how this guided our selection of behaviour change theories.

Stage 1: Understanding the Behavior

In the case of this paper, the core problem is household energy consumption by homeowners, renters, and other occupants. Within the domain of energy conservation, there are a plethora of behaviours that can bring about reduced energy consumption. A commonly used dichotomy in energy conservation behaviours is the distinction between curtailment behaviours (which are generally every-day actions that are repeated with each instance of the action bringing about a small usage impact and are low in cost) and efficiency behaviours (which are generally once-off or irregular actions with a large usage impact and can sometimes be high in cost).

A list of energy behaviours from various sources (Fielding & Housing 2010; Karlin et al. 2014) was sourced, and identified as either curtailment or energy efficiency behaviours. Following the BCW process, we then scored each of the behaviours on the four factors of: impact upon the overarching problem; the likelihood of changing the behaviour; the likelihood of spillover effects onto other behaviours; and how easy it is to measure the behaviour, and prioritised them by score. Table 1 shows the best and worst examples that resulted from this prioritization.

Potential target behaviours	Impact	Likelihood of Change	Spillover	Measurement	Score
Curtailment Behaviours					
Turning off lights when you are not in a room	Very promising	Very promising (motivation)	Promising (standby, un-used appliances)	Very promising	15
Shorter Showers	Promising	Unpromising (motivation)	Unacceptable (no link)	Unpromising (water)	5
Effectiveness Behaviours					
Purchasing Energy Efficient light bulbs	Promising	Very Promising (motivation)	Promising (purchase efficient appliances)	Unpromising (installation, detection)	11
Add insulation in the home	Promising	Unpromising (opportunity)	Promising (other effectiveness)	Unacceptable (installation)	5

Table 1: Examples of prioritisation of curtailment and efficiency behaviours (adapted from the worksheets provided by Michie et al (2014)). Note: score calculated as very promising = 4, promising = 3, unpromising = 1, and unacceptable = 0.

Three target behaviours were identified based upon their resultant score on the above criteria: adjusting air conditioner usage, turning off lights when you are not in a room, and standby electricity consumption. These areas were determined to be particularly promising focuses as they are easily measured by smart meters, and are large contributors to overall household energy consumption.

We then analysed each of the target behaviours with respect to the COM-B model in terms of what needs to change. Analysis of all three target behaviors indicated that aspects of social opportunity, reflective motivation, automatic motivation, and psychological capability needed to change (illustrated in Table 2).

COM-B Components	What needs to happen for the target behaviour to occur?	Is there a need for change?
Social opportunity	See others with similar houses turning off their lights appropriately	Change needed as this information is not readily available in a reliable and understandable fashion.
Reflective motivation	Hold the belief that turning off lights will make an environmental difference	Some change needed as many hold a belief that their contribution to Climate Change is negligible
Automatic motivation	Routinely turn off lights when leaving a room empty on a regular basis	Change needed since this behaviour is not currently a routine practice for most residents
	Resist the desire for easier lifestyle where turning lights back on when re-entering a room is not needed because the lights are on from last time the room was used.	Change needed as many enjoy the easiness of having a light ready for them in the room they are entering without the need to find a switch.

Table 2: COM-B analysis for an example selected target behaviour – turning off lights (adapted from the worksheets provided by Michie et al (2014)).

Social opportunity was a factor for all target behaviours as in general it is difficult to recognise if others with similar households are participating in the desired behaviour. Both reflective and automatic motivation were identified as areas for change as in general these behaviours are not habitual (since they are curtailment behaviours, they need to become habitual), issues with belief about the consequences on the environment, and the perceived impact upon comfort and standard of living.

At the conclusion of this stage, we have a clear understanding of what needs to change in order to attain the desired target behaviours. From here we can identify potential intervention functions, described in the next section.

