The PowerHouse: A Persuasive Computer Game Designed to Raise Awareness of Domestic Energy Consumption

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Abstract. Persuasive technologies can be useful to modify behaviors related to energy usage. In this paper, we present the PowerHouse a computer game designed to influence behaviors associated with energy use and promote an energy-aware lifestyle among teenagers. This prototype game aims to influence a set of target activities in the home using several persuasive techniques. Employing the format of a reality TV show (docu soap), the game informs implicitly and explicitly about various energy-efficient actions. We discuss our overall game design and its advantages and disadvantages in relation to the methods we have employed in the game.

1 Introduction

The increasing consumption of energy is a problem that affects the environment worldwide [1]. The rising energy prices – as a result of the demand – are also having far-reaching consequences on the global economy [2]. Governments throughout the world are promoting the development of renewable energy sources and various international agreements aim to restrain emissions, for example, the release of CO^2. However, our *personal energy consumption behavior* remains relatively unchallenged.

Over the last 30 years, the electricity usage has increased about 50 percent [3] and there is a potential to cut consumption significantly in the domestic environment [4]. A challenge in this work is to increase peoples' knowledge about how to use energy efficiently in *relation to everyday activities* in the home.

Our research aims to explore new designs and approaches that can be employed to raise awareness of energy-related issues and change the use patterns. We believe that persuasive technologies – particularly computer games – can be useful to reach out and change the patterns of energy usage. People are increasingly playing computer games and this can be seen in the overall world sales of gaming consoles and entertainment software packages that peaked 7.3 billion dollars in 2004 [5]. Interestingly, computer games seem to be particularly powerful to influence decision-making and influence behavior. According to Fogg, computer games have a natural persuasive power and they implement various kinds of persuasive approaches to create a high-quality gaming experience [6]. Games and media specifically designed to influence behavior have also

been developed for various domains such as healthcare [7,8] and military applications [9]. However, few games have been developed specifically to target energy usage behaviors.

In this paper, we present the PowerHouse, a computer game developed to motivate young people to increase their interest in energy-related issues and promote efficient use of energy in their homes. The game employs a set of persuasive technology methods presented by Fogg [6] and others. We describe the overall game design, particularly it's embedded persuasive strategies and finally we conclude the paper with a general discussion on tradeoffs between persuasion and gaming experience.

2   Persuasive Technology and Computer Games

The fact that people play computer games regularly has drawn interest from both researchers and public authorities and they are now exploring if computer games can be a new approach to inform the public. Early edutainment approaches on the Internet teach visitors about certain subjects, for example how to prevent a cold or how it is to be a refugee. These games are often humoristic and they seek to make the formal information appear less burdensome. We will now discuss a set of methods and theories that we have employed in the design of the PowerHouse.

One of the persuasive powers of games originate from that they are *simulated environments*. Within the micro-world of a game users can safely explore cause-and-effect relations and uncover new behaviors. Simulation can be used to convince in different ways, for example, to direct execution to specific tasks and let people rehearse target behaviors (learning loop) [ibid.]. This method has for a long time been employed in the flight industry in their simulators. Moreover, it is employed in the game the Sims [10] where the players create and guide a set of characters in a simulated world.

Operant conditioning is a well-known and controversial method that applies positive reinforcements to change someone's behavior [11]. It can also be used negatively, that is, punishing instead of rewarding, but this method can be seen to be unethical and will not be a part of this discussion. Operant conditioning is used frequently in computer games, for example, by means of positive sound and visual reinforcements. Accumulated points, level progressions, high-score lists and game comparisons can also be seen as operant conditioning approaches.

Cognitive and social scientists have studied memory and persuasion on a theoretical level and this research also applies to game design. For example, according to Chaiken and colleagues are there two principal modes of persuasion depending on how people process information; *systemic and heuristic cognitive processing* [12, c.f., 13]. Deep systemic processing takes place when subjects are involved actively in a discussion and scrutinize arguments and facts logically. This mode seems to strengthen attitude-behavior correspondences and prolong beliefs over time [14]. In the latter mode of thinking people are not examining deeply the core issues, but are instead influenced by superficial cues such as physical attractiveness, trustworthiness, and peer group expectations.

Naturally, developers could take the dual process persuasion model as a starting point and incorporate events in the game that require both local thinking and more

superficial cues such as having attractive characters. However, a general difficulty – from a design point of view – is to entail deeper cognitive processing that not impairs the gaming experience. One approach could be to use heuristic cues to direct behavior and attention to issues that require logical thinking and reflection. We will return to this difficult issue in the reminder of the paper.

