1-170-19 + Alina Mia Udall

Nudgeathon for Encouraging Energy Behaviour

*[1]Alina Mia Udall, *[2]Daniel Read, and *[3]Umar Taj
*Warwick Business School, University of Warwick, Scarman Rd, CV4 7AL, UK
Email: [1]alinamiaudall@bath.edu, [2]daniel.read@wbs.ac.uk, [3]umar.taj@wbs.ac.uk

Abstract

Humans are generating many environmental problems and our behaviours are not sustainable over the long term. According to an Intergovernmental Panel on Climate Change (IPCC) special report on the impacts of global warming by Allen and colleagues in 2018, encouraging pro-environmental energy behaviour is most likely to reduce carbon emissions, which is essential in order for the UK to reach the 2050 target of a 60% reduction in CO^2 emissions. Pro-environmental heating behaviours in contexts where there is little economic incentive to conserve energy, such as in our context (Higher Education Institutions [HEI]), is one of the key contexts for the UK to reach its goal. Many attempts have been made to encourage these behaviours, using design-thinking, participatory design, and choice architecture, however, each approach alone has its limitations. To overcome these challenges in order to optimally change behaviour, we combine these three approaches, and propose a new comprehensive behaviour change model, namely, *Nudgeathon*. Nudgeathon proposes seven consecutive stages that can lead to any type of behaviour change, including pro-environmental heating behaviours, and in any contexts, including university accommodation. These stages are as follows: *Define*, *Empathise*, *Ideate*, *Present* (*Figure Out Phase*), *Refine*, *Prototype* and *Test* (*Follow Through Phase*). This seven-stage process has been successfully tested at an Institution level, where we observed positive behaviour change – that of pro-environmental heating behaviours in university accommodation. Finally, we suggest questions to be addressed in future research in behaviour change, and for pro-environmental heating behaviours.

Introduction

Humans have generated many environmental problems and many of our behaviours are not sustainable over the longer term (Allen et al., 2018). According to an Intergovernmental Panel on Climate Change (IPCC) special report on the impacts of global warming (Allen et al., 2018), for the UK to reach the 2050 target of a 60% reduction in CO^2 emissions, pro-environmental energy behaviour is most likely to help (Maslin et al., 2019). Specifically, domestic energy consumption accounts for 25% of the energy used in Europe, wherein a 20% reduction can be achieved by having effective consumer behaviour interventions targeting these behaviours (European Environment Agency, 2013). Thus, this behaviour most negatively impacts the environment, and encouraging better practices will most positively help the environment (Boardman, 2007).

Encouraging pro-environmental heating behaviours, such as space and water heating (Fielding et al., 2010; Firth et al., 2010) in the domestic sector and specifically in contexts where there is little economic incentive, such as in our context (Higher Education Institutions [HEI]), is one of the key challenges that the UK is facing towards achieving the ambitious 2050 target (Bone et al., 2016). Pro-environmental heating behaviours can be defined as people carrying out actions that use equipment or devices that provide heat in ways that preserve, prevent damage to, and/or promote improvements to the world (c.f. Kollmuss & Agyeman, 2002). That is, pro-environmental heating behaviours span the whole of nature and human-made space. Therefore, there is a growing need to encourage pro-environmental heating behaviours in contexts where there are few economic incentives involved. To address this need, we examine the research on behaviour change, and specifically pro-environmental energy [heating] behaviour change in contexts where there were few economic incentives.

Attempts made to effectively encourage behaviour [pro-environmental/heating] change

First we discuss attempts made to encourage behaviour change generally. There is a surge of interest in the use of policy interventions to study behavioural change (Behavioural Insights Team, 2017; Lourenço et al., 2016; World Bank, 2015). However, policy interventions alone are not effective to overall change in behaviour. Hence, standard economic theories argue that policy interventions should be complemented by the use of cognitive biases because they are inherent in human decision making (Dolan et al., 2012), namely, choice architecture. Choice architecture does not intend to fundamentally change the system within which the user operates, rather re-design the context that users are in (nudge theory; Thaler & Sunstein, 2008). Choice architecture is widely used and positively viewed by policymakers as it has been successfully applied in a range

of government departments and organizations (Halpern, 2015). There are, however, a few limitations in the existing literature.

First, many of the society's problems (e.g. health, poverty, environmental) are behavioural in nature and their solutions rely on a broad coalition of distributed stakeholders to improve outcomes (World Bank, 2015). Despite this, existing behavioural change interventions using nudging, have only focused on central government. There is therefore a lack of input from a broader coalition across distributed stakeholders on key issues such as environmental concerns (World Bank, 2015). Second, only limited studies effectively encouraged energy consumption reduction using feedback with social comparison in contexts where there were few economic incentives, such as in HEI on-campus accommodations or in the workplace (Emeakaroha et al., 2014; Staddon et al., 2016). Although feedback is considered a major intentional factor for motivating students' behaviour (National Union of Students - UK, 2017), the exact impact of feedback on encouraging students' pro-environmental behaviour is yet to be established. Third, existing studies use small sample sizes (Emeakaroha et al., 2014), and do not control for long-term effects (Peschiera, Taylor, & Siegel, 2010). Hence, an understanding of the effects of pro-environmental energy behaviour in a large sample is lacking, particularly longitudinally. Finally, research endeavours so far have only targeted end-users, domain-specific experts, or practitioners. However, a deeper understanding of the effects of behavioural change interventions across all three types of users is missing. Hence, in order to address these limitations, we evaluate how design-thinking, participatory design, and choice architecture (nudge theory) can collectively help to effectively encourage behavioural change.

Design-Thinking

This premise reflects the entire method/process needed for behaviour change to occur and is defined as a new 'liberal art of technological culture', that aims to connect and integrate the diverse bodies of knowledge in the arts and sciences in a functional manner to help with the practical task of developing new solutions (Buchanan, 1992). Design-thinking attempts to invest academic rigor to the often un-scientific procedures that surround the designing and planning of new products or solutions. A wealth of literature and countless models have been put forward to encapsulate the methodology of design thinking (Meinel et al., 2011; Simon, 1996), where iteration is the inherent ingredient that links all design-thinking methodologies (Sheppard et al., 2017). An iteration model means that each stage produces evidence upon which the next stage is based, gradually building up a more detailed picture of what the person wants or how the problem may be solved. If judged by adoption, the Five Stage Model, comprising of *Empathise, Define, Ideate, Prototype*, and *Test*, has become almost ubiquitous in its widespread popularity (Meinel et al., 2011). However, after evaluation, we noticed that there were three changes that would enhance the effectiveness of using this process to encourage behaviour change.