Stage 2: Identify Intervention Functions

For the three target behaviours, the most promising intervention functions were considered to be persuasion, incentivisation, coercion, and modelling. Persuasion by creating positive beliefs about the desired behaviour, incentivisation by bringing about positive feelings for good behaviour and negative feelings about undesired behaviours, coercion, and modelling desired behaviour through feedback in a social and metaphoric way to bring about automatic imitation were all seen as promising avenues for intervention design. With an understanding of the target behaviours in terms of potential intervention functions, the following section now describes the process of what behaviour change techniques could be used, and the delivery method for these techniques.

Stage 3: Identify Content and Implementation Options

Now that an understanding of what intervention functions are appropriate, it is possible to identify promising Behaviour Change Techniques (BCTs) for the intervention.

Using the mapping of BCTs to intervention functions defined by Michie et al (2014), individual BCTs were evaluated against the APEASE criteria, and the results indicated that providing feedback both on an individual basis (as it commonly seen in existing methods for promoting energy conservation), and in a social context were useful techniques, as was providing rewards and punishments based upon individual results as well as social comparison. An example of this analysis is provided in Table 3.

Intervention function	COM-B component	Promising Individual BCTs	BCT Detail
Incentivisation	Psychological Capability	Feedback on behaviour	Providing feedback on performance of the behaviour
	Social Opportunity	Social reward	Providing a non-verbal reward for doing the behaviour
	Automatic Motivation	Incentive	Having a known reward for completing the behaviour
		Social reward	As above

Table 3: Promising Behaviour Change Techniques for selected COM-B components (adapted from the worksheets provided by Michie et al (2014). Note: only a subset of promising BCTs based upon the APEASE criteria are shown for space reasons.

Finally, with the identification of the behaviours to be focused on, and the techniques suitable for impacting those behaviors, the mechanism of delivering that intervention must be considered. Face-to-face delivery modes were considered impractical due to the large number of homes that are targeted (ideally all homes would be targeted). Among distance-based delivery methods, individual phone-based methods were considered to be unlikely to be effective as only limited feedback can be provided. Outdoor media such as billboards and posters, print media such as newspapers and leaflets, and broadcast media such as TV and radio were considered impractical as it is essentially impossible to provide personalized feedback to individuals.

Digital media was considered the be the most ideal delivery mechanism, in particular the medium of a mobile phone game since household members are likely to have a phone, and personalized feedback can easily and immediately be given on the device.

A review of literature suggests that this intervention delivery style is not new, and a number of researchers have attempted to create serious games with the purpose of promoting energy conservation behaviours. The most substantial serious game in the area

of energy conservation was run in Hawaii in a project titled the Kukui Cup (Brewer et al. 2011). In this game players could earn points for their building by completing various educational energy-related challenges and meeting actual energy usage goals, allowing for cooperation and competition. Overall the results of the Kukui Cup suggested some short-term reduction of energy usage (as high as 16% for one team), however the authors found "no evidence of sustained energy conservation after the challenge" (Brewer 2013).

Other examples include the PowerAgent mobile game by Gustafsson et al. (2009), Energy Battle (Geelen et al. 2012), however these serious game implementations are limited in their effectiveness as they make almost exclusive use of points, badges, and leaderboards—often referred to as the PBL Triad. The PBL Triad has been criticised by many (Bogost 2011; Deterding 2011) as not providing sufficient motivation for a task and being an "easy-fix" to user engagement problems, and indeed the demotivating effects of traditional "superstar" leaderboards has been well documented (Deterding 2011;).

What is lacking from the video game examples previously developed and trialed is the embedding of behavioural theory. However, by following the BCW, this new game is informed by a behavior theory that is indicated as most appropriate for the intervention goals and delivery of this intervention.

Theory Selection
Michie et al. (2014), identify 83 behavioural theories that can be used to assist in the design of interventions. Given that the BWC indicated that the provision of feedback on how others are performing the behavior was identified as a useful technique in Stage 3, Michie et al (2014) identifies that the appropriate theory to inform design targeting this particular theme is Social Normative Theory (Perkins & Berkowitz 1986)—in particular the use of normative feedback.