Related to the above issue are peoples' needs to fit in socially. Creating archetypical characters that the gamers can identify with makes it easier to send the message. For example, in the edutainment game *Kalas med Rut & Knut* (eng., Party with Rut and Knut) the designers have attempted to match the personalities of the characters to the target group, that is, kids between 5 and 8 of age [15]. In this game, players follow other kids and play with them to learn basic mathematical and language skills in relation to everyday activities in the home. Moreover, another approach game designers can employ is to let gamers design their own characters.

Nonetheless, it's likely that the game will improve its persuasive power if it has an attractive user interface, physically attractive characters and match the identification processes of the target group.

Finally, it can be beneficial to *combine several methods* in a computer game to further reinforce learning and persuasion. Let us exemplify; people that are in a good mood are more easily persuaded [16,17]. Moreover, according to Fogg, intervening at the right time is imperative when attempting to influence someone [6]. In a computer game one can merge these two approaches. One way to do this is to keep the player in a good mode, for example employing humor and praise, and subsequently provide suggestions and hints – that is, provide the message we want to convey – to the user just before he or she is going to perform a task.

In the remainder of the paper, we shall discuss how we combined humor, timing and praise in a persuasive loop to influence the gaming actions. However, before we discuss the actual persuasive methods in our game, let us motivate the design.

3   Survey

Preceding the actual game design, we conducted a pre-study to gain more knowledge about our target group – teenagers between 13 and 18 of age. This survey was carried out to learn more about their *attitudes* towards saving energy and gain an *understanding* on their knowledge of energy use in the home. The overall aim of the study was to produce a baseline of which we later can measure changes in attitude and comprehension after subjects have played our game.

A questionnaire was administered to 100 teenagers – both male and female. It consisted of two questions that targeted attitudes towards energy and the environment, and the following questions asked the subjects to rate – on a ten-point scale – how much energy different activities in the home consume.

As we have depicted in Figure 1, about 70% of the teenagers saw saving energy to be important and only 7% considered it to be unimportant. The difference between boys and girls attitudes is negligible.

Table 1 shows a representation of the subjects understanding of domestic energy usage. The domestic activities are ordered according to the proportion of correct
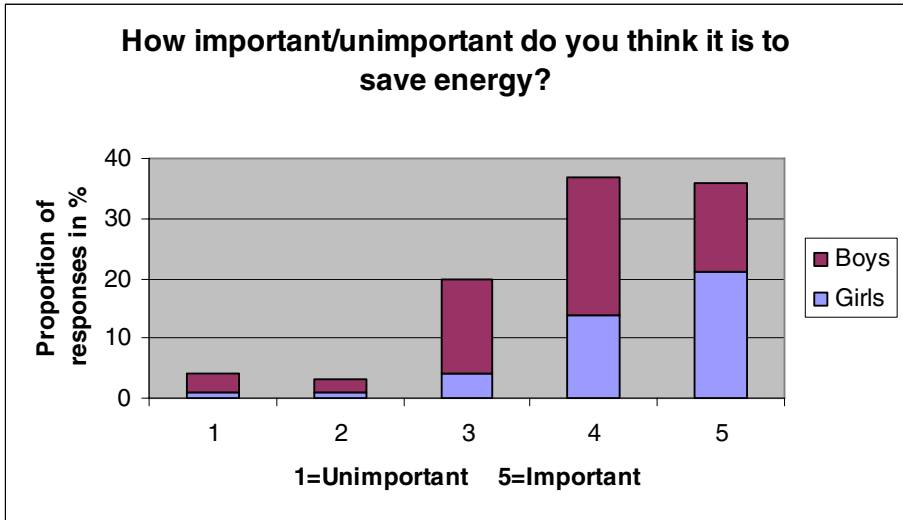
How important/unimportant do you think it is to save energy?