First, we re-ordered these stages – we define the problem first, rather than empathise, as empathy is cognitively demanding (Baumeister et al., 1998). Asking people to empathise with a specific problem, rather than the general problem reduces the cognitive load of the operation, as there is less for people to empathise with. Therefore, participants will effectively complete this *Empathise* stage. Second, we added two extra stages namely *Present* and *Refine*. These consecutive stages need to appear before the *Prototype* stage. The *Present* stage allows ideas to be shared, and evaluated in order to identify the most suitable ideas for addressing the problem, thus it must take place prior to the *Prototype* stage. Furthermore, including the *Refine* stage before the *Prototype* stage means overlaps and redundancies of the eligible ideas presented are established, leaving the most parsimonious ideas for prototyping. Therefore, the *Present* and *Refine* stages mean the ideas used for the *Prototype* stage are more likely to be effective and efficient for addressing the problem. Finally, these seven stages need to be implemented consecutively, with participants working explicitly on one stage, before moving to the next. This process allows researchers to ensure that each stage is completed, and in order to establish if the process is really effective for identifying a solution relevant for changing behaviour. Based on our extensions to design-thinking, and to encourage behaviour change, we developed/implemented an innovative, explorative, Seven Stage Model, which we call *Nudgeathon* (further details in section: Seven stage model – Nudgeathon).

Participatory design

This premise reflects the people needed for behaviour change to occur, which becomes most relevant at the *Empathise* stage of our Seven Stage Model. An exact term and definition for participatory design in this context appears to be evolving over time (Pieters & Jansen, 2017; Szebeko & Tan, 2010). However, for the purpose of this article we define participatory design as follows: All relevant stakeholders of an issue like end-users, policy makers, and user-experts, productively collaborate through all stages of the development process from research to implementation (cf. Pieters & Jansen, 2017; Szebeko & Tan, 2010). While the wisdom of the people existed before the arrival of the internet (Bødker, 1996), the popularity and prevalence of the use of participatory design increased rapidly in online communities (Reyes, 2012), and there is empirical support for

the efficacy of participatory design ideas for positive environmental behaviour change (Parviainen et al., 2016, July). Participatory design increased emotional investment for the users, created and delivered a product that reflected their needs, developed a deeper connection between the design and users, and was capable of achieving the desired behaviour, which in this case was to recycle (Parviainen et al., 2016, July). Therefore, harnessing user needs to generate meaningful solutions is central to the Nudgeathon approach.

For our Seven Stage Model, or Nudgeathon, participatory design is encouraged so all relevant stakeholders (e.g. end-users, domain-specific experts, and practitioners) have a voice and chance to be understood (empathised with) in the decision-making about the design of the intervention, which likely leads to effective interventions. For example, at the *Empathise* stage, different people (stakeholders) gain understanding/empathy of why people do what they do (end-users), why people provide what they do (practitioners) and what psychological motives affect these decisions (domain-specific experts). By understanding these different vantage points, a holistic bridging of these perspectives can be developed to make effective interventions accepted by all. Therefore, Nudgeathon uses a participatory design model to generate ideas for behavioural problems.

Choice architecture: Nudge theory

This premise is used during the implementation of the proposed methodology and reflects how, psychologically, behaviour change is expected to occur. This knowledge is used to guide the *Ideate* stage of our Seven Stage Model (Meinel et al., 2011). The choice architecture (nudge theory), used for guiding the *Ideate* stage, draws on psychology for behaviour change and is encouraged by specific participants (domain-specific experts) that are involved, as we take a participatory design approach. Furthermore, these experts guide the conversations at the *Ideate* stage using a pack of cards displaying the different psychological motivations that could be selected for behaviour change. Any one or combination of motivations can be selected and used to change the choice architecture (nudge). These people kindly volunteer their time and are personally approached by the research team. Also, having these people guide the conversation, ensures the most efficient and effective solutions are likely to be identified. Finally, these experts help in the *Present* and *Refine* stage where they ascertain the related costs of the ideas developed for addressing the solution, which are accounted for in order to identify the best solutions for the *Test* stage.

The choice architecture theory (nudge theory) proposes a positive reinforcement and indirect suggestion as a way to influence behaviour and people's decision making. The theory contrasts with education, legislation, or enforcement as a way to achieve a desired behaviour. The theory has been effectively used at the national (UK, Germany, Japan and others) and international level (OECD, World Bank, UN). The theory assumes any aspect of the person's environment (choice architecture) that uses prompts (nudges) can alter their behaviour in a predictable way (Thaler & Sunstein, 2008). This theory assumes these prompts (nudges) in that environment trigger the automatic (heuristic) cognitive processes related to that prompt in order to achieve the desired outcome (Parkinson et al., 2014; Thaler & Sunstein, 2008). Heuristics can be defined as a mental shortcut that allow people to solve problems and make judgments quickly and efficiently (Kahneman & Tversky, 1979), such as motivating sustainable food choices (Campbell-Arvai et al., 2014). Furthermore, to count as a mere prompt (nudge), the intervention must be easy and cheap (inexpensive) to implement (Saghai, 2013). Therefore, behaviour changes are not mandates (Thaler & Sunstein, 2008). For example, hanging a sign on the radiator stating that a setting of no higher than three is most suitable for heating in the winter is a positive cue (nudge), whereas banning a setting of four and above is a negative influence, and not a nudge. These examples show that behaviour change using this theory acknowledges that heuristics are often used when deciding how to behave in daily life (Kahneman & Tversky, 1979). Therefore, changing the environment and influencing people using heuristics (premise of choice architecture, nudge theory), will likely lead to the most positive and desired outcome (Campbell-Arvai et al., 2014). The following section of the report explains the Seven Stage Model's methods and results.

Seven stage model – Nudgeathon

The Seven Stage Model - Nudgeathon is a behavioural sciences' theory, which incorporates best-practice from research on design-thinking (which we modified), participatory design (such as using drama theory), and encouraging choice architecture (nudge theory) solutions. Nudgeathon can be used in any context, such as to encourage people to save for a rainy day, encourage women of child-bearing age to supplement folic acid, improve the rate of detection of atrial fibrillation (heart murmur), raise awareness of the problem of privacy on social media, increase volunteering rates among young Australians, and encourage pro-environmental energy [heating] behaviour in student accommodation. Nudgeathon aims to provide effective behavioural change interventions as the people concerned are engaged throughout the intervention lifecycle.