NORMATIVE FEEDBACK IN ENERGY CONSERVATION
Social Normative Theory (Perkins & Berkowitz 1986) suggests that our behaviour is governed at least in part by social norms. Social norms have such an influence over our behaviour mostly because an individual's nonconformity to these expectations can be met with various sanctions depending on the behaviour conducted. These sanctions are social rather than legal in nature—i.e. boycotting, ostracization, or public ridicule rather than jail time or fines (Cialdini & Trost 1998).

The definition by Cialdini & Trost (1998, p.152) of social norms states that they "are rules and standards that are understood by members of a group, and that guide and/or constrain social behaviour without the force of laws". They go on to describe four main kinds of social norms:

1. injunctive norms: societal expectations of our behaviour;

2. descriptive norms: expectations of our own behaviour based upon our observations of the behaviour of others;

3. subjective norms: perceived expectations from valued others of our behaviour; and

4. personal norms: expectations of ourselves for our behaviour based upon our own personal beliefs.

Cialdini et al. (1991) state that descriptive norms refer to that of what is done (the typicality of a specific behaviour) whereas injunctive norms refer to what ought to be (whether significant others approve of a specific behaviour). These norms provide the basis for normative feedback.

Normative feedback allows an individual to monitor their behaviour with reference to the norm and has been used in a variety of areas including: driver safety (Feng & Donmez 2013), recycling (Schultz 1999), alcohol consumption (Lewis & Neighbors 2007), littering (Cialdini et al. 1990), and—of particular importance for the focus of this paper—energy conservation (Schultz et al. 2007; Foster et al. 2010).

As Torriti (2012) points out, normative feedback (in the form of "consumption data sharing") has been used in the area of energy conservation in a number of cases. For example, a study conducted by Schultz et al. (2007) provided normative feedback to participants on their energy usage behaviours. They compared two kinds of feedback. The first showed the participants their energy consumption for previous weeks, alongside a descriptive norm that showed participants the average energy consumption of other people in their area (i.e. they were shown what the norm for energy consumption by similar others was). The second kind of feedback was the same descriptive norm plus an additional injunctive norm in the form of a simple hand drawn smiley face (☺) or sad face (☹) depending on whether or not the household had consumed more or less than the average consumption for their area, and this was found to improve the conservation effect by removing the boomerang effect, where usage levels tend to gravitate toward the average figure shown in the descriptive norm (for more information on this effect, refer to Cialdini & Trost (1998) and Torriti (2012)).

This exact kind of normative feedback (using injunctive and descriptive norm simultaneously) has been put into practice by electricity company OPOWER who place a smiley face (injunctive norm) and comparison feedback (descriptive norm) on customer bills. OPOWER have reported a 2%−5% aggregate increase in energy savings using this method (Allcott & Rogers 2014; Allcott 2011). According to Fischer (2008), electricity companies in Denmark are legally required to provide normative feedback on bills.

An example of normative feedback using social networking is the Wattsup application (Foster et al. 2010) that provided social comparison of energy usage powered by Facebook. They found a significant reduction in energy consumption for participants given the social comparison feedback compared to a control group who were not given it.

An important aspect of providing normative feedback is the reference group used as the source of the norm. Abrahamse et al. (2005) state that "by giving comparative feedback, a feeling of competition, social comparison, or social pressure may be evoked, which may be especially effective when important or relevant others are used as a reference group" (p. 279). Loock et al. (2012) found evidence to this effect, finding that reference groups that are more local were more effective than groups that were more distant. Goldstein et al. (2008) found similar evidence in a study involving towel reuse, and Lewis & Neighbors (2007) found that gender could also play a role in terms of group membership.

From Caildini & Trost's definition, we can see that social norms impact our behaviour, yet, remarkably the designs of serious games that have the purpose of behaviour change are yet to employ these methods. There is therefore an opportunity to explore the use of these methods to improve the design of a serious game.

The following section examines how we have integrated normative feedback concepts into the design of a serious game with the purpose of energy conservation.