Fig. 1. Attitudes toward saving energy by teenage boys and girls aged between 13 and 18

Table 1. Proportion of correct responses for questions on how much energy different activities in the home consume

Domestic activity	Intervals on 10-point scale judged as correct	Proportion of correct responses in %
Run a dishwasher for 1.5 hours	4-7	71
Heat food in an ordinary electric oven for 20 minutes	4-7	63
Run a washing machine for 2 hours	4-7	57
Energy saving light bulb burning for 5 hours	0-2	55
Using the computer for 2 hours	0-3	45
Heat food in micro oven for 3 minutes	0-3	35
60 W light bulb burning for 5 hours	0-3	31
Playing music on stereo for 3 hours	0-3	19
Watching TV for 3 hours	0-3	16
Take a hot shower for 10 minutes	8-10	13
Take a bath for 30 minutes	8-10	12

responses and do not correspond directly to the arrangement in the questionnaire. The answers were interpreted according to a relative scale and hermeneutic understanding of domestic energy consumption.

We found that the teenagers' knowledge on how much energy is being used by the different activities in the home is generally quite low. Only for four out of the eleven

activities was the correct response rate over 50%. Particularly notable is that correct responses were very few for activities extremely common for teenagers, such as watching TV and taking a shower.

To conclude, our pre-study indicates that although teenagers' in general thinks it is important to save energy, they lack knowledge on how much energy different activities in the home consume. Thus, a mismatch seems to exist between attitude and actual behavior. However, if they learn how they can contribute and save energy, we could bridge this mismatch. Accordingly, we decided to design a persuasive game with the objective to help players save energy – particularly – elucidate the relationships between energy consumption of ordinary activities in the home.

4   The PowerHouse

The PowerHouse is a computer game designed to motivate teenagers to increase their interest in energy-related issues and promote efficient energy use in their homes. To appeal to this particular group, we decided to adopt the popular television format of a

Fig. 2. In the PowerHouse, the game player manages a simulated domestic environment with seven characters. The meters in the lower pane displays a specific character's mental and physical state. In the upper right corner are the money and power meters that show the accumulated points and how much energy is being consumed.

reality TV show (docu soap) where people live together in a closed house (e.g., Big Brother). In the PowerHouse, a player manages a simulated domestic environment with seven characters. Figure 2 shows the environment in which the characters live.

Similar to the game the Sims [10], our characters have different personalities and basic needs and the player must meet these wishes such as letting them eat and sleep. The objective is to keep the residents within the house as long as possible and nourishing the characters and letting them do things they like. If a character gets annoyed he/she leaves the house eventually.

Almost all activities in the game require electrical energy such as taking a shower, washing clothes, cook, and watch television. Hence, the objective is to direct the characters to perform the appropriate energy-efficient actions. The outcome of the proper actions is income in terms of virtual money and better game control. The money can be used to buy different artifacts and services so that the inhabitants feel good in the short term, but also to improve the energy efficiency of the house, for example, buying an energy-efficient refrigerator. Thus, the player has to balance the available resources (short and long term choices) and aim towards a more sustainable lifestyle. To be able to motivate and influence the game players and modify their behaviours towards a more energy-efficient lifestyle, we have explicitly applied several techniques and we will discuss these methods in the following section.

5   Persuasive Methods in the PowerHouse

The PowerHouse can be seen as a simulated environment that models the energy consumption of different activities in a home. If someone is taking a long hot shower the energy meter will show this immediately and the money meter will drop. Moreover, since the player can explore safely the cause-and-effect relationships of different mundane activities and get instant feedback, we expect the players to try out different behaviours and configurations several times and reinforce the learning. For example, we hope that the players will perceive the differences in outcome of both the short- and long-term behaviours, such as what happens if the shower is changed to a luxury massage shower.

As we have discussed earlier, the persuasive power of a game could be improved with a nice-looking user interface and attractive characters that users can identify with. For this reason, we have involved the users early in the design process. In several design meetings, we discussed the game scenario and the teenagers provided us with a set of archetypical characters and an outline for the graphic design. Examples of the characters are Tyra – the feministic girl who is dressed in black and doesn't eat meat – and Emile – the football player who wants to play in the Italian football league and showers twice a day.

Operant conditioning is a crucial component in almost every computer game. In the PowerHouse, we have applied different kinds of conditioning. Sound and visual effects attuned to the target group have been implemented to motivate users to stay at the computer. Meters state how much time that is left of the game together with the players' accumulated points (money). Moreover, a high-score list was implemented so that the players can compare their results, and this will hopefully encourage them to compete. The player also gets direct feedback in terms of bonus points immediately

after executing a correct behavior in the game, for example when the microwave is used instead of the ordinary electrical oven. Naturally, the goal is to encourage players and direct them to perform the right actions.