The model has two consecutive phases. First, the *Figure Out Phase*, which comprises of four consecutive stages, *Define*, *Empathise*, *Ideate* and *Present*. Second, the *Follow Through Phase,* which comprises of three consecutive stages, *Refine, Prototype* and *Test*. Completing the two phases with their seven component stages consecutively leads to behaviour change. For example, pro-environmental heating behaviours in any context including on-campus university accommodation, or at the workplace, to name just a pair of examples, can be addressed. The *Figure Out Phase* comprising of four stages, *Define*, *Empathise*, *Ideate* and *Present*, aims to get participants to develop an understanding of the problem and provide potential solutions theoretically. Specifically, the *Define* stage refers to stating and describing exactly the nature, scope, and meaning of the given 'problem'. The *Empathise* stage refers to gaining an understanding and sharing the thoughts, feelings, and behaviours of others. The *Ideate* stage refers to thinking of ways to solve the given 'problem' each time through discussion, debate, suggestions, and development of novel perspectives. The *Present* stage refers to giving, providing, and communicating to all stakeholders involved the solution to the 'problem' as identified during the *Ideate* stage. Finally, the *Follow Through Phase* which comprises of three consecutive stages, *Refine, Prototype* and *Test*, aims to get participants to develop the final solutions to address the problem practically, which can be successfully implemented. The *Refine* stage refers to making changes to the ideas presented during the *Present* stage in order to improve and clarify the methods being used to solve the 'problem'. The *Prototype* stage refers to the initial evaluation of the identified solution in order to understand its usability and replicability. The *Test* stage refers to the procedure intended to establish the quality, performance, and reliability of the identified solution for addressing the 'problem' prior to becoming widely available. The solutions (interventions) identified during the Nudgeathon process (NP) are used to encourage behaviour change and can be applied in any context.

Nudgeathon Method

This section will outline in detail two consecutive phases. First, the *Figure Out Phase*, which comprises of four consecutive stages, *Define*, *Empathise*, *Ideate,* and *Present*. Secondly, the *Follow Through Phase* which comprises of three consecutive stages, *Refine, Prototype,* and *Test*.

Identify context

First, we identify the specific (as narrow as possible) context/location of the Nudgeathon. Given the abundance of available contexts, search commences by identifying the possible contexts that can be targeted. The aim is to target contexts that face major problems and hence would benefit the most from a potential intervention through an implementable solution. For example, such context is a university campus accommodation, because many people live on campus that positively contribute to the university's financial profits, whilst impacting negatively through carbon emissions. Second, we identify the 'problem' that Nudgeathon will solve. The 'problem' is identified by researching the selected context. Specifically, the aim is to identify the major issues that the context faces. Importantly, the selected issue is based on the notion that solving the issue would most positively and significantly improve the context's gains. For example, in a university campus accommodation, one of the main issues most negatively contributing to carbon emissions, and costing the university the most money, is students' over-use of heating during winter.

Identify context participants: Participatory design

As we use participatory design, it is important to identify all stakeholders relevant in the given context. The types of participants included end-users, policy makers, domain-specific experts, and user-experts.

Phase one: Figure Out Phase

The section below describes phase one, the *Figure Out Phase*, which takes place over one or two days. The phase comprises of four consecutive stages, *Define*, *Empathise*, *Ideate,* and *Present*.

Define stage

Here a brief is developed to identify a specific problem that needs a solution. The problem that needs to be solved must be "SMART": specific, significant, stretching (S), measurable, meaningful, motivational (M), agreed upon, attainable, achievable, acceptable, action-oriented (A), realistic, relevant, reasonable, rewarding, results-oriented (R), and time-based, time-bound, timely, tangible, trackable (T). Therefore, participants receive the 'defined' problem behaviour, in a detailed brief, with information detailing the situational context in which the problem occurs.

Empathise stage

Next, participants empathise with the problem, and the defined context of the challenge. An acting workshop is carried out where participants are asked to be 'great pretenders'. That is, they are asked to role play different stakeholders to imagine the challenges faced by each other. After gaining empathic insights, participants may revisit the *Define* stage to update what they see as the key problem.

Ideate stage

Next, participants are separated into teams. In these teams, participants develop their own ideas, have access to any materials presented previously, and are encouraged to explore the physical contexts in which people carry out the behaviour to identify solutions. Teams are given 24 hours to identify their solutions to address the problem.

Present stage

Next, teams present their ideas to the other teams. The ideas are evaluated by a panel of judges using three criteria: feasibility, impact, and the use of behavioural/psychological science theory. Feedback is given.

Phase two: Follow Through Phase

The section below describes phase two, which takes place over several months. Here we describe the *Follow Through Phase*, which comprises of three consecutive stages: *Refine*, *Prototype*, and *Test*.

Refine stage

All solutions from the *Present* stage are evaluated for Affordability, Practicability, Effectiveness/cost-effectiveness, Acceptability, Side-effects/safety, and Equity (APEASE; Michie et al., 2011). Feasibility, Practicability, Effectiveness/cost-effectiveness, are judged by the user-experts. In line with the APEASE process, the top five solutions are chosen for the *Prototype* stage. Additionally, a comprehensive literature and market research review is conducted to refine these top five solutions to the top three solutions. From this review, a full report of how to implement these solutions is established and the top three solutions are identified.

Prototype stage

Here, a designer looks at the solutions from the *Refine* stage. The designer is tasked with making parsimonious prototype solutions that can be quickly and cheaply implemented to help encourage behaviour change effectively, which addresses the issue as stated in the *Define* stage. Furthermore, we recommend that focus group discussions of the prototype are carried out with the end-users. It is important to explore the acceptability of the prototyped from these end-users in order to help maximise the effectiveness of the solutions at the *Test* stage. The discussion with end-users allows for the refinement of these solutions.

Test stage

Finally, solutions are made to address the *Define* stage. The designer launches the *Test* of the intervention. End-users are asked to offer feedback of the intervention for further improvement, and to establish the effectiveness of the intervention (solution).