AN IMPLEMENTATION OF A SERIOUS GAME INTERVENTION IN ENERGY CONSERVATION USING NORMATIVE FEEDBACK

Energy Explorer

The *Energy Explorer* prototype is an exploration game, which is played from a 2D top-down perspective. The player controls an avatar that traverses a procedurally generated world. Sections of the world (referred to as zones) are generated using cellular autonoma techniques to produce unique shapes of mountains, rivers, caves, and forests (see Figure 2). Other characters and animals populate the world and can be interacted with. Some sections of the world are pre-generated and contain puzzles that the player needs to complete to access new items or characters.

Figure 2: A screenshot of Energy Explorer, illustrating a procedurally generated area with dynamic weather elements, player character, in-game resource pickups, and preliminary interface.

The player is given a large checklist of tasks to complete in the world and the aim of the game is to explore as much as possible of the generated world, in order to complete items on this checklist. The checklist items are completed by finding characters and animals who provide the player with quests, and by finding in-game resource.

In order to explore and do actions however, the player must exert energy. Energy is the player's main resource and is governed directly by real world energy usage as recorded by an in-home smart energy meter provided by the player's local energy provider. Once a player runs out of energy, they cannot complete any more actions or travel any more until they earn more energy (done by saving real world energy). It should be noted that the need for a smart meter reduces the possible number of people who can play the game and also presents a bias in the selection of participants for testing the game (the participants may be more energy-conscious than others). Additionally, this may be a deterrent for others since there is considerable debate on the privacy concerns raised smart meter data collection (Weaver, 2014), however this is beyond the scope of this paper.

The state of the environment of the virtual world is also governed directly by real world energy consumption in the form of an exaggerated Climate Change simulation. The target behaviours relating to air conditioning, light usage, and standby electricity are part of this

intervention as these components of consumption are recorded individually by an in-home smart meter and handled separately by the game. For example the ice resource in the game is directly related to air conditioner usage, and quests in the game where characters need ice target this behaviour.

Conservation results in better weather throughout the game and means that areas cost less to traverse, are safer, and more visually appealing, whereas lack of conservation results in difficult to traverse, unsafe areas. Good weather allows access to new characters and items. The characters and items are visible to show the player what improving the weather will help them access. An example of this is shown in Figure 3 where a player can see that if they improve the weather, they will gain access to a character in the game called Ellie the Giraffe, which will complete an item on the checklist.

Figure 3: A pre-generated area within Energy Explorer. On the left the player can see that changing the weather will result in access to "Ellie the Giraffe". On the right is the result of improving the weather in that area.

This design links well with the identified BCTs as it allows players to obtain feedback on their energy consumption in a novel way. Table 4 shows the link between the BCTs and the in-game elements described previously. A description of all of these game elements is beyond this scope of this paper and thus we will focus on a specific subset relating to normative feedback.

Behaviour Change Technique	Game Elements
Feedback on behaviour	Game resources and environment linked to usage
Social comparison	Meaningful reference groups (clans) Average community score Normative leaderboards (feedback)
Identity associated with changed behaviour	Game avatar's progress and identity associated with positive behaviours
Information about others' approval	Game characters providing messages of approval and disapproval of positive and negative behaviours Social system (other players' feedback)
Identification of self as role model	Normative leaderboards showing the player as being higher than relevant others Social system (providing tips to other players)
Salience of consequences	Game resources and environment linked to usage
Information about social and environmental consequences	Game resources and environment linked to usage
Social reward	Normative leaderboards (feedback)
Incentive	Quest Rewards (given) Normative leaderboards (rewards)
Discrepancy between current	Quests, showing possible game progress if behaviour is

Behaviour Change Technique	Game Elements
behaviour and goal	perfect
Punishment	Game resources and environment linked to usage
	Quest Rewards (not given)
Behaviour cost	Game resources and environment linked to usage
Remove reward	Quest Rewards (not given)

Table 4: Relevant game elements that address each of the promising Behaviour Change Techniques.