Intervening at the right time has been discussed earlier in the paper. In the PowerHouse, players are provided suggestions before task completion. These suggestions are provided by a special character that has the role of a TV host (c.f., the TV show Big Brother). The host helps players and provides special hints that – if followed by the player – boost up the points. A typical case is when a character is directed to go to the kitchen. The TV anchor says: "well…if you use the dishwasher – and not doing the dishes under flowing water – you will get some extra points". Additionally, the TV host persuades through praise, for example, after the gamer has accomplishing a task appropriately.

More generally, we have aimed to implement a persuasive timing loop to reinforce our message. Here, the attempt is to incorporate several elements such as timing, conditioning and persuading through praise that are being distributed over time. For example, if the player is taking his character to the washing machine the TV-host will give him some explicit hints (timing). This is exemplified in Figure 3.

If the player follows the advice we implicitly plant some information (cool sound effect and/or message) followed by some additional bonus points (conditioning/reward).

Fig. 3. If a player is taking a character to the laundry the TV host provides explicit hints on how to reduce the energy consumption of this activity

The player is now hopefully in a good mood and hence disposed for additional persuasion and we follow up this by some implicit or explicit message. Finally, the TV-host will praise the player or provide a general hint (praise/reward).

Naturally, successive strategies such as these are difficult to employ so that they not become obtrusive and impact the gaming experience negatively. We will discuss this in the following section. Figure 4 shows the concept of the persuasive timing loop of the PowerHouse.
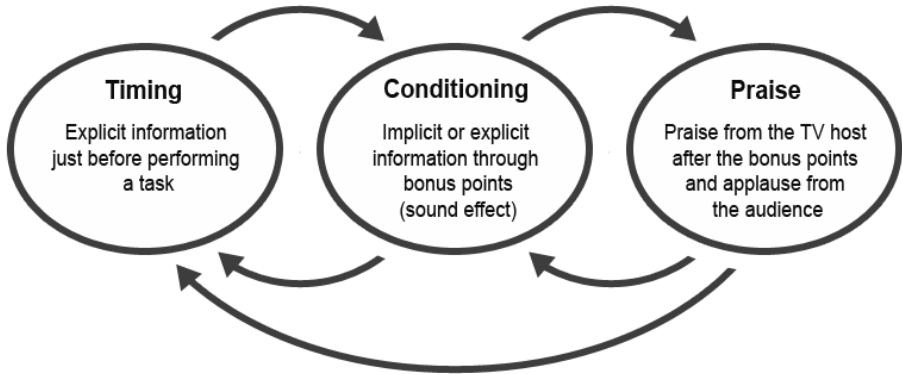

Fig. 4. The persuasive timing loop employed in the PowerHouse

6   Discussion

The objective of our game design was to increase players' interest in energy-related issues and improve their knowledge on energy-consuming activities in the home. We are now setting up a study to evaluate the game and the efficacy of its integrated persuasive methods. Of particular interest is to see how it affects attitudes and understanding of our subjects. In this study, 20 teenagers between 13-15 years will be asked to play the PowerHouse. After the session they will fill out the same questionnaire we employed in the baseline survey. They will also be interviewed about the game play experience. In this way we expect to see a differentiation among the baseline study and game player groups respectively, particularly in terms of increased understanding of how much energy different activities in the home consume. Moreover, we expect to gain knowledge on how they conceived their gaming.

A pronounced challenge for edutainment game designers is to balance the tradeoff between persuasive methods/information and the overall gaming experience. Too much praise and explicit information can naturally impair the gaming experience negatively. The experienced game designers in our team also raised this question early in the project. They wanted to avoid explicit information such as information and pop-up boxes.

To understand this tradeoff, we have designed the game so that we can explore the effectiveness of the different embedded persuasive techniques in greater detail. For example, we can modify the level of praise, turn the program host and his hints on and off, and also provide more or less explicit information upfront. Thus, the game can be seen as a platform where we can evaluate more generally the effective persuasive methods for game design.

7   Summary and Conclusion

In this paper, we have presented a computer game designed to influence everyday behaviors of energy-consuming activities in the home. The game employs several implicit and explicit techniques to reinforce learning about how to save domestic energy without being obtrusive. We are currently fine-tuning the game platform with its configurable persuasive methods with the goal to balance the explicit persuasive approach and maintain a good gaming experience. Subsequent empirical studies will tell if our approach is successful to learn about energy and if it can modify energy-related behaviours in the home.

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