Nudgeathon Results

Identify context

Our Nudgeathon context was the University of Warwick residential campus as many people live on campus (over 6,500 students, coming from over 100 different countries). Furthermore, the residential campus for students account for 31% of the total energy used by the university, thus contributing most negatively to the university's carbon emission and profit goals. Therefore, any successful widespread behaviour change initiative to reduce energy consumption in this context will represent a significant opportunity for emission savings/costs.

Identify context participants: Participatory design

Each participant was recruited through an online application process. The process assessed student's familiarity with the 'behavioural insights team'. Participants also submitted a video explaining why they would like to participate. This video assessed student's willingness to engage with tasks outside their comfort zone. After screening, we had 32 postgraduate students from 10 different universities in the UK, studying in a variety of disciplines, including behavioural and social sciences, that participated. Therefore, we had six teams consisting of five or six participants. To promote independence of opinion and boost creativity, participants were

randomly assigned to their teams (Surowiecki, 2004). Importantly, each team had at least one student from the University of Warwick that had lived on campus for at least part of the duration of their study.

Phase one: Figure Out Phase

The section below describes phase one which takes place over two days. Here we describe the implementation of the *Figure Out Phase*, which comprises of four consecutive stages, *Define*, *Empathise*, *Ideate,* and *Present* in the University of Warwick, HEI, student accommodation context.

Define stage

Prior to taking part in the two-day event at the University of Warwick, each participant was sent a detailed problem brief which was established through the University of Warwick Estates Department. The problem brief outlined the characteristics of the student population in Warwick and provided extant information regarding the current energy system that is in place on-campus. Various details around fuel sources, energy costs, metering data, flats' appliances, and heating schedules were all included. From this information the challenges were set and detailed. Finally, the issue of overheating rooms in student accommodation was given. Participants were expected to have read the problem brief and make contact (via Skype) with their team members before attending the two-day event.

Participants then arrived at the two-day event and an introduction from domain-specific experts giving a detailed synopsis of the specific problem in question was given. This information was given in the form of a presentation by one of the authors of this article, a University of Warwick Estates Department Member, and an Executive Staff Member. Detailed expert advice was given on the issues of room heating overuse in student accommodation, and how energy systems work at the University of Warwick. Furthermore, psychological theory of behaviour change was briefly outlined to give practical advice for designing behaviour change interventions, such as the informing participants of the Capability, Opportunity, Motivation-Behaviour (COM-B) model (Michie et al., 2011) and the Messenger, Incentives, Norms, Defaults, Salience, Priming, Affect, Commitments, and Ego (MINDSPACE) framework (Dolan et al., 2012).

Empathise stage

Next, participants empathised with the University of Warwick, HEI, and student accommodation challenges. An acting workshop was carried out where participants were asked to be 'great pretenders'. That is, they were asked to role play as different stakeholders and imagine the challenges faced by one another. After gaining empathic insights, participants would re-visit the *Define* stage to update what they saw as the key problem.

Ideate stage

Participants separated into their teams. In teams, participants developed their own solutions to reduce heating consumption at the University of Warwick. This was also guided by the domain-specific experts who had the psychological motivations cards, that can be used to change the choice architecture (used as nudges). Also, participants visited the residential flats where the behaviour would occur. Finally, teams were given 24 hours to identify their solutions.

Present stage

Next, participants presented their solutions to the rest of the group (Table 1). A panel of judges comprising of the Warwick Estates Department Staff, Accommodation Services Staff, In-Accommodation Residential Tutors, and domain-specific experts evaluated the ideas.

Table 1

Present stage solutions for the University of Warwick using the APEASE criteria (Michie et al., 2011)

Solution	Behavioural/Psychological Science Theory	A	P	E	Ac	S	Eq	Total
Energy feedback reports	*Information feedback and social norm messaging.*	*3*	*2*	*2*	*3*	*3*	*3*	*16*
Energy saving incentive scheme	*Adding monetary incentives for students to save energy.*	*3*	*3*	*2*	*2*	*3*	*2*	*15*
Shower timers	*Timely information feedback.*	*2*	*3*	*2*	*2*	*2*	*3*	*14*
Graduated thermometer	*Adding salience and subtle injunctive message to the preferred behaviour.*	*1*	*1*	*2*	*3*	*3*	*3*	*13*
Heat map imagery	*Make wasting energy more visually salient.*	*1*	*2*	*2*	*2*	*3*	*3*	*13*

Energy commitment contract	Pre-committing students to an energy-saving mind-set.	3	2	2	1	2	2	12
Shower curtain polar bear eyes	People have been found to act more pro-socially when they feel they are being watched.	1	1	2	2	2	3	11
A 'cool plant buddy'	Developing an emotional attachment to an item that requires less heat energy.	1	1	1	2	1	3	9
Timely text message prompts	Timely useful messaging	2	1	1	2	2	1	9
Radiator beeps & signs	Timely feedback of potential wastage of energy.	1	1	1	2	1	2	8

Note. Affordability (A), Practicability (P), Effectiveness/cost-effectiveness (E), Acceptability (Ac), Side-effects/safety (S) and Equity (Eq) Ranging from 1 = Low/Poor Solution - 3 = High/Good Solution. *Italic text* = The top five solutions were chosen for the *Prototype* stage (Michie et al., 2011). Normal text = Solutions did not receive further exploration in this research.

Phase two: Follow Through Phase

The section below describes phase two which takes place over several months. Here we describe the implementation of the *Follow Through Phase*, which comprises of three consecutive stages, *Refine*, *Prototype*, and *Test* in the University of Warwick, HEI, student accommodation context.

Refine stage

All solutions presented at the *Present* stage (Table 1) were reduced to the top three solutions. These solutions were energy feedback reports, energy saving incentive scheme, and shower timers.

Prototype stage

Prototypes of the *Refine* stage solutions are made, namely, the energy feedback report which establishes the new energy-saving student competition results (Figure 1), and selecting the most effective shower timer devices to help encourage behaviour change effectively. Focus groups with end-users (students living at the University of Warwick) took place. Four groups of seven students received these and were requested to give feedback. A thematic analysis (Braun & Clarke, 2006) was used to analyse the student feedback in order to build a grounded theory (Ritchie et al., 2014). Four themes were identified: salience (information needs to be more in the foreground), granularity (specific information via personalisation; Karlin et al., 2015; Lewis & Brandon, 1999), incentives (energy-saving student competition; reporting which flat each week is saving the most energy), and positivity - in general (Cotton et al., 2016). Payment incentives were not needed for behaviour change (Heyman & Ariely, 2004). Lastly, a report was made in line with similar home energy ones used in the widely-cited 'Opower studies', and theory – injunctive norms ('smiley faces') to affirm saving energy is good (Allcott, 2011; Allcott & Rogers, 2014; Ayres et al., 2013).