Meaningful Reference Groups

Comparisons should be made to those in meaningful reference groups, much like those seen in the Goldstein et al. (2008), and Loock et al. (2012) studies. Games are already trying to make use of these kinds of groupings, by providing leaderboards and comparisons to users' friends groups using Facebook, as well as location-based groupings at for example the country- or city- level.

Energy Explorer uses relevant reference groups for comparison of energy consumption. Players can define their own reference groups by their selection of friends, but also are placed in automatically generated reference groups based upon a similarity factor. The similarity factor between users takes into account demographic information, the number of occupants of the household, the size of the house, and the income of the household. When designing features which use meaningful reference groups, it is important consider any ethical concerns relating to the data which is used to determine the groupings. In this case, the variables for the similarity factor are quite sensitive. The current implementation doesn't describe to players the variables used, and instead just calls these users "similar". The system also doesn't allow users to personally identify others other than by a username which players are encouraged to not make similar to their real identity. Any future versions of the game outside of a purely research environment (i.e. run by an energy company) would need to handle this sensitive data with similar ethical standards to what is required for research.

Meaningful groupings within Energy Explorer are called clans. Game progression (dictated by real-world energy use) contributes to a clan score and this is used to rank clans (see Figure 4). Cooperation is fostered by not wanting to let the clan down by letting another clan achieve a higher rank. Competition within the clan is fostered by wanting to be the best ranked within a clan on the clan leaderboard.

Meaningful others as determined by the similarity measure are used by *Energy Explorer* to enable the owned zones feature to work. Players can claim a procedurally generated zone for their own (e.g. if they like the layout, or it has favourable resources). As players travel around the game world, they will randomly come across zones that are owned by other players from their meaningful reference groups. The weather and general quality of owned zones is intended to be an indication of that meaningful others' energy consumption. While in another player's owned zone, players have quick access to that player's game progression and compare progress with that player.

Figure 4: The clan leaderboard in *Energy Explorer*, showing a ranking of meaningful groups (left), and ranking within that group (right).

In terms of the BCW, game elements that use meaningful reference groups allow players to see that others are participating in the desired behaviour and may act as a form of persuasion via feedback. The cooperative and competitive effects of group play help provide incentivisation and coercion to the intervention.

The concept of meaningful reference groups is particularly important as they can serve as a way of enhancing the effectiveness of other game elements that require groupings, such as the ones suggested in the remainder of this paper.

Average Player Community Score

Previously mentioned studies have successfully used the showing of individuals their efforts (be it amount of energy used, or amount of recycling done, etc.) in comparison to the average of other people. Video games may also benefit from providing players with a similar comparison of their score to an average player community score.

Energy Explorer includes a leaderboard which shows players the average energy consumption of other players within the game (descriptive norm; collected from smart electricity meters in the players' homes), and provides an injunctive norm in the form of providing positive, bright graphics, and rewards for those above the norm, and darker gloomier graphics with fewer or no rewards for those below the norm.

Injunctive norms are provided by the characters in *Energy Explorer* who approve or disapprove of the players' conservation efforts. This is further linked to currency within the game, where characters provide specialised quests to the player based upon various aspects of their consumption. If a player is doing poorly on any one of the three target behaviours (air conditioning, lights, or standby power), characters will spawn who give a quest which can only be completed by improving their conservation efforts in that area. If players do this effectively and quickly then the character gives the player increased quest rewards such as more money (making the reward more injunctive, by associating the reward with approval or disapproval). An example of this is given in Figure 5.

From a BCT perspective, comparison to the average energy consumption of a relevant reference group provides the player with a clear indication of how others are engaging in the desired behaviour. Since a relevant group is used, it also serves as useful feedback on the player's performance.

Figure 5: A quest reward screen in Energy Explorer, showing approval from a quest giver, and an improved reward for reaching the target conservation amount.