Test stage

The shower devices were removed after the first iteration of the *Prototype* and *Test* phase due to difficulty attaining accurate measurements of their effectiveness. However, the energy feedback report, with energy-saving competition information, was used for the first *Test* stage (Figure 2). We tested these solutions' effectiveness for reducing energy at the University of Warwick student campus. The information on the reports included energy feedback for a flat's current electricity usage, historic comparison with the previous occupants of the same flat, social comparison with the other flats in the halls, and their rank position of electricity usage out of all the flats involved in the intervention (student competition element).

Also, we had the signature of the Head of Energy and Sustainability at Warwick given to increase credibility of the source (Figure 2). The feedback reports with the student competition element were posted on kitchen noticeboards of each flat every two weeks. We also collected electricity usage (in kilowatt-hours [kWh]) for each flat through an online metering software during the intervention, which included heating behaviours from October - December 2017. A stepped-wedge cluster randomised trial was chosen as the experimental design to allow for a staggered roll-out of the intervention across several blocks at a time (Table 2). The consumption was analysed using a linear mixed model regression. That is, we compared the electricity usage data from the previous years in those flats to the trial period which lead to a reduction of 6.1 kWh/flat/week. This result represents a 3.5% reduction when keeping covariates constant like number of beds per flat and the baseline load (35 kWh/week non-discretionary consumption). Therefore, a saving of 2,623 kWh/9,442,800 kilojoules, or £283.83/€318.28 based on the standard unit price for electricity was saved during the intervention period (Figure 3) in line with similar research (Allcott, 2011; Andor & Fels, 2018). Additionally, after controlling for time of

day/week/month effects, we found a significant reduction of up to 1.9 kWh per student per day, resulting in a total reduction in consumption of up to 18.4 kWh during the intervention.

Furthermore, a survey was sent to each end-user (student) to evaluate the interventions' perceived effectiveness to inform the *Prototype* stage of how we could increase the effectiveness for future and even further reduce energy behaviours including heating behaviours. The results affirmed that feedback was important as established via the focus groups in the *Prototype* stage. That is, 80% of the students enjoyed receiving the feedback, 18% did not mind either way, while 2% did not enjoy receiving the feedback. Interestingly, 94% of students wanted to continue to receive regular energy feedback reports. This finding is largely reflective of similar research with students in university settings having this positivity as identified in the *Prototype* stage (Cotton et al., 2016). The students in this *Test* stage also made recommendations leading to further iterations needed for the *Prototype* and *Test* stage. Clearer energy saving advice was requested. Changing the metrics used to convey energy information from kWh to something more relatable such as monetary cost and effect on global warming was also requested. Finally, as heating behaviours have the most impact, specific information such as heat usage and water heating usage was requested, although interestingly, it was initially phased out after the first iteration of the *Prototype* stage.

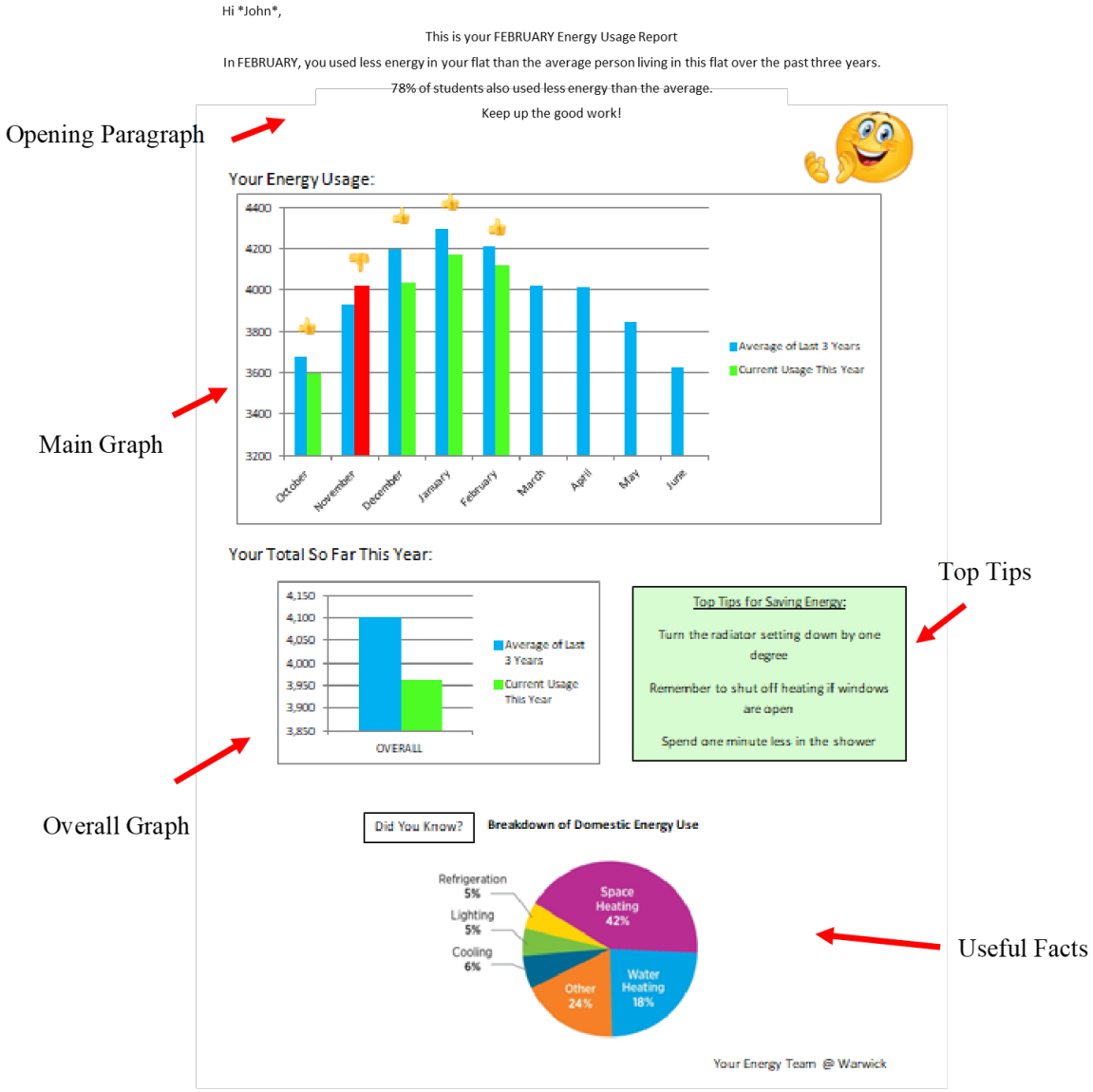

Figure 1. An energy report example that was shown to participants in the focus group discussion with the named sections.

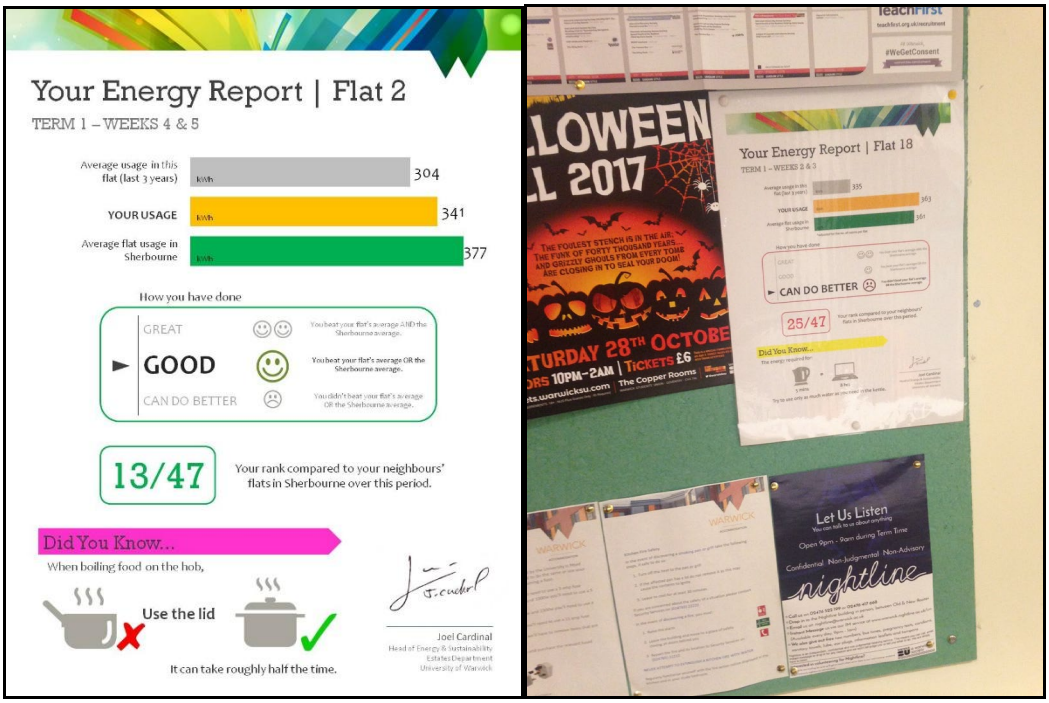

Figure 2. An example of the energy report. An image showing an energy report displayed on the kitchen noticeboard in the flats.

Table 2

Experimental Design of the Energy Report Trial (October - December 2017)

Cluster	Block	Week 1	Weeks 2&3	Weeks 4&5	Weeks 6&7	Weeks 8&9	Week 10
1	3						
	5						
2	1						
	2						
3	4						
	6						

Note. No clusters received the treatment (energy reports) for first three baseline weeks. Blocks were randomly assigned to one of three clusters that crossover to treatment at different weeks. All blocks were receiving the intervention by the end of the trial. Yellow boxes = Control condition. Blue boxes = Treatment condition.

Discussion

Completing the NP was effective at reducing energy behaviours, eliciting an increase in pro-environmental heating behaviours. Therefore, the NP is successful at addressing a specific 'problem'. Furthermore, a university setting with students having little economic incentives to save energy is an important area to focus on, and differs considerably to the context in which the vast majority of research in this area is conducted – the domestic household with a live-in bill payer (Andor & Fels, 2018; Karlin et al., 2015).

This distinction between our context (no extra cost for increasing energy use) and most of the literature into energy conservation interventions (involving household bill-payers) requires further research. The reason is because individuals who pay for their energy usage are likely be engaged in energy conservation initiatives. However, our students were unexpectedly engaged which may be because they may become involved in the bills in the near future. Therefore, engaging in conservation now would help them in the near future when they are bill payers. Our context is just an example that can be used to solve a specific problem and can be compared to

other contexts, like heating in shared professional accommodation which may lead to different outcomes. This NP has been used in other contexts, such as for reducing in air pollution by public members in the city of Coventry, UK, and improved doctor's detection, diagnosis, and treatment of patients' Atrial Fibrillation in the West Midlands, UK.

The NP makes an original contribution to both behavioural theory and design practice in four important ways. First, the NP, in general, successfully integrates the principles of design-thinking, participatory design (via drama theory), and the choice architecture (nudge theory), which should be present throughout any behaviour change model used in society (Meinel et al., 2011). Second, the NP is transferable and can address a wide range of behavioural problems in any context. Third, as the NP encourages participatory design, which means the solutions remain user-focused, practically implementable and known to drive enthusiasm and positive outcomes (Akkerman et al., 2015). Fourth, the NP is a constantly iterating process, in which learning from old settings can be implemented again in new settings. For example, during the *Ideate* stage the guidance to participants for the creation of ideas is unstructured, where various techniques can be trialled in future, such as *brainstorming*, *storyboarding*, and *bodystorming* (Dam & Siang, 2018). This trial may help to streamline and improve the number of usable ideas for the following stages. In this way, the NP is a useful tool for practitioners looking to encourage a behaviour change which can be updated and built upon in future.