Normative Leaderboards

Instead of providing top-down, "superstar" leaderboards, we suggest an alternative leaderboard that shows other players who are slightly above and slightly below an individual. This kind of normative leaderboard plays off the theory by Festinger (1954) that we gain motivation and guidance from those better-off than us and self-esteem from those worse-off, all while attempting to address the demotivating effects of top-down leaderboards where users feel they have fallen too far behind the leading players. Additionally this style of leaderboard promotes competition among players of (potentially) the same skill level, but also gives a sense of similarity to players who are less competitively-inclined by showing people with the same or similar score to them.

Energy Explorer implements a normative leaderboard that shows players others who are at a similar level of energy consumption to them. There is a danger here that a normative message that other people are also exhibiting poor energy consumption behaviours could be given by this kind of feedback, potentially making the player believe their behaviour is less harmful than it really is. However combining this with an injunctive norm showing that the people with these poor energy consumption behaviours are well below average and are doing poorly in terms of game progression may combat this.

By restricting the scope of what players can be seen to simply those with similar usage behaviours, the potential demotivating effects of seeing players who are much better off may be alleviated (such as what would be present in a "superstar" leaderboard). It should also provide closer competition, and allow players to find themselves at the top of their "division" (despite potentially being quite low on an overall leaderboard).

It should be noted that *Energy Explorer*'s use of a leaderboards differs greatly to the styled used in criticised Gamification PBL-based games previously mentioned as many systems that implement PBL tend to be comprised *only* of PBL with nothing else resembling a game, whereas *Energy Explorer* uses these normative leaderboards in *addition* to, and to supplement many other game elements.

Energy Explorer ties these normative leaderboards in with in-game rewards using a temporal mechanic. Players are paired automatically with similar others and prompted to battle with that other player during a time period (daily challenger, and weekly challenger, as shown in Figure 6) to consume less energy than them. The player in the

pair with the lower consumption by the end of the time period is given an in-game reward. As previously discussed, it is important to ensure this reward is meaningful.

Figure 6: Players are paired with other relevant players
on a daily and weekly basis, showing relative progress.

Once again this works towards the identified BCTs as this provides feedback to the player on their performance, and shows the player that other people are participating in the desired behaviours. The in-game rewards act as a form of incentivisation, and the feedback of the comparison is a form of persuasion.

CONCLUSION

By using the Behaviour Change Wheel method, we identified behaviours of reducing air conditioner temperature, turning off lights in unoccupied rooms, and reducing standby electricity usage which can be targeted by a serious game intervention which uses persuasion, incentivisation, coercion, and modelling.

In introducing the idea of a serious game with the purpose of energy conservation that goes beyond simple Gamification implementations by leveraging behaviour change techniques, we argue that the ability of video games to provide social feedback and the wide audience they have make them an extremely viable candidate for an intervention.

This paper has focussed on the intervention's ability to provide social opportunity to the individual, and looked in particular at normative feedback. The research on normative feedback in video games is surprisingly non-existent, despite recent attempts in mainstream games to move away from the "superstar" style of leaderboard toward ones that show those relatively above and below a player's current position or matched to a player's skill level. The field of research promoting energy conservation behaviours has seen positive results through general feedback and, in particular, normative feedback. Similarly the field has also seen positive results from serious game implementations such as the Kukui Cup. The serious game intervention *Energy Explorer* described in this paper combines these two concepts as a means for both moving forward the research on normative feedback, but also for improving the toolkit of motivational and behaviour change strategies used in serious games.

To this end, we have presented three specific game elements within Energy Explorer that allow normative feedback techniques to be integrated into the design of a serious game: meaningful reference groups, average player score, and normative leaderboards. It is important to note that these elements are intended to supplement existing elements of serious games rather than to supplant them—a game consisting of only these elements to bring about behaviour change would likely not be very successful or engaging.

Future work aims to evaluate the design and effect of *Energy Explorer*, and there is opportunity to examine the long-term effects (an issue which has plagued other studies) since the smart meters required present an effective form of data collection. In a time where video games are as popular as they have ever been, the successful implementation of this serious game for energy conservation may provide an exciting and entertaining new avenue for us to mitigate Climate Change.

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