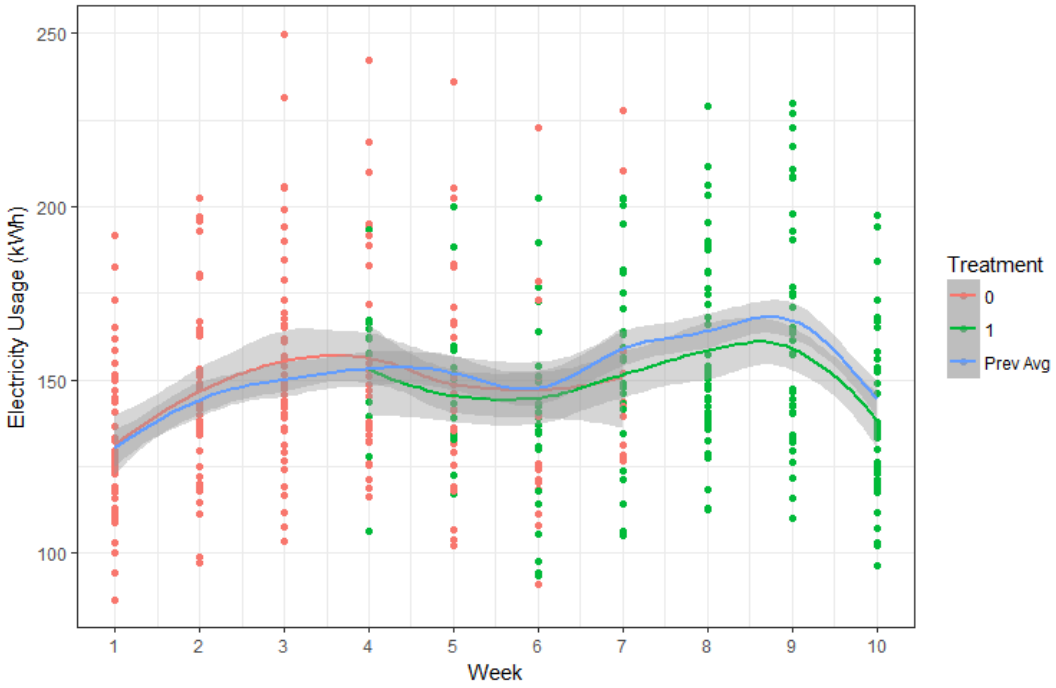

Figure 3. Electricity usage by flat, per week, over the course of the trial. The control (red line) begins above the previous average (blue line). When the intervention is in place (green line), a drop below the previous average appears and remains thereafter. We see spill over effects from the introduction of the energy feedback reports to the control of other blocks in weeks 4-7, and explained by students in one block seeing reports of other blocks.

References

Akkerman, A., Sluiter, R., & Jansen, G. (2015). *Third European Company Survey: Direct and indirect employee participation*. Dublin: The European Foundation for the Improvement of Living and Working Conditions (Eurofound). doi: 10.2806/771155

Allen, M. R., Dube, O. P., Solecki, W., Aragón–Durand, F., Cramer, W., Humphreys, S., Kainuma, M., Kala, J., Mahowald, N., Mulugetta, Y., Perez, R., Wairiu, M., & Zickfeld, K. (2018). Framing and Context. In: *Global warming of 1.5°C. An Intergovernmental Panel on Climate Change Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., Zhai, P., Pörtner, H. O., Roberts, D., Skea, J., Shukla, P.R., Pirani, A., Moufouma-Okia, W., Péan, C., Pidcock, R., Connors, S., Matthews, J. B. R., Chen, Y., Zhou, X., Gomis, M. I., Lonnoy, E., Maycock, T., Tignor, M., & Waterfield, T. (eds.)]. In Press. Retrieved January 25, 2018, from

https://www.ipcc.ch/site/assets/uploads/sites/2/2018/11/SR15_Chapter1_Low_Res.pdf
Allcott, H. (2011). Social norms and energy conservation. *Journal of Public Economics*, *95*, 1082–1095. doi: 10.1016/j.jpubeco.2011.03.003
Allcott, H., & Rogers, T. (2014). The Short-Run and Long-Run Effects of Behavioural Interventions: Experimental Evidence from Energy Conservation. *The American Economic Review*, *104*(10), 3003–3037. doi: 10.1257/aer.104.10.3003
Andor, M., & Fels, K. (2018). Behavioural economics and energy conservation – A systematic review of non-price interventions and their causal effects. *Ecological Economics*, *148*(January), 178–210. doi: 10.1016/j.ecolecon.2018.01.018
Ayres, I., Raseman, S., & Shih, A. (2013). Evidence from Two Large Field Experiments that Peer Comparison Feedback Can Reduce Residential Energy Usage. *Journal of Law, Economics, and Organization*, *29*(5), 992–1022. doi: 10.1093/jleo/ews020
Baumeister, R., Bratslavsky, E., Muraven, M., & Tice, D. (1998). Ego depletion: Is the active self a limited resource? *Journal of Personality & Social Psychology*, *74*, 1252–1265. doi: 10.1037/0022-3514.74.5.1252
Behavioural Insights Team. (2017). *The Behavioural Insights Team Update Report 2016-17*. London.
Boardman, B. (2007). Examining the carbon agenda via the 40% House scenario. *Building Research & Information*, *35*(4), 363-378. doi: 10.1080/09613210701238276
Bone, E., Whitmarsh, L., Agombar, J., & Waterman, H. (2016). *Switch on to 'Switching Off': Innovative approaches for achieving energy-efficient behaviours in Universities*. NUS Services. Defra, London.
Bødker, S (1996). Creating conditions for participation: Conflicts and resources in systems design. *Human Computer Interaction*. 11 (3): 215–236. doi: 10.1207/s15327051hci1103_2
Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. doi: 10.1191/1478088706qp063oa
Buchanan, R. (1992). Wicked Problems in Design Thinking. *Design Issues*, *8*(2), 5–21. doi: 10.2307/1511637
Campbell-Arvai, V., Arvai, J., & Kalof, L. (2014). Motivating sustainable food choices: The role of nudges, value orientation, and information provision. *Environment and Behaviour*, *46*(4), 453-475. doi: 10.1177/0013916512469099
Cotton, D., Shiel, C., & Paço, A. (2016). Energy saving on campus: A comparison of students' attitudes and reported behaviours in the UK and Portugal. *Journal of Cleaner Production*, *129*, 586–595. doi: 10.1016/j.jclepro.2016.03.136
Dam, R., & Siang, T. (2018). Introduction to the Essential Ideation Techniques which are at the Heart of Design Thinking. Retrieved April 4, 2018, from https://www.interaction-design.org/literature/article/introduction-to-the-essential-ideation-techniques-which-are-the-heart-of-design-thinking
Dolan, P., Hallsworth, M., Halpern, D., King, D., Metcalfe, R., & Vlaev, I. (2012). Influencing behaviour: The MINDSPACE way. *Journal of Economic Psychology*, *33*(1), 264–277. doi: 10.1016/j.joep.2011.10.009
Emeakaroha, A., Ang, C. S., Yan, Y., & Hopthrow, T. (2014). Integrating persuasive technology with energy delegates for energy conservation and carbon emission reduction in a university campus. *Energy*, *76*, 357–374. doi: 10.1016/j.energy.2014.08.027
European Environment Agency. (2013). *Achieving energy efficiency through behaviour change: What does it take? Luxembourg: Publications Office of the European Union, 2013*. doi: 10.2800/49941
Fielding, K. S., Thompson, A., Louis, W. R., & Warren, C. (2010). *Environmental sustainability: understanding the attitudes and behaviour of Australian households* AHURI Final Report No. 152. Melbourne: Australian Housing and Urban Research Institute. Retrieved April 4, 2018, from https://www.ahuri.edu.au/__data/assets/pdf_file/0014/2237/AHURI_Final_Report_No152_Environmental_sustainability_understanding_the_attitudes_and_behaviour_of_Australian_households.pdf
Firth, S. K., Lomas, K. J., & Wright, A. J. (2010). Targeting household energy-efficiency measures using sensitivity analysis. *Building Research & Information*, *38*(1), 25-41. doi: 10.1080/09613210903236706
Halpern, D. (2015). *Inside the Nudge Unit:* London: WH Allen.
Heyman, J., & Ariely, D. (2004). Effort for payment - A tale of two markets. *Psychological Science*, *15*(11), 787–793. doi: 10.1111/j.0956-7976.2004.00757.x
Kahneman, D. & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*. *47*(2), 263. doi:10.2307/1914185.
Karlin, B., Zinger, J. F., & Ford, R. (2015). The effects of feedback on energy conservation: A meta-analysis. *Psychological Bulletin*, *141*(6), 1205–1227. doi: 10.1037/a0039650
Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behaviour? Environmental Education Research, 8(3), 239-260. doi:10.1080/13504620220145401
Lewis, A., & Brandon, G. (1999). Reducing Household Energy Consumption: A Qualitative and Quantitative Field Study. *Journal of Environmental Psychology*, 75–85. doi: 10.1006/jevp.1998.0105
Lourenço, J. S., Ciriolo, E., Almeida, S. R., & Troussard, X. (2016). *Behavioural Insights Applied to Policy:*

European Report 2016. EUR 27726 EN. doi: 10.2760/903938
Maslin, M., Austin, P., Dickson, A., Murlis, J., & Owen, M., & Panizzo, V. (2019). Audit of UK Greenhouse Gas emissions to 2020: Will current Government policies achieve significant reductions?. *UCL Environment Institute: Environment Policy Report Number 2007:01*. Retrieved April 4, 2018, from https://www.researchgate.net/publication/251225767_Audit_of_UK_Greenhouse_Gas_emissions_to_2020_will_current_Government_policies_achieve_significant_reductions.
Meinel, C., Leifer, L., & Plattner, H. (2011). *Design Thinking: Understand - Improve - Apply*. Berlin: Springer-Verlag. doi: 10.1007/978-3-642-13757-0
Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, *6*(1), 42. doi: 10.1186/1748-5908-6-42
National Union of Students - UK. (2017). *Students Achieving Valuable Energy Savings: Project Report 2014-17*.
Parkinson, J. A., Eccles, K. E., & Goodman, A. (2014). Positive impact by design: The Wales Centre for Behaviour Change. *The Journal of Positive Psychology*, *9*(6), 517-522. doi: 10.1080/17439760.2014.936965
Parviainen, E., Lagerstöm, E., & Hansen, P. (2016, July). Compost table: participatory design towards sustainability. In *Proceedings of the 30th International BCS Human Computer Interaction Conference: Companion Volume* (p. 16). BCS Learning & Development Ltd. doi: 10.14236/ewic/HCI2016.63
Peschiera, G., Taylor, J. E., & Siegel, J. A. (2010). Response-relapse patterns of building occupant electricity consumption following exposure to personal, contextualized and occupant peer network utilization data. *Energy and Buildings*, *42*(8), 1329–1336. doi: 10.1016/j.enbuild.2010.03.001
Pieters, M & Jansen, S. (2017). *The 7 principles of complete co-creation*. Amsterdam: BIS Publishers. p. 15. ISBN 978 90 6369 473 9.
Reyes, L. F. M. (2012). *Participatory design through social media: The translation of a future workshop* (Master's thesis). Retrieved February 22, 2019, from http://urn.nb.no/URN:NBN:no-31861
Ritchie, J., Lewis, J., Nicholls, C. M., & Ormston, R. (2014). *Qualitative Research Practice* (2nd ed.). London: Sage.
Saghai, Y. (2013). Salvaging the concept of nudge. *Journal of Medical Ethics*. *39*, 487-493. doi: 10.1136/medethics-2012-100727
Sheppard, B., Edson, J., & Kouyoumjian, G., (2017). More than a feeling: Ten design practices to deliver business value. *McKinsey Design*, (December), 9. Retrieved April 4, 2018, from https://www.mckinsey.com/business-functions/mckinsey-design/our-insights/more-than-a-feeling-ten-design-practices-to-deliver-business-value
Simon, H. A. (1996). *The sciences of the artificial, (third edition)*. *Computers & Mathematics with Applications* (Vol. 33). Cambridge: MIT Press. doi: 10.1016/S0898-1221(97)82941-0
Staddon, S. C., Cycil, C., Goulden, M., Leygue, C., & Spence, A. (2016). Intervening to change behaviour and save energy in the workplace: A systematic review of available evidence. *Energy Research and Social Science*, *17*, 30–51. doi: 10.1016/j.erss.2016.03.027
Surowiecki, J. (2004). *The Wisdom of Crowds: why the many are smarter than the few and how collective wisdom shapes business, economies, societies, and nations*. New York: Doubleday & Co.
Szebeko, D., & Tan, L. (2010). Co-designing for society. *Academy of Management Journal*, 3(9), 580-590. doi:10.4066/AMJ.2010.378
Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health wealth and happiness*. New York: Penguin.
World Bank. (2015). *World Development Report 2015: Mind, society, and behaviour.* Washington, DC. doi: 10.1596/978-1-4648-0342-0